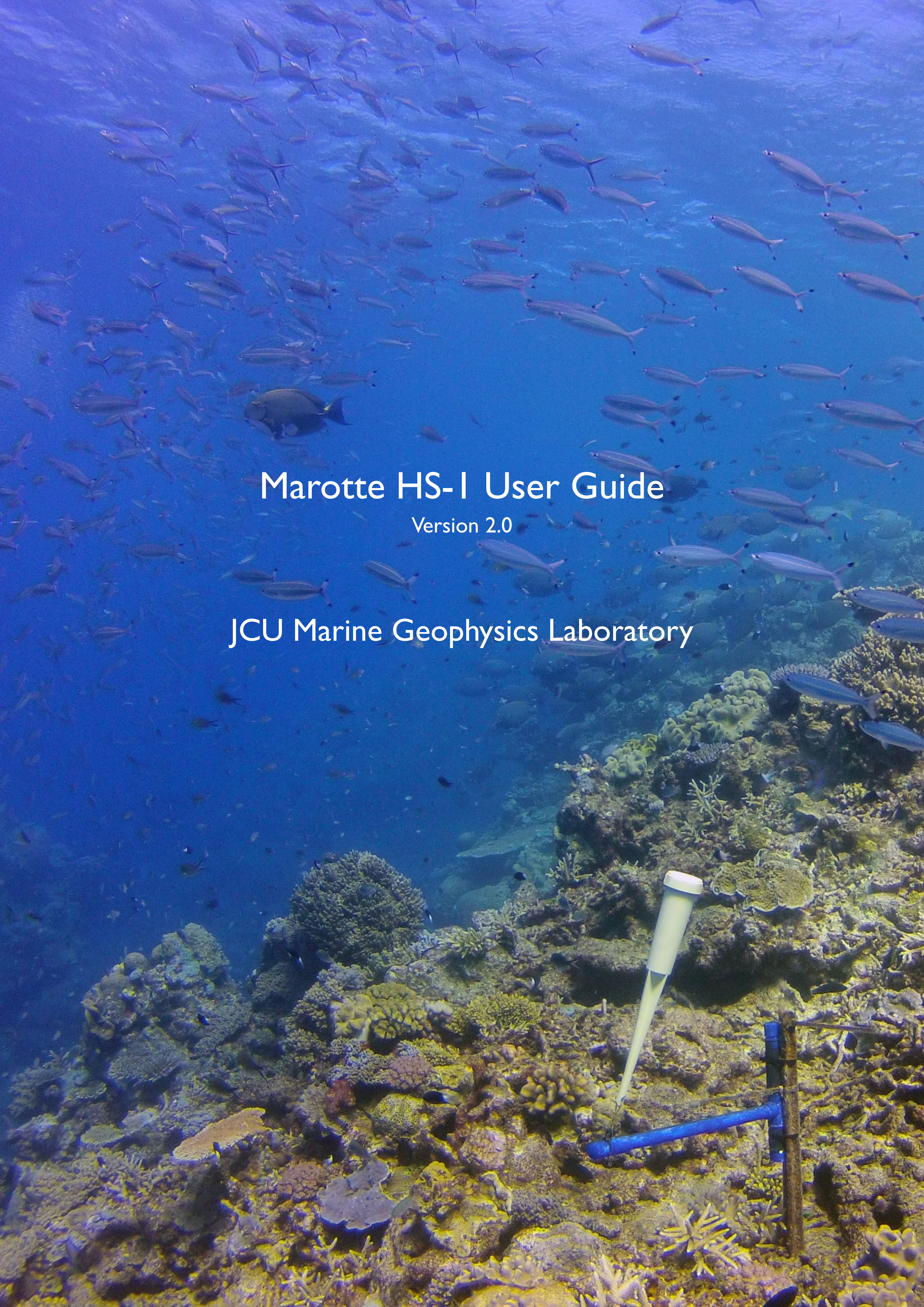


Marotte HS-1 User Guide

Version 2.0

JCU Marine Geophysics Laboratory

Chapter 1
Getting started

1.1 Introduction

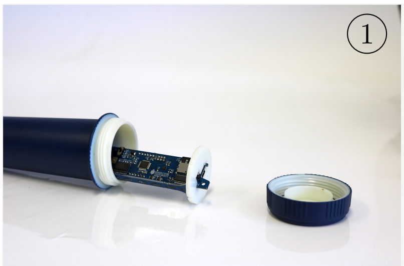
The *Marotte HS* is a drag-tilt current meter developed and manufactured by the Marine Geophysics Laboratory at James Cook University. The manual describes how to set up and deploy the instrument, and how to retrieve and process the data into current speed and direction. This chapter contains brief instructions for the most common operations.

To set up the instrument, the following items are required:

- *Marotte HS* instrument
- 2 × AA batteries (may be supplied)
- USB A to Mini B cable (supplied)
- Micro SD card - Lexar or Verbatim brand (supplied)
- Micro SD to SD card adapter (supplied)
- Windows or Mac computer
- *MarotteHSConfig* software

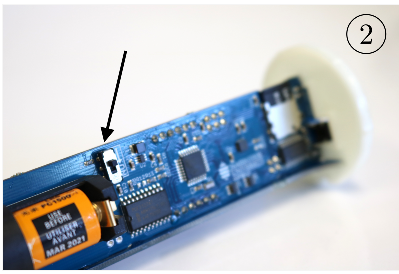
The *MarotteHSConfig* software can be downloaded from:
`http://www.marinegeophysics.com.au/current-meter/marotte-hs`

1.2 Set up Logger



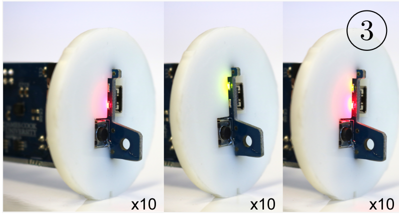
1

Unscrew the lid of the current meter and remove the logger inside.



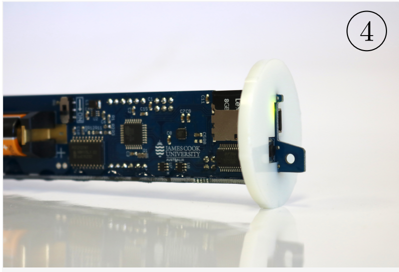
2

If the logger was supplied with batteries, simply switch the on-board micro switch to the On position.
Otherwise, insert two alkaline AA cell batteries and switch the device ON, taking care that the polarity is correct. Note: when inserting new batteries, a magnetic calibration is required. See Section 3.3.2 for the calibration procedure.



As soon as the batteries are inserted, the LEDs at the top of the logger will flash with the startup sequence:

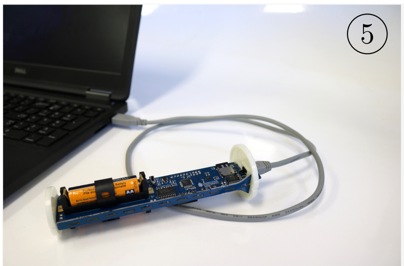
- 10 rapid red flashes
- 10 rapid green flashes
- 10 alternating red and green flashes



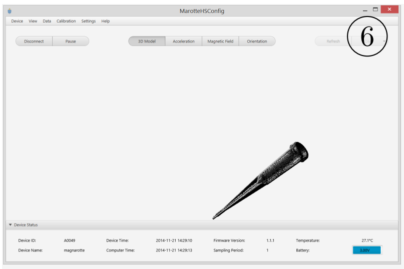
The LEDs will then flash twice per second:

- Green flashing: A Micro SD card is inserted, the instrument is logging.
- Red flashing: No micro SD car is inserted, the instrument is not logging.

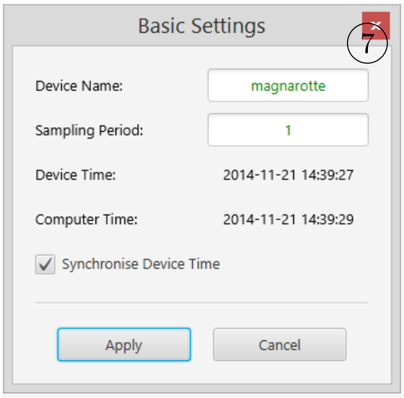
The instrument will always log if an SD card is inserted unless a delayed start has been set up.
After 10 seconds the LEDs will turn off to save power. The logging status of the intrument can be checked at any time by pressing the button, located at the top of the logger, for half a second to re-enable the LEDs for a further 10 seconds.



Connect the logger to a computer with the **MarotteHSConfig** software installed, using the supplied USB cable.
If this is the first time a logger has been connected, the drivers will install. On Windows 7, Windows 8 and Apple OSX, this process should be automatic. On Windows XP, the FTDI serial drivers need to be installed manually; they can be downloaded from: **http://www.ftdichip.com/Drivers/VCP.htm**



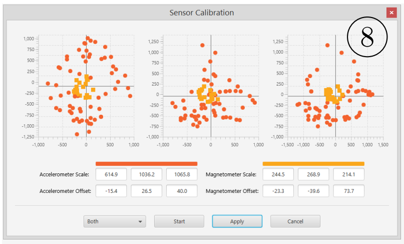
Open *MarotteHSConfig*, select the correct COM port of the instrument, and press *Connect*.
The main screen will show a 3D model of the instrument that moves as you move the instrument (except for Windows XP). The *Acceleration*, *Magnetic Field*, and *Orientation* tabs show real-time sensor readings.
For more information see Section 3.1.2



From the menu bar, select *Settings* → *Basic Settings* to open the Basic Settings dialog.

- Give the instrument a name, such as the deployment location.
- Set the sampling period (in seconds). It is safe to leave the sampling rate at 1 (second) as the data can be sub-sampled over a longer period during processing. Increasing the sampling period increases the battery life (see Section 2.4.1).
- Leave *Synchronise Device Time* checked to sync the instrument time with the computer time.

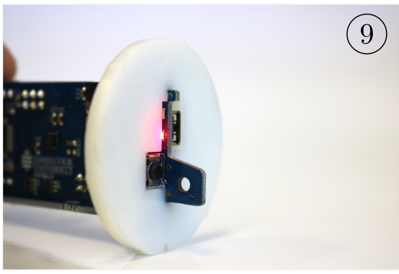
Click *Apply* to save the settings.



If new batteries have been inserted, the magnetometer must be re-calibrated. This operation is similar to the recalibration often required when using a smart phone compass. From the menu bar, select *Calibration* → *Perform Sensor Calibration* to open the sensor calibration settings dialog.

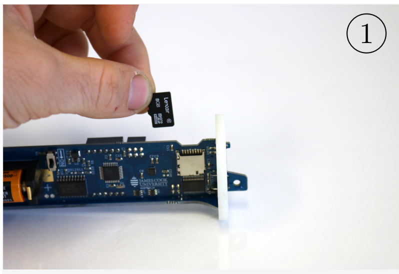
- Move to a location away from large iron objects such as desks with metal.
- Ensure *Magnetometer* is selected in the drop-down box and click *Start*.
- Twist and rotate the logger in the one spot to get a range of orientations over at least 30 seconds.
- Once the calibration values have stablised, click *Stop*.

Click *Apply* to save the settings.



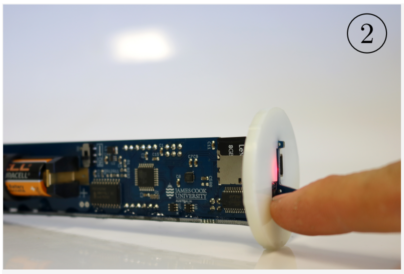
Setup is complete.
Click *Disconnect* and unplug the logger from the computer.

1.3 Start Logging



1

Insert the supplied micro SD card into the logger. For long battery life use Lexar or Verbatim brand micro SD cards.
The LEDs will display the startup sequence, alternately flashing red and green.
The green LED should then start flashing, indicating that logging has started. If the red LED starts flashing or the startup sequence repeats continuously, try removing the SD card and reinserting it after 5 seconds.

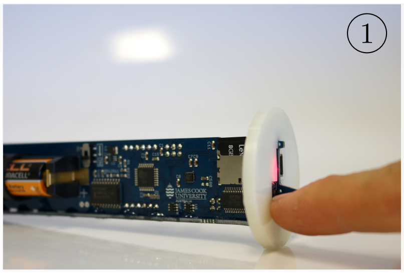


2

After 10 seconds the LEDs will turn off to save power. However, the instrument is still logging.
To see the logging status, press the button for half a second to turn on the LEDs

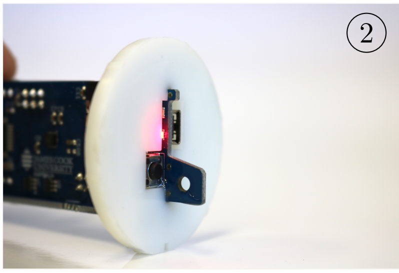
- Green LED flashing: Instrument is logging.
- Red LED flashing: Instrument is not logging, micro SD card is not present.

1.4 Start A New Log File



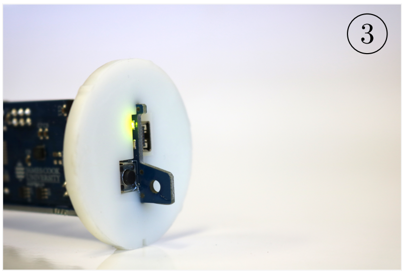
1

Starting a new log file is often performed just before deployment.
Finalise the running log file by holding down the button (about four seconds) until the red LED gives two long flashes.



2

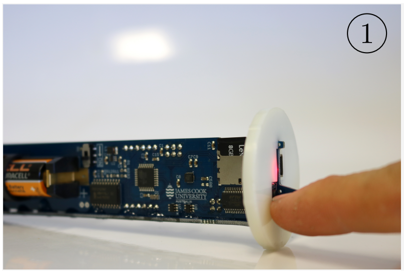
The red LED will begin flashing twice per second. **Do not** remove the micro SD card.



3

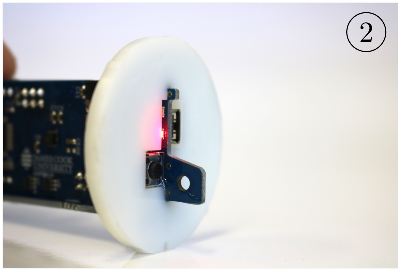
After 15 seconds logging will restart with a new log file created, as indicated by the LEDs flashing the startup sequence then the green LED twice per second.

1.5 Stop Logging



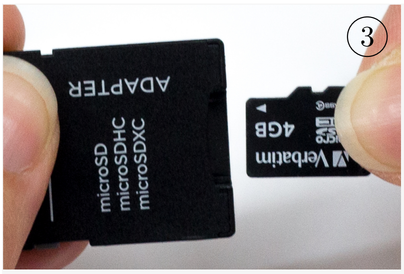
1

Logging must be stopped before retrieving the log files from the micro SD card.
Finalise the log file by holding down the button (about four seconds) until the red LED gives two long flashes.



2

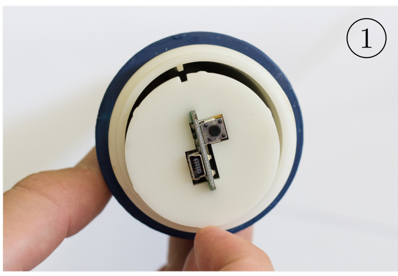
The red LED will begin flashing twice per second. Remove the micro SD card within 15 seconds, otherwise logging will restart.



3

Insert the micro SD card into the SD card adapter and then into the computer. Copy the log files to the computer hard drive for processing later.
Files are stored in folders according to the date on which they were generated and are named according to the instrument serial number and the record number. The latest files are usually the largest numbered files.

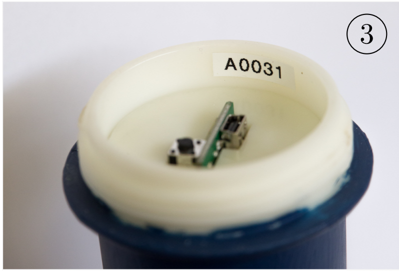
1.6 Before Deployment



1

Insert the logger into the enclosure, aligning the cutout of the logger with the ridge on the inside of the enclosure.

2 Check the o-ring for any debris that could prevent a good seal.



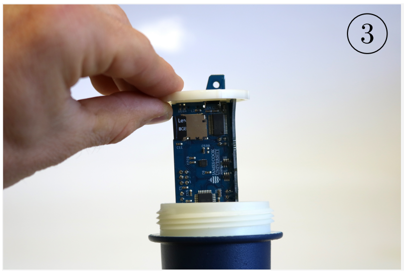
3 Check the top surface of the enclosure for any grooves or damage that could prevent a good seal. Lubricate the top surface with some o-ring grease if necessary.

4 Screw on the lid and hand-tighten.

1.7 After Deployment

1 Dry the logger, especially around the cap.

2 Hold the instrument vertically so that any water around the cap drains. Unscrew the cap and place it with the bottom facing downwards so that no water gets inside it.



Remove the logger and dry the inside of the enclosure if any water dripped in there when removing the lid.

Chapter 2
Instrument

2.1 Drag-Tilt Theory

2.1.1 Overview

The *Marotte HS* is a drag-tilt current meter. The instrument consists of a buoyant enclosure containing an electronic logger. It is tethered to a stationary object, such as a stand, star picket (fence post) or weight, where it measures current velocity at a fixed point in the water column.

The buoyancy force causes the instrument to float directly upwards when there is no current. When there is current, the movement of the water exerts a drag force on the instrument, tilting it over until the buoyancy, drag and tether forces are balanced. The amount of tilt is proportional to the speed of the water. The logger records the tilt angle using an accelerometer, and the tilt direction using a magnetometer, which is converted to current speed and direction in post-processing using a pre-defined tilt-to-speed calibration curve.

2.1.2 Drag force

The drag force, F_D, can be described by the relationship,

$$F_D = \frac{1}{2}\rho v^2 C_D A \tag{2.1}$$

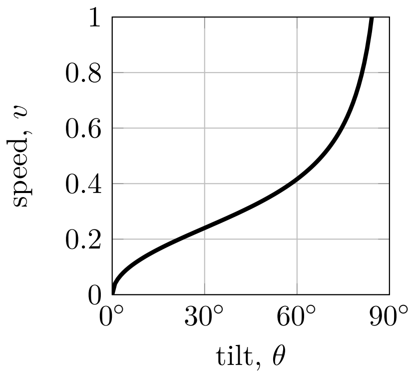
where F_D is the drag force, ρ is the density of the water, v is the current speed, A is the cross-sectional area of the instrument perpendicular to the flow, and C_D is the drag coefficient.

The drag force, and thus current speed, is related to the tilt angle θ by

$$\theta = \tan^{-1}\frac{F_D}{F_B} \tag{2.2}$$

$$v = \sqrt{k\tan\theta} \tag{2.3}$$

$$k = \frac{2F_B}{\rho C_D A} \tag{2.4}$$



Assuming a constant area and drag-coefficient, and thus setting $k = 0.1$, the ideal relationship between tilt and speed looks like the figure on the right. Note that for tilt values near 0 and 90 degrees, a small change in tilt corresponds to a large change in speed. Drag-tilt current meters are therefore least accurate when the current is at very low or high speeds, with a sweet spot in the middle.

When current speeds are below 5cm/s, the *Marotte HS* measurements are inaccurate, and users must take this into consideration when analysing results.

2.1.3 Vortex Shedding

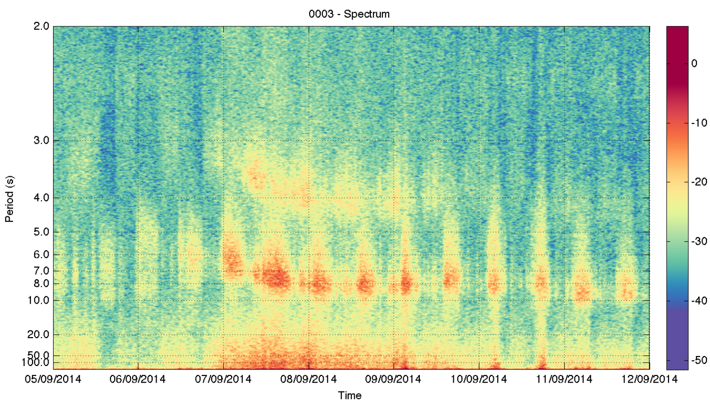
As current speed increases, the flow around the instrument stops being laminar and unstable vortices form behind the instrument. The vortices eventually 'shed' off which causes the instrument to oscillate in both the up-down and side-to-side directions. The period of these oscillations is generally between 0.5 and 3 seconds.

For general current measurements the results should be 'smoothed' to remove the effect of these oscillations. This can be done in processing using the *MarotteHSConfig* software. The effect of vortex shedding on speed measurement is shown in the following table. Errors were calculated from experimental data at the 90th percentile.

	Speed Range		
Averaging	< 0.1m/s	0.1 - 0.7m/s	> 0.7m/s
1s	< 0.02m/s	< 0.1m/s	< 0.14m/s
10s	< 0.02m/s	< 0.04m/s	< 0.06m/s
60s	< 0.02m/s	< 0.02m/s	< 0.02m/s

These results include other sources of turbulence and therefore overestimate the error. Actual values are lower.

To combat the effect of vortex shedding 'wobble', it is recommended that data be processed with at least 10 second smoothing. However, this does not preclude the instrument being used to measure high frequency events such as waves. Typically, the surge from waves has a much higher magnitude than wobble from vortex shedding. The image below shows a spectrogram created from the data of a *MarotteHS* processed with a 1 second sampling period (no averaging). A wave surge period of 8 seconds is clearly defined.



2.2 Sensors

The *Marotte HS* has three sensors: an accelerometer, a magnetometer, and a temperature sensor.

2.2.1 Accelerometer

The accelerometer is used to measure the tilt of the instrument. It records acceleration values along three orthogonal axes, $\{a_x, a_y, a_z\}$. In this case, the acceleration is not a change in velocity, but rather the force exerted due to gravity. The acceleration values therefore describe a 3D vector pointing in the direction of gravity relative to the reference frame of the sensor. For example, if the x axis of the accelerometer was pointing straight down, the acceleration vector would be $\{1, 0, 0\}$.

For best accuracy, the accelerometer is calibrated during manufacturing to remove any offsets and to make sure each axis has the same sensitivity. The accelerometer can be recalibrated using the *MarotteHSConfig* software, but this is **not recommended.** Please contact us if you believe a recalibration is necessary. See section 3.3.1 for the calibration procedure.

2.2.2 Zero Point

The axes of the accelerometer are never perfectly aligned with those of the instrument and the sensor itself has small offsets due to manufacturing. Therefore, **tilt is measured compared to a reference acceleration vector that corresponds to zero current**, called the zero point vector. The zero point vector is found by placing the instrument in perfectly still water at 25°C and measuring the acceleration vector. Tilt angle is then calculated as

$$\theta = \cos^{-1} \frac{\mathbf{a} \cdot \mathbf{a_0}}{\|\mathbf{a}\| \, \|\mathbf{a_0}\|} \tag{2.5}$$

where $\mathbf{a}$ is the current acceleration vector and $\mathbf{a_0}$ is the zero point vector. An incorrect zero point will offset the current speed by a fixed amount.

The zero point vector has already been obtained during manufacturing. However, the zero point can change due to extreme temperatures. If the instrument is being deployed in very cold or very warm water, a zero point calibration can be performed to give more accurate measurements. See Section 3.3.3 for instructions.

2.2.3 Magnetometer

The magnetometer is used to measure the earth's magnetic field. It records magnetic field values along three orthogonal axes $\{m_x, m_y, m_z\}$, and thus describes a 3D vector pointing towards magnetic north, relative to the reference frame of the sensor. The accelerometer is compared to the magnetic field vector to find the direction of instrument tilt.

When sensing the earth's magnetic field, be aware that it can be distorted by ferrous objects such as

- Instrument frames
- Star pickets (fence posts)
- Wreckage
- Other instruments
- **Batteries**

See Section 4.1.1 for more details about the effect of frames/anchors when deploying.

The magnetic field readings can also be affected by metal parts on the logger, in particular, **batteries**. *The magnetometer must therefore be calibrated whenever new batteries are inserted.* This includes if the batteries are removed and reinserted on opposite sides of the logger. The calibration procedure is similar to the figure 8 calibration that is often required on smart phones when using compass applications. Calibration takes approximately 1 minute and requires a computer with the *MarotteHSConfig* software. See Section 3.3.2 for instructions. For instruments supplied with batteries inserted, the magnetometer has already been calibrated for those particular batteries.

Note that if the calibration procedure is not performed, the processing software can attempt to estimate the calibration values from field data.

The magnetometer is not used to calculate speed, only direction. Thus, if the calibration is not performed, speed measurements will not be affected. Furthermore, a calibration can be performed post-deployment and the log files modified accordingly. See Section 3.3.2 for instructions.

2.2.4 Temperature Sensor

The temperature sensor is a thermistor type with ±0.2°C repeatability. It is glued to the bottom of the logger. Temperature readings are logged with every sample, but only **measured once every 5 minutes.** The temperature reading is a raw measurement of the thermistor resistance and can be converted into Celcius using the equation,

$$\text{Temperature } (^\circ\text{C}) = \big(1.129241 \times 10^{-3} + 2.341077 \times 10^{-4} \ln(t) \tag{2.6}$$

$$+\, 8.775468 \times 10^{-8} \ln(t)^3\big)^{-1} - 273.15 \tag{2.7}$$

$$\text{where } t = \frac{10000 \times \text{raw temp}}{1023 - \text{raw temp}} \tag{2.8}$$

This conversion is already taken care of in the *MarotteHSConfig* software when viewing data or processing files.

2.2.5 Real Time Clock

Sensor samples are timestamped using the values from the logger's 'real time' clock (RTC). The RTC is powered by AA batteries during normal operation and by the CR1225 coin cell battery if the AA batteries are removed. Therefore, the clock will continue to keep time if the batteries are removed or swapped. The RTC can be synced with the current time on a computer using the *MarotteHSConfig* software (Section 3.2.5).

2.2.6 Calibration Values

Sensor calibration values are stored on the logger in persistent memory and will not be cleared if batteries are removed. The calibration values can be edited using the *MarotteHSConfig* software. Each log file has the current calibration in the initial header entries and *a new log file is created whenever any settings are changed.* The table below shows the calibration values that are stored:

Setting	Parameters					
Zero Point:	Offset X	Offset Y	Offset Z			
Accelerometer:	Scale X	Scale Y	Scale Z	Offset X	Offset Y	Offset Z
Magnetometer:	Scale X	Scale Y	Scale Z	Offset X	Offset Y	Offset Z

2.3 Recording

The *Marotte HS* records configuration and sampling data to a CSV file on the micro SD card. The log file is processed by the *MarotteHSConfig* software to convert the raw sensor values into current speed and direction.

2.3.1 Format

Log files are stored as *.txt files on the micro SD card (older instruments may save files as *.csv). Files are created in subfolders according to the date on which the recording was started, Folders have an 8 charchter numeric name following the convention YYYMMDD. The log files within the subfolders are given a name 8 characters long. The first 5 characters are the serial number of the device, and the last 3 are the sequentially increasing record number. For example, an instrument with serial number `B1020` will record log files as follows:

- `B1020000.TXT`
- `B1020001.TXT`
- `B1020002.TXT`
- . . .
- `B1020nnn.TXT`

Configuration and calibration settings are recorded in the log file headers as follows:

Header Example							Comments
serial	B1020						Unique serial number
name	maggie						Configurable name
firmware	3.0 - delay/burst						Current firmware version
zeropoint	-13	1023	50				Zero point [x,y,z]
acccal	1017	1011	1066	3	39	42	Accelerometer calibration scale [x,y,z], offset [x,y,z]
magcal	207	232	219	11	-50	-17	Magnetometer calibration scale [x,y,z], offset [x,y,z]
period	1	2					Period
burst	-1	-1					Burst mode enabled/disabled
reserved							For future use

Following the headers, the samples are recorded as shown below:

datetime	acc_x	acc_y	acc_z	mag_x	mag_y	mag_z	batt	temp
2014-10-02 12:49:15.000	-661	670	265	-170	140	-34	2803	488
2014-10-02 12:49:16.000	-869	529	-79	-189	90	-68	2803	488
2014-10-02 12:49:17.000	-883	501	-154	-170	69	-100	2803	488
2014-10-02 12:49:18.000	-851	517	-148	-171	69	-102	2803	488
2014-10-02 12:49:19.000	-749	267	218	-173	74	-97	2803	488

The columns are

Column name	Description
datetime	The timestamp of the sample in the format year-month-day hour:minute:second:millisecond
acc_x	Raw accelerometer X axis
acc_y	Raw accelerometer Y axis
acc_z	Raw accelerometer Z axis
mag_x	Raw magnetometer X axis
mag_y	Raw magnetometer Y axis
mag_z	Raw magnetometer Z axis
batt	Battery voltage in millivolts
temp	Raw temperature sensor resistance

If log files are deleted, numbering will restart at the smallest record number available.

2.3.2 Sampling Rate

Internally, the logger samples acceleration and magnetic field twice per second. The values are stored and averaged after each *sampling period*. The sampling period is configurable via the *MarotteHSConfig* software, and the minimum sampling period is 1 second.

The sampling rate chosen affects battery life, storage capacity and temporal detail.

Battery life is increased slightly by choosing a longer sampling period:

Sampling period	Estimated Battery Life
1 seconds	> 12 weeks
10 seconds	> 14 weeks
1 minute	> 14 weeks

Increasing the sampling period decreases the log file size. For example, for a 1 month deployment the file sizes are:

Sampling period	Typical File Size
1 seconds	200 MB
10 seconds	20 MB
1 minute	3.3 MB

The instrument is supplied with an 8GB or larger micro SD card, giving about 40 months of storage capacity. Therefore, reducing the file size is not necessary unless the card is nearly full or you do not wish to work with large files. It is recommended that you delete any unwanted log files before the card gets too full.

Large files can be difficult to work with due to constraints in spreadsheet programs such as Microsoft Excel. However, the *MarotteHSConfig* software can decimate the samples in processing. For example, a raw file with a 1 second sampling period can be converted into a smaller, more manageable processed data file with a 1 minute sampling period. See Section 5.1.2 for details.

We recommend the sampling rate be set at the default 1 second.

2.3.3 Burst Sampling

At times it may be desirable to perform sampling in bursts rather than continuously. The instrument remains in a sleep state for a predetermined period before waking up to take a short burst of samples. This may be done to conserve battery life, reduce file size or to generate a dataset consistent with those generated by other oceanographic equipment.

It should be noted that there is always some power consumption, even when the instrument is in its sleep state. Setting an instrument to burst sample half the time will not therefore double the battery life.

Burst sampling is set using two parameters; *Burst Samples Burst Period* in addition to the *Sampling Period*. *Burst Samples* defines how many samples you wish to record while *Burst Period* defines the number of samples in one complete sampling and non-sampling cylce.

For example, if you wish to get data every second, for 1 minute every hour the instrument settings are as follows;

- Sampling Period = 1 second
- Burst Samples = 60 samples
- Burst Period = 3600 samples

If however you wish to get data every 0.5 seconds, for 1 minute every hour the settings are as follows;

- Sampling Rate = 0.5 seconds
- Burst Samples = 120 samples
- Burst Period = 7200 samples

2.3.4 Micro SD Card

Important

A 4GB or larger (Lexar or Verbatim brand) Micro SD card is supplied with each instrument. **The brand of SD card is important, as some micro SD cards consume significant power.** If replacing the micro SD card please choose a Lexar or Verbatim brand card with a storage capacity of between 4GB and 16GB.

2.4 Power

The logger is powered by two AA batteries and one CR1220 / CR1225 coin cell battery.

2.4.1 AA Batteries

Higher capacity AA batteries increase the amount of time the logger can be deployed before running out of power. As the logger uses only a small amount of power, the difference between alkaline batteries and lithium AA batteries is small. However, the logger has been calibrated for alkaline AA batteries, which weigh around 24 grams each. Lithium batteries are much lighter, and therefore should not be used.

Important

- Always replace the batteries with high-capacity alkaline AA cells such as Duracell Procell or similar.
- After replacing the batteries a magnetometer calibration is required. See Section 3.3.2 for details.

2.4.2 Coin Cell Battery

The coin cell battery is a backup power source for the real time clock chip. It allows the main AA batteries to be changed without losing the device time. When AA batteries are present, the coin cell is not used. Without AA batteries inserted, the coin cell battery will last approximately one year before running flat.

The logger can operate with a drained coin cell battery; however, this requires the device time to be set using the *MarotteHSConfig* software every time the logger is powered on again.

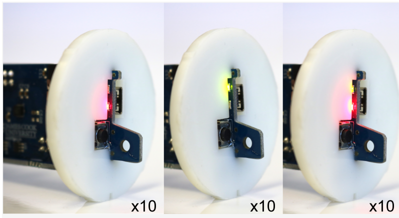
2.4.3 On / Off Switch

The logger does not have an on/off switch. To save battery power when not in use, simply remove **one** battery, making sure to keep it with the logger. This way a magnetometer calibration does not need to be performed when the battery is reinserted as the logger will have the same batteries in the same position.

2.5 Hardware

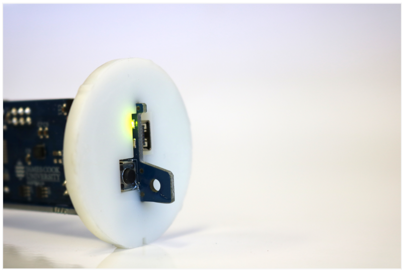
2.5.1 Indicator LEDs

Red and green indicator LEDs are located at the top of the logger. The LEDs show the current state of the logger:

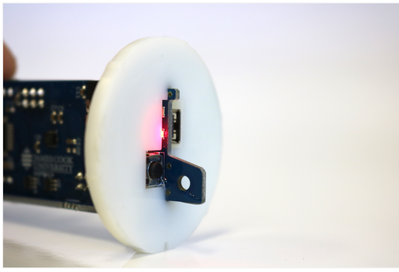


Startup sequence:
Occurs when batteries are inserted. The sequence is:

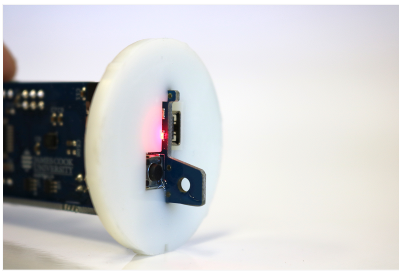
- 10 rapid red flashes:
  Communications have been initialised.
- 10 rapid green flashes:
  Sensors have been initialised.
- 10 alternating red and green flashes:
  Real time clock has been initialised.



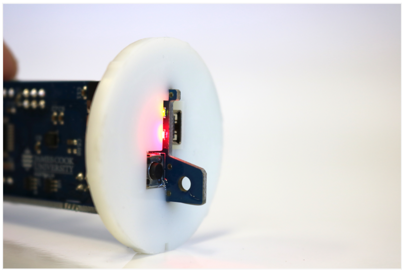
Green LED flashing twice per second
Micro SD card is inserted and data is being logged.



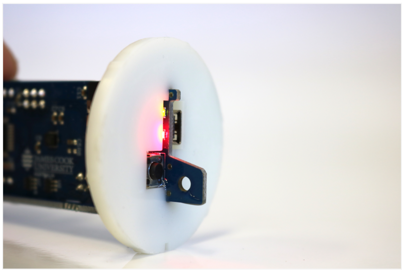
Red LED flashing twice per second
Micro SD card is **not** inserted and **no** data is being logged.



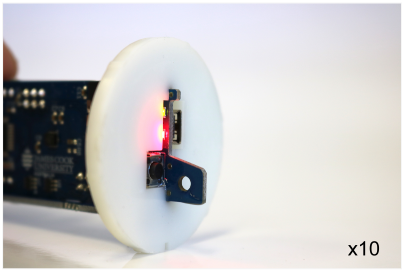
Red LED flashing very rapidly
The logger is communicating to the computer over USB.



Red and green LED flashing - Burst Mode
When the logger is in burst sampling mode both the red and green LEDS will flash simultaneously 15 times.



Red and green LED double flash - Delayed Start
When the logger is setup for a delayed start both the red and green LEDS will blink simultaneously, twice in quick succesion 5 times.

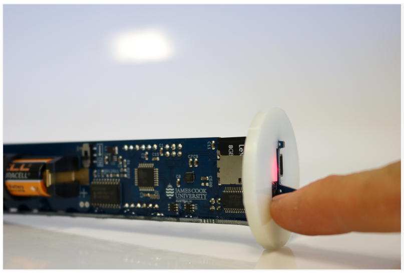


SD Card Sequence
Occurs when SD card is inserted. 10 alternating red and green flashes in quick succession followed by the green LED flashing twice per second.

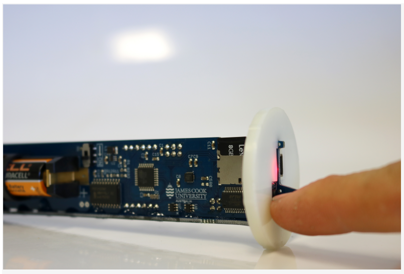
If the startup sequence repeats over and over, there may be a problem initialising the SD card. Remove the card and re-insert it.

2.5.2 Button

The button is used for two purposes, showing the logger status and finalising the log file.



Show logger status
To save power, the LEDs turn off after 10 seconds.
To see the state of logger, press the button for half a second to turn on the LEDs for another 10 seconds.



Finalise log file
Logging must be stopped and data flushed to disk before the Micro SD card can be removed.
To finalise the log file, press the button until the red LED gives two long flashes (about four seconds), then begins flashing red. The Micro SD card can then be removed.
If the Micro SD card is not removed, logging will resume after 15 seconds and a new log file will be created.

2.5.3 Micro SD Card Socket

Log files are stored on the Micro SD Card. The Micro SD card socket is a push-pull type. Push the card into the socket to insert it, and pull it out to remove it. Remember to finalise the log file before removing the SD card.

The brand of Micro SD card is important, see Section 2.3.4 for more details.

2.5.4 USB Port

The logger communicates with a computer over a USB serial connection via the USB port at the top of the logger. The port requires a USB Mini-B type cable, commonly used for USB hard drives. A suitable cable is included with the instrument.

2.6 Enclosure

The instrument enclosure is made from ABS plastic and consists of a lid with o-ring, main electronics housing and a tether. The enclosure serves two purposes:

- A waterproof housing for the electronics.
- The drag-object that catches the water flow.

2.6.1 Waterproof Seal

The lid screws onto the main housing. Located in a groove inside the lid is a 46mm internal diameter, 3.5mm cross-section diameter o-ring. The o-ring seals between the sides of the lid groove and the **top surface** of the main housing.

Screwing down the lid gives a tighter seal. However, the lid should only be tightened by hand, as if it is screwed on too hard it may be difficult to get off. The top surface of the main housing where the enclosure sits should be greased every so often to reduce friction on the o-ring and thus give a tighter seal.

Important

The instrument is rated to a depth of 40m.

2.6.2 Drag

The long thin shape of the enclosure is designed to give better low current sensitivity by increasing the surface area. As current increases, the instrument tilts over, exposing less surface area, allowing for higher current measurements. The fins on the lower half of the instrument provide stability at very high currents.

2.6.3 Pairing With Logger

Each logger has been custom fit to a particular enclosure. Each enclosure has the serial number of the corresponding logger on the inside surface and on the tether. The enclosure and logger are a pair, and have been calibrated as a unit. Swapping loggers between enclosures could result in changes to the actual zero point and require a re-calibration.

Important

Only use the logger with the enclosure it is paired with.

2.6.4 Tether

The tether consists of two grade 316 stainless steel loops. The first attaches to the instrument and is chain link or carabiner. The second is a round ring and is used as the attachment point to an instrument stand or frame. Together they allow the current meter to tilt and swivel freely. See section 4.2.2 for information about attaching the tether.

2.6.5 Anti-fouling Paint

Marotte HS enclosures are coated with antifouling paint on request. The antifouling paint prevents marine organisms from growing on the instruments. **Marine growth will affect the zero point and sensitivity of the instrument**. Extra coats of paint may be applied as the anti-fouling effect wears out.

2.7 Specifications

Parameter		Value			
Speed	Range	Min	Max		
		0.05m/s	1.20m/s		
	Systematic Error	Speed	< 0.10m/s	0.10 - 0.70m/s	> 0.70m/s
		Error	±0.05m/s	±0.03m/s	±0.06m/s
	Vortex Error	Speed	< 0.10m/s	0.10 - 0.70m/s	> 0.70m/s
		1s	±0.02m/s	±0.10m/s	±0.14m/s
		10s	±0.02m/s	±0.05m/s	±0.07m/s
		60s	±0.01m/s	±0.03m/s	±0.03m/s
Direction	Error	Speed	0.05 - 0.15m/s	0.15 - 0.60 m/s	> 0.60m/s
		1s	±45°	±20°	±20°
		10s	±45°	±10°	±5°
Logging	SD Card Capacity	4GB - 16GB			
	File Size	200MB / month at 1s sampling			
Temperature	Error	±0.3°C			
	Sampling Period	5 minutes			
	Lag	1 hour			
Logger Batteries	Type	AA alkaline			
	Life	> 12 weeks			
	Mass	24g each			
RTC Battery	Type	CR1220 or CR1225			
	Life	1 year with logger batteries disconnected			
Waterproof Seal	O-ring Type	46mm I.D., 3.5mm C.S.			
	Max. Depth	40m			

Notes:

1. Zero point calibrated at approx. 25°C.

Chapter 3
Operation

The following chapter describes the operation and configuration of the instrument using the *MarotteHSConfig* software.

3.1 Initial Setup

The *MarotteHSConfig* software is used to configure the *MarotteHS*. The software is written in Java and will run on the following operating systems:

- Windows Vista
- Windows 7
- Windows 8
- Mac OS X 10.7.3 and above
- Windows XP with reduced functionality (no 3D model view)

3.1.1 Installation

Download and install the latest version of *MarotteHSConfig* from
`http://www.marinegeophysics.com.au/current-meter/marotte-hs`

There are three versions of the software:

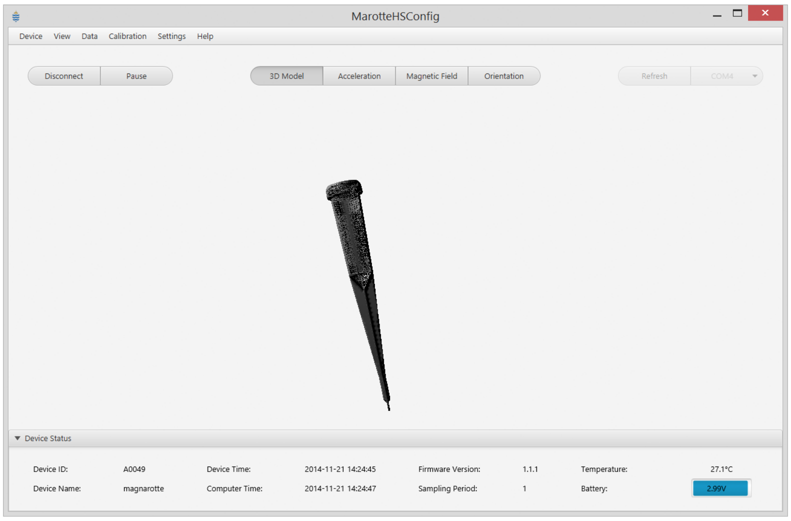
- Windows 32-bit
- Windows 64-bit
- Apple OS X

To find out if your computer is running a 32-bit or 64-bit version of Windows in Windows 7 or Windows Vista, do the following: Click *Start*, right-click *Computer*, and then click *Properties*. Under *System*, you can view the system type.

If your computer is running Windows XP, do the following: Click *Start*, right-click *My Computer*, and then click *Properties*. If "x64 Edition" is listed under *System*, you are running the 64-bit version, otherwise you are running the 32-bit version.

3.1.2 Main View

When *MarotteHSConfig* is opened, the main view will be shown. It provides real-time data of the instrument's acceleration, magnetic field, tilt, orientation and configuration status. The main view also provides controls for connecting and disconnecting Marotte HS instruments.



The floating toolbar consists of 8 buttons, from left to right:

- *Connect [Disconnect]*: Connect [disconnect] to a *Marotte HS* that is plugged into the computer.
- *Pause [Run]*: Pause [run] the real time displays.
- *3D Model**: Select the 3D Model real time display.
- *Acceleration*: Show real time acceleration readings.
- *Magnetic Field*: Show real time magnetometer readings.
- *Orientation*: Show real time tilt and direction readings.
- *Refresh*: Refresh the list of available serial ports.
- *COM? or /dev/tty. etc.*: List of available serial ports.

*If your system does not feature a recommended graphics card or graphical processing unit (GPU) supported by JavaFX, the 3D model feature will not be present. For a full list supported GPUs visit: `https://docs.oracle.com/javafx/2/system_requirements_2-2-5/jfxpub-system_requirements_2-2-5.htm`.

3.1.3 Connecting to an Instrument

(1) Plug the USB cable into the logger USB port and into the computer.
The logger uses an FTDI USB to Serial converter chip to communcate. If this is the first time a *MarotteHS* has been connected, drivers may need to be installed depending on the operating system:

- Windows Vista, 7, 8: Driver installation will proceed via the normal *Update Driver Software Dialog*. If asked how you want to search for driver software, choose the option to search automatically.
- Windows XP: Before connecting the instrument, download and install the FTDI driver package at: `http://www.ftdichip.com/Drivers/VCP.htm`. After the FTDI drivers are installed, connect the instrument. The *Found New Hardware Wizard* should open, from which installation can be completed. When prompted if Windows can connect to Windows Update to search for software, select *No, not at this time*. The previously installed FTDI driver files should now begin to install for the instrument.
- Apple OSX: Apple have in-built drivers and no installation is necessary.

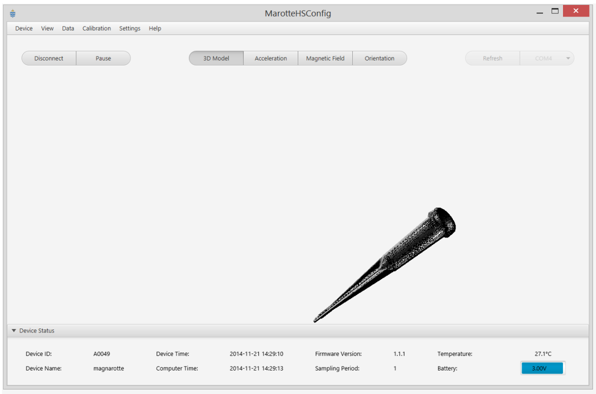
2 Open up the *MarotteHSConfig* software. Select the serial port of the instrument and click *Connect*.

- In Windows, serial ports are called COM ports and are numbered sequentially according to when a device was *first* connected. If this is the first time connecting a *MarotteHS*, it will be given the first free COM port number. Typically this will be the largest. Therefore, when trying to connect, try the highest numbered COM port in the list first.
  Take note of the number of the COM port for which the connection was successful. The instruments are all identical, and therefore any *MarotteHS* will present as the same COM port number, making connection easy.
- In Apple OSX, serial ports are named */dev/tty.**. The *MarotteHS* will have the name */dev/tty.usbserial-magna*.

3 If the correct COM port / device name is not in the list, click *Refresh*.

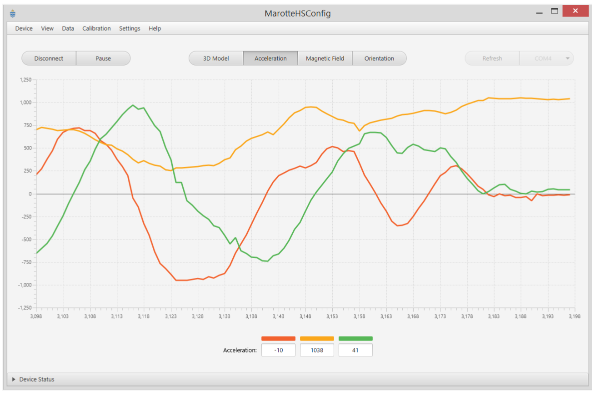
3.1.4 Real Time Data

Once connected, the *MarotteHSConfig* software will start displaying real time data. There are four different displays which can be selected from the floating toolbar.

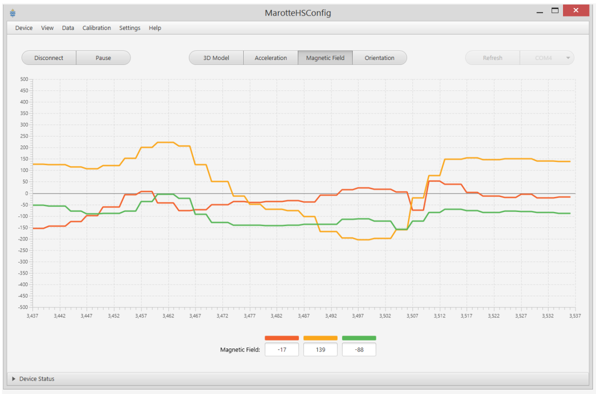


3D Model
3D representation of the instrument showing the instrument's tilt and direction, calculated using its zero point calibration. Please note the direction of tilt of the model will not be the same as the physical direction of tilt of the *MarotteHS*. The screen display is:

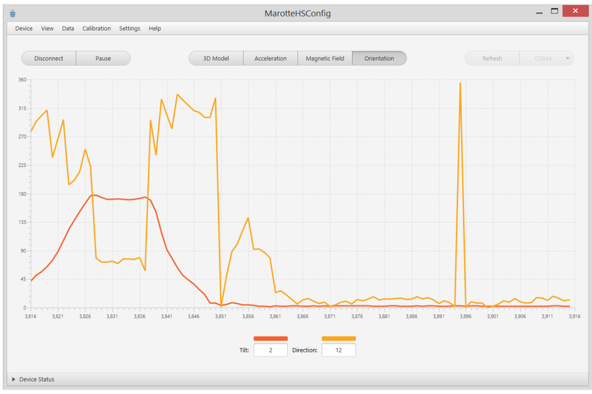
- *North:* Model tilts toward right of screen.
- *East:* Model tilts towards screen.
- *South:* Model tilts toward left of screen.
- *West:* Model tilts away from screen.



Acceleration
Graph of raw accelerometer readings for each of the three axes. This view can be used to check if the accelerometer is functioning correctly. Note: the actual subsampling rate used for logging is 2Hz.



Magnetometer
Graph of raw magnetometer readings for each of the three axes. This view can be used to check if the magnetometer is functioning correctly. The magnetometer does not update as fast as the accelerometer, so the graph will have flat segments due to repeated measurements. Note: the actual subsampling rate used for logging is 2Hz. This view is useful for checking if a metal stand or other deployment anchor has a discernible affect on the magnetometer due to magnetic interference.



Orientation
Graph of tilt and direction (degrees clockwise from magnetic North), calculated using the zero point calibration. This view is useful for checking if a metal stand or other deployment anchor has a discernible affect on direction due to magnetic interference.

3.1.5 Device Status

The device status dock is located at the bottom of the main view. It provides real-time configuration information for the connected *Marotte HS* instrument, from left to right:

- *Device ID:* instrument serial number.
- *Device Name:* instrument name that can be changed in *Basic Settings*.
- *Device Time:* current time on the instrument's real time clock.
- *Computer Time:* current time on the computer.
- *Firmware Version:* program version running on the logger.
- *Sampling Period:* in seconds.
- *Temperature:* in degrees Celcius.
- *Battery:* battery voltage with a bar graph showing estimated capacity.

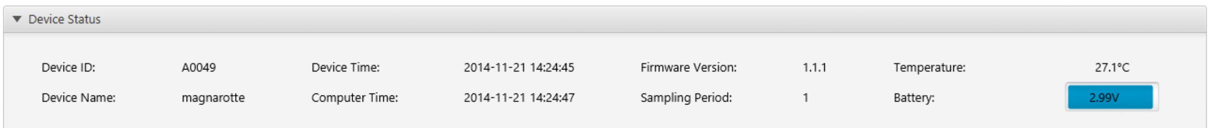


Figure 3.1: The device status information dock.

3.2 Basic Configuration

The three operations commonly performed are setting the instrument name, setting the sampling rate and syncing the instrument time with the computer time. To access these settings:

(1) Connect to the *MarotteHS* using the *MarotteHSConfig* program.

(2) From the menu bar, select *Settings* → *Basic Settings*.

(3) The *Basic Settings* dialog will pop up as shown below:

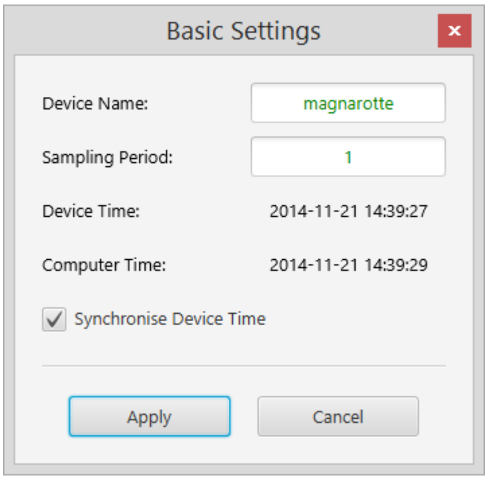


Figure 3.2: The basic settings dialog

(4) Edit the settings and click *Apply* to save them to the instrument.

3.2.1 Device Name

The device name can be modified to identify the instrument for a particular deployment or purpose. For example, `Site 1 - Moore Reef`. It can be up to 32 characters long (including spaces) but only supports the standard ASCII character set at this time: [0-9, a-z, A-Z] and punctuation. The device name is stored in non-volatile memory and will remain after power is removed.

Log files contain the device name in the header, and processed files contain the device name in the filename. Therefore, choosing a descriptive name will help to keep track of files and data.

3.2.2 Sampling Period

Internally, the instrument subsamples acceleration and magnetic field every 0.5 seconds. The sampling period (in seconds) determines the amount of subsamples to average and log to the Micro SD card. For example, a sampling period of 1 will average 2 subsamples, logging every second. Logging is synced to the clock seconds. For example, if the sampling period is 5, the instrument will log when the clock seconds are a multiple of 5 - 0, 5, 10, 15, 20, etc. If the sampling period is 300 (5 minutes), the instrument will log when the minutes are a multiple of 5.

Longer sampling periods result in smaller log files and slightly improved battery life. **We recommend a sampling period of 1 second be used**.

3.2.3 Clock Synchronisation

Ticking *Synchronise Device Time* will set the instrument time to the computer time when the *Apply* button is pressed.

3.2.4 Enable Burst Mode

Ticking *Enable Burst Mode* will set the instrument for burst sampling. This is done by setting the parameters *Burst Samples* and *Burst Period*. *Burst Samples* is the number of samples that the instrument records and *Burst Period* is the number of samples between the start of succesive bursts.

3.2.5 Enable Delayed Start

Ticking *Enable Delayed Start* allows the setting of a delayed start. A starting date and time is selected using the calendar and time slider.

3.3 Sensor Calibration

The accelerometer, magnetometer and zero point must be calibrated before use.

Please note:

- **Accelerometer:** The accelerometer is calibrated during manufacturing and should **not** require re-calibration.
- **Magnetometer:** The magnetometer is calibrated during manufacturing, and requires re-calibration whenever the batteries are changed.
- **Zero Point:** The zero point is calibrated during manufacturing, but can be re-calibrated if desired.

3.3.1 Accelerometer

Calibrating the accelerometer improves the linearity of acceleration measurements by removing any offsets and rescaling each axis measurement. The offsets and scale differences are an unavoidable part of the sensor manufacturing process and are common to all accelerometers.

Important

The accelerometer has already been calibrated during manufacturing. Re-calibration is not recommended.

1. Connect to the *MarotteHS* using the *MarotteHSConfig* program.
2. From the menu bar, select *Calibration* → *Perform Sensor Calibration*.
3. The *Sensor Calibration* dialog will pop up as shown below. The number fields will hold the results of the calibration.

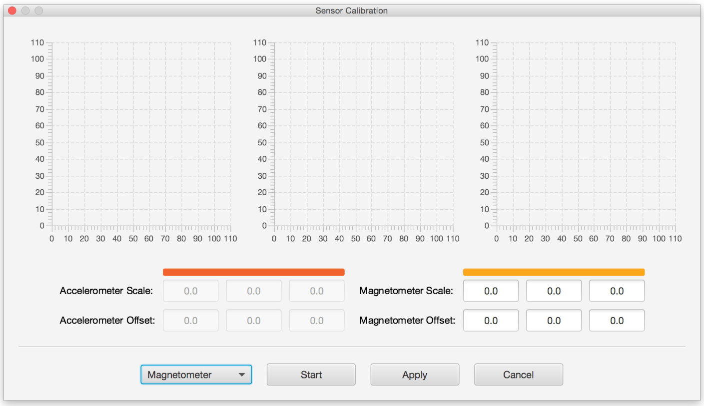
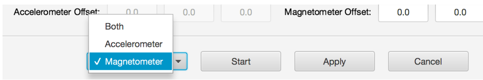


Figure 3.3: Sensor calibration dialog.

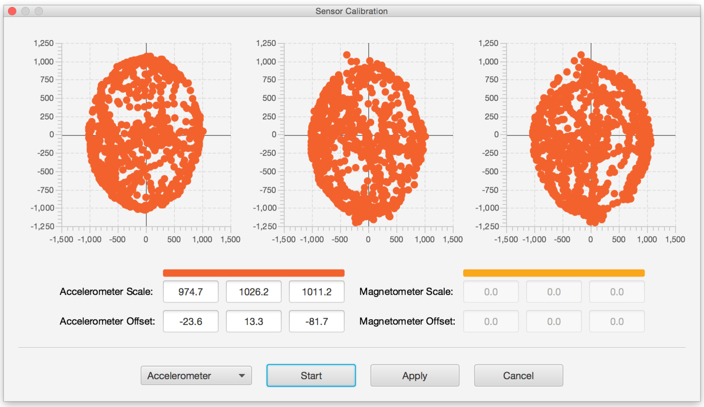
4 Select *Accelerometer* from the drop-down menu to the left of the *Start* button.



5 Hold the logger out where it will not be obstructed. If it is still in the enclosure, take it out.

6 Click *Start*. **Very slowly** begin to rotate the instrument in a range of orientations. A single axis roation should take about 10 seconds, and movement should be steady. Measurements will appear on the three graphs. Some outliers are acceptable as they will be excluded from the final calculations.

7 After about 2 minutes the scale and offset estimates should have stabilised, and the graphs should look like ovals similar to that shown below If this case, click *Stop*, otherwise continue with more rotations or start the calibration again.



8 Click *Apply* to save the accelerometer calibration to the instrument.

3.3.2 Magnetometer

Magnetometer calibration improves the linearity of measurements by removing any offsets and rescaling each axis measurement. Offsets can be caused by:

- The sensor manufacturing process.
- Components on the logger's printed circuit board.
- Instrument batteries.

Calibrating the magnetometer is required whenever new batteries are inserted, or if the current batteries are re-inserted on opposite sides.

If a previously calibrated instrument has one battery removed (to save power) and the same battery is re-inserted, magnetometer calibration **does not** need to be performed.

(1) Connect to the *MarotteHS* using the *MarotteHSConfig* program.

(2) From the menu bar, select *Calibration* → *Perform Sensor Calibration*.

(3) The *Sensor Calibration* dialog will pop up as shown below. The number fields will display the results of the calibration.

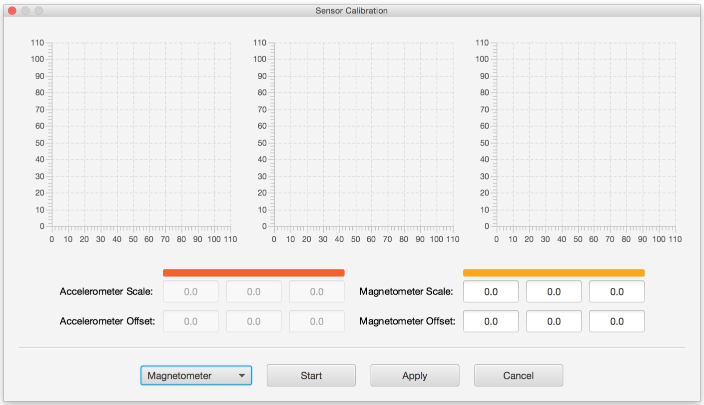
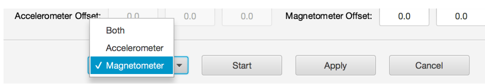


Figure 3.4: Sensor calibration dialog.

(4) Check *Magnetometer* is selected in the drop-down menu to the left of the *Start* button.



(5) **Find a location away from large ferrous (iron / steel) objects.** If the logger is still in the enclosure, take it out.

(6) Click *Start*. Begin to rotate the instrument in a range of orientations; this can be done fairly rapidly. Try not to move the overall position of the logger too far from its starting point as the earth's magnetic field can vary within a room. Measurements will appear on the three graphs. Some outliers are acceptable as they will be excluded from the final calculations.

(7) After about 30 seconds the scale and offset estimates should have stabilised, and the graphs should look like ovals similar to that shown below. If this is the case, click *Stop*, otherwise continue with more rotations or start the calibration again.

8. Click *Apply* to save the magnetometer calibration to the instrument.

3.3.3 Zero Point

The zero point is perhaps the most important calibration setting as it determines the orientation of the instrument at zero current. It is, therefore, the reference point for calculating speed (tilt) and direction. An error in the zero point appears in processed data as a constant speed offset in a constant direction.

The zero point can change with temperature, and during manufacturing it is calibrated for water at 25° Celcius. If an instrument is to be delpoyed into very cold (<15° Celcius) or very warm (> 35° Celcius) water, another zero point may need to be taken in water at this temperature. The zero point has been factory calibrated for each instrument logger / enclosure pair. Therefore, swapping loggers between instruments can change the zero point and should not be done.

The *MarotteHSConfig* software can be used to find the zero point in the case of extreme temperatures or if the data suggests the zero point has drifted.

To perform a zero point calibration:

1. Fill a bucket or tub which is at least 1m deep with water within 5 degrees of the temperature at which the instrument will be deployed. The bucket should be located away from wind, people and any other factors that could move the water.
2. Start the logger running, or start a new file if the logger is already running.
3. Tether the instrument to a weight of at least 300g and submerge it completely in the bucket of water. Water must completely cover the top of the instrument by at least 5 cm, and the instrument must be able to float upwards unimpeded.
4. Leave the instrument sit for at least 30 minutes.
5. Remove the instrument, dry it, stop logging, and transfer the log file to the computer.
6. Connect to the *MarotteHS* using the *MarotteHSConfig* program.
7. From the menu bar, select *Calibration* → *Load Zero Point Calibration*.
8. The *Zero Point Calibration* dialog will pop up as shown below. The number fields will hold the results of the calibration.

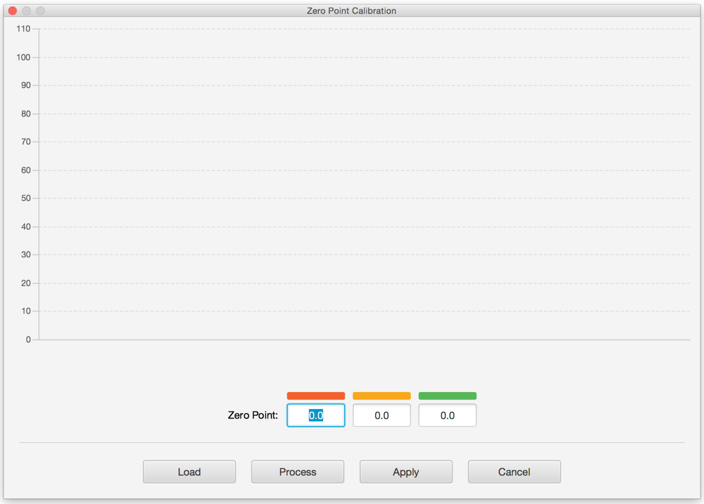
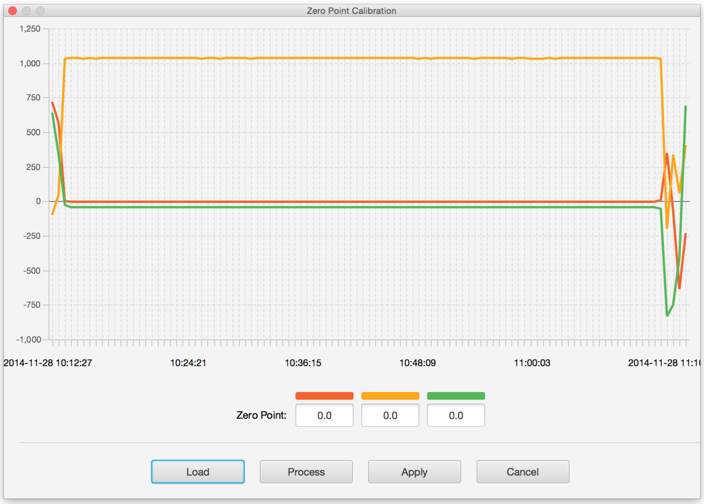


Figure 3.5: Zero point dialog.

(9) Click *Load* and select the log file corresponding to the zero point calibration. A graph of the acceleration will appear as shown below:



(10) The zero point measurements should be the middle section of the graph where the acceleration values look fairly constant. One axis will be a high value; this is the vertical axis. The other two will be low values; these are the horizontal axes. Using the mouse, click and drag to select the constant section, leaving a buffer on the edges, similar to the graph below:

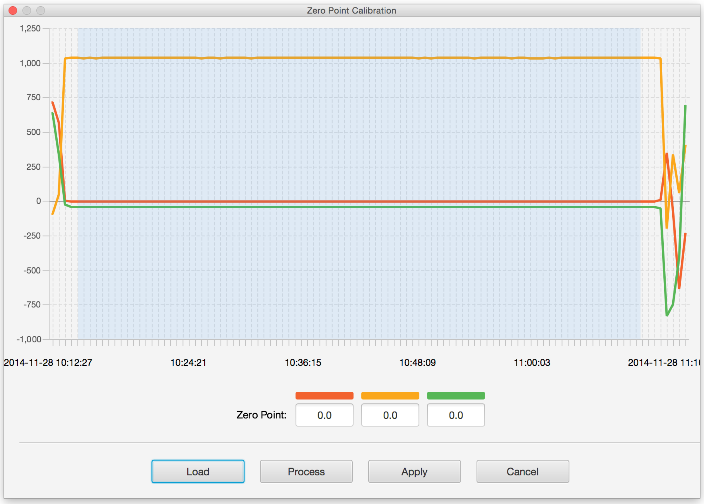


Figure 3.6: Zero point dialog.

11. Click *Process*. The zero point values will be calculated and shown in the number fields, from left to right they correspond to the x, y, and z axes respectively. Make a note of the values.
12. Click *Apply* to save the zero point calibration to the instrument.

3.3.4 View / Manually Edit Calibrations

1. Connect to the *MarotteHS* using the *MarotteHSConfig* program.
2. From the menu bar, select *Calibration* → *Edit Calibration Values*.
3. The *Calibration Values* dialog will pop up as shown below. Green number fields show the current calibration applied to the instrument. Orange number fields show new calibrations that have not yet been applied. Red number values show new calibration values that could not be applied.

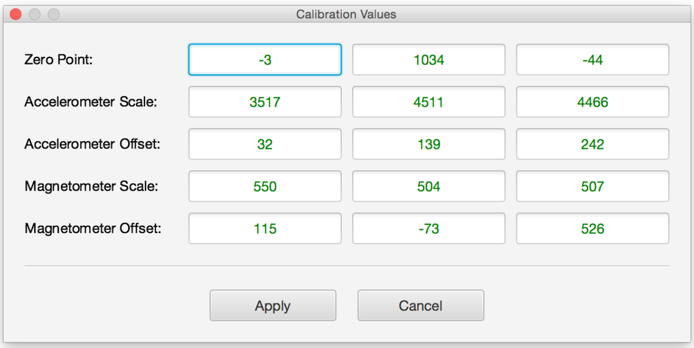


Figure 3.7: Calibration values dialog.

4. Edit any calibration values if desired, and click *Apply* to save them to the instrument. Otherwise, click *Cancel* to exit.

Chapter 4
Deployment

4.1 Planning

Important

Deployment is affected by two factors:

Battery Life: The minimum battery life is 12 weeks. If the deployment is longer than 12 weeks, the batteries may run out. *Note: if the batteries run out, none of the data will be lost as it saved to the SD card.*

Current Range: The usable current measuring range is **0.05m/s - 1.20m/s**. The instrument is not suitable for accurate measurement of currents outside of this range.

4.1.1 Weight / Anchor Selection

The instrument needs to be tethered to a solid object to work properly. Common anchors include star pickets (fence posts), instrument frames, and heavy objects such as dive weights.

Star Picket

Advantages / Disadvantages

+ Current can be measured at different heights above the substrate by choosing a different length picket.
+ The deployment location is fixed, so there is no effect from spatial variation.
– Requires diving to attach current meter.
– Very large star pickets may cause magnetic anomalies and alter direction measurements. Testing of small star pickets (0.65m - 1.35m) has shown no effect, but this should be checked.

Example tethering method for a star picket is shown on the left.

Instrument Frame

Advantages / Disadvantages

+ Deployment location can be fixed, so there is no effect from spatial variation.
+ Can be deployed by boat.
+ Other instruments may also be attached.

− Frames may cause magnetic anomalies and alter direction measurements. **Use stainless steel frames if possible as they do not affect the magnetic field readings**.

Example tethering method for a metal frame is shown on the left.

Brake Drum

Old brake drums are available (and very cheap) from automotive wreckers and are an excellent anchor for boat deployments. *Advantages / Disadvantages*

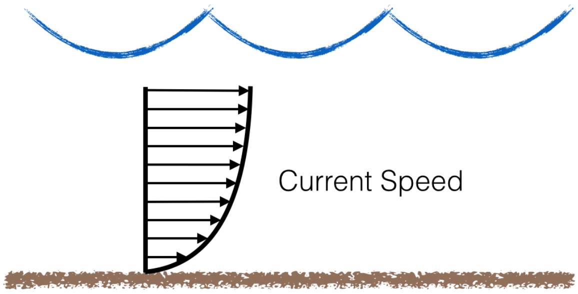
+ Deployment location can be fixed, so there is no effect from spatial variation.
+ Can be deployed by boat.
+ Rope can be attached using the pre-existing holes.
+ Instrument height can be extended above the substrate by attaching threaded rods.
+ Testing has shown little effect on magnetic field readings, but this should be checked.

Example tethering method for a brake drum is shown on the left.

Ideally, the cable tie holding the bottom ring should be just loose enough that the ring can move freely. However, if it is pulled tight, so long as the loop is standing upright and free of obstruction, it should be fine.

4.1.2 Height Above Substrate

Currents close to the substrate are slower than currents higher in the water column. The difference mainly depends on the roughness of the bottom and the speed of the water. Since the *MarotteHS* is typically deployed at the bottom, this speed difference must be taken into consideration, especially when analysing final data. A star picket or larger frame can be used to position the instrument higher in the water column.



4.1.3 Scuba Deployment

When deploying via SCUBA please note that each instrument has a net buoyancy of 130 grams equivalent and will rapidly ascend to the surface if let go. We recommend the following:

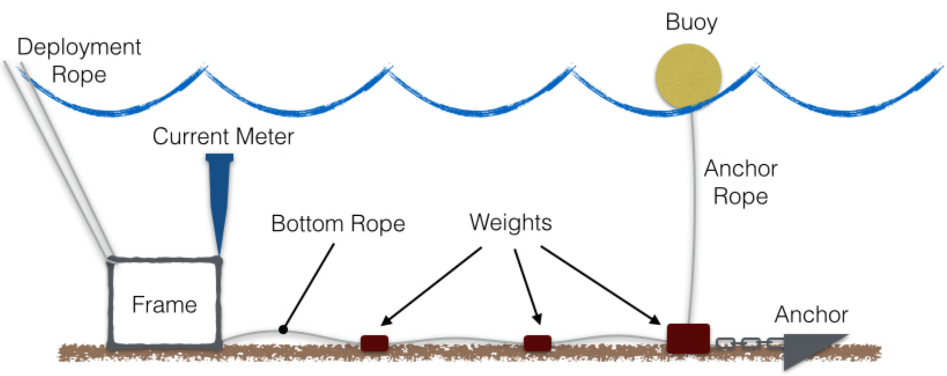
- Tether each instrument together using a carabiner, and again to a rope looped through some dive weights.
- Carry enough extra dive weights to account for the increased buoyancy from the instruments.
- Use a two person team where one person positions the instrument while the other cable ties the tether.

4.1.4 Boat Deployment

Boat deployment is useful where SCUBA is either too time consuming or not possible. However, there are a few things that must be considered:

- The instrument frame must be easy to deploy the right way up. Frames that are bottom heavy are recommended because even if they fall on their side, with correct rigging they can be righted by using a second rope for lowering.
- Buoy ropes and rigging cannot go straight from the instrument frame to the surface as they may interfere with the current meter operation. Instead, connect the frame to a second anchor located 10m - 20m away using a weighted rope, and attach any buoys to the second anchor.

An example deployment configuration for a small boat is shown below:



The same deployment configuration is possible without a buoy. The bottom rope is made at least 30m long and GPS positions of the anchor and frame are taken during deployment. A grappling hook or reef anchor is then used to trail for the bottom rope. This configuration is useful in areas where surface buoys are prohibited or there is a chance that anglers will pull up the instruments out of curiosity.

4.1.5 Fouling

If an instrument becomes fouled during deployment, the zero point and sensitivity of the instrument will be affected, and the accuracy of current measurements will therefore be reduced. This should be taken into account when analysing the data from a fouled instrument.

4.2 Preparation and Deployment

4.2.1 Instrument Setup

The following equipment is required to set up the instruments before deployment:

- Computer with the *MarotteHSConfig* software installed.
- USB to Mini-B cable to connect the instrument to the cable.
- Micro SD card adapter.

Also remember to have the following:

- Fresh AA batteries if required.
- Micro SD card for each instrument.

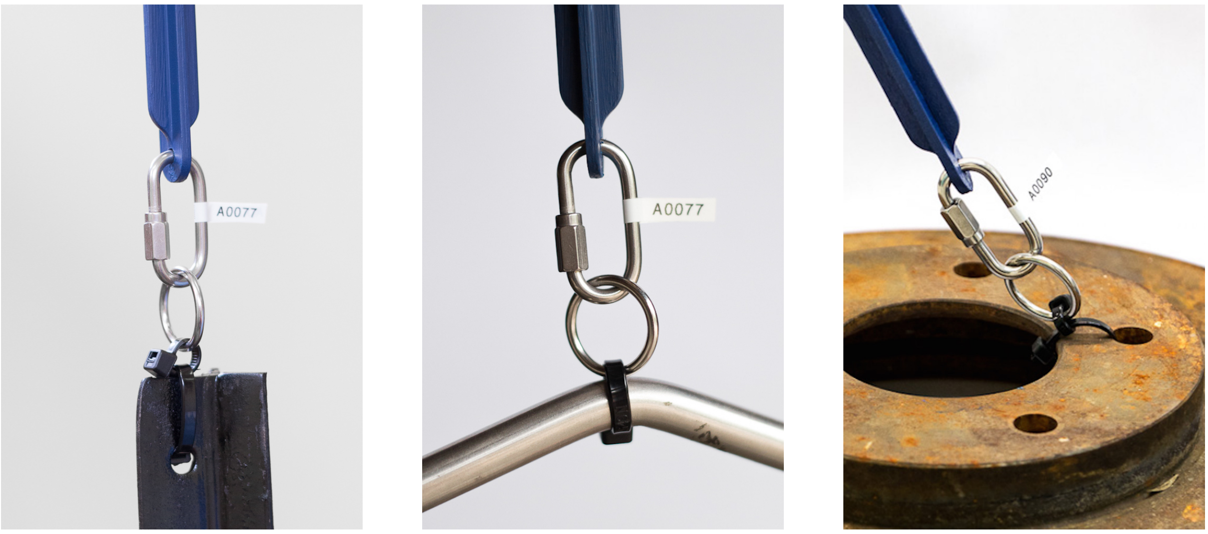
To setup each instrument:

1. Connect to the *Marotte HS* using the **MarotteHSConfig** program. (Section 3.1.3)
2. Check the remaining battery capacity is enough for the deployment and change if required.
3. If the batteries have been changed since the last deployment, perform a magnetometer calibration. (Section 3.3.2)
4. Setup the instrument name and sampling rate, and synchronise the time. (Section 3.2.1)
5. Check that there is enough space on the Micro SD card for the deployment, and delete files if necessary.
6. Insert the Micro SD card into the logger and make sure it starts logging. (Section 1.3)
7. Appy O-ring grease to the top surface of the main housing if required.
8. Insert the logger into the main housing and screw on the lid tightly. (Section 1.6)

If the instruments are prepared well in advance of deployment, prior to deployment a fresh log file can be started by holding down the button for more than 4 seconds. (Section 1.4)

4.2.2 Tethering

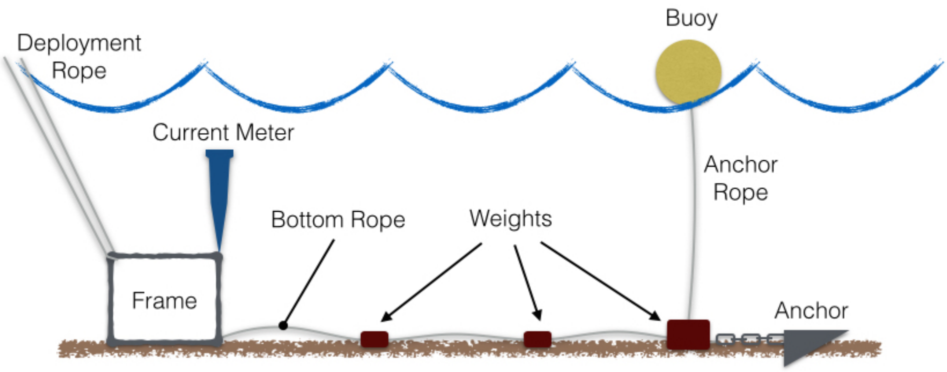
Tether the instrument to a weight if required. Example tether configurations are shown below. Each uses cable ties to attach the instrument to the weight.



(a) Star Picket (b) Frame (c) Brake Drum

4.2.3 *Boat Deployment*

The following procedure is for the example boat deployment setup below:



① Loop the deployment rope through the frame on the opposite side of the bottom rope.
② Lower the anchor up-current of the deployment site using the anchor rope.
③ Hold the frame on or over the side of the boat using the deployment rope and anchor rope.
④ Drift back from the anchor, letting the anchor rope out.
⑤ Release the anchor rope once it becomes tight.
⑥ Lower the frame using the deployment rope, keeping some tension on the rope to keep the frame upright.
⑦ When the frame reaches the bottom, release one half of the deployment rope and pull the other half through.

If not using a buoy:

- Use a bottom rope of at least 30 metres length.
- Lower the anchor using a second deployment rope. Take a GPS position just beforehand.
- Take another GPS position just before the frame is lowered.

4.3 Retrieval

4.3.1 Boat Retrieval

The following procedure is for the example boat deployment setup.

1. Pull up the anchor using the anchor rope.
2. If in windy or choppy conditions, tie off the bottom rope to the boat.
3. Pull up the frame using the anchor rope.

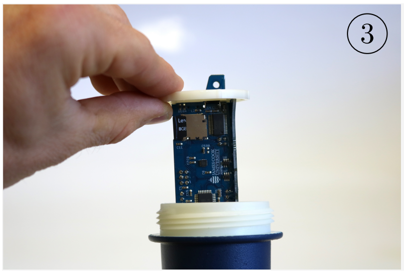
For the boat deployment without buoy:

1. Construct two marker buoys by tying one end of a rope to some dive weights and the other end to a small buoy. The length of the rope should be at least twice the water depth.
2. Deploy one marker buoy at the GPS location of the anchor and another at the GPS location of the frame. This makes navigating much easier.
3. Using the marker buoys as a guide, drag a grappling hook or reef anchor along the bottom across the bottom rope. For very muddy surfaces the grappling hook rope may need to be tied off to the boat.
4. Pull up the frame and the anchor using the bottom rope.

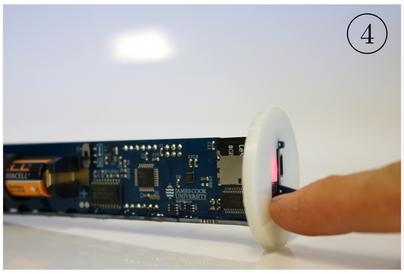
4.3.2 Data Retrieval

1. Dry the logger, especially around the cap.

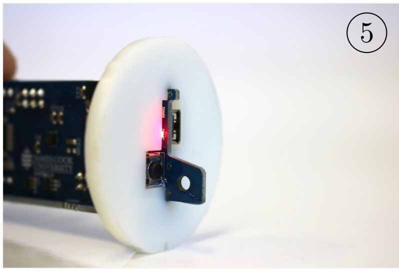
2. Hold the instrument vertically so that any water around the cap drains. Unscrew the cap and place it with the bottom facing downwards so that no water gets inside it.



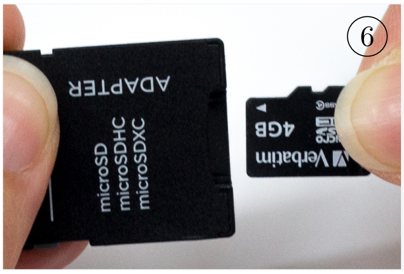
(3) Remove the logger and dry the inside of the enclosure if any water has dripped in there when opening.



(4) Logging must be stopped before retrieving the record files from the micro SD card.
Finalise the record file by holding down the button (for about four seconds) until the red LED gives two long flashes.



(5) The red LED will begin flashing twice per second. Remove the micro SD card within 15 seconds, otherwise logging will restart.



(6) Insert the micro SD card into the SD card adapter and then into the computer. Copy the relevant log files to the computer hard drive. It will make processing easier if all the log files are stored in a new folder unique to the deployment.

Chapter 5
Data Processing

5.1 Processing

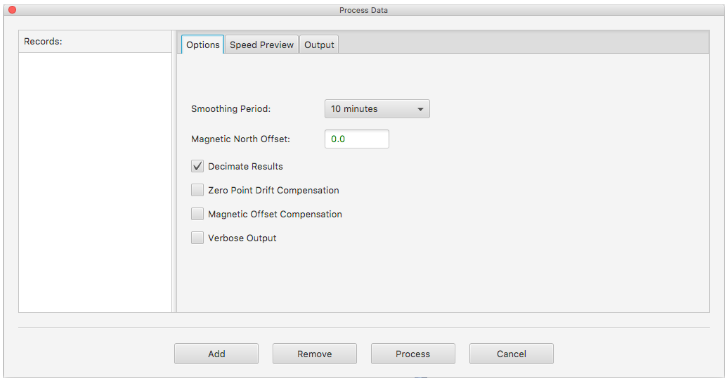
The log files are in comma separated value (CSV) format and can be opened by any tex editor or spreadsheet program such as Microsoft excel. The file consists of header information about the instrument serial number, name and calibration parameters followed by raw accelerometer, magnetometer, temperature and battery data.

The files must be processed to convert the raw data into current speed, current direction, and temperature measurements.

5.1.1 *Loading Files*

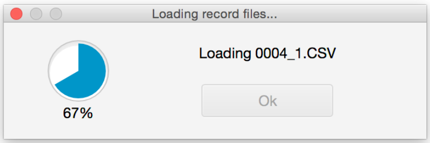
To begin processing, load the log files using *MarotteHSConfig* as follows:

1. Open the *MarotteHSConfig* program. No instrument needs to be connected.
2. From the menu bar, select *Data* $\rightarrow$ *Process Data*.
3. The *Process Data* dialog will pop up as shown below.

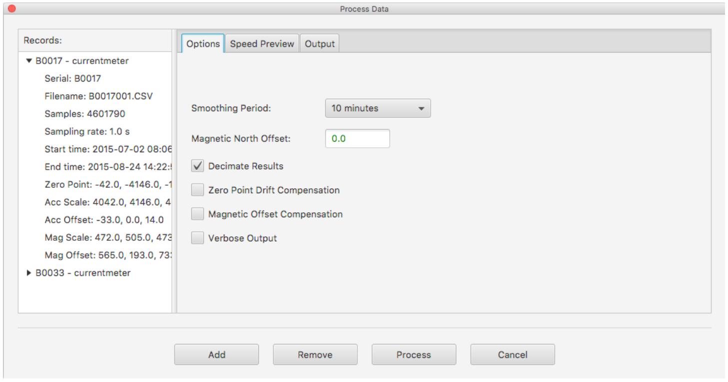


4. Click *Add*. Select the log files to process from the file selection window that pops up.
5. Clicking *Open* in the file selection dialog will begin the loading process.

The log files will be parsed for calibration settings and other metadata. This process can take a few minutes for very large files. Progress is shown in a window similar to that shown below. Note that the progress only changes once an enitre file has been processed, so please be patient.



Once the files have finished loading they will be shown in the *Records* list according by their serial number and instrument name. Click the arrow head next to the name to show the deployment details parsed from the files:



To add more log files, click *Load*. To remove log files from the list, click the log name and then click *Remove*.

5.1.2 Processing Options

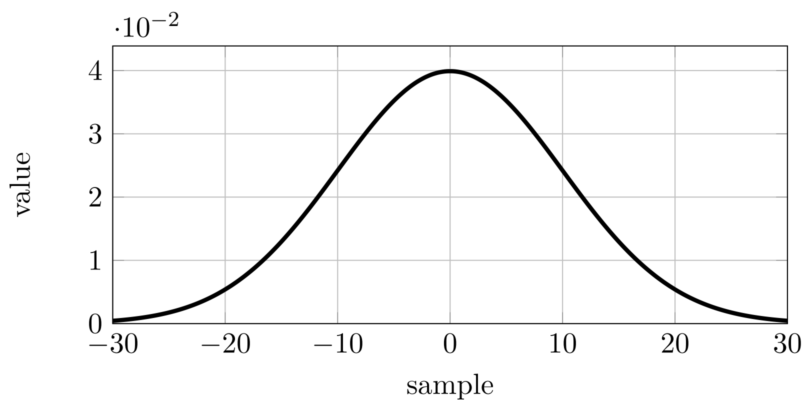
There are a number of processing options:

Smoothing

Smoothing the data is performed to remove high frequency components of the signal, such as:

- Instrument wobble due to vortex shedding (0.5Hz - 2Hz)
- Back-and-forth surging from wave motion
- Current variation and turbulence.

The *Smoothing* option allows the data to be smoothed using a Gaussian filter with a standard deviation equal to 1/3 of the *Gaussian Smoothing* setting. For example, a setting of 30 seconds smoothing uses a Gaussian function with a standard deviation of 10 seconds as shown below:



Magnetic North Offset

A fixed magnetic north offset or declination can be applied to the data before processing. This value is measured in decimal degrees from true north with positive being in the clockwise (east) direction.

For example, in Townsville, Australia where the magnetic declination is approximately 7° east using an offset value of 7 will subtract 7° from all processed heading values.

Decimate Results

Ticking *Decimate Results* will down-sample the output to have a sampling period equal to the *Smoothing* setting. For example, if the default sampling rate is 1 second and *Smoothing* set to 30 seconds, there will be one output sample for every 30 input samples. The output samples will be aligned to fall at the start of each minute or hour. For example, for 1 second sampling with *Smoothing* set at 30, the output samples will have a timestamp of either 0 or 30 seconds past the minute.

Zero Point Drift Compensation

Zero Point Drift Compensation allows for the zero point to be appoximated from the data. This may be necessary if an instrument has been deployed incorrectly or the zero point has changed since the last calibration for some other reason. This option will only work correctly if the actual current drops to zero during the deployment. In general, for regular deployments this option will not be necessary.

Apply Magnetic Offset Calibration

Ticking *Apply Magnetic Offset Calibration* will find the magnetometer offset calibration using the field data, overriding the calibration values stored in the log file. This can be used to give more accurate direction results if a magnetic calibration was not performed after batteries were changed. However, there are some caveats:

- The data should have a wide range of current speeds.
- The data should have a wide range of current directions.

Tidal data gives typically good results.

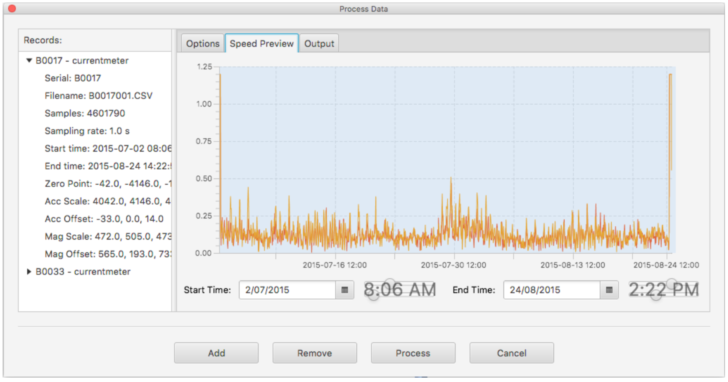
If the batteries used for deployment still have charge, it is better to do a magnetic calibration post-deployment and edit the log file instead of using the *Apply Magnetic Offset Calibration* option. See Section 5.2.2 for details.

Verbose Output

Ticking *Verbose Output* adds extra information to the output file that may be used for troubleshooting.

5.1.3 Speed Preview

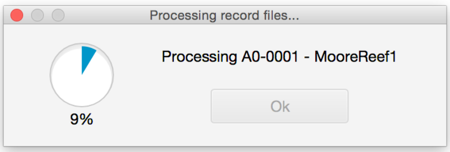
The *Speed Preview* tab shows a preview of the time series current data that is ready for processing. By highlighting a section of the plot it is possible to select only a portion of the data for processing. This can save time deleting unwanted data points later on.



5.1.4 Processing

① Select all the records to process:
- Hold down the *Ctrl* key (Windows) or *Command* key (Mac) to select multiple individual entries.
- Hold down the *Shift* key (Windows and Mac) to select consecutive entries.
- Select all files by clicking the first entry then holding down shift while clicking the last entry.
- Leaving all files unselected will also process them all.

② Click the *Process* button. A dialog box will popup where you can select the output folder where the processed files will be saved. After the folder is selected, the records will begin processing. This can take a very long time depending on the size of the files and the processing speed of the computer. Progress is shown in a window similar to that shown below.



③ Once processing is finished, click the *Ok* button. Processed data can be viewed in the *Output* tab, or the newly generated file/s can be opened from their saved location and manipulated as required

5.2 Changing Calibration Values

5.2.1 Header Information

Records are processed using the calibration values in the header lines of each log file. For example, the first lines of a file look like:

```
serial,A0045
name,moorereef1
firmware,1.1.1
zeropoint,-9,993,-44
acccal,1011,995,1032,-4,-2,-35
```

```
magcal,204,230,187,-43,-17,36
reserved
reserved
reserved
datetime,acc_x,acc_y,acc_z,mag_x,mag_y,mag_z,batt,temp
2014-11-05 11:31:39.000,-13,937,-92,6,140,209,1780,503
2014-11-05 11:31:40.000,39,-48,-1077,1,-3,-47,1780,503
2014-11-05 11:31:41.000,50,-41,-1100,0,-3,-47,1780,503
2014-11-05 11:31:42.000,48,-45,-1079,0,-3,-48,1780,503
2014-11-05 11:31:43.000,47,-42,-1090,0,-2,-47,1780,503
2014-11-05 11:31:44.000,46,-41,-1073,1,-2,-48,1780,503
2014-11-05 11:31:45.000,62,-42,-1113,3,-2,-46,1780,503
2014-11-05 11:31:46.000,67,-40,-1043,1,-4,-46,1780,503
```

Details of each setting are shown below:

Header Example							Comments
serial	A0005						Unique serial number
name	maggie						Configurable name
firmware	1.1.1						Current firmware version
zeropoint	-13	1023	50				Zero point [x,y,z]
acccal	1017	1011	1066	3	39	42	Accelerometer calibration scale [x,y,z], offset [x,y,z]
magcal	207	232	219	11	-50	-17	Magnetometer calibration scale [x,y,z], offset [x,y,z]

5.2.2 Magnetometer Calibration

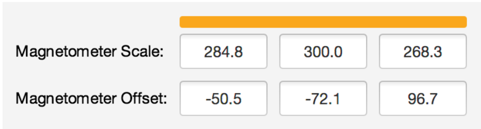
Magnetometer calibration is performed whenever the batteries are changed (see Section 2.2.3). If the batteries are changed and the instrument is deployed without re-calibrating the magnetometer, the calibration values in the corresponding log file will refer to the previous set of batteries, and thus the processed data may give incorrect direction measurements.

One fix is to tick the *Apply Magnetic Offset Calibration* when processing. This gives best results for large tidal currents; however, it may give incorrect results when the range of current speed or direction measurements is small.

Instead, if the batteries used for deployment are still inserted and retain charge, a magnetometer calibration can be performed post-deployment.

1. Do not remove the batteries. Perform a magnetometer calibration as described in Section 3.3.2. Make a note of the 6 calibration values.
2. Open the log file corresponding to the deployment using *Notepad* (Windows) or *TextEdit* (Mac). Do not use *Microsoft Excel* or any other spreadsheet program. Often these programs are set to open CSV files by default, so either open the record file via *Notepad* / *TextEdit* or right-click the file and click the *Open As:* (Windows) or *Open With* (Mac) option in the popup menu to choose the correct program.

③ Record the old `magcal` values just in case, then replace them with the new magnetometer calibration values. The first three value are the x, y, z scales, the last three are the x, y, z offsets. **The values must be in whole numbers.**
For example, for a magnetometer calibration as shown below:

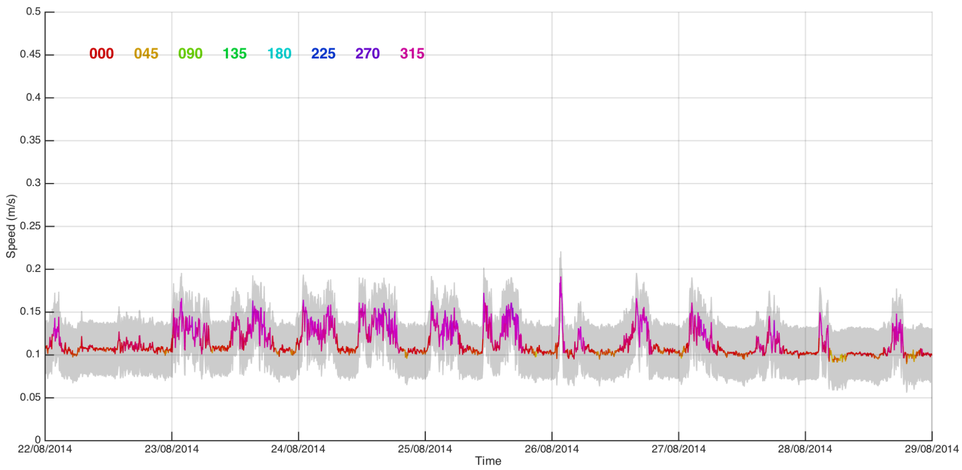


The new magnetometer calibration line would be written: `magcal,285,300,268,-51,-72,97`

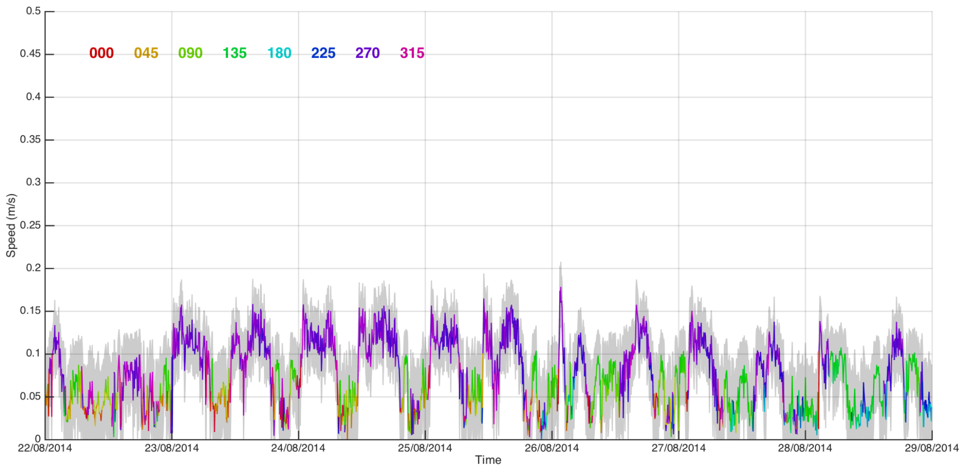
④ Save the log file. Re-run processing using the updated log file.

5.2.3 *Zero Point Calibration*

The zero point is factory calibrated but can change with temperature or if a different enclosure is used to house the logger. The effect of an incorrect zero point is a tilt offset in a particular direction, resulting in a speed offset, which is stronger at low speeds, in the same direction. An example of a bad zero point is shown below:



The figure shows an offset of approximately 0.1m/s in the north (heading 000) direction. The output for the correct zero point is shown below:



If a constant offset is observed in the processed results, an incorrect zero point can be suspected. A post-deployment zero point calibration can thus be performed to check the results.

1. Perform a zero point calibration as described in Section 3.3.3. Make a note of the 3 calibration values. Another set of batteries may be used, different to that used in deployment, if necessary.

2. Open the log file corresponding to the deployment using *Notepad* (Windows) or *TextEdit* (Mac). Do not use *Microsoft Excel* or any other spreadsheet program. Often these programs are set to open CSV files by default, so either open the record file via *Notepad* / *TextEdit* or right-click the file and click the *Open As:* (Windows) or *Open With* (Mac) option in the popup menu to choose the correct program.

3. Record the old `zeropoint` values just in case, then replace them with the new zero point calibration values, ordered by x, y, z. **The values must be in whole numbers.**

4. Save the log file. Re-run processing using the updated log file.

Chapter 6
Service and Support

For repairs, replacement parts or any other support, please contact:

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