



KONGSBERG

Operator Manual

Seapath[®] 130 series

Compact GNSS aided Inertial Navigation System

Kongsberg Maritime
ID: 422035/F





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Rev. 6.0	June 2024	Updated roll and pitch specifications. Updated the chapter “Post-processing of raw data”.

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Kongsberg Discovery AS endeavours to ensure that all information in this document is correct and fairly stated, but does not accept liability for any errors or omissions.

Warning

The equipment to which this manual applies must only be used for the purpose for which it was designed. Improper use or maintenance may cause damage to the equipment and/or injury to personnel. The user must be familiar with the contents of the appropriate manuals before attempting to operate or work on the equipment.

Kongsberg Discovery disclaims any responsibility for damage or injury caused by improper installation, use or maintenance of the equipment.

Comments

To assist us in making improvements to the product and to this manual, we welcome comments and constructive criticism.

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1 About this manual

1.1 About this manual

Observe the general information about the Seapath 130 series in this manual. This manual applies to the Seapath 130–3, 130–5 and 130–5+ products.

Purpose of manual

The purpose of this operator manual is to provide the descriptions and procedures required to operate the Seapath 130 series of products on a vessel.

Target audience

This operator manual is intended as a reference manual for the personnel operating the system.

License information

Export of the MRU 5+, MRU 5, MRU H, miniMRU 50 or miniMRU 60 component requires an export license.

Registered trademarks

Seapath® is a registered trademark of Kongsberg Discovery AS in Norway and the People's Republic of China.

2 Seapath 130

2.1 Product description

The Seapath 130 is developed specifically for hydrographic surveying where high precision heading, position, roll, pitch, heave and timing are critical measurements. The product combines state-of-the-art dual frequency GNSS receivers (GPS/GLO/GAL/BDS), inertial technology and processing algorithms in a compact and portable package.

The main component is the sensor unit with the motherboard, GNSS antennas and receivers. The sensor unit is to be mounted on top of the vessel mast or pole. On top of the transducer, the inertial sensor of type MRU 3, 5 and 5+ is mounted within a light weight subsea bottle. The Seapath operator software is installed on a connected PC for configuration and monitoring. All the components are connected through a spider cable with MRU (Motion Reference Unit) connection, three configurable serial lines, DGNSS (Differential GNSS) correction input, 1PPS output, network communication and power inlet.

The latest Seapath software includes Automatic Online Calibration (AOC) that significantly improves the roll and pitch accuracy. With the AOC functionality recalibration of the IMU is now longer required if the vessel is in motion with heading changes (not stationary vessels).

The Seapath 130 series is delivered in the following and improved product range:

- **Seapath 130–3** with MRU 3 to 0.010° roll and pitch accuracy
- **Seapath 130–5** with MRU 5 to 0.008° roll and pitch accuracy
- **Seapath 130–5+** with MRU 5+ to 0.005° roll and pitch accuracy

Note

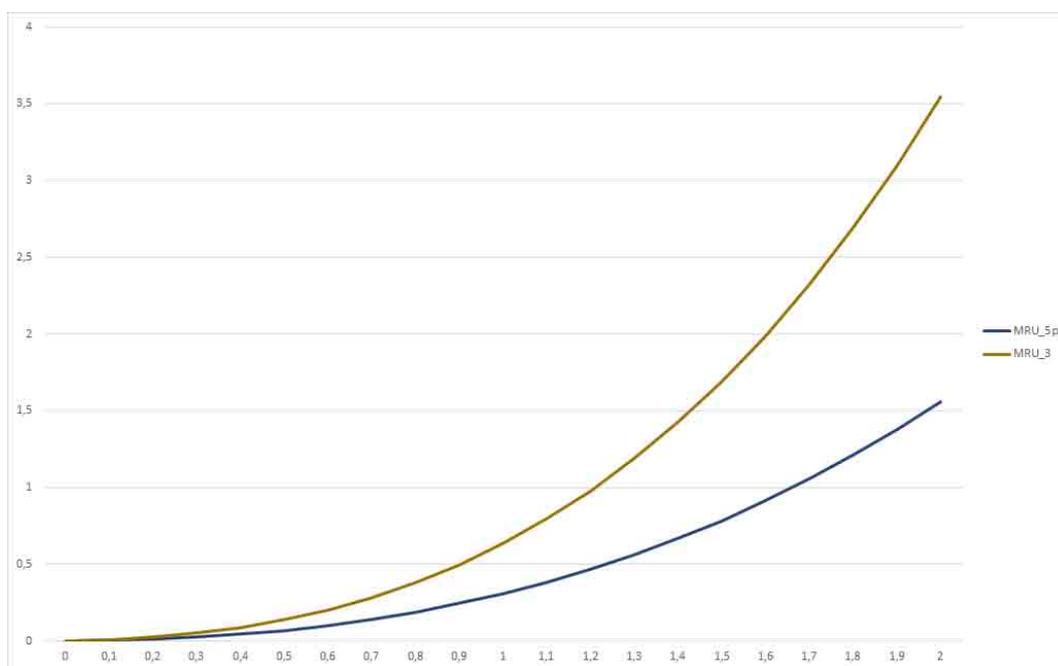
The MRU 3 model part of Seapath 130–3 has to be mounted in a fixed direction relative to the vessel and that is with the connector pointing up or down. Else the performance of the Seapath 130–3 will be degraded.

The advanced Seapath navigation algorithms integrate the RTK GNSS data with the inertial sensor data. This gives the Seapath 130 unique advantages compared to stand alone RTK products. The Seapath product's accurate roll, pitch and heading measurements allow the RTK antenna position to be referenced to any point on the vessel where accurate position and velocity are required. All the data from Seapath have

the same time stamp and the output is in real-time. Subdecimetre position accuracy can be achieved through download of satellite orbit and clock data from internet and by post processing of satellite and IMU (Inertial Measurement Unit) data. The Seapath is robust against GNSS dropouts by using the inertial sensor for dead reckoning navigation in order to provide position, velocity and also heading measurements when GNSS is not available.

With latest Seapath software the typical position drift for MRU 3, and MRU 5/5+ after GNSS dropout is shown in the plot below:

Figure 1 Typical position drift in meters after GNSS dropout in minutes

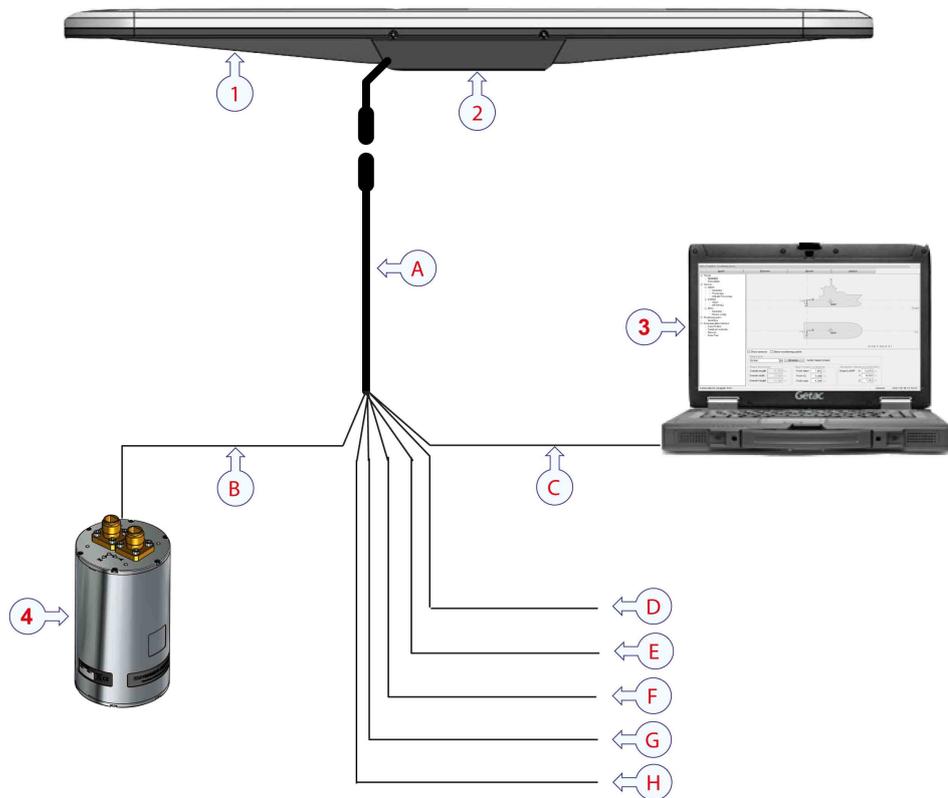


The product has three configurable RS-232/422 serial lines and Ethernet for output of motion data and NMEA messages to the multibeam and survey computer. Input of DGNSS corrections of various quality and sources are input on a configurable RS-232/422 serial line or Ethernet.

By utilising standard DGNSS, Fugro SeaSTAR XP2/G2/G4/G4+, VERIPOS Ultra/Ultra², C-NavC¹, C-NavC² and RTK corrections, this system is a unique solution for hydrographic surveying and dredging work which demand the most comprehensive, most accurate surveying data available.

2.2 System diagram

A system diagram for a Seapath setup.



Main units

- 1 Sensor unit with 1 meter cable with male connector
- 2 Mounting bracket
- 3 Seapath operator software installed on a PC (not part of the delivery)
- 4 Motion reference unit (MRU) in subsea bottle

Cables

- A Cable to the sensor unit, part of the spider cable, 20 meter length with female connector
- B MRU umbilical cable with 8-pin SeaCon connector, 15 meter length
- C Ethernet cable to PC and other users, 5 meter length
- D Input/output serial line for GNSS corrections with 9-pin Dsub, 5 meter length
- E Output serial line for motion data to multibeam or survey computer with 9-pin Dsub, 5 meter length
- F Output serial line for NMEA data with 9-pin Dsub, 5 meter length
- G 1PPS output with 9-pin Dsub, 5 meter length
- H 24 VDC input, 5 meter length

2.3 System units

The Seapath product comprises the following main components.

2.3.1 Seapath 130 sensor unit description

The sensor unit runs the navigation software. This software combines the GNSS signal and the inertial measurements to determine accurate position, heading, attitude and heave signal. This software utilises Kongsberg Discovery AS advanced true multi-reference algorithms for real-time parallel processing of all available correction signals.

The sensor unit includes:

- Two GNSS receivers and antennas
- Motherboard
- Connector board for termination of the spider cable
- Cable of 1 meter with male connector
- Mounting bracket



2.3.2 MRU description

The MRU (Motion Reference Unit) is designed for motion measurement in marine applications. The unit incorporates 3-axis sensors for linear acceleration and angular rate, along with complete signal processing electronics and power supply. The MRU outputs absolute roll and pitch as well as dynamic acceleration in the north, east and down direction, velocity and relative position.

The interior of the MRU is divided into two sub-assemblies consisting of an electronic part and a sensor part. The sensor unit shall not be repaired or serviced by anyone else than Kongsberg Discovery AS.



2.3.3 Light weight MRU subsea bottle description

The MRU is mounted in a light weight subsea bottle. The top and bottom cover plates of the bottle are made of PVC and the cylinder of aluminum. The bottle is designed for use down to 10 metres. The MRU is mounted on a steering plate inside the bottle.

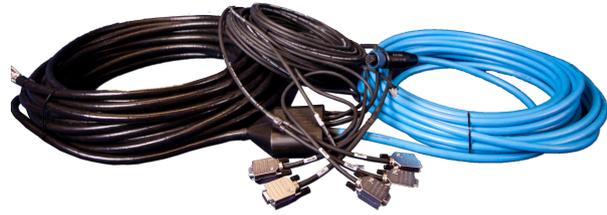
On the outside there are four mounting holes (M6) on both cover plates. The mounting direction of the MRU within the bottle is indicated on the bottom cover plate.

The bottle is delivered with two 8-pin Seacon connectors, one for serial and one for Ethernet communication.



2.3.4 Spider cable description

The product is delivered with a spider cable for sensor unit connection through the female connector, MRU connection through the 8-pin SeaCon connector, three configurable serial lines through 9-pin Dsubs, 1PPS output through 9-pin Dsub, network communication and power inlet.



Delivered in either 20 meter length or 8 meter length (short).

2.4 Network security

Equipment manufactured by Kongsberg Discovery AS is frequently connected to local area networks (LAN). Connecting any computer to a network will always expose the data on that computer to all other computers connected to the same network. Several threats may immediately occur:

- Remote computers can read the data.
- Remote computers can change the data.
- Remote computers can change the behaviour of the computer, for example by installing unwanted software.

Usually, two parameters are used to define the threat level:

- 1 The likelihood that any remote connection will do any of the above.
- 2 The damage done if a remote connection succeeds doing this.

Because Kongsberg Discovery AS has no information regarding the complete system installation at a location, we can not estimate the threat level and the need for network security. For this reason, we can not accept responsibility for network security. Systems provided by Kongsberg Discovery AS are regarded as stand-alone offline systems, even though they may be connected to a network for sensor interfaces and/or data distribution.

Note

No network safety applications are installed on any Kongsberg Discovery computers. The computers are thus not protected against viruses, malware or unintentional access from external users.

Securing the system itself has no meaning unless there is a policy in place that secures all computers in the network. This policy must include physical access by trained and trusted users. The customer/end user of the system will always be in charge of defining and implementing a security policy, and providing the relevant network security applications.

Note

Kongsberg Discovery AS will not accept any responsibility for errors and/or damages caused by unauthorized use or access to the product.

2.5 Support information

- **Company name:** Kongsberg Discovery AS, Seatex
- **Address:** Havnegata 9, 7010 Trondheim, Norway
- **Duty phone:** +47 33 03 24 07 (24 hours)
- **Support e-mail address:** support.seatex@kd.kongsberg.com
- **Website:** <http://www.kongsberg.com/discovery>

KM-Support App

Support is also available from the KM Support App. This app is available for free in App Store and Google Play.

3 Getting started

3.1 Starting and stopping the Seapath operator software

3.1.1 Starting the Seapath operator software

Start the Seapath operator software to be able to operate the Seapath system. There are two ways to start the operator software.



Procedure

- 1 Double-click the Seapath HMI icon on the desktop to start the software.
- 2 Select the Windows **Start** button and type `Seapath` in the search box. Select **Seapath Operator SW**.

3.1.2 Stopping the Seapath operator software

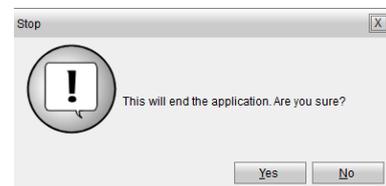
You can stop the Seapath application on your PC.

Note

The system will still calculate and output data if you stop the operator software.

Procedure

- 1 Select the **System** menu → **Stop** → **Operator SW**
The message `This will end the application. Are you sure?` appears.
- 2 Select **Yes** to confirm.



3.2 Restarting the Seapath system

You may need to restart the Seapath system, for example for configuration changes to take effect.

Procedure

- 1 Select the **System** menu →**Restart** →**Sensor unit**

The message `This will reboot the sensor unit. Are you sure?` appears.

- 2 Select **Yes** to confirm.

3.3 Operational principles

The system starts automatically after power on and is operated through the Seapath operator software application installed on an external PC.

The Seapath application has a graphical user interface. Use a mouse and keyboard to operate the application from the application menus and to navigate and select in the menus. Some commands may also be executed by use of key combinations.

3.3.1 Operator software configuration description

You can adjust the appearance of the display views through the **Operator software configuration** dialog box.

The dialog box contains tab pages for various presentation options and each page contains two confirmation buttons with different properties and a cancel button.

- **OK button:** selecting the **OK** button will save the changes and close the **Operator software configuration** dialog box.
- **Apply button:** selecting the **Apply** button will save the changes but the **Operator software configuration** dialog box will not close.
- **Cancel button:** selecting the **Cancel** button will close the dialog box and changes will not be saved.

Note

The position properties selected in the Operator software configuration dialog box are only for display purposes.

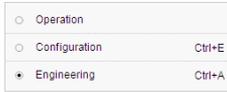
3.3.2 Changing the system mode

The system has three modes: **Operation**, **Configuration**, **Engineering**. To be able to make changes to the setup you must be in **Configuration** or **Engineering** mode. You need a password to enter these modes. The password is **STX** and it is not case sensitive. The password is not possible to change.

Via the System menu**Procedure**

- 1 Select the **System** menu →**Change system mode**.

- 2 Select either **Configuration** or **Engineering** to open the **Change system mode** dialog box.



- 3 Type the password **STX** and select **OK**. The password is not case sensitive. You are now able to carry out changes and/or set system parameters.

With keyboard commands directly from the display

Procedure

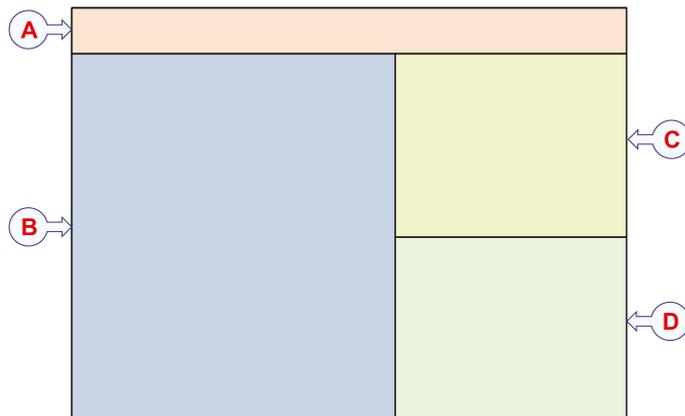
- 1 In the display, press
 - **CTRL+E** to enter Configuration mode
 - **CTRL+A** to enter Engineering mode

Observe that the **Change system mode** dialog box appears.

- 2 Type the password **STX** and select **OK**. The password is not case sensitive. You are now able to carry out changes and/or set system parameters.

3.3.3 Browsing or switching display views

The display is divided into three view sections: View 1, View 2 and View 3. You can select which view you want to appear in these sections.



- A** Top bar
- B** View 1
- C** View 2
- D** View 3

Menu selection

In the **View** menu, select the browse or toggle option.

Keyboard commands

Press the **F2** key to browse to the next available view in View 2.

Press the **F3** key to switch the contents of View 1 and View 2.

View	
Browse top views	F2
Browse bottom views	Shift+F2
Toggle top view	F3
Toggle bottom view	Shift+F3

3.4 User preference procedures

3.4.1 Selecting colour palette for display

You can adjust the brightness and the colours of the display to suit your current light conditions.

Menu selection

In the **View** menu, select the display mode which best suits your current operation:

- **Day white**: this is the recommended colour palette for daylight use.
- **Day black**: this palette has dark background and bright colours.
- **Night**: special colour palette for night operations which will not weaken the night sight of the system operator.



Keyboard commands

You can press the **F7** key to toggle between the day palettes and the **F8** key to switch to the night palette.

3.4.2 Selecting presentation format

You can select which formats to use for the presentation of various data in the display.

In the **View** menu, select the display format you want to set and select your preferred options from the submenu.

The display formats you can modify.

- Date format
- Time format
- Position format
- Datum
- Unit system



Related topics

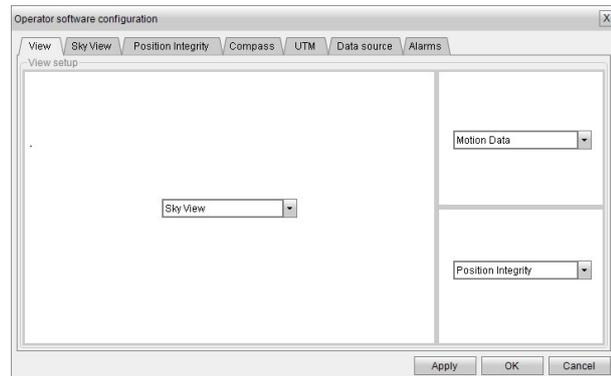
- *View menu* on page 42

3.4.3 Selecting the default position of views in the display

You can select a default appearance of the views in the display so they will appear in the same position each time you start the application.

Procedure

- 1 Select the **System** menu,
→**Operator SW** to open the
Operator software configuration
dialog box.
- 2 Select the View tab.
- 3 Select which view you want for
View 1, View 2 and View 3 from
the drop-down lists.
- 4 Select **Apply** to store the settings.



Related topics

- *System menu* on page 48

4 Operational procedures

The sensor unit starts automatically after power on and it is operated through the operator software installed on an external PC. The operator software is used for performance monitoring, configuration and system troubleshooting.

Normally, the sensor unit outputs signals on the serial lines and Ethernet ports without any involvement from the user. After power on, it takes up to 30 minutes before full accuracy on all data is obtained. Since there normally is no reason to turn off the sensor unit, it should be left running continuously.

4.1 Tuning heave measurement performance

Before a survey and/or during operation, check the Seapath heave performance and tune the heave parameters until the best heave performance is achieved.

Context

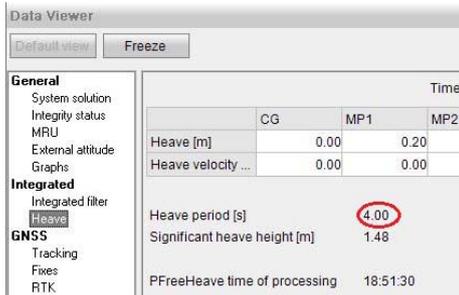
When using the Seapath for real-time heave measurements, it is important to tune the heave period to the vessel size and motion characteristics for the actual weather conditions. The configuration parameter **Heave filter mode** defines default values of the heave period. In order to achieve optimum heave performance, these values have to be tuned for the actual vessel and weather conditions.

The simplest option is to select **Automatic** or **GNSS aided** heave filter mode in **NAV Engine configuration** and let the system estimate the heave filter parameters during operation.

Or you can manually tune the heave measurement performance by checking the heave period parameter in the Data Viewer and then enter this value in the **NAV Engine configuration**.

Procedure

- 1 Select the **Tools** menu → **Data Viewer** to open the **Data Viewer** tool .
- 2 Under **Integrated**, select **Heave**.
- 3 Observe the **Heave period [s]** parameter and close the Data Viewer.



- 4 Select the **System** menu, →**NAVEngine** →**Standard** to open the **NAV Engine Configuration** dialog box.
- 5 Select the **MRU** node →**Heave config**.
- 6 Select **Hydrographic survey** or **General purpose** from the **Options** list.
- 7 Type the **Period** parameter you observed in the Data Viewer. Allowed value between 1 and 25 seconds. Default value is 10 seconds.



- 8 Or you can select **Automatic** or **GNSS aided** for the system to estimate the heave filter parameters.
- 9 Select the **Roll/Pitch dependent** box if you want the heave measurement dependent on the roll and pitch measurements.
- 10 Select **Apply** to store the settings.

Note

*If you decide to let the system automatically estimate the heave filter parameters, by selecting **Automatic** or **GNSS aided**, you do not need to observe the heave period parameter in the **Data Viewer**.*

4.2 Acknowledging events

The Top bar will show if the system has one or more event situations. These can range from informational messages to warnings and alerts. If a situation has been handled and there is no need for it to be displayed, it can be acknowledged and thus removed from the Top bar.

Procedure

- 1 Observe the alarm(s) in the Top bar.
- 2 Select the Event severity symbol, letter **A**, **W** or **I**, for the event to acknowledge the event directly.

Observe that the event disappears form the Top bar.

- 3 Or you can select the **Even list button**  to open the **Event list** and view all events.
- 4 Select the Event severity symbol in the list to acknowledge an event.
- 5 Or you can select the **Alarm menu** → **Ackn. all events** to acknowledge all events.
Observe that there are no events in the Top bar.

Related topics

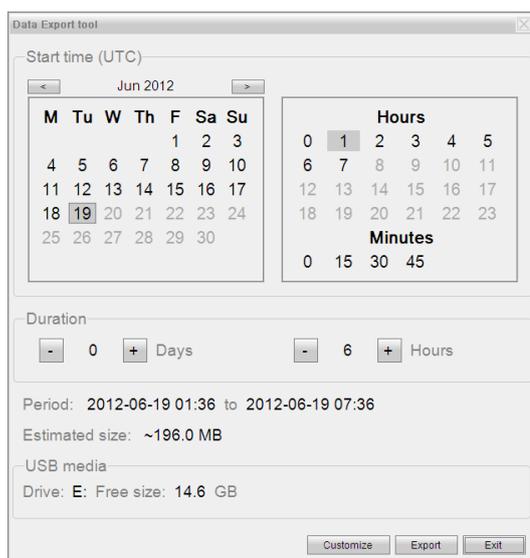
- *Alarm menu* on page 45
- *Events* on page 32

4.3 Exporting system data with Data Export tool

Use the **Data Export** tool to copy log data to a USB flash drive, either for documentation, post-processing or diagnostics purposes.

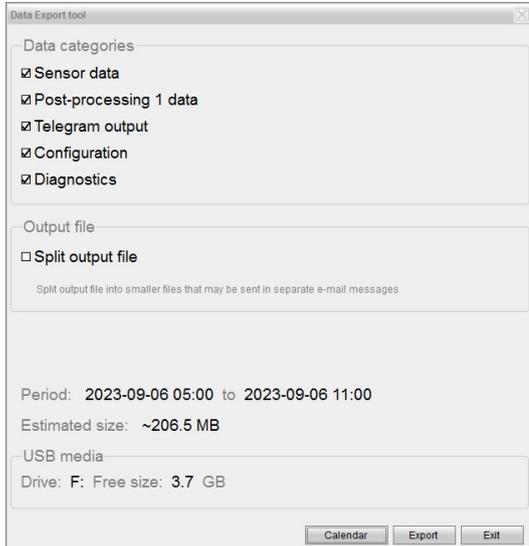
Procedure

- 1 Insert a USB flash drive into the external computer with the Seapath operator software.
If you do not insert a USB flash drive, the files will be written to local disk.
- 2 Select **Tools** → **Data Export**.



- 3 Select the start time for the data export from the calendar.
- 4 Select the duration of the exporting period.
- 5 Select **Customize** if you want to change which data files you want to export.

Select which data you want to export and if you want to split the output file into smaller files.



- 6 Select **Export** to start exporting data.
A progress bar will appear on the screen.
- 7 Exit the **Data Export** tool when the logging session is finished.

Result

The files are zipped and placed on the USB flash drive inside a folder named DataExport.

4.4 Exporting system data with FTP (File Transfer Protocol)

The Seapath system contains an FTP server which can be used to export files to your computer.

FTP client software must be installed on your computer. For installation, see documentation for the chosen FTP client.

The directory structure on the FTP server:

/data/user/loghost

Data from telegram outputs where **Log to file** has been selected in the **NAV Engine Configuration** → **Communication interface** → **Input/Output**. The file name extensions are **.lnn** (lowercase L, not one), where **nn** is the two-digit output number.

/data/user/other

Other directories are used for diagnostic and maintenance purposes. Instructions are given from customer support if these types of files are needed.

Prerequisite

You must be familiar with the sensor unit's internet protocol (IP) address to be able to connect to it.

The default IP address for the sensor unit is: 192.168.1.10.

Procedure

- 1 Start the FTP client software on your computer and connect to the sensor unit IP address.
- 2 Log in by typing the user name and password.
 - **User name:** navigator
 - **Password:** navigatorThe user name and password are case sensitive.
- 3 Select Binary or Text transfer mode depending on how the data shall be used. Binary transfer mode is usually the correct choice for machine-readable data.
- 4 Transfer the wanted files.
- 5 Disconnect.

4.5 Post processing of raw data

Seapath can output raw GNSS and IMU data for post-processing with Field Geospatial's TerraPos.

It is recommended to log the data on Kongsberg Discovery K-Controller system or on another connected logging system. Alternatively, the data can be logged internally in the Seapath system. If logged internally on Seapath, use FTP to download files from the Seapath disk. Login with user name "navigator", password "navigator" and binary transfer mode. The files are found on the user/loghost directory. Use the Ethernet port in the front of the Processing Unit (192.168.1.4). The file extension on the Seapath log files and enabling logging are as follows:

- The **TelegramOut15** interface number is used to log raw GNSS and IMU data to file by the format **Post-processing 1**. The raw data log file will get the file extension *.15.

Note

Make sure to retrieve the data logged internally on the sensor unit periodically if you need it. When the internal disk reaches 80 % of capacity, it will delete the oldest 120 minutes of logged data. The more logging you enable, the faster the disk will fill up.

4.5.1 Configuring Seapath for post processing output

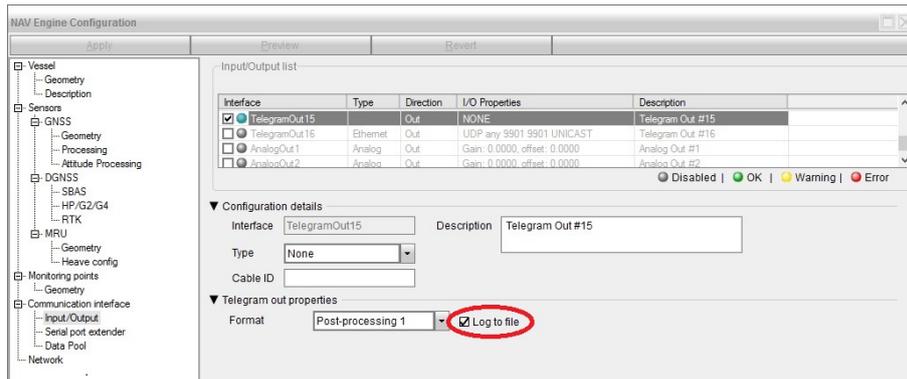
The outputs must be set up and connected to the optional external logging system before data collection starts.

This procedure describes how to set Telegram output interface and, under the **Telegram out properties**, how to set up one output with the following format:

- **Post-processing 1** (include both raw IMU and GNSS data).

Select **Log to file** on the output if the data shall be logged **internally** in the Seapath system.

A possible selection is indicated in the procedure.



Procedure

- 1 Select the **System** menu, →NAVEngine →Standard.
- 2 Select the **Communication interface** node →Input/Output.
- 3 Select the **TelegramOut15** interface in the **Input/Output list**.

Observe that the configuration details for **Telegram out properties** appear at the lower part of the page.

- 4 Select **Type** for output of data on **Serial line**, **Ethernet** or **None**.
- 5 As **Format**, select **Post-processing 1**.
- 6 Select **Log to file** if you want data logged internally.
- 7 Select **Apply** to store the settings.

4.5.2 Post processing of raw data in TerraPos

After you have logged the raw data you can process these data using TerraPos position and attitude post-processing software.

Prerequisites

Contact Kongsberg Discovery AS by email: seatex.sales@kd.kongsberg.com and request the TerraPos software and license.

Context

The TerraPos software integrates satellite positioning and inertial sensors for a full six degrees of freedom solution. It uses Precise Point Positioning (PPP) technology to provide true autonomy: anywhere, anytime - without worrying about base stations or reference networks.

Post-Processed Kinematics (PPK) is also available through selection of a value for **Base station service (CORS)**. Alternatively, the base station files can be added manually by adding a DGNSS setup file. The DGNSS setup is created by selecting the **Tools** menu, →**Edit DGNSS setup**.

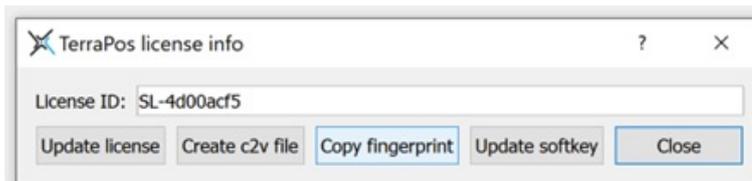
Note

In the procedure below, you only install the TerraPos software once. If TerraPOs is already installed and the softkey updated, you go to Processing data.

Procedure

1 Installing TerraPos software:

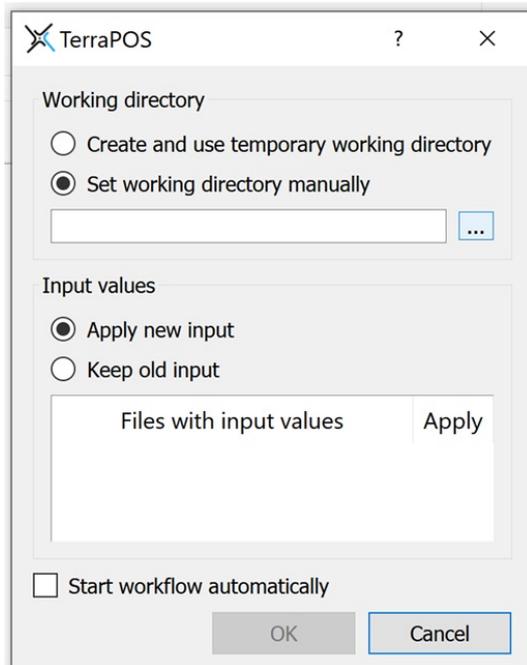
- Request the TerraPos software
- Install the software using the standard options
- Open the TerraPos application and select **Tools** →**License Tool** →**Copy fingerprint**.



- Send the fingerprint to the Kongsberg Discovery AS sales office. You will now receive a file by mail.
- Select **Tools** →**License Tool** →**Update softkey**.

2 Processing data:

- Select **Workflow** →**Seapath** →**Seapath INS**.
- Select **Workflow directory** for where to store the files associated with the project. You can let the system create a directory by selecting **Create and use temporary working directory** or you can select which directory you want to use by selecting **Set working directory manually**.



- Select if you want to **Apply new input** or if you want to **Keep old input**.
- Select **OK**.
- Type a **TerraPos project name**.

Input Execute

Description
Complete INS workflow: Extract raw data, convert to RINEX, tightly coupled INS processing, and export.

Workflow and location

Property	Value
Workflow template	C:/ProgramData/Terratec/TerraPos/system-files/workflo...
Working directory	C:/seatex/Data_and_files/Regen/202311155/terrafos

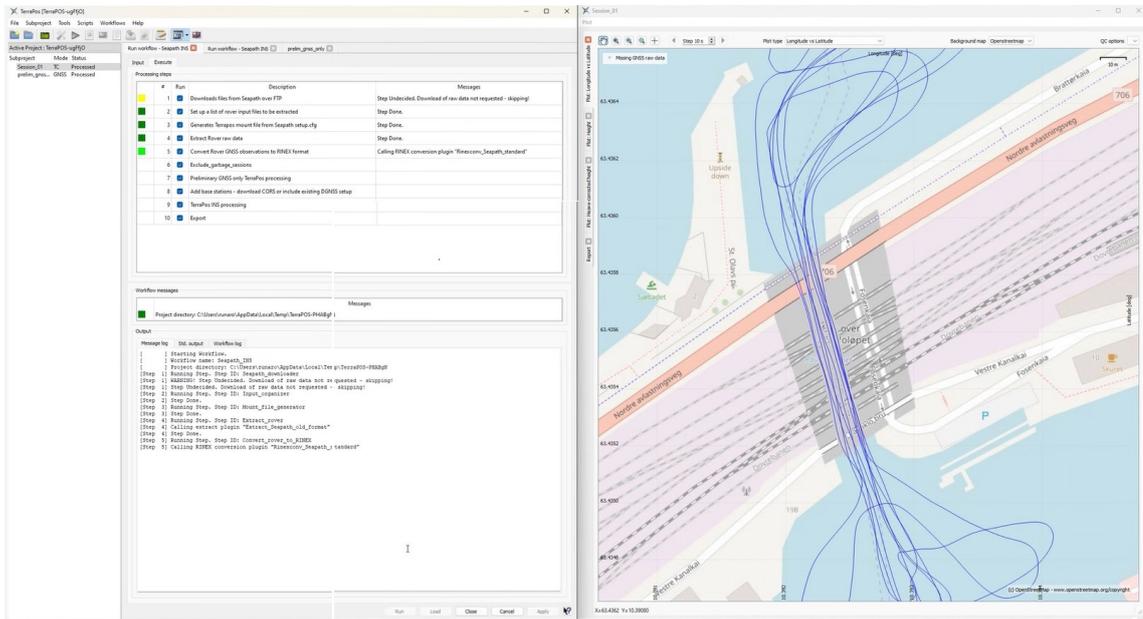
Input

Mandatory Optional Advanced

Property	Value
TerraPos project name	Regen_20231115
Seapath raw data directory	release
Export format	sbt
Transformation	Euref89nor
Height system	
Map projection	
Zone	Automatic
Hemisphere	Automatic

Run Load Close Cancel Apply ?

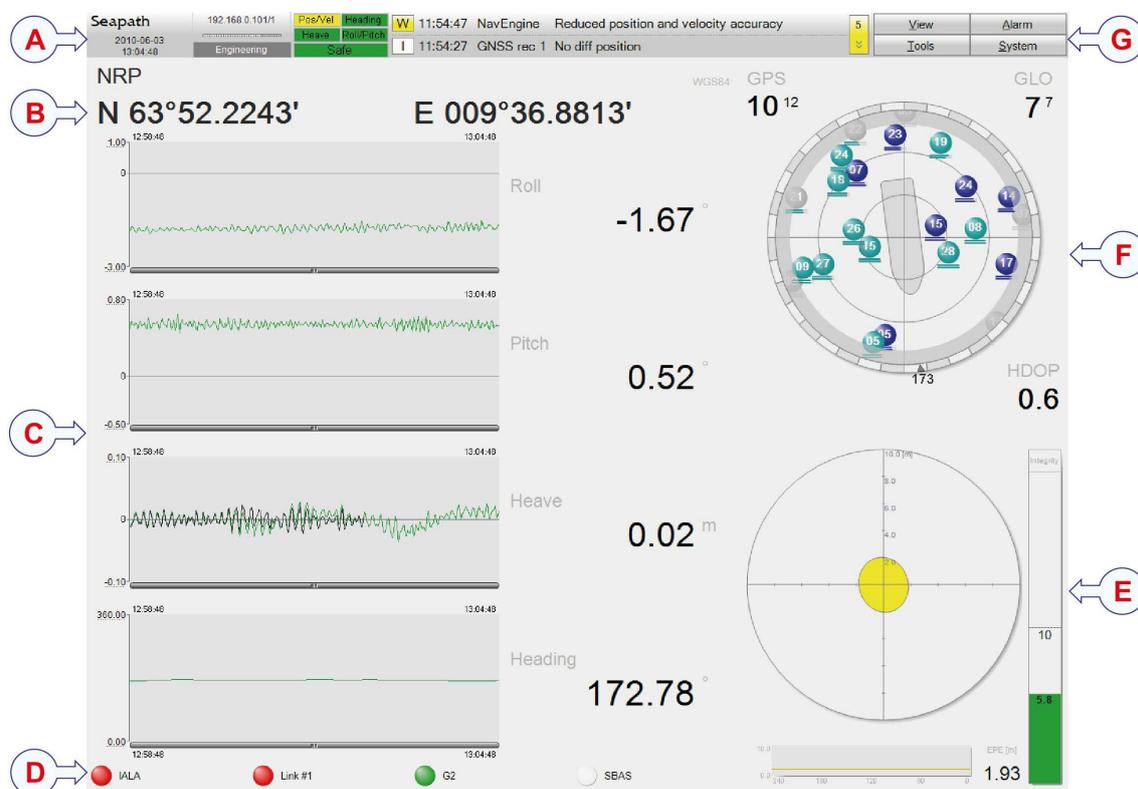
- In **Seapath raw data directory**, select the directory where you have stored the Seapath raw data on format **Post-processing 1**.
- Select data format, **Export format**.
- Select datum, **Transformation**. If you do not select anything here, the default datum is ITRF.
- Select **Run** to run the worrkflow.



5 User interface

5.1 Display organisation

Typical Seapath display.



A Top bar (with Application menu)

B Position data

C View 1

D DGNSS link status bar

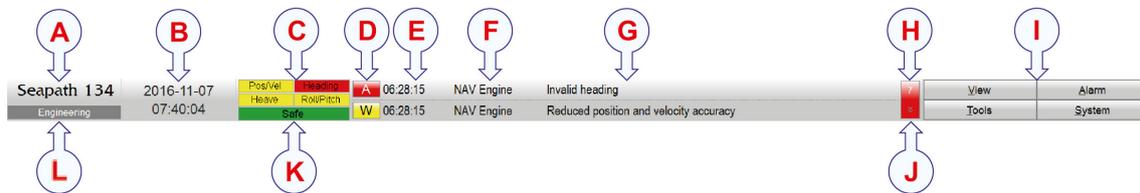
E View 3

F View 2

G Application menu

5.1.1 Top bar

The **Top bar** holds system and system status information as well as the **Application menu** with the various menus in the system.



- | | |
|--------------------------------|--|
| A Type of system | G Event message |
| B Current date and time | H Number of unacknowledged events |
| C Data quality status | I Application menu |
| D Event severity symbol | J Event list button |
| E Event time tag | K System status |
| F Event source | L System mode (indicated only in Engineering or Configuration mode) |

5.1.2 DGNS link status bar

The **DGNS link** status bar holds status information regarding GNSS differential correction data links.



The colour of the symbol indicates the status of the link.

- **Grey:** link not enabled.
- **Yellow:** data received but not used.
- **Green:** data are available and OK.
- **Red:** no data available.

Select the link symbol to open the DGNS Monitor tool for more detailed information about the link status.

Related topics

- *Tools menu* on page 47
- *View menu* on page 42

5.1.3 System modes

There are three system modes, indicated in the System mode area of the **Top bar**:

Operation mode	This is the default mode. In this mode it is not possible to start any external applications, diagnostic tools or re-configure the system. A password is not required to switch to this mode.
Configuration mode	In this mode it is possible to change settings related to the connected sensors, applications and system-wide settings.
Engineering mode	This mode is primarily intended for field engineers during initial installation, fault diagnostics and system-wide re-configuration.

A password is required to switch from *Operation* to *Engineering* or *Configuration* mode. The password is **stx** and it is not possible to change. The password is not case sensitive. The system will return to *Operation* mode after 30 minutes of user inactivity.

5.1.4 System status

There are three system states. The system status describes the position integrity level, and is indicated in the Status field of the **Top bar**. The background colour of this field helps indicate the system status. The system states are:



- Safe: System integrity OK.
- Caution: Reduced system integrity.
- Unsafe: Low system integrity.

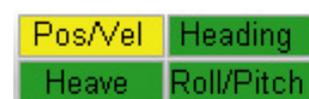
Relate topics

- *Integrity view* on page 36

5.1.5 Data quality status

The system has four data quality status indicators which indicate the status of the system measurements.

- Horizontal position and velocity
- Heave
- Roll and pitch
- Heading



The colour codes represent:

- **Green:** normal operation, input data has good quality.

- **Yellow**: reduced performance, input data has reduced quality.
- **Red**: invalid data or no input data.

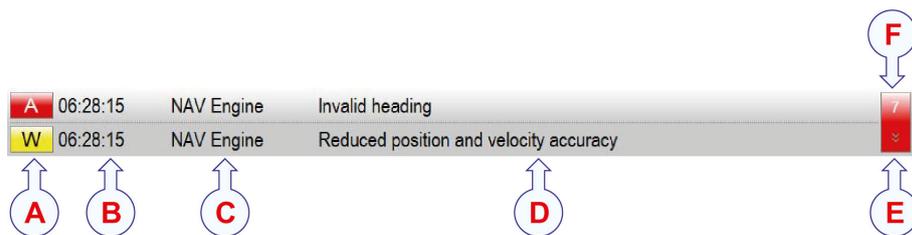
The quality status information output on serial lines or Ethernet is the same as indicated on the data quality status indicators.

5.1.6 Events

Events which appear in the Seapath application can be set up with different alarm types. These alarm types have different severity levels.

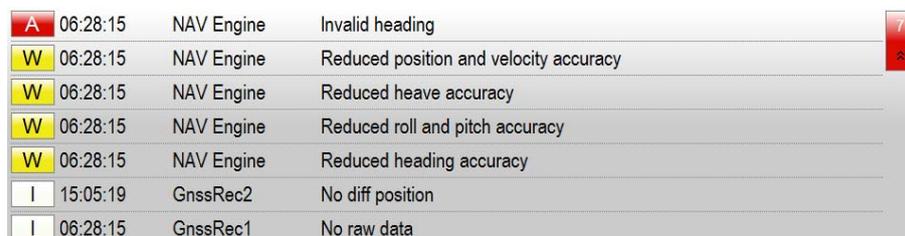
-  **Alarm**: alarms – **high** priority
-  **Warning**: warnings – **medium** priority
-  **Info**: information messages – **low** priority

An event message is acknowledged by selecting the Event severity symbol, letter **A**, **W** or **I**, in the Top bar. When an event is acknowledged, it disappears from the **Event list**. However, the event can still be viewed in the alarm status under the **Alarm** menu.



- | | |
|--------------------------------|--|
| A Event severity symbol | D Event message |
| B Event time tag | E Event list button |
| C Event source | F Number of unacknowledged events |

Select the **Event list button**  to open the **Event list** where you can see all the unacknowledged events. Select the button again to close the list.



5.1.7 Application menu

The four menu buttons located to the far right on the Top bar constitute the **Application** menu. Select a button to open the menu to reveal a drop-down list of sub-menus. These menus offer various operational and visual options.

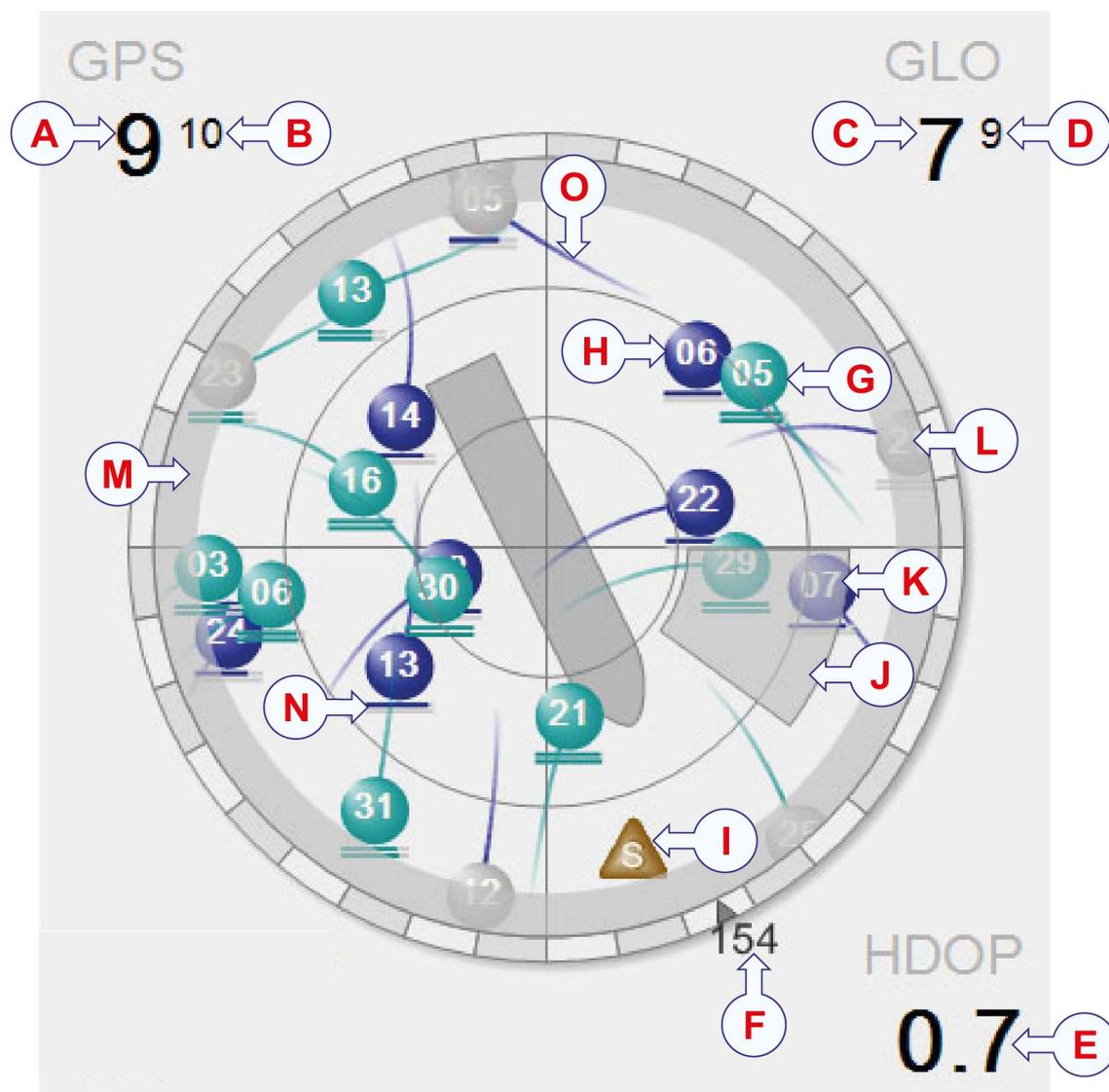
<u>V</u> iew	<u>A</u> larm
<u>T</u> ools	<u>S</u> ystem

- **View:** selections for colour palette, switching between views, display format presentation and display of DGNSS link status bar and/or position data in main view.
- **Alarm:** acknowledge alarms, view status of active alarms.
- **Tools:** selection of operational tools and tools to use for various diagnostic purposes.
- **System:** system configuration, system mode change, system version, system stop and log off.

5.2 Display views

5.2.1 Sky view

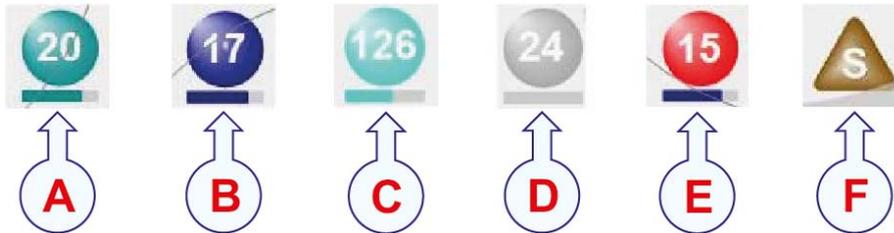
The **Sky view** display shows which satellites the system is tracking and using in the position computation. The satellites are presented according to satellite geometry. The grey outer circle represents the elevation mask. The satellite azimuth angle is according to the north-south axis.



- | | |
|---|--|
| A Number of used GPS satellites | I Correction satellite |
| B Number of tracked GPS satellites | J Shadow sector |
| C Number of used GLONASS satellites | K Satellite under shadow sector |
| D Number of tracked GLONASS satellites | L Satellite under elevation mask |
| E Current HDOP value | M Elevation mask |
| F Vessel heading | N Signal-to-noise ratio indicator |
| G GPS satellite | O Track plot |
| H GLONASS satellite | |

The number of GPS and/or GLONASS satellites tracked and used in the position solution, is presented in the upper left and right corners of the display.

The satellite colours represent type of satellite and condition of satellite.



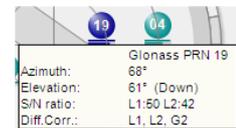
- | | |
|----------------------------|-------------------------------|
| A GPS satellite | D Disabled satellite |
| B GLONASS satellite | E Rejected satellite |
| C SBAS satellite | F Correction satellite |

The satellites with grey colour are disabled as they are not used directly in the position fix. Satellites with red colour are faulty and not used in the position fix.

The bar(s) at the bottom of each satellite represent(s) the signal-to-noise level for the satellite, and the longer the bar, the stronger the signal.

The upper bar indicates the signal strength for GNSS receiver 1, the lower for GNSS receiver 2.

When the cursor hovers over a satellite symbol, a tooltip will appear with the status of the satellite including azimuth, elevation, L1/L2 signal-to-noise ratio and differential correction availability.



If the vessel has a gyro interfaced, the display shows the vessel's true heading.

The shadow sector represents areas with obstructions. You can add shadow sectors. Adding shadow sectors will have no effect on calculations but will assist in explaining why some satellites are not used in the position fix.

The HDOP (Horizontal dilution of precision) is a measure of the geometric quality of a GPS satellite configuration in the sky. The smaller the DOP number, the better the geometry.

You can select the appearance of the Sky view from the **System** menu → **Operator SW** → **Sky view** tab. Here you can enable or disable the correction satellites, the signal strength bars, the track plot length, shadow sectors and the elevation mask.

Related topics

- For more details on the Sky view, refer to the *Installation manual*.

5.2.2 DGNSS view

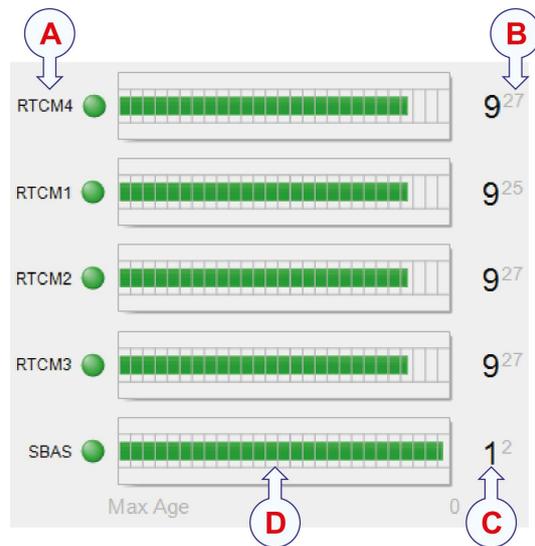
The **DGNSS** view indicates the status of the available correction links.

The link status for all links is indicated with a colour:

- **Green:** correction data are received and used in the position solution.
- **Yellow:** data are received but not used.
- **Red:** no data are received through that link.
- **Grey:** the link has been disabled for some reason.

Status of up to 9 correction links can be displayed. Each link is identified by a name which is defined in the **NAV Engine Configuration** dialog box, **Communication interface** node →**Input/Output**. The number of reference stations used in the position calculation and the number of reference stations available, are indicated for each correction link.

- A** Name of correction link
- B** Number of available reference stations
- C** Number of reference stations used in the position solution
- D** Age of correction data



The **DGNSS** view presents each link as a circular button and presents a bar that indicates the quality as the age of the corrections received through that link. If a bar is filled green, the correction signals are newer. The older the signals are, the shorter the bar is.

If the bar is grey, the age of the corrections has exceeded the maximum age, and the corrections from the link are not in use.

If you select one of the link buttons, the **DGNSS Monitor** appears. This view lists details of all available reference stations from all correction links.

Select the **System** menu →**NAV Engine** →**Standard** to enter the **NAV Engine Configuration** dialog box. You will find the DGNSS configuration details under the **Communication interface** node →**Input/Output**.

Related topics

- For more details on the DGNSS view, refer to the *Installation manual*
- *Tools menu* on page 47

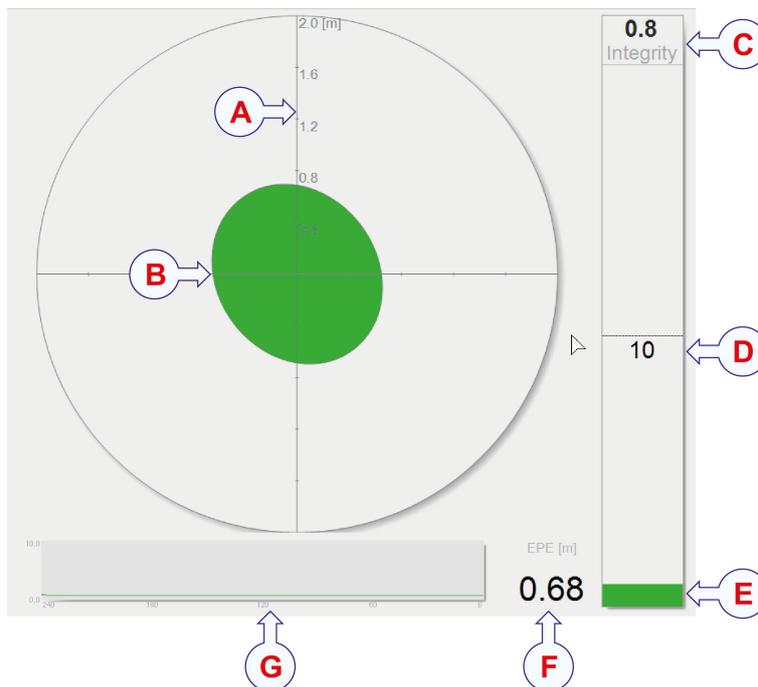
5.2.3 Integrity view

The **Integrity** view indicates the position integrity of the system position according to the IMO requirements to positioning equipment based on the RAIM exclusion and detection algorithm implemented. The integrity indication for different position accuracy levels is expressed in three states (Safe, Caution and Unsafe) according to the requirements. The different states are indicated with colours (green, yellow and red) on the vertical bar in the view.

The error ellipse describes the position quality and the geometry of the position solution. The position accuracy level is configurable from the setup file (the value is displayed as the outer circle on the axis). Default value is 10 m.

The system integrity value is often referred to as the horizontal external reliability. It gives an indication of how large a horizontal position error might be, at the condition of an arbitrary undetected satellite failure.

- **Safe (green)** indicates that the system accuracy is below the selected accuracy level and that a single satellite failure cannot make the actual horizontal position error exceed the selected integrity limit (95 % confidence level).
- **Caution (yellow)** indicates that the system accuracy is below the selected position accuracy level but a single satellite failure might not be detected. If such a satellite failure is detected, the actual horizontal position error might exceed the selected integrity limit (95 % confidence level). With only four satellites (three when height aiding is chosen), there is no way to detect a satellite failure, and the system will always be in the state Caution or Unsafe. The expected accuracy and HDOP might still be reasonably low.
- **Unsafe (red)** indicates that the system accuracy is above the selected accuracy level (95 % confidence level)



- A Diagram resolution scale, configurable
- B Error ellipse
- C Integrity indication bar value
- D Default position accuracy value, 10 m
- E Integrity indication bar
- F Current EPE (Estimated Position Error)

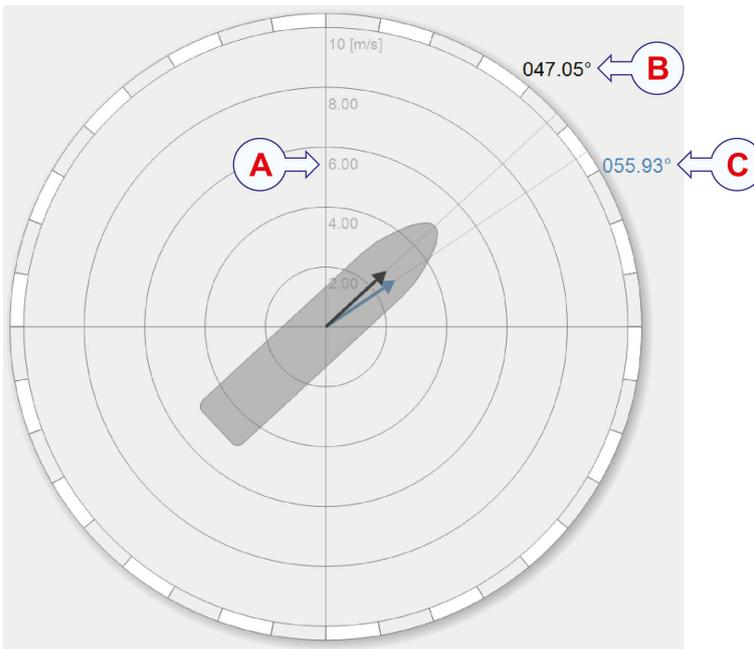
G Graphical presentation of EPE over the last 240 seconds

Related topics

- For more details on the Integrity view, refer to the *Installation manual*.

5.2.4 Compass view

The **Compass** view shows the vessel heading, course over ground (COG) and speed over ground (SOG). The arrow heads indicate the speed according to the speed scale.



- A** Speed scale
- B** Vessel heading and (HDG) and speed along ship (SL)
- C** Vessel speed over ground (SOG) and course over ground (COG)

Related topics

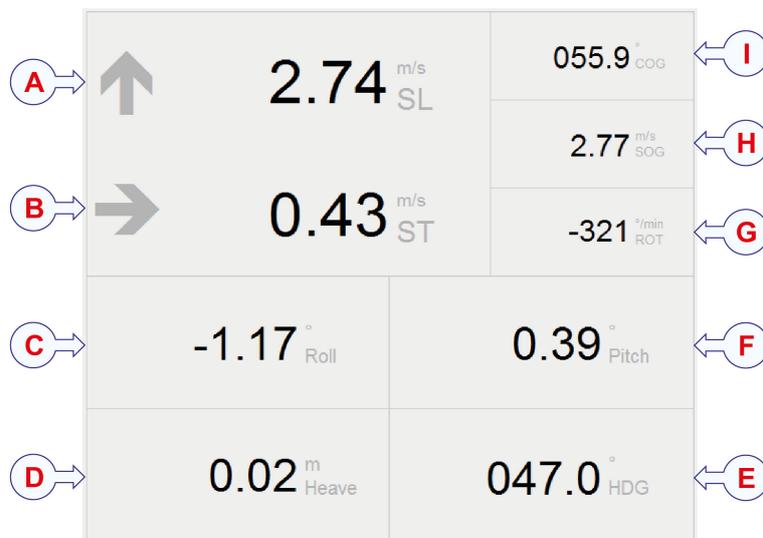
- For more details on the Compass view, refer to the *Installation manual*.

5.2.5 Motion data view

The main function of the **Motion data** view is to give information about the speed and heading of the vessel.

Longitudinal and transversal speed (SL and ST) are presented together with arrows indicating forward/aft and port/starboard directions. The arrows and the vessel's course over ground (COG) are not displayed if the speed over ground (SOG) is less than 0.1 m/s.

Also the vessel roll, pitch, heave and rate of turn (ROT) are shown in this view.



- | | |
|--|--|
| A Vessel speed along ship (SL) | E Vessel heading (HDG) |
| B Vessel speed transverse ship (ST) | F Vessel pitch |
| C Vessel roll | G Vessel rate of turn (ROT) |
| D Vessel heave | H Vessel speed over ground (SOG) |
| | I Vessel course over ground (COG) |

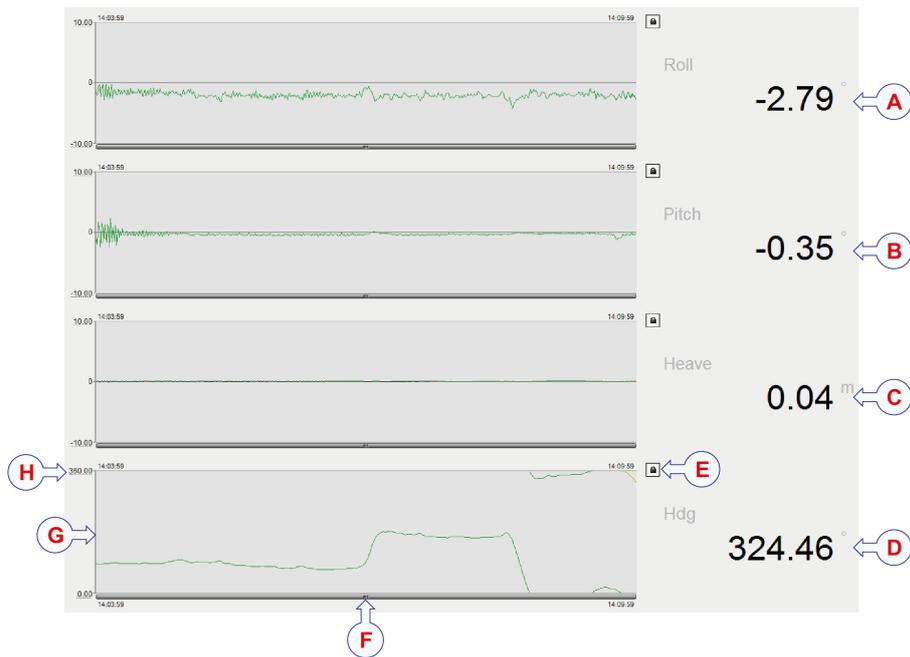
5.2.6 Time series view

This view plots roll, pitch, heave and heading as time series. The colour of the time series graph indicates the data quality.

- **Red**: invalid data.
- **Yellow**: reduced accuracy.
- **Green**: normal performance.

In the heave time series both real-time heave and delayed heave are presented in the same time series. Therefore the heave time series is always 2 minutes delayed in time in order to be able to present both measurements in the same curve and for the same sample.

You can zoom in parts of each plot and pan the time series by dragging the active controls. You can lock the time axis for the time series you want to take a closer look at by selecting the padlock symbol.



- A** Roll in degrees
- B** Pitch in degrees
- C** Heave in metres
- D** Heading in degrees
- E** Lock/unlock time axis
- F** Time axis
- G** Y axis 0
- H** Y axis scale, max.

5.3 Application menu (Menu system)

Access to the menu system is in the **Application menu** part of the **Top bar**.

<u>V</u> iew	<u>A</u> larm
<u>T</u> ools	<u>S</u> ystem

Select the menu buttons to reveal the menu items and select the menu items to reveal the sub-menus.

View menu

The **View** menu holds user preference selections for which colour palette to use for the current light conditions. Here you can maximize the main view and switch and toggle between the various display views. You can select which format to use for presentation of data in the display, such as date and time format, position format, unit measurement system. Position data can be displayed at the top of View 1 and DGNSS link status can be displayed at the bottom of View 1.

Alarm menu

The **Alarm** menu allows you to acknowledge alarms, or events, which have occurred in the system. You can also see status details for the alarms which are active. The NAV Engine debug option is for advanced users and shows output of status messages for NAV Engine and is used for troubleshooting purposes.

Tools menu

The **Tools** menu holds various tools used for planning and operation and tools used for diagnostic purposes. Which tools are available will differ according to type of product purchased.

System menu

The **System** menu holds the NAV Engine configuration and the operator software configuration. This is where you change the system mode or performs a restart, stop or shutdown of the system. This is also where you find various information about the system, such as contact details, software version and equipment information. This menu holds a quick help with shortcut keys for switching display views and changing the colour palette.

6 Menu system

6.1 About the menu system

Access to the menu system is in the **Application menu** part of the **Top bar**.

Select the menu buttons to reveal the menu items and select the menu items to reveal the sub-menus.

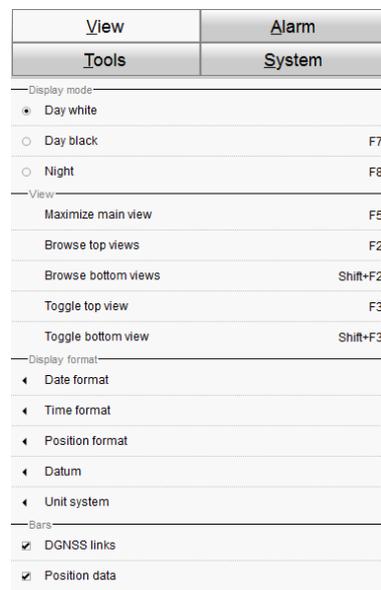


6.2 View menu

The **View** menu is located in the Application menu part of the Top bar. It is divided into four groups which provide selections for colour palette, switching between views, display format presentation and display of DGNSS link status bar and/or position data in View 1.

How to open

Select **View** in the Application menu on the Top bar.



6.2.1 Display mode

Display mode controls the selection of colours used by the HMI. Select the menu item which corresponds to the desired mode or colour palette.

Details

Day white

This is the recommended colour combination for daylight use.

Day black

This colour combination uses bright colours, but has a dark background.

Night

This is a special palette with very low contrast on black background, intended to be used during night without weakening the night sight of the operator.

You can press the **F7** key to toggle between the day palettes and the **F8** key to switch to the night palette.

6.2.2 View group

The display is divided into three view sections: View 1, View 2 and View 3. **View** allows you to decide which view you want to appear in these sections.

Details

Maximise main view

Select to let View 1 cover the whole screen. This has the same effect as pressing the **F5** key.

Browse top views

Select to browse to the next available view in View 2. This has the same effect as pressing the **F2** key.

Browse bottom views

Select to browse to the next available view in View 3. This has the same effect as pressing the **Shift + F2** key.

Toggle top view

Select to switch the contents of View 1 and View 2. This has the same effect as pressing the **F3** key.

Toggle bottom view

Select to switch the contents of View 1 and View 3. This has the same effect as pressing the **Shift + F3** key.

Note

*Browsing or switching views using F2 and F3 is not stored. The only way to ensure that the selected contents is displayed every time the software starts, is to make the selection in the **View** tab in the **Operator software configuration** dialog box.*

Figure 2 Browse with F2 key

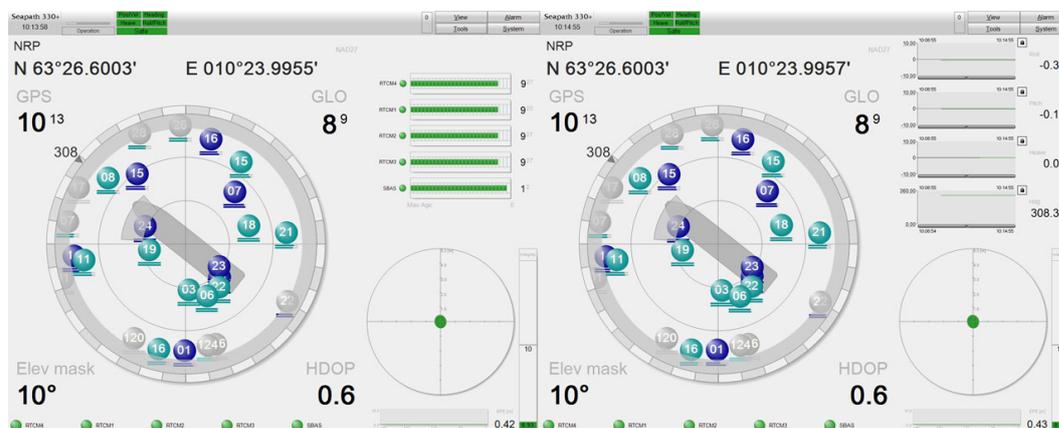


Figure 3 Switch with F3 key



Related topics

- *Browsing or switching display views* on page 16
- *Selecting the default position of views in the display* on page 17

6.2.3 Display format

Display format provides alternatives to modify the presentation of various data types. When selecting a view menu item of this group, or hovering the mouse cursor over it, a sub-menu will appear to the left, containing option items for selecting the wanted format.

Details

Date format

Select between various date formats. The selected format is used in displayed fields presenting date information, e.g. the date part of the Top bar.

Time format

Select between AM/PM and 24-hour display of time values. Influences all displayed fields presenting time information, for example current date and time and event fields of the Top bar.

Position format

Select between decimal seconds (e.g. N 63°26'31.92"), decimal minutes (e.g. N 63°26.5320') and UTM. All positions displayed in the various views and dialog boxes will follow this selection.

Datum

Select the datum in which positions are presented. Be aware that this selection is only valid if the datum on the corrections input to the product is in WGS84 or if no corrections are input. If the corrections input are in another datum than WGS84, you must select **WGS84**. See the *Installation Manual* for available selections.

Unit system

Select the length and speed units used in the various views. Two types of unit system selections are available: Fixed units and Auto-scaling units. Each

alternative indicates the distance unit, then the speed unit. Auto-scaling units will change from short range unit to long range unit (indicated in parenthesis) when the number of digits in the displayed value exceeds a certain limit.

Available fixed units:

- NM, knots
- m, m/s
- ft, ft/s

Available auto-scaling units:

- M (km), km/h
- m (NM), knots
- ft (NM), knots

Related topics

- *Selecting presentation format* on page 17

6.2.4 Bars group

The Bars group allows you to decide whether the DGNSS link status bar shall appear at the bottom of View 1 or not or if the vessel position and datum shall appear at the top of View 1 or not.

Details

DGNSS links

Displays the **DGNSS Link** status bar at the bottom of **View 1** when selected.

Position data

Displays the vessel position and datum at the top of **View 1** when selected.

6.3 Alarm menu

The **Alarm** menu is located in the Application menu part of the Top bar. The menu allows you to acknowledge alarms, or events, which have occurred in the system. You can also see status details for the alarms which are active.

How to open

Select **Alarm** in the Application menu on the Top bar.

Details

Acknowledge alarm

Select this menu item to acknowledge the topmost event viewed in the Top bar. You can also press the **F10** or select the **Event severity** symbol in the Top bar.

<u>V</u> iew	<u>A</u> larm
<u>T</u> ools	<u>S</u> ystem
Acknowledge alarm	F10
Ackn. all alarms	Ctrl+F10
Status...	Ctrl+H
Expert mode	
NAV Engine debug	

The Acknowledge alarm option is disabled if no alarms are available in the **Event list** in the Top bar. Acknowledged alarms are still available in the alarm log, but removed from the Top bar view.

Ackn. all alarms

Select this menu item to acknowledge all the events viewed in the **Event list** in the Top bar at once. You can also press **Ctrl+F10**. The Ackn.all alarms option is disabled if no alarms are available in the Top bar.

Status

Select this menu item to open the **Alarm status** dialog box. You can also press **Ctrl+H**. This dialog box allows you to see all the active alarms. Use the radio buttons to filter the alarms according to alarm severity. You can also acknowledge the selected alarm or all alarms. When an alarm message is acknowledged, but still active, the alarm message text will be grey. The alarm message will only be removed from the list when it becomes inactive.

Related topics

- *Events* on page 32
- *Acknowledging events* on page 20

6.3.1 Expert mode

Expert mode contains parameters which can be used for troubleshooting and they are for advanced users only.

Details

NAV Engine debug

Output of status messages for NAV Engine. For advanced users and troubleshooting purposes.

6.4 Tools menu

The **Tools** menu is located in the Application menu part of the Top bar. It is divided into three groups which provide applications for planning an operation, configuration tasks and various diagnostic and logging purposes.

How to open

Select the **Tools** button in the Application menu on the Top bar.

6.4.1 Utilities group

The Utilities group holds applications for export of system data and copying and restoring the system configuration.

<u>V</u> iew	<u>A</u> larm
<u>T</u> ools	<u>S</u> ystem
Utilities	
Data Export	
Copy Configuration	
Restore Configuration	
Diagnostics	
DGNSS Monitor	
Data Viewer	
Port Monitor	
Explorer	
Windows shell	
Log	
Screen dump	
NAV Engine Log	

Details

Data Export

Data Export is a tool which copies log data to a USB flash drive, either for documentation, post-processing or diagnostics purposes. You can select the start time and the duration of the data export.

Copy Configuration

The Copy Configuration tool copies the complete system configuration to a disk based archive file or to a USB flash drive. You can use the USB flash drive with the copied configuration to restore the system configuration at a later date. The use of this application is described in detail in the *Installation Manual*.

Restore Configuration

The Restore Configuration tool restores all relevant configurations from a disk based archive file or from a USB flash drive. The use of this application is described in detail in the *Installation Manual*.

Note

A configuration archive can only be restored from the same type of unit (Remote HMI or Processing Unit) on which it was created.

6.4.2 Diagnostics group

The Diagnostics group holds applications for advanced users for diagnostic purposes only.

Details

DGNSS Monitor

The DGNSS Monitor tool shows information about available reference stations.

Data Viewer

The Data Viewer tool shows raw data information about the satellites which are tracked by the receiver, position fix information, correction data and Processing Unit status. You can use this tool for system verification and diagnostics.

Port Monitor

The Port Monitor tool shows the data traffic on all serial and net ports.

Explorer

The Explorer menu item opens Windows Explorer where you can view the file system of the HMI Unit.

Windows shell

The Windows shell menu item opens a Windows command shell.

6.4.3 Log group

The Log group is for advanced users for diagnostic purposes only.

Details

Screen dump

The Screen dump tool creates screen dumps of the operator software. You can store the screen dump image on the local disk or on a USB flash drive.

NAV Engine Log

Opens the Windows Explorer in the root folder for the NAV Engine log data.

If the NAV Engine software is not running on the same unit as the operator software, an FTP session is opened on the Processing Unit to which the operator software is connected rather than a session on the local file system.

Note

*It is recommended to use the **Data Export** tool rather than **NAV Engine Log**.*

6.5 System menu

The **System** menu is located in the Application menu part of the Top bar. It is divided into three groups which allow you to configure the system, specify the contents of the views, change the system modes, stop and log off the system in a controlled way.

Some menu items may be disabled depending on the system mode selection. Disabled menu items appear with light grey text. Change system mode to *Configuration* or *Engineering* to activate the disabled menu items.

View	Alarm
Tools	System
—Configuration—	
◀ NAV Engine	
Operator SW	
—Information—	
Help	Alt+F1
About	Ctrl+F1
—System control—	
◀ Change system mode	
◀ Restart	
◀ Stop	

How to open

Select the **System** button in the Application menu on the Top bar.

6.5.1 Configuration group

The Configuration group allows you to enter the system setup parameters and to enter the display setup settings.

Details

System configuration

Opens the **System configuration** dialog box from which you can set up your system to be ready for operation.

Operator SW

Opens the **Operator software configuration** dialog box with the tab pages where you can set up visual parameters for the display views.

6.5.2 Information

Information contains quick help and product version information.

Details

Help

Displays the **Quick Help** information sheet with basic information regarding navigation and selection.

About

Displays the **About** dialog box which contains various information about the system, such as contact details and software version. Select **Details** to see more equipment information.

6.5.3 System control group

The System control group allows you to change the mode in which the system shall operate, to stop and restart the GUI, to shutdown and restart the unit and to log off the system in a controlled way.

Change system mode

Changes the system's operating mode. Switching to Configuration or Engineering mode requires a password. This password is always "stx" and is not possible to change.

The password is not case sensitive. The system will return to Operation mode after 3 minutes of user inactivity.

Access to Engineering or Configuration mode can also be gained by key commands directly from the display.

- press **Ctrl+E** to enter Configuration mode
- press **Ctrl+A** to enter Engineering mode.

This opens the password dialogue directly.

Restart

From the **Restart** menu item you can stop and immediately start:

- the NAV Engine
- the sensor unit
- the GNSS receivers

When restarting the NAV Engine or the sensor unit, the system will stop all processing, calculation and output from the system for about 2 minutes. When restarting the GNSS receivers both GNSS receivers will be restarted.

Stop

From the **Stop** menu item you can stop:

- the NAV Engine
- the Operator SW.

Stopping NAV Engine will stop data processing. Stopping the Operator SW will close the Seapath application.

7 Maintenance

7.1 Recalibration of the MRU

For Seapath installations with product software version 1.02.01 or later installed, recalibration of the 5th generation MRU units are no longer required. This since the Seapath software estimates the bias in the accelerometers and therefore recalibration is no longer required.

The estimated accelerometers biases values are shown in the **Data Viewer** under the **Tools** menu. The unit [μg] is used for the estimated accelerometer biases and is equal to $1\text{e-}5\text{ m/s}^2$. A horizontal accelerometer bias of $200\mu\text{g}$ (200 micro-g) will lead to an angle offset of 0.01° if the bias is not corrected for. Over time the X-axis accelerometer measures the static (mean) pitch angle and the Y-axis accelerometer measures the static (mean) roll angle. It is the estimated accelerometer biases in the X and the Y that are of interest and values are shown in the figure below. In the X axis the accelerometer bias has been corrected with $28.374\mu\text{g}$ since the unit was calibrated. This correspond to 0.00142° pitch angle offset if the unit is disconnected from the Seapath or the pitch measurements are output from the MRU junction box. It will be similar for the Y-axis accelerometer bias and the static roll angle.



Data Viewer	
<input type="button" value="Default view"/> <input type="button" value="Freeze"/>	
General	
System solution	Filter time 2023-06-20 08:54:04
Integrity status	Position N 63°26.34445' E 010°23.93490' H 37.282
IMU	Velocity [m/s] North: -0.002 East: -0.003 Down: -0.002
External attitude	Attitude [°] Roll: 0.305 Pitch: 1.622 Heading: 140.523
Graphs	Accelerometer bias [μg] X: -28.374 Y: -16.888 Z: -263.235
Integrated	Gyro bias [°/h] X: -0.00084 Y: -0.01562 Z: -0.00711
<input type="checkbox"/> Integrated filter	
<input type="checkbox"/> Heave	

7.2 Updating the sensor unit software

We recommend that you keep your product updated with the latest software version.

Prerequisites

The default IP address for the sensor unit is: 192.168.1.10.

Note

The below procedure assume that the Seapath unit operate on processing software version 2.01.00 or newer.



Procedure

- 1 Open a browser and type: `http://<the default sensor unit IP address>` in the address bar.
- 2 Type the default login credentials:
 - User name: **scompact**
 - Password: **1234**

The user name is case sensitive.

- 3 Enter the **Configuration** management and select **Update SW**.
- 4 Select the provided update package zip file.
- 5 Select **Upload** and wait up to 10 seconds for the file to be transferred.



- 6 Select **Install**.

The unit will then start to unpack the update package. The update process can take some minutes.



Result

If the update was successful, the sensor unit will restart and the installation results will show **Installation successful** together with a detailed report.

Should the update be unsuccessful, try again and contact Kongsberg Discovery AS customer support.

7.3 Checking the product version

For software update or contact with customer support it is useful to know the product version of the system.

Procedure

- 1 Select the **System** menu → **About**

Observe the product version.

- 2 Select **Details** for more information about the unit.
- 3 Select **Close** to exit the dialog box.

7.4 Repairs and parts replacement

7.4.1 Repairing the sensor unit

The sensor unit is not designed for customer maintenance. All repairs and modifications of the unit, except:

- installation of new software versions

should be carried out by qualified personnel. A failed unit should be shipped back to Kongsberg Discovery AS or other agreed service point for repair.

7.4.2 Installing a spare sensor unit

If a spare unit is rented while your unit is in for repair, it is delivered with the latest version of the product software.

Procedure

- 1 Disconnect the spider cable from the sensor unit.
- 2 Unscrew the four screws which hold the sensor unit to the mounting bracket.
- 3 Remove the sensor unit from the mounting bracket.
- 4 Place a new sensor unit in the mounting bracket.
- 5 Refasten the four screws which hold the sensor unit to the mounting bracket.
- 6 Reconnect the spider cable.

7.4.3 Repairing the MRU subsea bottle

The MRU subsea bottle holds the motion sensor unit (MRU). All repairs and modifications of the subsea bottle and the motion sensor unit, except for installation of new software versions and user configuration, have to be carried out by Kongsberg Discovery AS.

Caution

Opening the sensor unit housing will result in permanent damage and the user should under no circumstances make any attempt to do so.

A failed subsea bottle should be shipped back to Kongsberg Discovery AS or other agreed service point for repair.

7.4.4 Installing a spare MRU subsea bottle

You may want to install a spare MRU subsea bottle, for example if your bottle is in for recalibration or pressure testing.

Procedure

- 1 Disconnect the MRU cable from the subsea bottle.
- 2 Unscrew the M6 screws which hold the subsea bottle to the mounting structure.
- 3 Remove the MRU subsea bottle and replace it with a new one.
- 4 Refasten the M6 screws which hold the subsea bottle to the mounting structure.
- 5 Reconnect the MRU cable to connector A on the connector lid.

7.5 Troubleshooting

Should you experience some problems with the product, try to use the troubleshooting procedures to fix the problem. If you have followed the procedures for troubleshooting and the problem is still not solved, contact Kongsberg Discovery AS support for assistance.

Related topics

- *Support information* on page 13

7.5.1 System status

The error conditions in the system are usually observed by looking at the system status field in the Top bar. The quality status information output on serial lines or Ethernet is the same as data quality status indicated in the Top bar.

7.5.2 No power

If the Top bar shows `No connection` this can be due to the fact that the sensor unit does not receive any power.

Procedure

- 1 Check the power connection to the unit.
- 2 Check that the PC with the operator software is configured to the same subnet as the sensor unit.

7.5.3 External output problems

During operation situations may occur where the external equipment receives not data from the sensor unit.

Procedure

- 1 Check the serial lines, net cables and cable connectors for mechanical damage.
- 2 Check that the connectors are connected to the correct output ports on the external equipment.
- 3 If the cable connectors are OK, check that the external output configuration of the sensor unit is set up correctly.

This is described in the *Installation manual*.

7.5.4 All data quality status indicators are grey

During normal operation it takes a minute from the sensor unit is powered on until the four data quality status indicators in the Top bar turn red. If all the indicators are still grey after three minutes from power on, do as follows:

Procedure

- 1 Check the power connection to the sensor unit.
See power specification in the *Installation manual*.
- 2 Check that the PC with the operator software is configured to the same subnet as the sensor unit.

If the indicator lights are still not turning red, contact your nearest Kongsberg Discovery AS office.

7.5.5 All data quality indicators are red

During normal operation it can take up to 30 minutes from the sensor unit is powered on until full accuracy on all data is obtained and the data quality indicators change colour from red. If all the indicator lights are still red after 30 minutes from power on, do as follows:

Procedure

- 1 Check if the MRU cable is properly connected to the sensor unit.
- 2 If not, switch off the power and connect the cables properly and power on the unit again.
- 3 Check that the installation location of the sensor unit complies with the instructions given in the *Installation manual*.

7.5.6 Pos/Vel indicator is red

The **Pos/Vel** data quality indicator in the Top bar is red. This may occur if the sensor unit does not receive data from any of the GNSS receivers.

Procedure

- 1 Check that the sensor unit is not damaged.

If the sensor unit is damaged, it has to be shipped back to Kongsberg Discovery AS for repair.

- 2 Check that the installation location of the sensor unit complies with the instructions given in the *Installation manual*.

7.5.7 Pos/Vel indicator is yellow

The **Pos/Vel** data quality indicator in the Top bar is yellow. This may occur if the system experiences a reduced position/velocity function.

Procedure

- 1 No differential corrections are input on the GNSS serial cable of the sensor unit. If differential corrections are input to the sensor unit, check that the link is properly set up in the DgnssLink, part of the Input/Output subfolder in the **NavEngine configuration**.
- 2 The vessel can be out of range to a radio reference station and the differential corrections are therefore missing. If the reference station is too far away or it is in the shadow of geographical obstructions or other equipment on board, reception may be unreliable or missing. The location of the reference stations connected to Seapath is shown in the **DGNSS Monitor** under the **Tools** menu.
- 3 The antenna or the MRU offset setup can be incorrect. Check the setup of the lever arms from NRP to antenna #1 and to the MRU once again. Check particularly that the sign for each of the vector components are correct by entering the **Geometry** subfolder under **Sensor**→ **GNSS** →**MRU** in the NavEngine configuration.

7.5.8 Heave and Roll/Pitch indicators are red

The **Heave** and **Roll/Pitch** data quality indicators in the Top bar are red. This may occur if the sensor unit does not receive any data from the motion reference unit (MRU).

Procedure

- 1 Check that data is coming in to the MRU connector on the sensor unit by selecting the **Tools** menu →**Port Monitor** and selecting **MRU**.
- 2 Check that the MRU cable is properly connected to the subsea bottle.
- 3 If the above items are OK, see the section on troubleshooting the motion reference unit (MRU).

Related topics

- *No data from the motion reference unit (MRU)* on page 58

7.5.9 Heave and Roll/Pitch indicators are yellow

When the **Heave** and/or **Roll/Pitch** data indicators in the Top bar are yellow, this indicates that there are some problems with the motion reference unit (MRU). The MRU may for some reason be unstable. See the section on troubleshooting of the motion reference unit (MRU).

Related topics

- *Unstable data from the motion reference unit (MRU)* on page 58

7.5.10 Heading indicator is red

When the **Heading** data indicator in the Top bar is red, it can indicate a problem with the heading calculation.

Procedure

- 1 Perform a new calibration of the antenna baseline.
- 2 The sensor unit receives no data from GNSS receiver no. 1 or 2. That can be verified by checking whether data appear on the **Port Monitor** in the **Tools** menu and by selecting **GNSSA1** for GNSS antenna number 1 and **GNSSB1** for antenna no. 2. If no data are received, perform a receiver reset by selecting the **System** menu →**Restart** →**GNSS receiver**.

7.5.11 Heading indicator is yellow

When the **Heading** data indicator in the Top bar is yellow, the system may experience a reduced heading performance.

Procedure

- 1 It may be due to a problem the motion reference unit (MRU). Check that by troubleshooting the MRU.
- 2 If the MRU is functioning OK, check that the antenna baseline setup parameters in the **NAV Engine Configuration, Sensors** →**GNSS** →**Geometry**, are properly configured, and if needed, perform a new calibration of the antenna baseline.
- 3 The sensor unit receives no data from GNSS receiver no. 1 or 2. That can be verified by checking whether data appear on the **Port Monitor** in the **Tools** menu and by selecting **GNSSA1** for GNSS antenna number 1 and **GNSSB1** for antenna no. 2. If no data are received, perform a receiver reset by selecting the **System** menu →**Restart** →**GNSS receiver**.

If it is still not working after checking all of the above items, then the GNSS receiver board within the sensor unit is most likely damaged and the sensor unit has to be shipped to Kongsberg Discovery AS for repair.

Related topics

- *Unstable data from the motion reference unit (MRU)* on page 58

7.5.12 Heave indicator is yellow

If the **Heave** data indicator in the Top bar is yellow, this can be due to the fact that the system, to which the sensor unit is connected, is experiencing reduced performance in heave or depth errors in the centre beam of an echo sounder. If reduced performance in heave or depth errors occur in an echo sounder, check the following.

- There are oscillations in heave or in the depth of the centre beams. Check that the correct Heave filter mode and Heave period are selected in the sub-folder **Sensors** → **MRU** → **Heave config** in the **NAV Engine Configuration**.

7.5.13 Roll/Pitch indicator is yellow

If the **Roll/Pitch** data indicator in the Top bar is yellow, the system experiences a reduced roll or pitch performance.

Procedure

7.5.14 No data from the motion reference unit (MRU)

If the **Heave** and/or **Roll/Pitch** data indicators in the Top bar are red, a possible cause can be that the sensor unit does not receive any data from the motion reference unit (MRU).

The tools for troubleshooting the MRU are the **Data Viewer** and the **Port Monitor**.

Procedure

- 1 Check that data is coming in to the MRU connector on the sensor unit by selecting the **Tools** menu → **Port Monitor** and selecting **MRU**.
- 2 Check that the cable from the sensor unit is properly connected to the MRU subsea bottle.

7.5.15 Unstable data from the motion reference unit (MRU)

If the **Heave** and/or **Roll/Pitch** data indicators in the Top bar are yellow, a possible cause can be that the data received from the motion reference unit (MRU) are unstable.

The tools for troubleshooting the MRU are the **Data Viewer** and the **Port Monitor**.

Procedure

- 1 Select **Tools** menu → **Data Viewer** → **PPS and time** to check if the **Status** parameter in the PPS information group indicates **Sync**. If this is the case, the sensor unit and the MRU are probably synchronized with GPS.
- 2 In order to be sure that the sensor unit gets MRU data on time, select **Tools** menu → **Data Viewer** → **Time delay**. The time delay for the **Raw MRU** parameter should be 0.020 seconds or less.

If the time delay is greater than 0.020, the MRU cable carrying the PPS signal from the sensor unit is not properly connected.

7.5.16 Echo sounder depth error

Sometimes the system may experience depth errors in the outer beams on a multi-beam echo sounder. Check the following if a depth error occurs.

Procedure

- 1 The oscillations in the depth of the outer beams are correlated with the pitch angle of the vessel. Check the mounting angle around the z-axis. The sensor unit x-axis has to be parallel with the ship's longitudinal axis as long as the echo sounder transducer head is aligned with the ship axes.
- 2 The oscillations in the depth of the outer beams are correlated with the roll angle of the vessel. Check that the distance vector from the ship Origin to the MRU is input correctly both when it comes to the length and the sign. Check also that the vector from Origin to GNSS antenna no. 1 is input correctly both when it comes to the length and sign. Check specially the sign in the vertical direction, which always shall have a negative sign. Look at the background vessel in the **NAV Engine Configuration** (part of the operator software) to check whether the arms and vector signs look correct.
- 3 There is incorrect synchronisation of the Seapath and the multi-beam data (timing error). Check that the measurements from the two data sources are handled correctly and that a timing error has not occurred. Post-processing of the Seapath and the multi-beam data can be used to analyse whether incorrect synchronisation is the reason for the depth errors.

7.5.17 Unstable heading calculations for high dynamic vessels

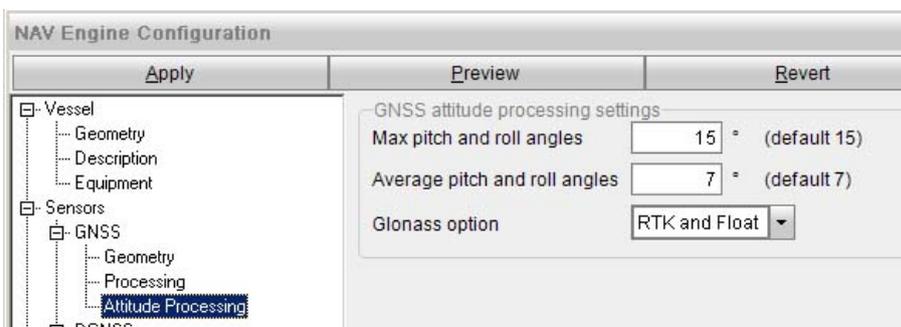
The GNSS attitude processing setting allows you to improve heading calculations for vessels which experience a roll of more than 15 degrees.

Context

If the vessel has a roll and pitch above 15 degrees, the system will have problems with heading calculations. The maximum values to be used for attitude processing can be changed if the vessel has an unusual characteristic.

With the **Glonass option** you can decide whether the GLONASS satellites shall be used in the heading solution or not.

The default setting is **RTK and Float**



Procedure

- 1 Select the **System** menu, →**NAVEngine** →**Standard** to open the**NAV Engine Configuration** dialog box.

- 2 Select the **Sensors** node →**GNSS** →**Attitude Processing**.
- 3 Type the wanted degrees for max pitch and roll angles.
- 4 Type the wanted degrees for average pitch and roll angles.
- 5 In the **Glonass option** drop-down list, select if you want GLONASS satellites to be used in the heading solution.
 - **Off**: GLONASS satellites are not used.
 - **RTK and Float**: This is the default value.
 - **Float only**: Should only be used by experts after advice from Kongsberg Discovery AS support.
- 6 Select **Apply** to store the settings.

7.5.18 Using GLONASS in RTK solution

The RTK (Realt Time Kinematic) parameters allow you to enhance the precision of position data which are derived from satellite-based positioning systems, such as GPS and GLONASS.

Context

These settings can be changed to optimise the performance in RTK mode.

Search mode

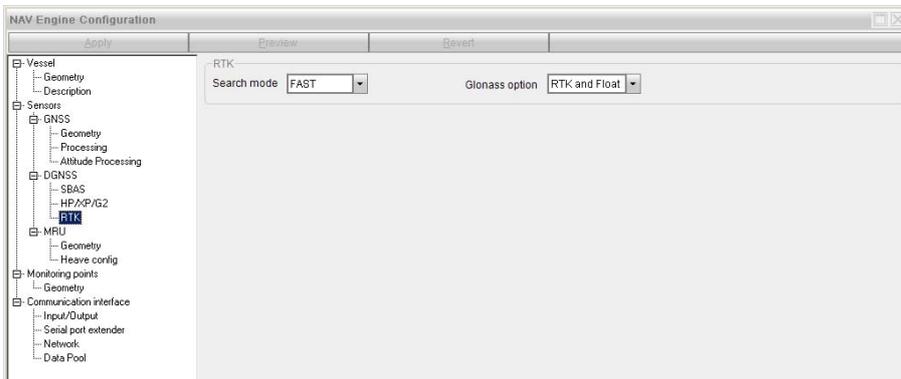
The default search mode is **Normal**. **Safe** mode is recommended used under difficult conditions with much multipath or ionospheric activity and for long baselines. **Fast** mode is recommended used when a fast RTK solution is required.

Note

In Fast mode the probability for an incorrect solution from the system will increase.

Glonass option

The default setting is **RTK and Float**. The **RTK and Float** selection is recommended used under conditions where the RTK correction source is known (own local reference station). The **Float only** selection is used when the system has problems with getting an RTK solution. The **Off** selection is used when the RTK corrections include only dual frequency GPS corrections.

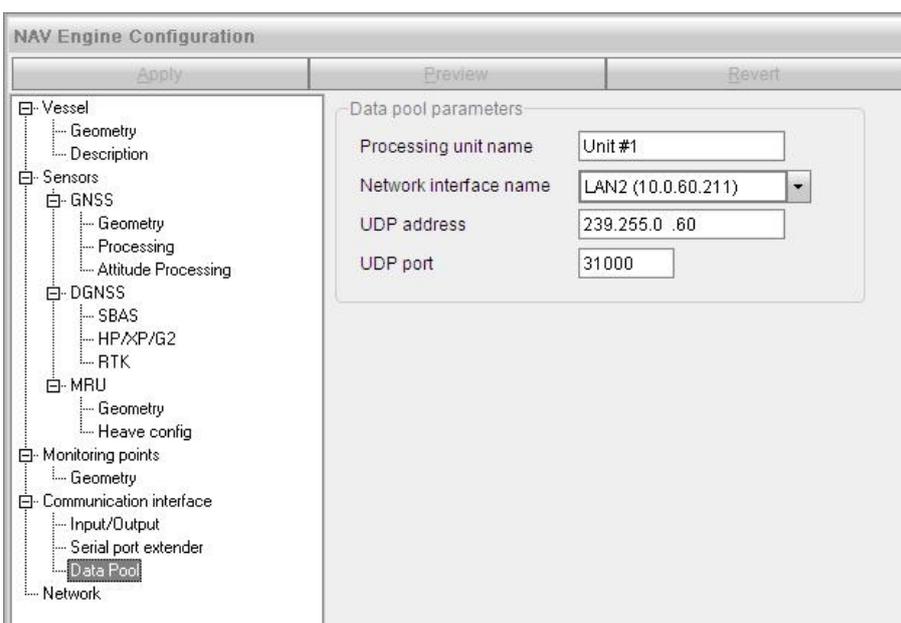


Procedure

- 1 Select the **System** menu, →**NAVEngine** →**Standard** to open the**NAV Engine Configuration** dialog box.
- 2 Select the **Sensors** node →**DGNSS** →**RTK**.
- 3 In the **Search mode** drop-down list, select the wanted search mode if you do not want the default mode Normal.
- 4 In the **Glonass option** drop-down list, select the wanted parameter if you do not want the default setting RTK and Float.
- 5 Select **Apply** to store the settings.

7.5.19 Setting up distribution channel parameters for the sensor unit

Data pool is the distribution channel for data from the NAV Engine software running of the sensor unit to the operator software (HMI).



Procedure

- 1 Select the **System** menu, →**NAVEngine** →**Standard** to open the **NAV Engine Configuration** dialog box.
- 2 Select the **Communication interface** node →**DataPool**.
- 3 Type an identifying name for the sensor unit (Processing unit name).
- 4 Type the UDP address to which the NAV Engine shall send data.
- 5 Type the UDP port to which the NAV Engine shall send data.

Note

The UDP address and UDP port entered here have to match the Address and Port entered in the Data Source tab in the Operator software configuration to ensure communication between NAV Engine and the Operator software.

- 6 Select **Apply** to store the settings.
- 7 Change the HMI settings to reflect the new data pool parameters in the **System** menu →**Operator SW** →**Data source**.

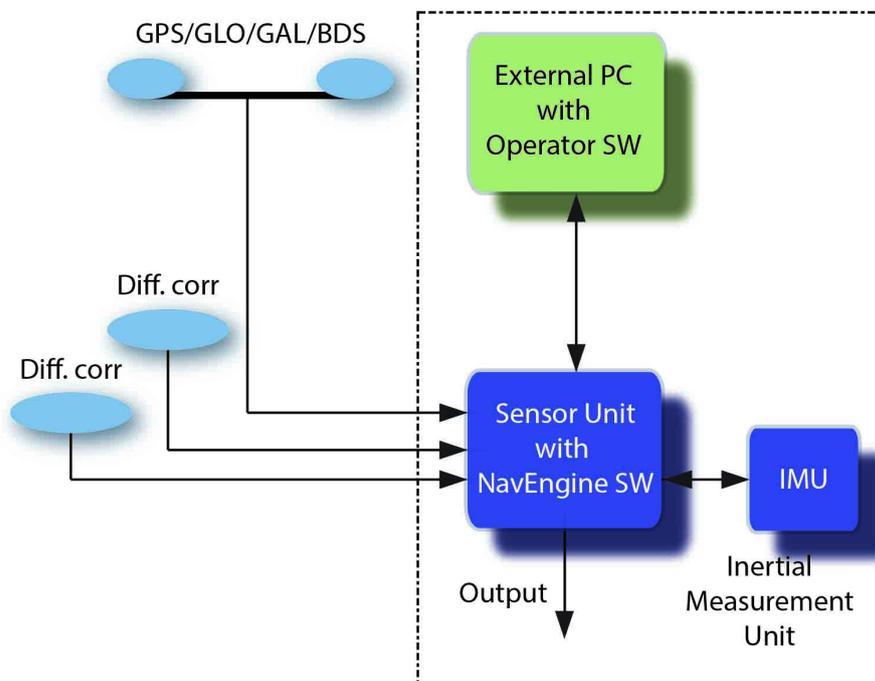
8 Concept description

8.1 System architecture

The product is a two-module solution with a Sensor Unit and an external PC with the operator software connected via Ethernet. The Sensor Unit runs the processing software which handles all critical computations independent of the user interface on the external PC to ensure continuous and reliable operation.

The product is operated through the operator software installed on the external PC. This software is used for performance monitoring and configuration of the system. For performance monitoring the software includes a number of views that can be adjusted to different operations.

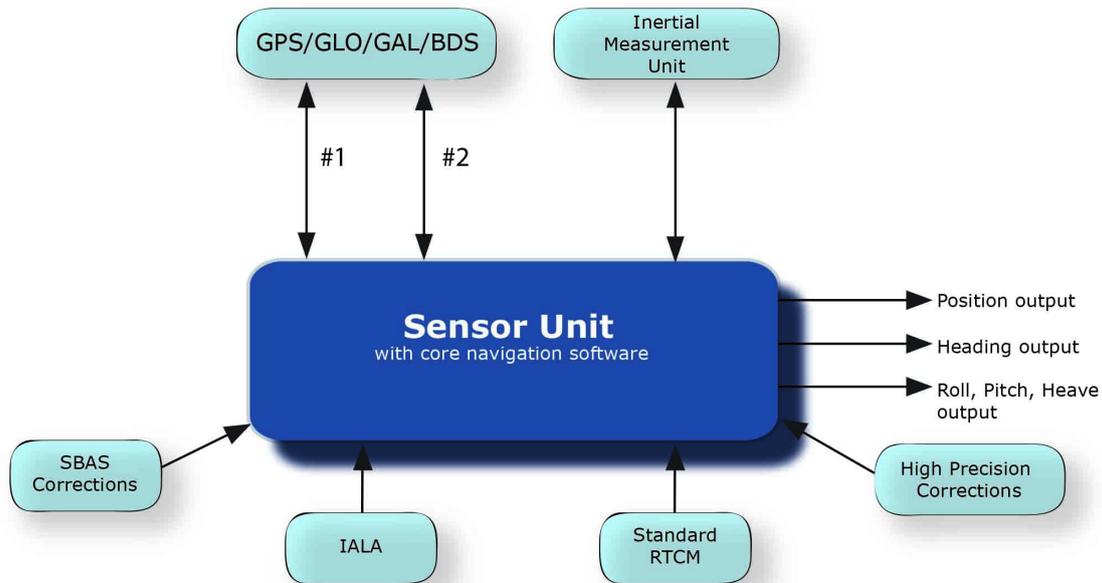
Figure 4 System sketch



8.2 Main data flow

The illustration shows the main data flow to and from the Sensor Unit.

Figure 5 Sensor Unit with the NavEngine software



The NavEngine software runs on the Sensor Unit. This software combines the GNSS signal and the inertial measurements to determine accurate position, heading, attitude and heave signal. The NavEngine software utilises Kongsberg Discovery AS advanced true multi-reference algorithms for real-time parallel processing of all available correction signals including:

- SBAS (WAAS, EGNOS, MSAS, QZSS)
- IALA
- Standard RTCM corrections (DGNSS)
- Fugro SeaSTAR High Precision services (XP, G2, G4, G4+)
- VERIPOS Ultra/Ultra² correction services
- C-NavC¹ and C-NavC² correction services
- RTK corrections of RTCM version 3 messages or type 18 and 19

There is no practical limitation to the number of correction signals/reference stations handled by the NavEngine.

8.3 Real-time heave computation

Heave is the vertical position or height relative to a zero mean level and positive downwards. The vertical acceleration is high pass filtered and integrated twice over time to heave position. Heave velocity is computed with one integration over time of filtered vertical acceleration. The heave filter removes static and slowly varying errors.

The user must tune this filter according to user requirements. The heave filter parameters should be selected according to the expected average wave period T_0 for the vessel. The expected average wave period T_0 can be selected in the range 1 to 25 seconds. If a too long period is selected, the velocity and position outputs will have a slowly varying error. If a too short period is chosen, the estimated heave will have a phase error for long period motions.

A low damping factor ε reduces the short-term error for long period motions close to the selected average period T_0 , since the phase error is reduced. However, ringing in the output at T_0 may cause some problems. The damping factor ε is recommended set fixed to 0.7.

In the software two different types of filter structures are implemented. The filter mode "General purpose" is implemented to achieve optimal amplitude performance, whereas the "Hydrographic survey" mode provides optimal phase performance. For the "Automatic" filter mode the hydrographic survey filter structure is used. This algorithm estimates the sea conditions by computing the dominating period of the waves seen from ship or vehicle and automatically sets the average heave period T_0 in real time during operations.

In the "GNSS aided" mode the heave and height measurements are determined by blending vertical acceleration and RTK height measurements in a Kalman filter.

8.3.1 Selection of heave filter mode

The following selections are available in the configuration in order to achieve the optimal heave performance:

- **Heave filter mode.** Selection between different filter structures.
- **Period.** The average heave period for the vessel, T_0 .

The heave filter average period should be chosen in order to obtain the best possible correspondence between the estimated heave motion and the real heave motion. The average period can be set to a constant value or the automatic adaptive filter may be selected in case of varying sea states.

The following should be considered when selecting the different heave filter modes:

Heave filter mode:

- **General purpose.** Is selected when optimal heave amplitude is to be measured and the heave phase is of no importance. This mode is typically selected when the system is to be used for measuring the heave height and period on oceanographic buoys.

- **Hydrographic survey.** To be selected when the heave phase and amplitude have to be output correctly in real time and the heave period is known. This mode is typically selected when the heave output signal from the system is to be used for heave compensation of echo sounders, hydro acoustic positioning systems and offshore crane systems.
- **Automatic.** To be selected when the amplitude and phase have to be output correctly in time and the wave period is not known. The automatic filter estimates the heave period adaptively and can be used instead of *Hydrographic survey* filter when the heave period is unknown or varying. This is the recommended filter mode for real-time heave at sea.
- **GNSS aided.** To be selected when RTK DGNSS corrections are available or the GNSS velocity measurements are accurate. In this mode the heave and height measurements are determined by blending vertical acceleration and GNSS height measurements in a Kalman filter. This combination makes it possible to measure wave slopes and the tide in real time with high precision ideal for hydrographic work. The height measurements are provided with centimetre accuracy and independent of wave frequency. If RTK is not available the algorithm will use the GNSS velocity measurements for aiding the heave. If GNSS velocities are not available, the *Automatic* algorithm is used.

Period:

- An expected average heave period has to be set to the heave filter unless the automatic or the integrated mode is chosen.
- The settling time for the heave measurements from power-on will be about 10 times the selected period, T_0 .

The selection of heave filter period is a trade-off between low heave error over a wide range of heave periods and the settling time after an occurrence introducing a step response in the heave filter.

The figure *Relative heave error as function of wave period* on page 67 illustrates the relative heave residual in percentage of amplitude for the "Hydrographic survey" filter with damping 0.7 and various average heave periods of 5, 10, 15 and 20 seconds.

The figure *Heave step response with corresponding settling time* on page 67 illustrates the heave step response with corresponding settling time for the "Hydrographic survey" filter with damping 0.7 and various average heave periods of 5, 10, 15 and 20 seconds.

Figure 6 Relative heave error as function of wave period

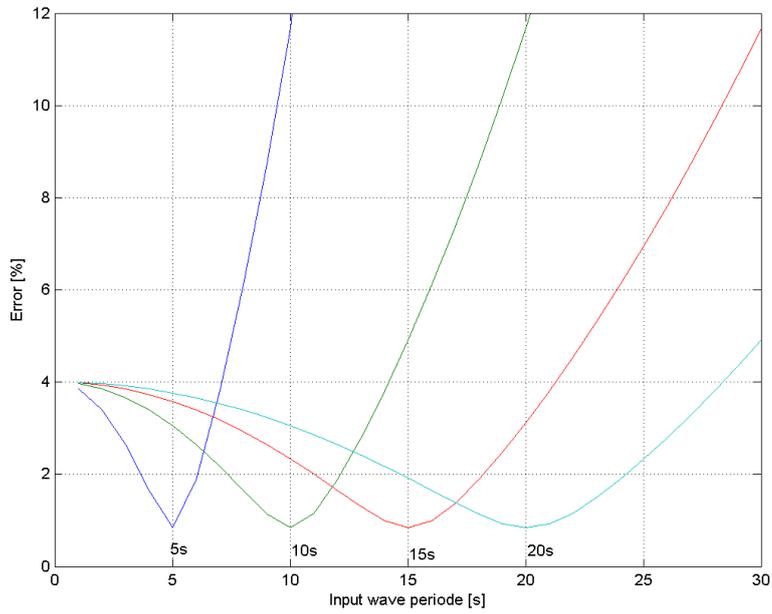
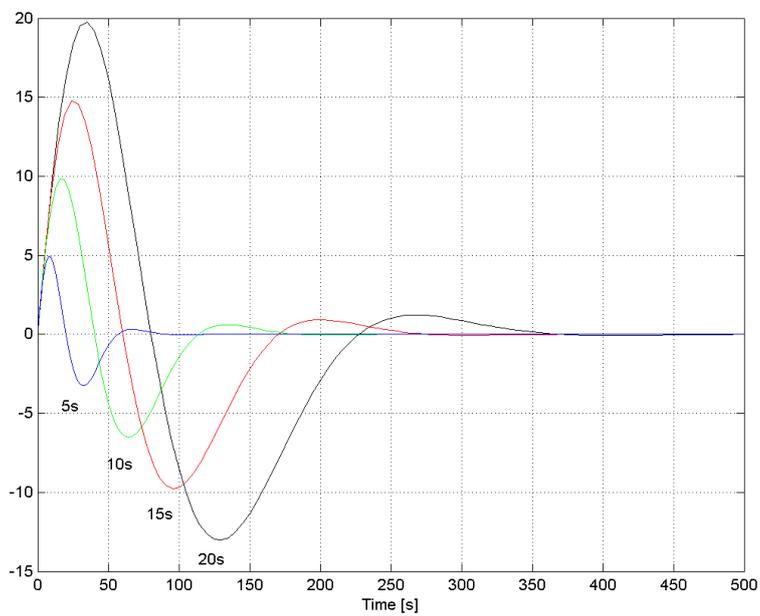


Figure 7 Heave step response with corresponding settling time



8.4 Delayed heave output

The new developed PFreeHeave[®] algorithm uses past measurements to output a correct and phase-free heave from Seapath. PFreeHeave[®] has an advantage in long swell conditions and for applications that can utilise a heave signal that is delayed some minutes, typical seabed mapping applications. The PFreeHeave[®] signal can be output on serial line or Ethernet (UDP/IP) together with the real-time heave signal.

To take advantage of this new functionality, the Seapath user has to post-process the echo sounder recordings together with the motion sensor recordings. The application of delayed heave has to be performed in post-processing software delivered from QPS, CARIS, EIVA, HYPACK, Kongsberg Discovery and others. These software packages are able to read the PFreeHeave[®] format. See the *Installation Manual* for details on the PFreeHeave[®] format.

8.5 High speed data in real-time

By the integration of motion data with GNSS positions in the Kalman filter, a 100 Hz update rate of heading, roll, pitch and position is achieved. All Seapath data are output in real-time, including the position data, due to internal processing by use of accelerometer measurements between each GNSS position. This eliminates delays due to processing.

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