STAR : ODDI

Starmon compass

Hands-on description

Heading, Pitch & Roll, 3D Tilt, Depth, Temperature Data Logger

Contents

General Description 3
1 Compass Heading with Pitch & Roll 3
1.1 Horizontal position: Compass heading and pitch & roll 4
1.2 Vertical position: Compass heading and pitch & roll 5
2 Three directional (3D) tilt acceleration sensor 5
3 Viewing measurements in real-time 8
4 Launching the logger for measurements 9

General Description

The Starmon compass data logger measures heading, pitch & roll, 3D acceleration, 3D tilt-acceleration, depth/pressure and temperature. The logger can be attached horizontally or vertically. Each logger is delivered with a temperature and pressure calibration certificate.

1 Compass Heading with Pitch & Roll

The compass heading is measured with reference to the earth's magnetic North.
The heading measurements are compensated with the pitch and roll measurements. This enables good tilt compensation on compass heading data for optimal accuracy. It should be noted that iron and some other metallic objects close to the sensor may influence the heading accuracy. The larger the object, the more influence.

Heading data are displayed in degrees (with reference to magnetic North) where:

0° = North
45°= Northeast
90°= East
135° = Southeast
180°= South
225°= Southwest
270°= West

This would mean that a heading output like 22° for example can be approximated to North. The operating software, SeaStar, offers data conversion to true North, as explained in the Reconvert chapter in the Starmon compass user manual, accessible under the Help menu in the Seastar user software.

The Starmon compass has a built in chip containing both heading and pitch and roll sensors. It is critical for the user to know how different placements of the logger affect the data output from those sensors. Data quality is dependent on correct placement on the gear being studied.

For mounting flexibility, the logger can be set to measure the heading direction from either a horizontal or a vertical position. This is defined in the SeaStar software upon launching into measurement mode. In both cases the compass heading is associated with tilt angles defined as Pitch and Roll angles (X and Y axis). The 2D pitch and roll sensor can show a 0° start-up pitch and roll reference in both horizontal and vertical position.

The pitch has a ±90° range but the roll has a ±180° range. The Roll will change to 180° when the Pitch crosses the 90°, and that goes for both the horizontal and the vertical position definition.

1.1 Horizontal position: Compass heading and pitch & roll

The Starmon compass has four lines on its housing, at the probe end. One line is marked with the letter **C** which is the reference line for the compass heading.

When placing the logger in a horizontal position, the line marked with the letter **C,** should face directly up as shown in figure 1.1. In this position the pitch and roll are at 0° tilt. The sensor probe end should face onward, in same direction as the gear moving forward.

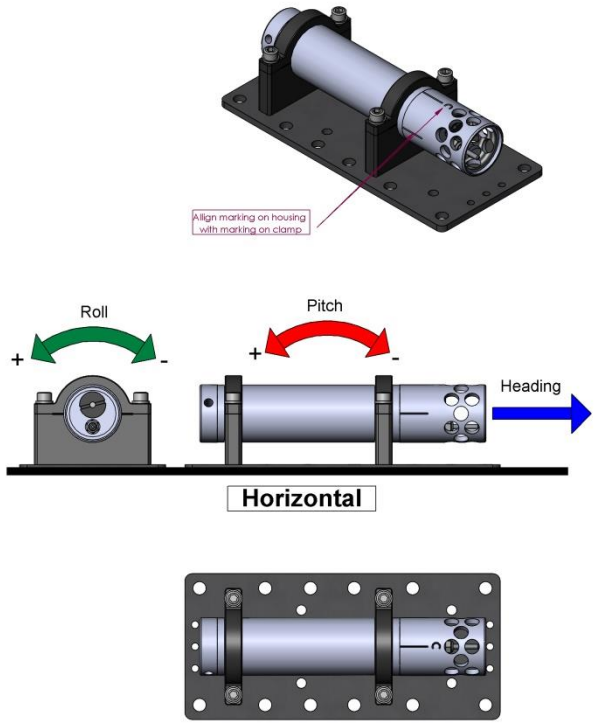

Figure 1.1 Horizontal positioning

1.2 Vertical position: Compass heading and pitch & roll

If the logger is to be placed vertically, then the probe end must face downwards as shown in figure 1.2. Furthermore, the line marked with the letter **C** on the logger housing should face straight onward, in same direction as the gear moving forward.

The heading position is defined by the line on the housing and if the logger is on a fastening plate as shown in figure 1.2 it is perpendicular to the plate through the logger. That way the two lines on each side of the **C** line would be parallel, having same distance from the plate. In the position shown in fig. 1.2 the plate would be mounted at the front or at the nose of the gear.

When placed vertically the pitch and roll are now defined as shown in figure 1.2.

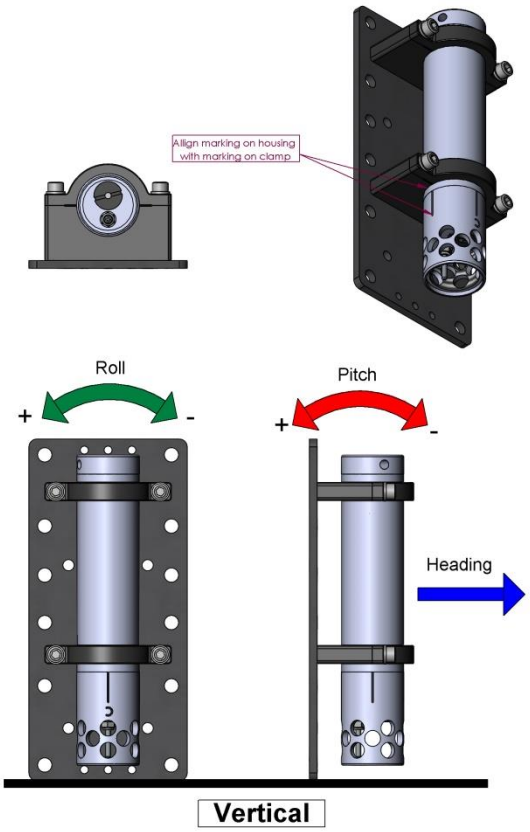

Figure 1.2 Vertical positioning

2 Three directional (3D) tilt acceleration sensor

The logger has an additional 3D acceleration sensor giving three axis tilt (X, Y and Z) data output, stored in a separate data file. Unlike the 2D pitch and roll sensor discussed earlier, the 3D tilt sensor only shows pitch and roll as 0° in a horizontal position. This is the same 3D acceleration sensor as used in the Starmon tilt model. Figure 2.1 shows the three axis X, Y and Z.

3D-Tilt orientation

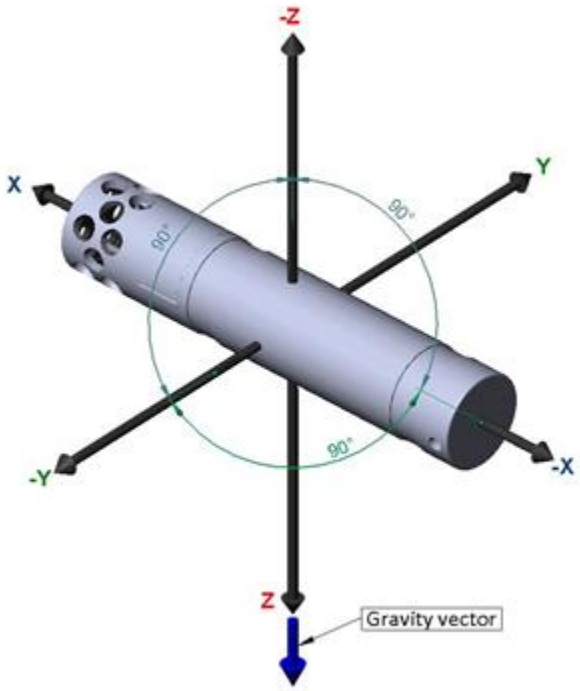

Figure 2.1 Starmon compass 3D-tilt axis

When sitting horizontally on a flat plane and the longest line facing directly up, the axis should give approximately:

X = 0°
Y = 0°
Z = 90°

The tilt measuring range is +/-90° for each axis.

The tilt angles are referenced to the local horizontal plane, i.e. the plane perpendicular to the earth's gravitational vector.

X axis tilt is defined as the angle between the recorder's longitudinal axis and the local horizontal plane (positive for nose up). Y axis tilt is defined as the angle about the longitudinal axis between the local horizontal plane and the actual logger orientation (positive for right wing down).

When the logger is placed horizontally the following applies:
If the recorder is rolled to the portside, i.e. to the left, seen from the threaded end cap of the logger, the Tilt-Y measurements are negative down to -90°. If rolled to the starboard (to the right), the Tilt-Y measurements become positive up to +90°C.

The Tilt-X axis rises positively when the sensor end of the housing tilts up but declines negatively when tilting down.

The 3D tilt values are not displayed together with other sensors parameters but can be accessed in a text file or viewed as graph and table. See more in the **View Data** chapter in the Starmon compass user manual.

The 2D Pitch and Roll data (X, Y axis) displayed in a graph and table upon data retrieval are generated from the heading sensor chip, a separate sensor from the 3D acceleration sensor and with greater accuracy than measured with the 3D sensor. If 2D pitch and roll is sufficient for the analysis then the 3D data file has low importance.

3 Viewing measurements in real-time

The software offers an online view of measurements while the logger is connected to a computer. This feature is helpful in learning about the functionality of the heading, pitch and roll sensors when placed in different directions and angles. It is recommended to do an online or offline test before placing the logger on gear. When doing an online test the measurements can be viewed in real-time as shown in figure 3.1.

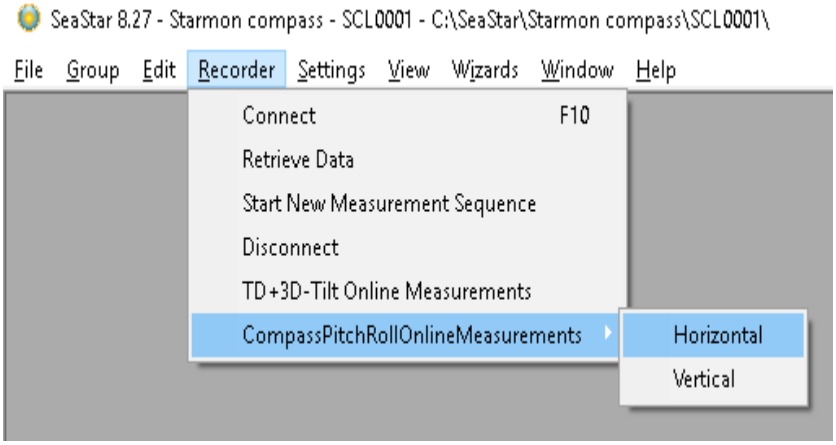

Figure 3.1 Online measurements options

After choosing either a horizontal or vertical position, the measurements are displayed on a screen with a graph and table as show in figure 3.2. The user can now manually move the logger into different positions for viewing the results in real-time in the software on the computer screen. The test can be finished by clicking the Exit button and a time-series DAT file is created for the online test performed.

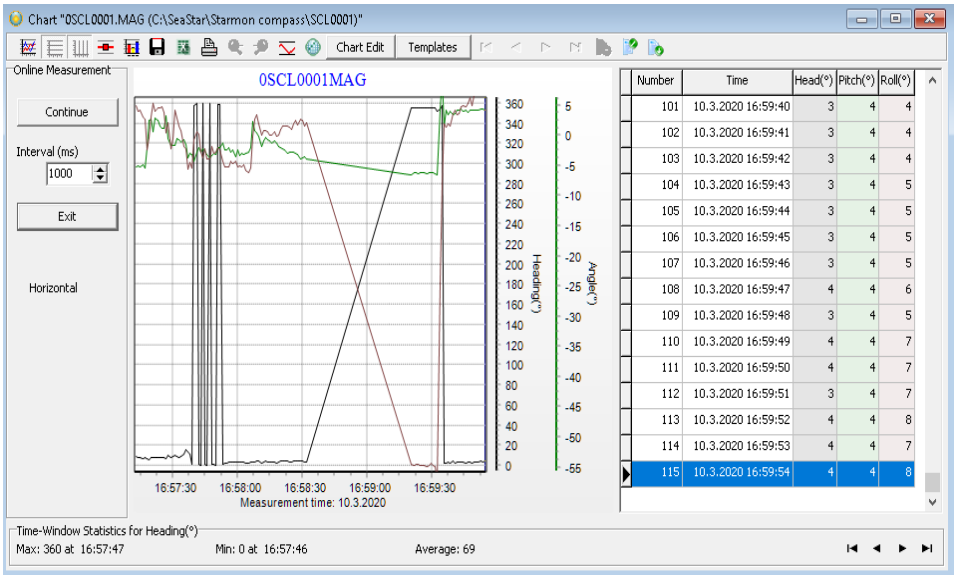

Figure 3.2 Heading, pitch and roll measurements viewed in real-time

4 Launching the logger for measurements

As the logger takes reference to the PC clock it is important to check if the PC clock is correct on the computer before connecting to the logger.

For the interval setup there is the option to run a single interval or to define multiple intervals during the measurement period, where shifting between different intervals is made possible.

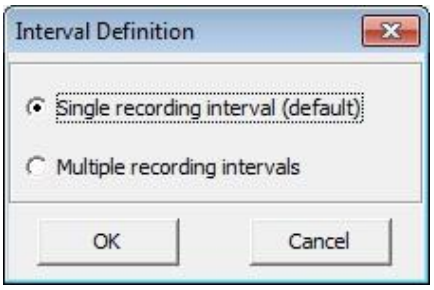

Figure 4.1 Choose single or multiple intervals

Single recording interval definition setup is shown in figure 4.2.

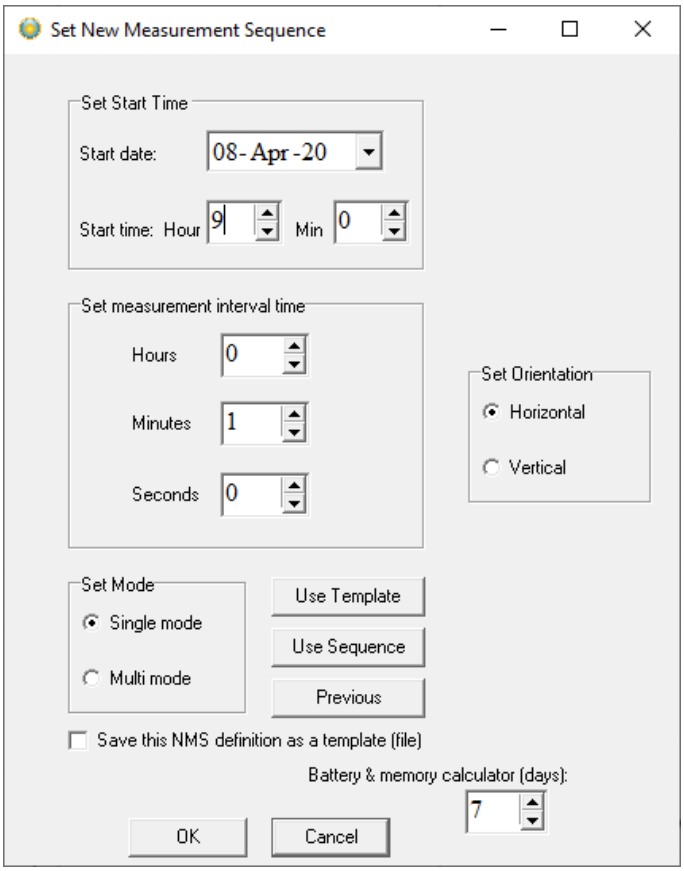

Figure 4.2 Measurement Sequence Definition

Select the **Start Time** of recordings and the **Sampling Interval**.

The **Set Orientation** option gives the user the flexibility to mount the logger horizontally or vertically to the gear. For optimal accuracy of measurements it is critical to set the orientation correctly, which the heading, pitch and roll make reference to. Horizontal is the default position, but vertical would be selected for placing the logger on underwater lines or towed sensor arrays.

By using the **Battery & memory calculation (days)** feature the user can enter the intended length of the research. This is for information purposes only, to help deciding on the interval setup. After the settings have been selected, press the **OK** button. A text file appears with information on how much energy and memory remains after the defined study length. See example on calculation below, for one week in use.

```
Experiment period (7 days) ended : 15-Apr-20 9:00:00 AM
    Total meas. taken      : 10081
    Battery used (%)       :   0,9
    Battery remaining (%)  :  99,0
    Memory left (%)        :  99,5
```

Also reported in same text file is calculation on when the memory fills based on the defined interval and energy remaining after the memory fill. After deciding on the interval setup the new measurement sequence is activated.

Once the **New Measurement Sequence** has been acknowledged, a window appears on the screen in order to verify the settings.

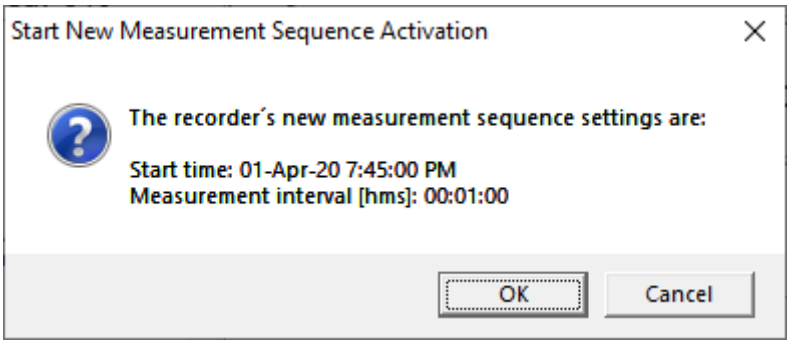

Figure 4.3 Start New Measurement Sequence

Confirm and start recordings by pressing **OK.** The logger goes into **Measurement Mode**.