NORTEK MANUALS

Nortek VM Acquisition

N3015-042 | V3.0

Contents

1 Introduction

This manual is designed to help users of Nortek Vessel Mounted (Nortek VM) get familiar with the Nortek VM Acquisition software. This manual includes sections on all features of the software, keep in mind that your specific Nortek VM Acquisition version may not include all features.

1.1 Installation manuals

Separate manuals exist explaining installation details of the Nortek VM hardware. Make sure the hardware is setup correctly before proceeding with the software setup explained in this manual.

1.2 Nortek online

At our website, http://www.nortekgroup.com, you will find technical support, user manuals, and the latest software and firmware. General information, technical notes and user experience can also be found here.

The Nortek Support website has an FAQ section. Here you can find short articles that answer some common questions about our instruments, and related topics.

1.3 Feedback

If you find errors, omissions or sections poorly explained in this manual, please do not hesitate to contact us. We appreciate your comments and your fellow users will as well.

1.4 Contact

We recommend first contacting your local sales representative before the Nortek main office. If you need more information, support or other assistance, you are always welcome to contact us or any of our subsidiaries by email, phone or fax.

Email: support@nortekgroup.com (for technical support questions)
Phone: +31 88 6543700

1.5 Revision history

Version	*Date*	*Supports software version*	*Notes*
V3.0	dec-2024	3.0	Added licensing, merged VM Operations and Signature VM into Nortek VM Acquisition
Version 2.10	oct-2024	2.10	Support file; manually check for updates
Version 2.9	jul-2024	2.9	Echosounder functionality reworked
Version 2.8	apr-2024	2.8	Various extra trigger options; NTP as an optional time-source
Version 2.7	sep-2023	2.7	Layer; automatic instrument alignment; mounting offsets diagram
Version 2.6	apr-2023	2.6	Section on measuring a (noise) spectrum; removed details on older hardware
Version 2.5	dec-2022	2.5	
Version 2.4	jul.2022	2.4	
Version 2.3	23.feb.2022	2.3	
Version 2.2	02.11.2021	2.2	
Version 2.1	25.03.2021	2.1	
Version 1	11.04.2018	1.5	Initial release

2 Scope

This manual describes the Nortek VM Acquisition software. It excludes any details on the hardware setup of your system. Please consult the installation manual on how to set up the various hardware components.

2.1 Harware and Installation manual

To get started with the installation procedure, please use the Nortek VM Hardware and Installation Manual that can be found on the Nortek website[7] .

2.2 This manual

We keep adding to and improving existing products of the Nortek VM product family. We will keep updating the Nortek VM Acquisition manuals in future releases, and from time to time restructure them. For the latest versions of the manual, please keep your software updated. The latest versions can also be found on our website[7] .

2.3 Nortek VM Acquisition software

*A VM-ADCP sensor marked as 'Signature **VM'** (with bottom-track firmware) cannot be programmed with the 'Signature Deploy' software! Use only the Nortek VM Acquisition software.*

The Nortek VM software is under continuous development, so it is advised to check on a regular basis if a new version is available. Note that a decent internet connection is required for checking and possible downloads.

The software automatically checks every 30 days if an update is available. A manual check can be done through the Software section in the Settings menu. The software will check for software, GNSS firmware and VM-ADCP firmware updates.

3 Licensing

The features available in Nortek VM Acquisition depend on your license. There are two parts to this, one is the licenses within the VM-ADCP instrument. These include bottom-track license and an optional echosounder license for some instruments, among others. The other part is the licenses for Nortek VM Acquisition. These are linked to the serial number of the instrument connected to the software.

3.1 Features

Depending on your license, certain features might or might not be available. The features are generally contained within a window within the software. Examples of windows available for most licenses are the Status[34] and Track[37] windows. Examples of features that might not be available for some licenses are Echograms[39] and the 3D profile[51] windows.

The features available to you can be viewed in the software section of the configuration[23]. An example is shown in Figure 1 below.

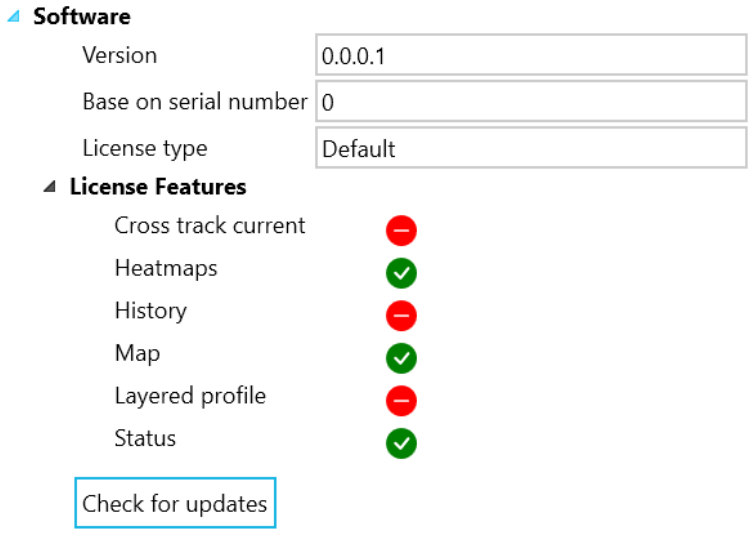


Figure 1: License features available for a Default license

3.2 Playback

Since the license is linked to the instrument, any file recorded with Nortek VM Acquisition can be played back by any user. The features available while playing back will be the features available to the instrument the data was recorded by.

3.3 Multiple instruments

If you have multiple instruments with different licenses, switching instruments will change the features available in Nortek VM Acquisition.

3.4 Missing features and other issues

If you get a message about no license being available when connecting to an instrument, please first check for updates[9]. If there were no updates or the issue is not resolved after installing the updates, please contact support.

If you would like to change the features available to you, please contact your local sales representative.

4 Getting started

This section explains how to use Nortek VM Acquisition to connect to the various instruments and check if they are setup correctly.

For details on how to setup the physical instruments and how to connect all parts of the setup, please refer to the installation manuals[9] .

4.1 Software overview

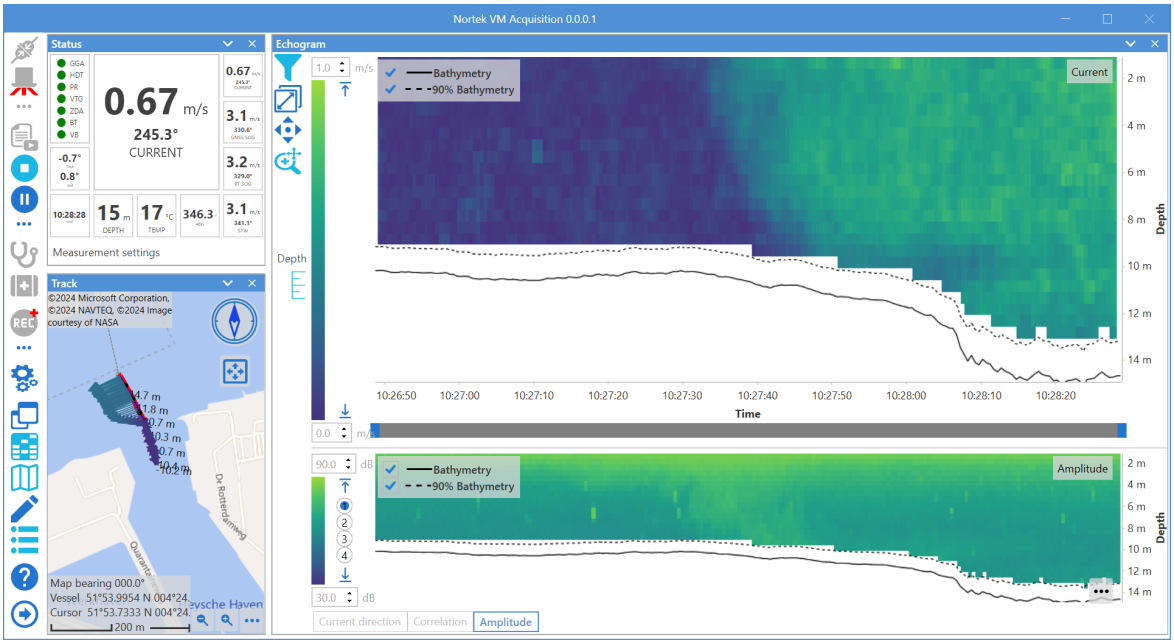


Figure 2: Nortek VM Acquisition software main window

The Nortek VM Acquisition software consists of several windows. Each window may be moved, rescaled, or closed if required. To recover a window, or to reset the screen layout to defaults, click on one of the five window recovery buttons in the lower left. Clicking the appropriate button will bring up the related window, or you can click 'Restore Layout' to get back to default. When a certain window is hidden, the corresponding button has a lighter color.

The main task bar (see the close-up in figure 3[12]) is on the left. This contains the controls for starting and stopping the measurement, changing the settings, replaying data, as well as buttons to show and hide windows.

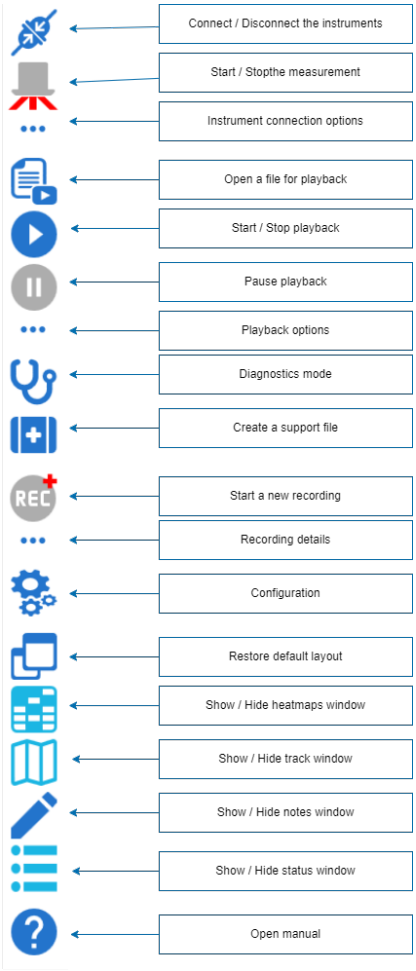


Figure 3: Taskbar explained

4.2 Connecting to instruments

The first step to getting data in Nortek VM Acquisition is connecting to the instruments. Depending on your setup, the details might vary slightly.

Regardless of your setup, all connections are made in the connection options screen, accessible by clicking the 'three dots' button in the instruments section of the task bar.

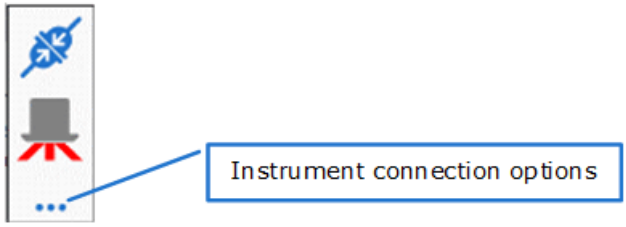


Figure 4: Instrument section of the task/button bar

4.2.1 GNSS

As can be seen in Figure 5 below, here are different options for connecting to a GNSS.

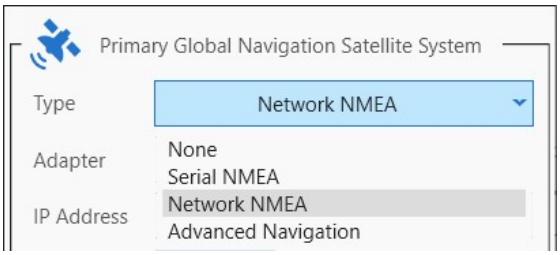


Figure 5: GNSS connection options

A short explanation on each option is shown in table 0 below.

Type	*Description*
Advanced Navigation 13	GNSS supplied with some Nortek VM systems. Connection is through ethernet using a proprietary protocol.
Network NMEA 16	Connect to any GNSS that supports ethernet.
Serial NMEA 17	Connect to a serial GNSS directly connected to the Nortek VM Processing Unit.

Skip to the relevant sections for instructions on connecting to your GNSS.

4.2.1.1 VM Coastal with Advanced Navigation GNSS

Make sure the adapter shows 'SurveyVM Interface' .

Click 'Connect' to start reading the GNSS data. The IP Address and Port box will turn grey and the button text will change to 'Disconnect'.

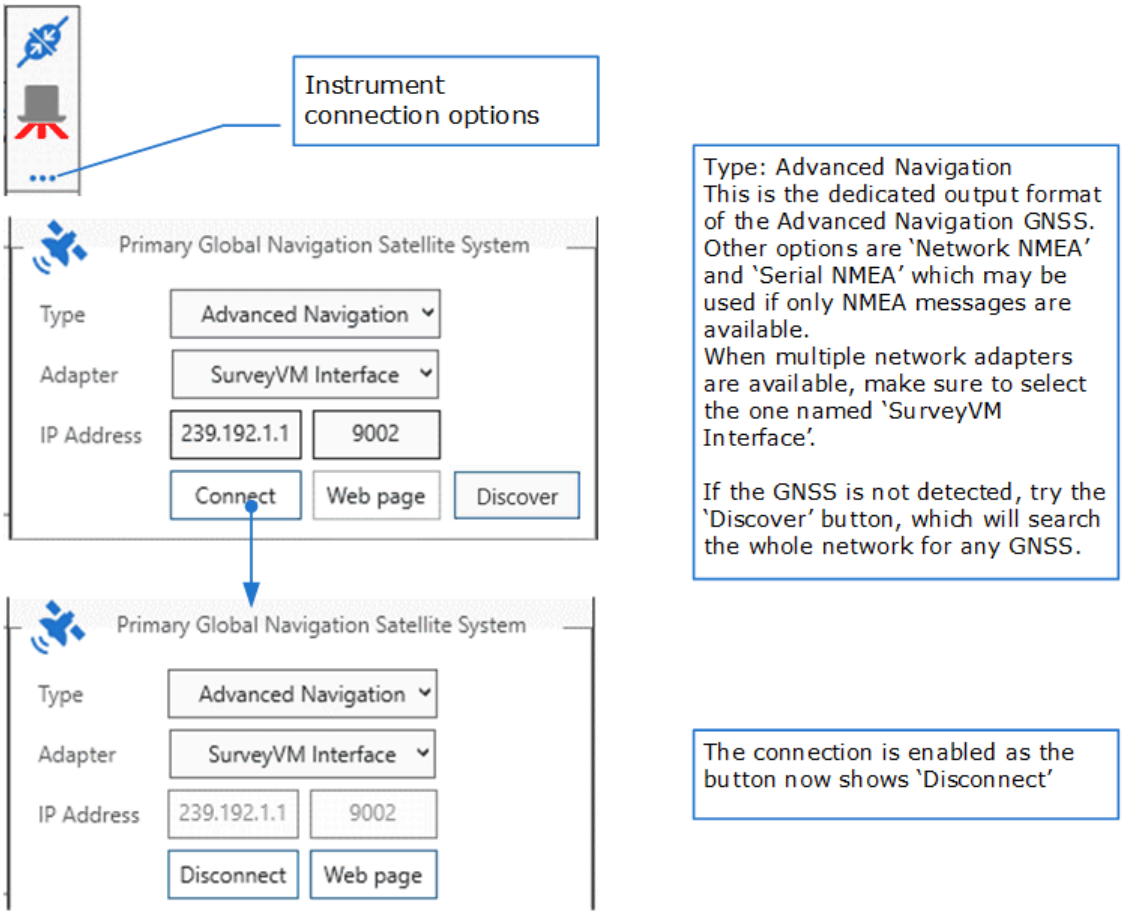


Figure 6: GNSS Connection

4.2.1.1.1 Checking the GNSS

Once the GNSS is connected, click on 'Web page'. This will open the internal web-interface page of the GNSS Sensor (see figure 7 14).

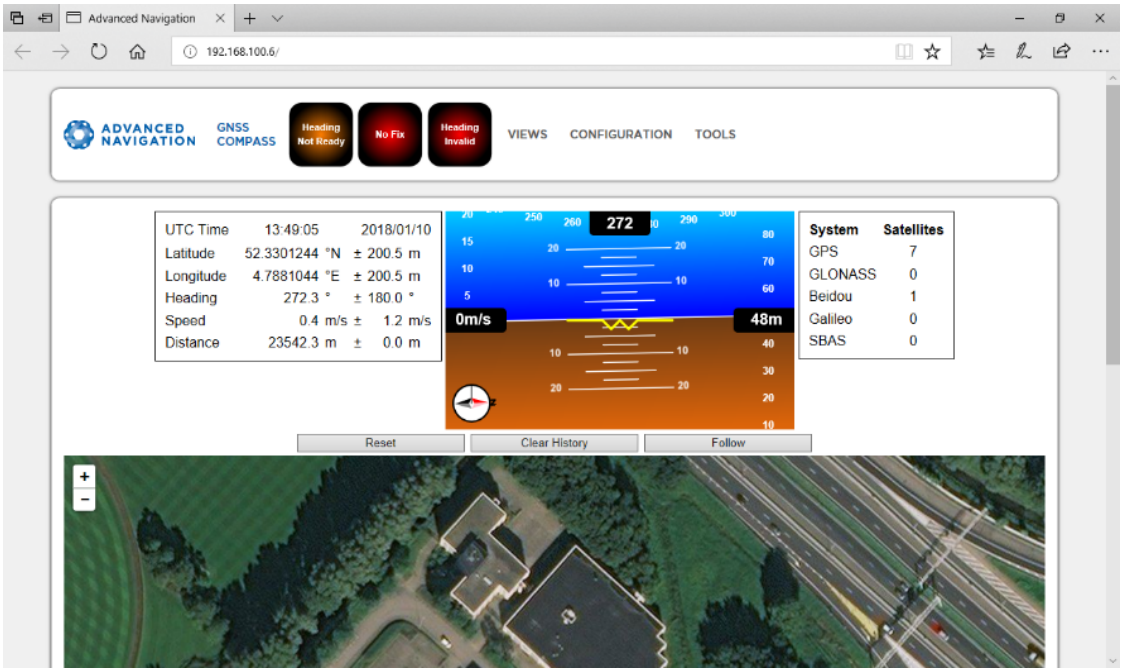


Figure 7: GNSS WEB interface

It is important that the GNSS is fully functional and has a correct position and heading, so make sure all markers in the top row are green.

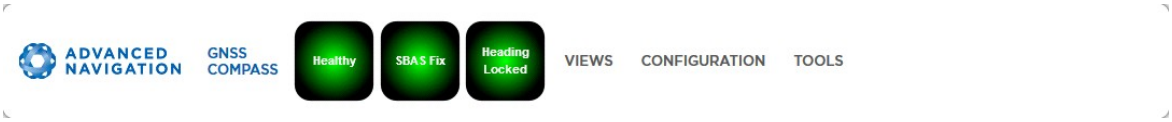


Figure 8: GNSS indicators should be all green

Note that this may take a while, especially after the system has been moved to a different location. Also, the antenna should have a real clear view of the sky to achieve a faster lock. Refer to the installation manual details on mounting the GNSS antenna. The map is only visible if the computer is also connected to the internet.

4.2.1.1.2 Using a NTrip Server

The Advanced Navigation GNSS can receive external correction signals over the Ethernet link using a protocol named 'NTRIP' (Networked Transport of RTCM via Internet Protocol). The NTRIP corrections improve the position accuracy down to the cm level (depends in the distance to the correction source)

To allow easy access to an NTRIP server there is a NTRIP client build into Nortek VM Acquisition. This client will forward the RTCM messages from internet to the GNSS.

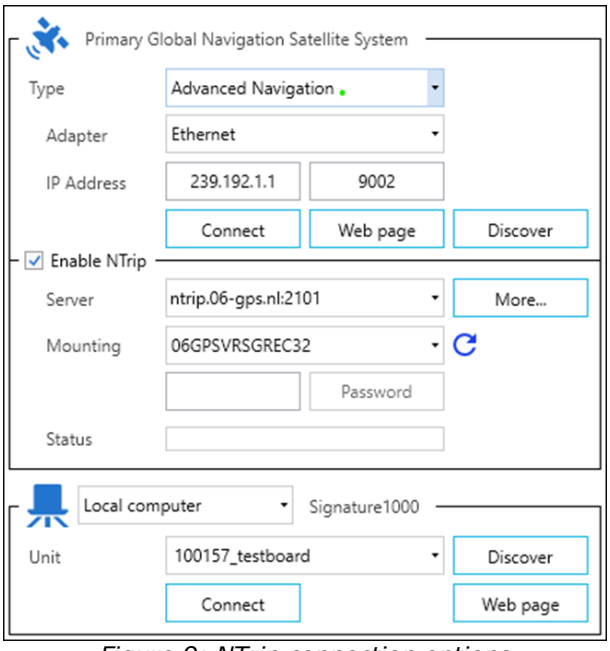


Figure 9: NTrip connection options

To connect to an NTRIP Server type the name of the server followed by a colon and the port number e.g. rtk2go.com:2101 in the server box, select the refresh button.

The mounting dropdown box will show the available mounting points. Select the required mounting point.

When selection a mounting point select a mounting point nearby your location will in general give the best result. The list with mounting points can be ordered by clicking on the column names.

The username and password are optional, for paid a NTRIP server use the passwords supplied by you service provider.

Note: to use NTRIP an Internet connection must be available.

4.2.1.2 Network NMEA

Receiving NMEA data over ethernet can be done in different ways. Depending on your setup, the selected network adapter and IP address might change.

The adapter should be set to "SurveyVM" when using the preconfigured serial interface. When the NMEA stream is received directly from the GNSS / gyro on an unused ethernet port, the "Ethernet" interface should be used.

For receiving unicast NMEA, the IP address should be set to 0.0.0.0 since the source of the NMEA stream is configured to send directly to the IP of the machine running Nortek VM Acquisition. When the source of the NMEA stream is configured to send multicast packets, the IP of the source should be filled in, instead of 0.0.0.0 for unicast.

Be aware that you may have to adjust the Windows firewall settings to allow the processing unit (and Nortek VM Acquisition) to receive this network traffic.

4.2.1.2.1 Unicast

If you are using the recommended settings of the serial interface and have it set to send out unicast messages, connect to the GNSS using the settings shown in Figure 10 below.

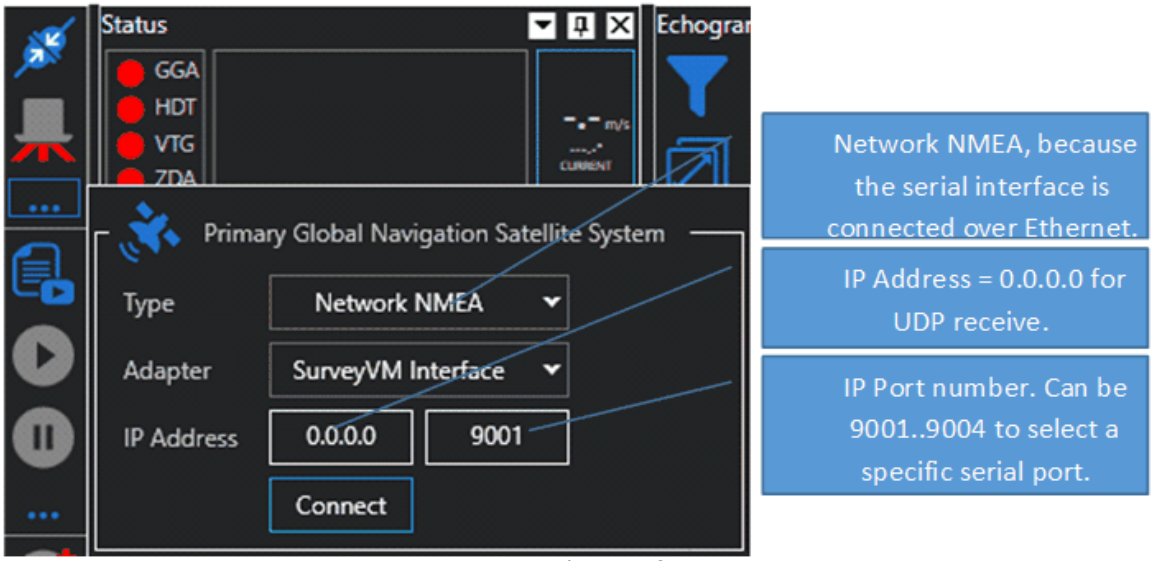


Figure 10: Unicast network NMEA for GNSS connection

4.2.1.2.2 Multicast

As an alternative, when the source of the GNSS NMEA stream is set to multicast, enter the IP address of the source as shown in Figure 11 below.

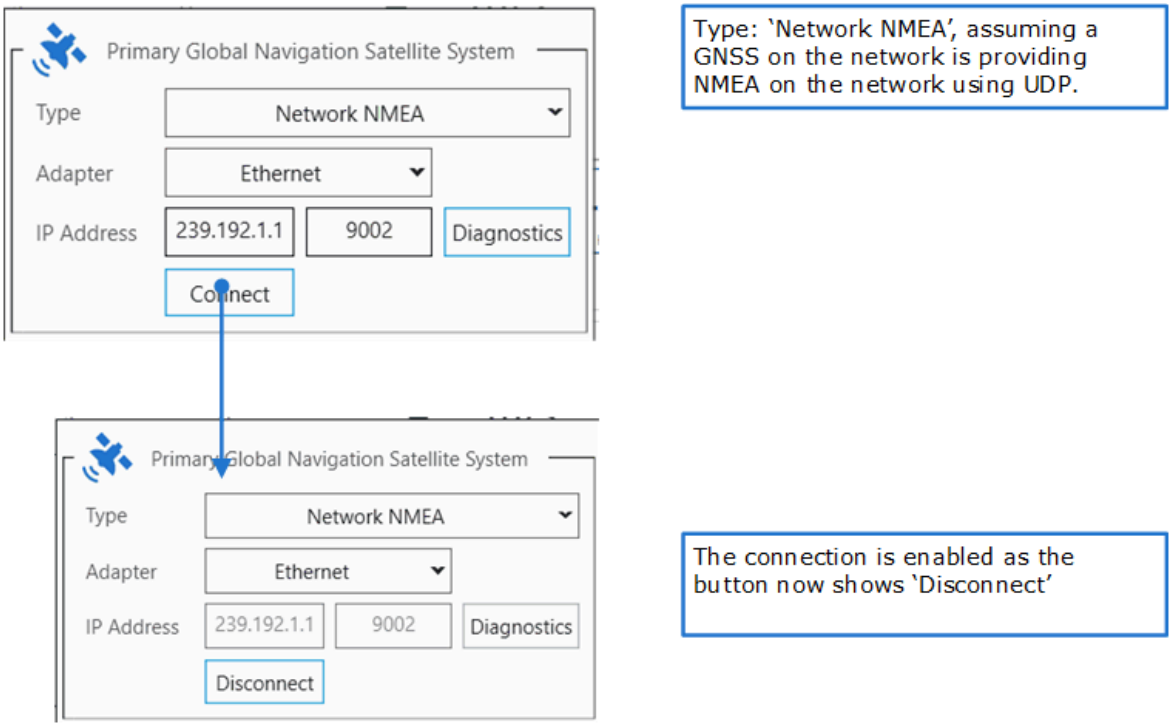


Figure 11: Mutlicast network NMEA for GNSS connection

Click 'Connect' to start reading the GNSS data. The IP Address and Port box will turn grey and the button text will change to 'Disconnect'.

It is important that the GNSS is fully functional and has a correct position and heading.

4.2.1.3 Serial NMEA

Even though it is not supported out of the box, it is possible to connect a serial NMEA GNSS directly to the Processing Unit. This requires a USB-to-Serial converter which is not supplied with any standard setup.

Connecting to a serial GNSS requires entering the serial port the device is connected to, as well as other serial communication related details. Consult the documentation of your serial NMEA source for information on these parameters.

An example of the serial NMEA connection options is shown in Figure 12 below.

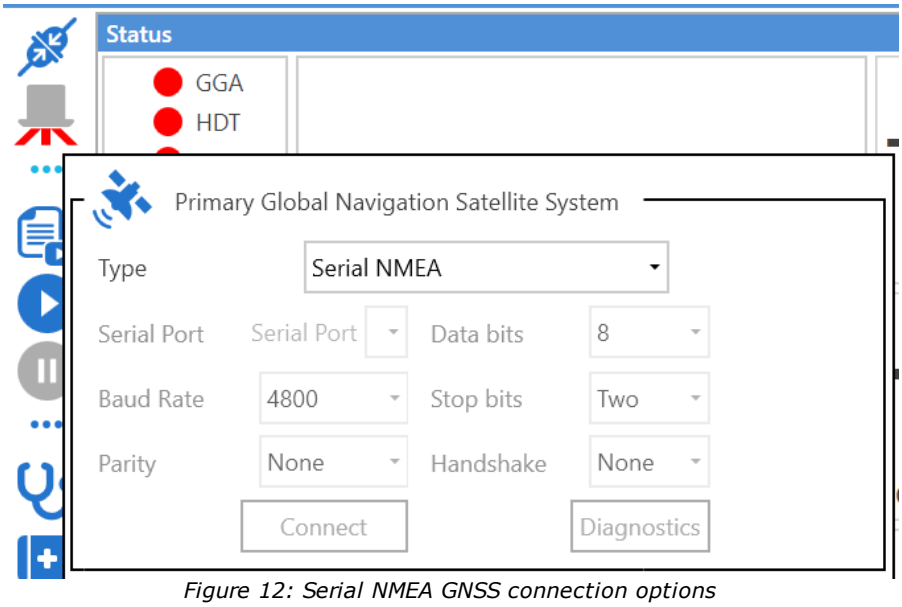


Figure 12: Serial NMEA GNSS connection options

4.2.1.4 Primary and secondary GNSS

The software can read NMEA compatible data from two different sources or 'channels' at the same time. These channels are named 'primary' and 'secondary', and both channels can read NMEA messages. If you have just one navigation source (a GNSS with serial output), select 'Primary channel' in the settings window (figure 13).

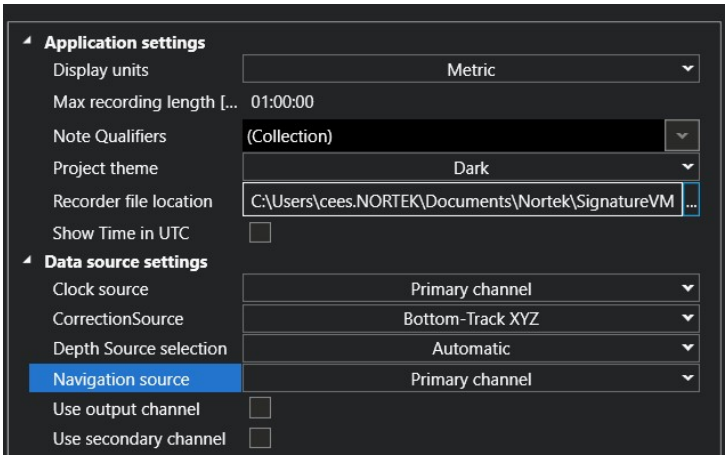


Figure 13: Configuration settings: Primary channel

If you have a second source, you can enable this in the settings by checking 'Use secondary channel'. If enabled, there will be an extra section in the setup for 'Secondary Global Navigation Satellite System' which can be configured to read data from a specific port (figure 14[19]).

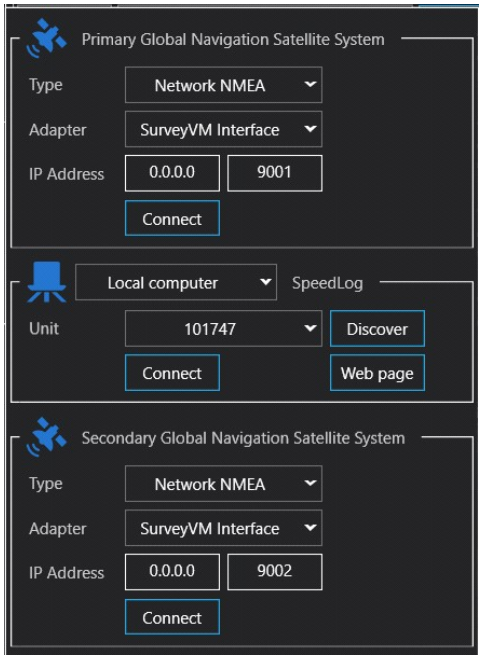


Figure 14: Options for Primary and Secondary channel

This secondary channel can then be used in the data source section in the settings.

4.2.2 ADCP

Next select your VM-ADCP in the Unit dropdown (see figure 15[20]). When the program is started it will automatically search for any VM-ADCP sensors on the network. In general, there will be only one, so when the sensor settings appear it will show the serial number of the attached sensor.

Click 'Connect' to start the Nortek sensor. The address / serial number box will turn grey and the button text will change to 'Disconnect'.

The contents of the dialog box will change: options for triggering and clock source will appear, as well as a checkbox "Use default deployment".

For details on triggering and clock source, see the section Triggering and time-synchronization[76].

As for deployment: the measurement configuration of the VM-ADCP is stored in a deployment file. If this checkbox is ticked, the software will use the default deployment file that comes with the installation. If unchecked, the software will ask the user to select a custom deployment file instead. (For further information on custom deployment files, and how to use the "deployment details" from section Start measuring[29], see the Nortek VM Frequently Asked Question "Custom deployment with raw bottom-track" on the Nortek Support web-site.

The example above assumes only one Nortek sensor is connected to the network. If multiple sensors are connected it is important to know which sensor is in use. The 'Discover' option fills in the list of serial numbers of the instruments found, but the drop-down box only shows the first one of this list. This may not be the instrument you want. In that case it is important to check that the model and serial number as shown here match the correct instrument. You can use the drop-down box to select a different instrument.

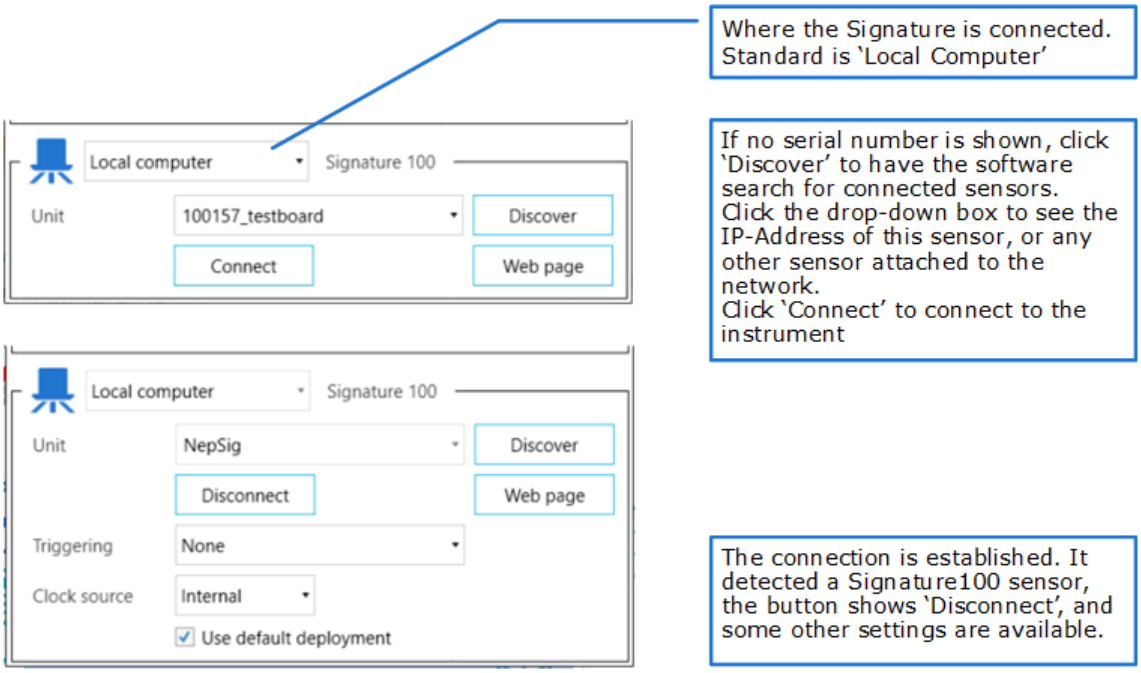


Figure 15: VM-ADCP connection

4.2.2.1 Additional Options

With the optional "INS compatible" license the VM-ADCP can send out Nortek's DVL bottom-track propriety called DF21 over a direct serial line. This data can be processed as aid for navigation by external software or an INS. The option will give the VM-ADCP a similar functionality as a Nortek DVL.

This option is only available with an INS compatible license, the DF21 an DF22 output options will not be visible if this license is not present.

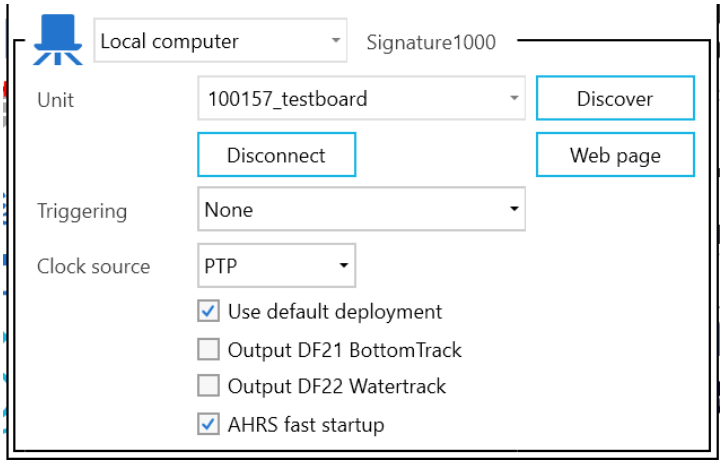


Figure 16: Special output options

The DF21 and DF22 format are output on 115.2 KBaud.

For additional information on the DF21 and DF22 formats see the Integrator's Guide, N3015-008_NortekDVL-IntegratorsGuide.

AHRS fast startup skips hardware initialization of the AHRS. Hardware initialization can cause invalid pitch and roll values when not done in a static situation. In most cases, AHRS fast startup without hardware initialization should be sufficient.

4.2.2.2 Checking the VM-ADCP

Once connected, click on 'Web page'. This will open the internal web-interface page of the VM-ADCP sensor (figure 17 21). This allows a number of low-level tasks, in particular a firmware update. (The software will check the instrument firmware, and will issue a warning if a firmware update is required.)

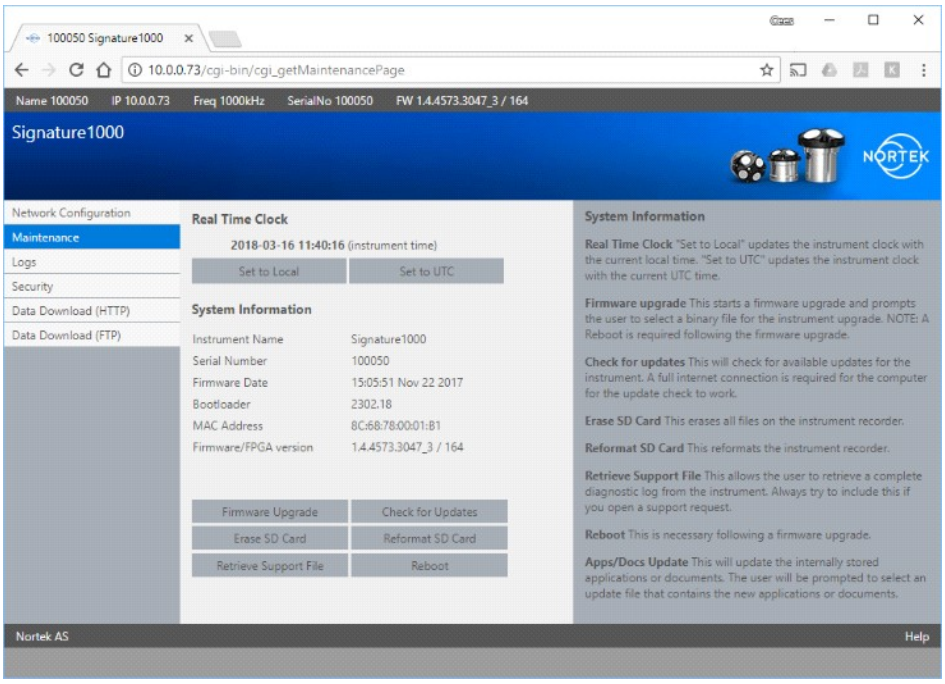


Figure 17: Signature web interface

4.2.3 Status panel

The 'Status' panel shows a quick overview of what is received and what is not.

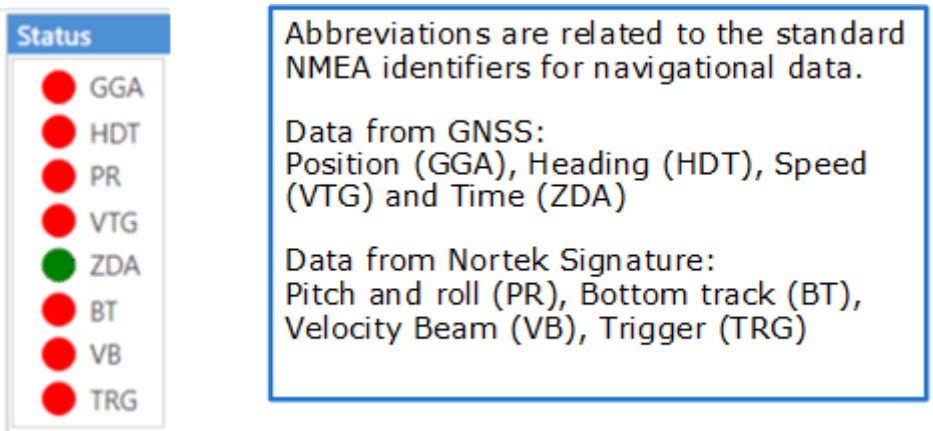


Figure 18: Status panel with status indicators

The Position, Heading, Speed and Time are provided by the GNSS and or gyro. If they are all marked red there is no GNSS / gyro data. If only Heading information is missing, there might be a problem with the GNSS measurement due to bad environmental conditions. When there is data, but the data may be unreliable the indicators will go Yellow. Table 1 22 gives a bit more information on the different indicators and their meaning.

Note that the trigger indicator (TRG) is only visible if the trigger option has been selected in Connection options.

For details of the status panel, other than these status indicator 'lights', see section Status 34 .

Table 1: Meaning of the colors of the status indicators

	RED	YELLOW	GREEN
Position (GGA)	No data from GNSS	2D Fix (degraded accuracy)	3D GNSS Fix
Heading (HDT)	No data	Heading from internal gyro sensors.	Heading from the Dual antenna
Pitch and roll (PR)	No data	Degraded data	Good pitch and roll data
Speed (VTG)	No data	(N/A)	Speed from the GNSS
Time (ZDA)	No data	(N/A)	Time from the GNSS
Bottom-track (BT)	No data	Degraded: data is coming in, but there's something wrong with it	Bottom-track data from the VM-ADCP
Velocity Beam (VB)	No data	(N/A)	Water velocities as determined by the beams of the VM-ADCP
Echosounder (ES) (if an echosounder is available and switched on)	No data	(N/A)	Echosounder data as measured by the VM-ADCP
Trigger (TRG)	Waiting for trigger	Data received outside expected trigger time-window	Data received within expected interval

5 Measuring

If everything is configured correctly and working as described in the previous section, the measurement may be started.

5.1 ADCP Measuring Essentials

Before starting your measurements and setting up the system, it is important to understand the essentials of an Acoustic Doppler Current Profiler based measurement system. In addition to the few notes below there is a comprehensive introduction available on our website at https://www.nortekgroup.com/knowledge-center/wiki/guide-to-understanding-adcps. A more specific Nortek VM introduction is available at https://www.nortekgroup.com/knowledge-center/wiki/understanding-vessel-mounted-current-measurement.

Following is a list of the most important points that should be kepth in mind when configuring a Nortek VM-ADCP.

- Larger cells provide more range and have a better velocity precision. Always choose the largest cell possible for your application. Smaller cells my seem to give a better layer resolution, but the accuracy per cell quickly decreases.
- Broadband pulses provide a better precision in time or space.
- Narrowband provides more range and may perform better in environments with background noise.
- Try to set the blanking distance at least equal but preferably larger than the cell size.
- Additional pings, such as echosounder or bottom-track pings, reduce the number of velocity pings in time and thus reduce the velocity precision in time. So, you may want to switch off the echosounder if it is not needed. And if the depth is too large for the bottom-track to work anyway: switch that off, too. (Note: not all instruments support this.)
- The maximum range depends on the acoustic scattering conditions. In very clean water your range may be limited due to a lack of acoustic scatterers, while very sediment rich water can dampen the acoustic waves.
- Maximum range can be limited by nearby acoustic noise like motors or other acoustic measurement equipment like echosounders.
- To limit the influence of electrical noise the instrument must always be fully submerged.
- Stratification in sound velocity does not influence the measured velocity, but it will influence the estimated measurement location.
- The performance of the bottom-tracking is a function of the vessel speed, depth and type of bottom. In general:
  - Hard, sandy bottom works better than soft and muddy or with lots of vegetation.
  - Its harder to track the bottom at higher speeds.
  - To an extent: it is harder to track on a soft layer on shallower water. Deeper is better, up to the maximum range of course.

5.2 Configuration

Start by checking the configuration and adjust the necessary variables. Click the 'Configuration' button to bring up the settings. Initially, the different categories of settings will be collapsed (see figure 19 24).

Click the small triangle to the left of a category of settings to switch between the collapsed and the expanded view.
The button "Restore factory defaults" will reset all settings to their defaults.
The button "Save configuration" will store all settings (including various settings that are not part of this window), so they will use these same values when the software is restarted. Note the implication: any configuration changes that are not saved, will not survive a software restart.

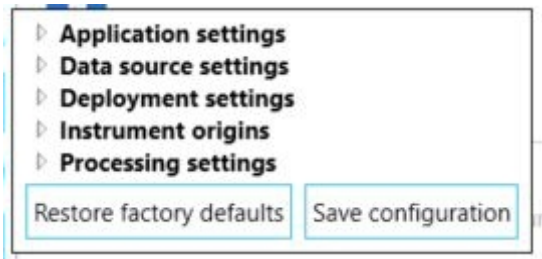


Figure 19: Configuration settings, collapsed view

FIgure 20 [25] shows the full list of configuration settings.
Table 2 [26] lists the default values, and gives an explanatory description of each configuration setting.

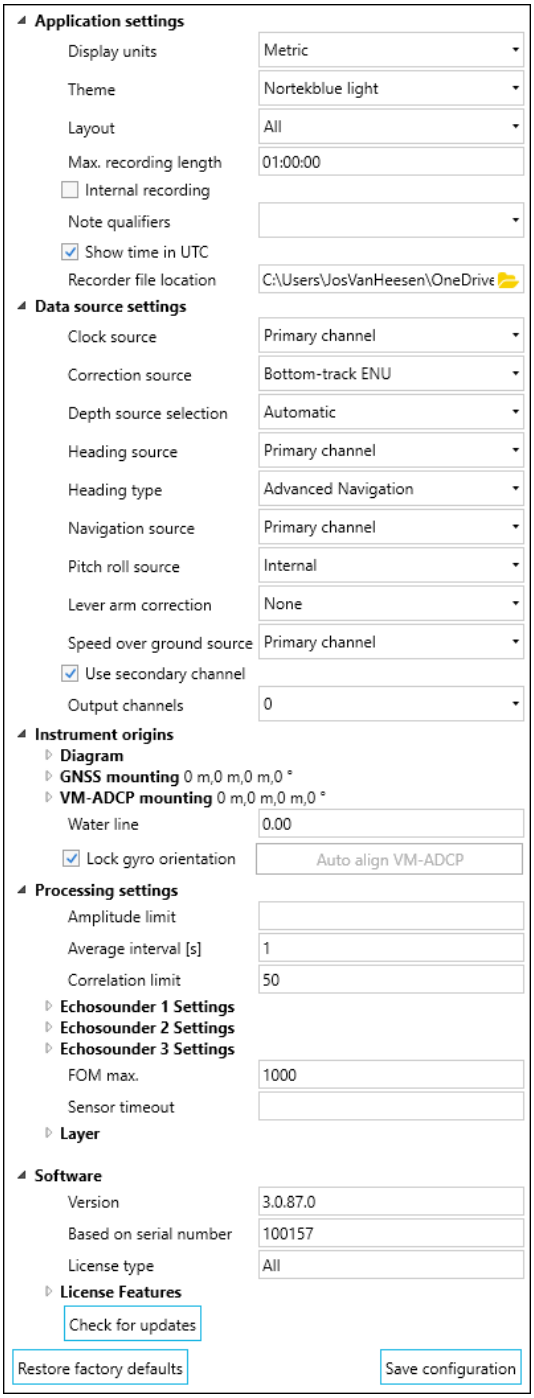


Figure 20: Configuration pop-up window

Table 2: Configuration details

Setting	Default	Description
Application settings		
Display units	Metric	Distance and speed on the screen in m/s or knots and feet
Theme	Nortekblue dark	Display theme, the application colors, background and heatmap color palettes change with the selected theme.
Layout	Default	Change between saved layouts or save the current layout.
Max recording length	1 hr (01:00:00)	Maximum length of a single recording. If left blank everything is recorded in a single continuous file. Else it is split in files of the specified length. The length should be specified in dd:HH:MM:SS format. Dd is the number of days, but if not used the time is just entered in hours minutes seconds. The minimum recording length is 10 minutes; values less than this are automatically changed to this minimum.
Internal recording	No	Enable recording on the VM-ADCP's internal disk
Note qualifiers		Predefined 'qualifiers' that may be inserted from a drop-down box when creating a note. See section "Adding Notes" for details.
Show time in UTC	Off (Local time)	Show time and date on the screen in UTC. Does not change the recorded data which is always recorded with UTC time tags.
Recorder file location	..\Documents\Nortek\Nortek\Nortek.VM.Acquisition	Where the recorded data is stored.
Data source settings		
Clock source	Primary channel	Where the clock as used for synchronisation is taken from. 'Primary' or 'Secondary' channel refer to the GNSS output channel.
Correction source	Bottom-track XYZ	Which velocity measurement is used to correct the measured water-velocities.
Depth source selection	Automatic	What data is used for measuring the depth.
Heading source	Primary channel	If multiple sources of heading information are available, you can select a specific one here.

Setting	*Default*	*Description*
Heading type	Advanced Navigation	You can select the type of heading information available on the channel you selected as Heading Source (the Advanced Navigation format, or a NMEA format, either HDT, THS, or NTHPR)
Navigation source	Primary channel	If multiple sources of navigation are available, you can select a specific one here. Not necessary if the system is only used with the standard GNSS.
Pitch roll source	Internal	If other sources for pitch and roll data are available, you can select a specific one here.
Lever arm correction	None	The lever arm correction uses angular velocities to compensate the movement of the GNSS antenna. The angular velocities and the mounting position of the GNSS are used to calculate the horizontal and vertical speed of the antenna due to the angular velocity. This is then subtracted from the antenna speed. This option can at this moment only be used when an Advanced Navigation GNSS is present.
Speed over ground source	Primary channel	If multiple sources of navigation are available, you can select a specific one here.
Use secondary channel	No	Enable the use of a secondary source for navigation information.
Output channels	0	Select the number of output channels for data output. Up to three channels are available. See section Data output for details.
Instrument Origins		
Diagram		Diagrams showing the offsets and orientations of the instruments in the XY and XZ plane. See chapter Offsets for details.
GNSS mounting	0m,0m,0m,0 º	Offsets of the GNSS from a reference point on the vessel. Check chapter Offsets for details.
VM-ADCP mounting	0m,0m,0m,0 º	Offsets of the VM-ADCP from a reference point on the vessel. See chapter Offsets for details.
Water line	0	The water line with respect to the reference point.

Setting	*Default*	*Description*
Auto align VM-ADCP		Automatically set the VM-ADCP mounting orientation, see section "Automatic alignment" for details.
Processing settings		
Amplitude limit	(blank)	Any measured cell where the amplitude is lower than this limit is discarded. If left blank, no limit is applied.
Average interval [s]	1	Measurements are averaged over this interval.
Correlation limit [%]	50	Any measured cell where the correlation is lower than this limit is discarded. If left blank, no limit is applied.
Echosounder settings[1] Noise level dB	(blank)	Base noise level of the echosounder. The data of the echosounder as shown is the volume backscatter strength. Part of the returned signal is caused by the inherent noise of the echosounder itself. If known, it can be used to correct the absolute reflection values. If left blank this value is not used. See section "Noise level" 41 for details.
FOM threshold	1000	Any measured cell where the FOM (Figure Of Merit) is higher than this limit is discarded.
Sensor timeout	(blank)	Time interval for bottom-track or velocity ping. Leave blank for instrument default.
Layer	1-2m	Options for enabling and adjusting the layer for current velocity data. See section "Layer 42 " for details.
Software		
Version		Installed software version
Check for updates		Manually check for updates

Notes:
[1]: If two echosounder channels are used, they can be configured independently. The third channel is for future expansion.

5.2.1 Save Configuration during acquisition

Any change made to the configuration is implemented in the processing and display immediately. Only when you click 'Save Configuration' are these values written to the configuration file and therefore can be read later by the Review software or when replaying the

data. This is also true when replaying the data. You can change the configuration during playback, but this is only stored in the file that is being replayed when you click 'Save Configuration'.

5.3 Start measuring

When every sensor has been checked and found to be working, as described in the previous section, the system can be started by first clicking the 'Connect' button. When the instruments are connected, click the 'Start measurement' button. There will be a pop-up window where you can set or verify the main measurement settings (see figure 21 29). The contents of this window may vary, depending on the type of sensor that is connected or the available options within that sensor.

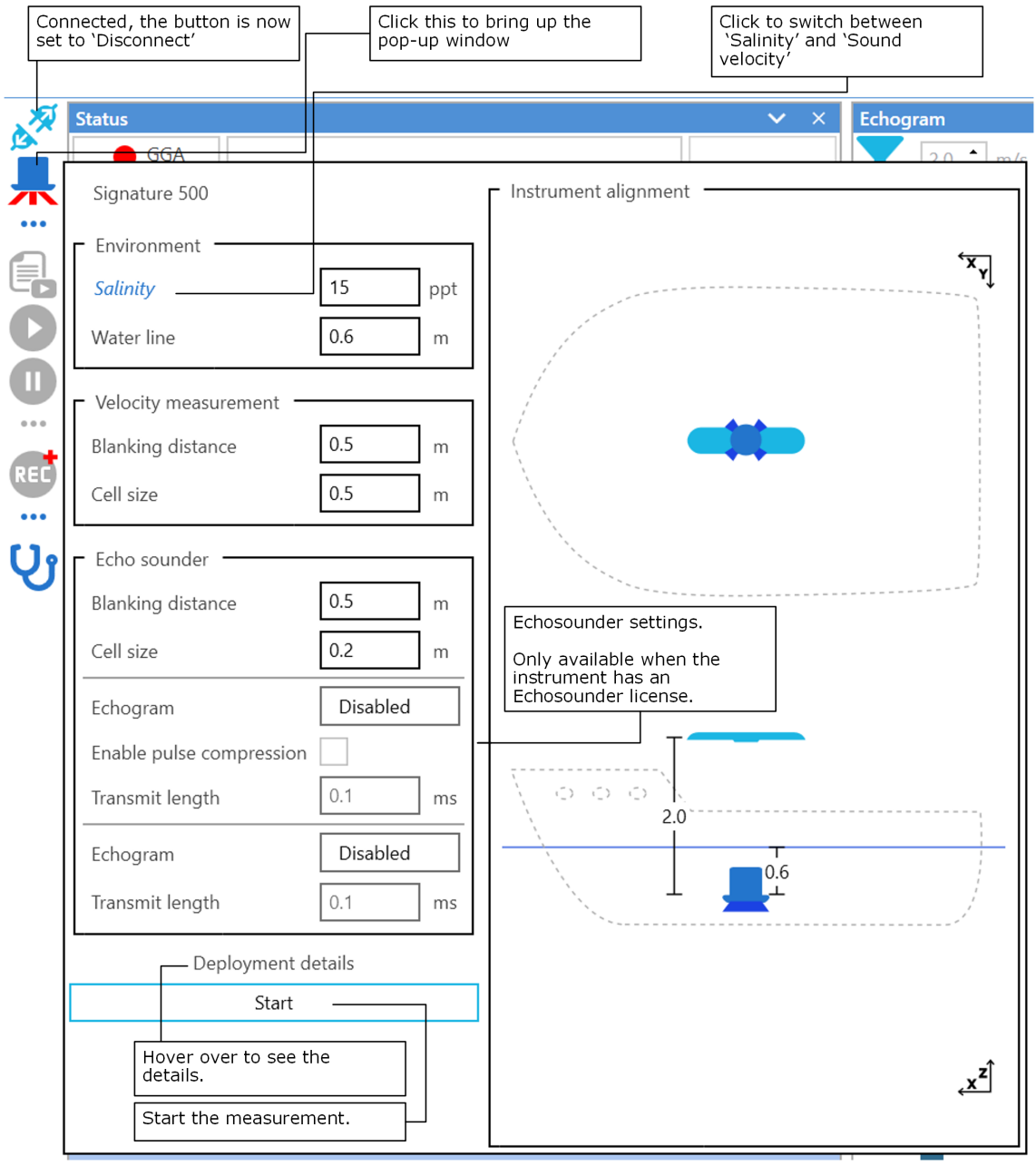


Figure 21: Start measurement pop-up window

When entering new values in the edit boxes they are automatically checked (when leaving the box), and if a setting is not compatible with the connected sensor the edit box will be marked red and the 'Start' button will be disabled.

Table 3: Measurement settings details

Setting[1]	***Default[2,3]***	***Description***
Environment		
Salinity / sound velocity	35 / 1500	Click on this field to switch between 'salinity' or 'sound velocity' The salinity is 0 for fresh water and typically 35 ppt for the ocean. This is used for automatic calculation of sound velocity. If sound velocity is selected, a fixed speed of sound in water has to be entered. In general, this is around 1500 m/s in seawater.
Water line[4] [m]	0	The distance between the reference point (for the instrument offsets) and the water line.
Velocity measurement		
Blanking distance [m]	0.5	Distance to the start of the first measuring cell.
Cell size [m]	0.5	Size of each measuring cell. A larger cell size will improve the accuracy per cell, at the cost of losing vertical resolution. The total number of cells that is recorded is limited by the selected cell size. The total measured distance (nr. of cells * cell size) cannot exceed the maximum range of the instrument.
Enable bottom-track	ON	Applies only to the Signature 250, 100 and 55. Enable or disable the use of bottom-track when calculating the velocities. If disabled, the velocity corrections are taken from the GNSS.
Enable altimeter	ON	Allow the use the Altimeter to measure depth. (The way the depth is determined depends on the setting for 'Depth source', in the Configuration[23])
Use broadband	ON	Applies only to the Signature 250, 100 and 55. If disabled, the sensor uses the narrow-band Doppler technique for measuring velocities. Narrowband may give more range, but it is less accurate.
Echosounder		Echosounder specific settings. Only available if the instrument has an echosounder licence. Two echosounder measurements are available, each can be enabled or disabled. For details refer to section Echosounder details[40] .

Setting[1]	*Default*[2,3]	*Description*
Blanking distance [m]	0.1	Distance to the start of the first measuring cell.
Cell Size [m]	0.5	Size of each measuring cell. This basically sets the vertical resolution of the echosounder.
Echogram		If disabled, this echosounder mode is not used. (echosounder is NOT recorded!). Select a frequency from the dropdown box to enable the echosounder. Most VM-ADCPs only have one frequency available, which is the base frequency of the sensors itself (e.g. 1000 kHz for a Signature 1000). On a Signature 100 with echosounder option it may be possible to select different frequencies.
Enable pulse compression	ON	Only available for the first echosounder.
Transmit length (ms)	0.1	Length of the transmit pulse in ms.

Notes:
[1]: The presence of some settings depends on the connected sensor.
[2]: Some defaults depend on the connected sensor.
[3]: If you change these values and want to store them for future measurements, open the 'Configuration window' and click 'Save configuration'.
[4]: This value was previously called "mounting depth", this was valid when using the VM-ADCP itself as the reference point, but can be confusing if the VM-ADCP is not the reference point.

When you hover the mouse cursor over 'Deployment details' a box will pop up showing the configuration as it will be sent to the instrument at start-up (see figure 22 31). These can be inspected or saved to file and used as a basis for constructing custom deploy files. Creating and using custom deploy files is an advanced feature. Please refer to the 'Nortek Signature Integrators Guide' for details.

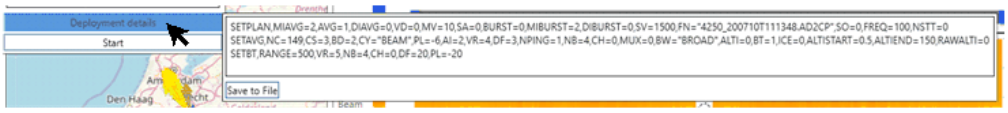


Figure 22: Deployment details

Click 'Start' to start the actual measurement. When any of the settings in this window is invalid for this specific sensor the Start button is not enabled and the measurement cannot be started.

The system will now start recording the measurement data. When it is recording this is indicated by the two progress bars that are visible in the details pop-up, when clicking "…" at the bottom of the 'Recording' group of buttons (see figure 23[32]). Use 'Next recording' to create a new file. This may be useful to start a new file when a specific area or track is started.

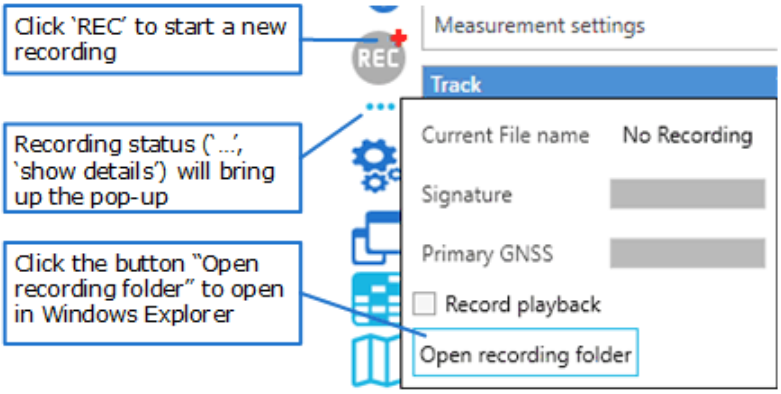


Figure 23: Recording and recording status

5.4 Measuring and Display

While measuring or playing back a file, the various windows that make up the software show real-time data.

Keep in mind that not all windows might be available based on your configuration.

5.4.1 Buttons to show/hide the different windows

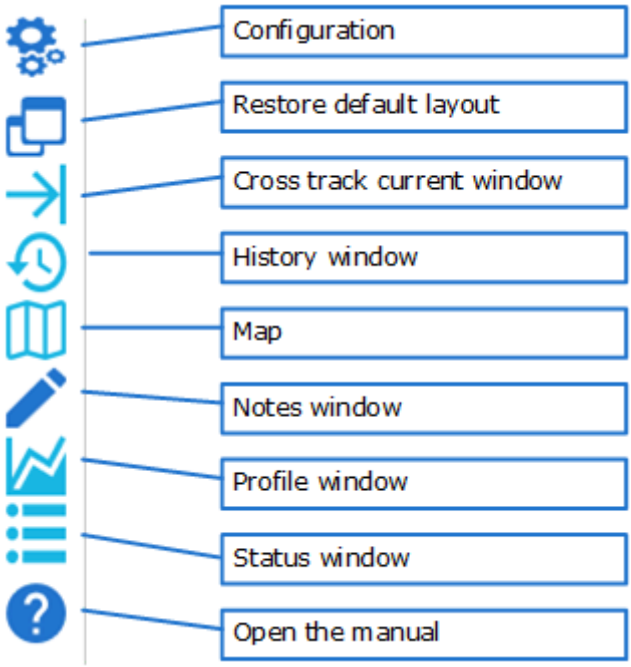


Figure 24: Lower left of the task/button bar

Figure 24 shows the buttons at the lower left side of the button bar, that control visibility of the different windows. Table 3 repeats the window names, and includes an indication of the section (if any) that gives more details about that window.

Table 4: Where to find details about each window

Window name	Section
Configuration	Configuration 23
Restore default layout	(self-explanatory)
Echograms	Echograms 39
Cross track current window	Cross track current window 43
History window	History window 52
Map	Track display
Notes window	Adding Notes
Profile window	Profile window 45
Status window	Status

Window name	Section
Open the manual	(self-explanatory)

5.4.2 Status

The status panel shows a set of panels with various metrics for insight in the status of the connected instruments and the data recorded.

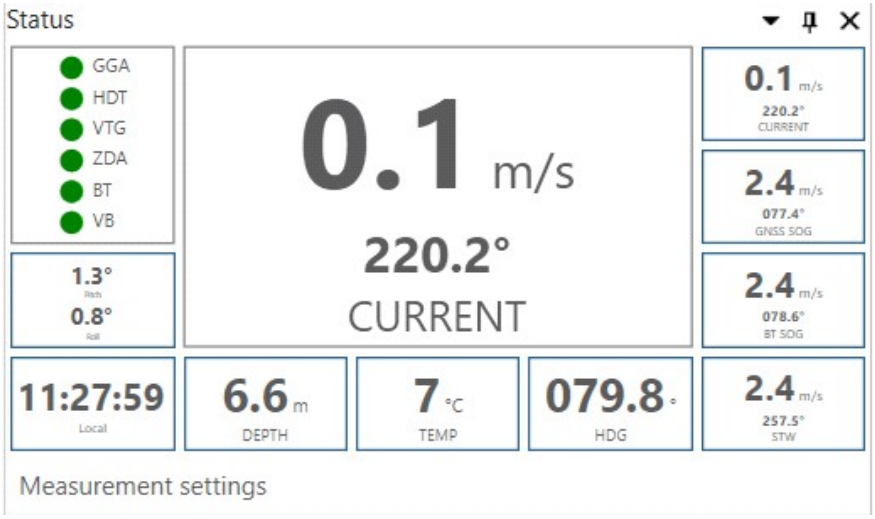


Figure 25: Status panel overview

The different parameters are (in figure 25, clockwise from top right):

Table 5: Status display parameters

Parameter	Meaning	Description
Current		Averaged current speed and direction referenced to earth.
GNSS SOG	Global Navigation Satellite System Speed Over Ground	Vessel speed and direction over ground as measured by the GNSS.
BT SOG	Bottom-track Speed Over Ground	Vessel speed and direction over ground as measured by the VM-ADCP.
STW	Speed Through Water	The speed of the ship through water, i.e., the speed and direction of the ship relative to the water.
HDG	Heading	Heading of vessel as measured by the GNSS.
TEMP	Temperature	Water temperature as measured by the VM-ADCP.
Depth		Depth as measured by currently selected depth source.

Parameter	Meaning	Description
Local / UTC		Time
Pitch, roll		Pitch and roll, measured by the instrument, converted to ship's axes.
Status lights		See section Status panel[21] for information on the status indicators.
Measurement settings		Hover your mouse over this text (just below the Status panel itself) to see the active settings. (Also see figure 28[36] and accompanying text.)

As the various small sub-panels around the edges can be difficult to read, there are two options to help with this.
Hovering the mouse (without clicking) over one of the edge sub-panels results in a pop-up balloon explaining the contents of that sub-panel, while at the same time the center panel temporarily shows the contents (and especially the values) of that same sub-panel. Figure 26 shows an example.

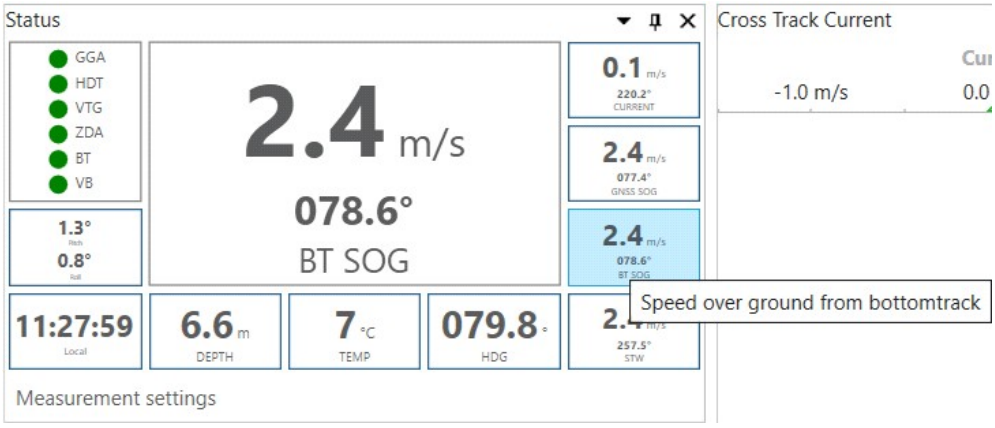


Figure 26: Hover over a sub-panel to show its values in the center panel and show an explanatory pop-up balloon

The other option is to click on a sub-panel. This will switch the center panel to display the contents of that sub-panel, even when you move the mouse away from that sub-panel. This way it is possible to have the center panel display the most important parameter continuously and prominently. Figure 27 shows an example.

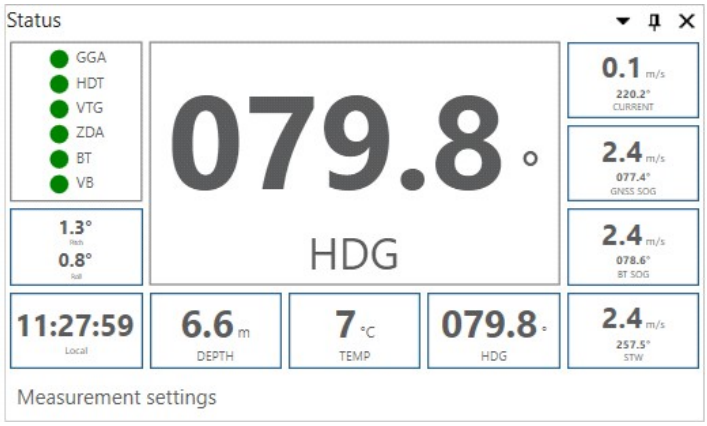


Figure 27: Click on a sub-panel and the center panel will display that panel's contents permanently

The bottom line of the status panel contains the text “Measurement settings”. Hover the mouse over this text, and a pop-up will show a list of detailed settings as configured for the measurements. Figure 28[36] shows an example. Note that if you do not move the mouse the pop-up will stay visible for a short time only; if you move the mouse away from the text “Measurement settings” the pop-up will disappear immediately.

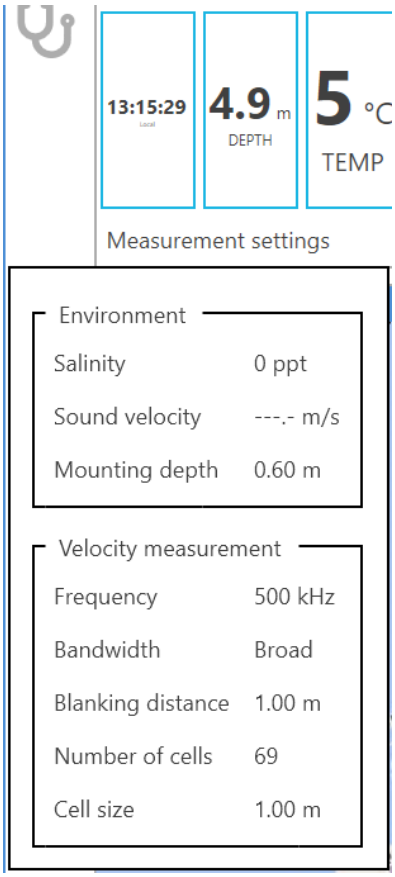


Figure 28: Hover over "Measurement settings" for a list of details

The values related to the water velocity (Current and STW) are averaged over the full water column by default. When a depth layer[42] is used, average values from this layer are displayed.

Note that the details shown may vary, depending on which instrument is connected.

5.4.3 Track display

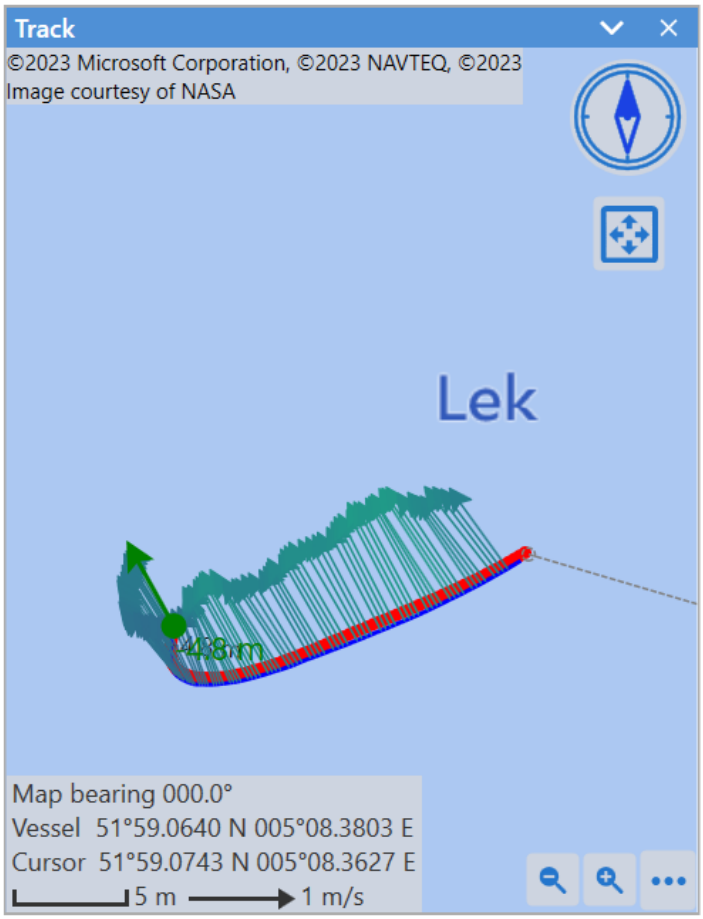


Figure 29: Track display

The track display shows the track as sailed by the vessel, and recorded by the GNSS, as a blue line. The calculated track from the bottom-track data is shown as red dots. Note that the background map may only be visible if there is a live internet connection since these maps are loaded from the internet (see map source selection 38 .)

Interaction with the map can be done using the mouse. Next to this the map can be rotated by clicking and dragging on the edge of the compass. There is also an option to fit the GNSS track to the dimensions of the track window.

Clicking the […] button at the bottom right of the map opens the map options menu.

When the calculated track starts to drift away from the actual track you can reset it by clicking 'Bottom-track-> Reset' or press <Ctrl>-R on the keyboard.

The following five items each have a toggle box (☐▣) to switch display of that option on or off; the color of the dot in the toggle box (indicating "on") is the same as the corresponding feature as drawn on the map.

The other items have a regular toggle box (☐☒), see table 6 38 for details on each option.

Table 6: Map display options

Options	Description
GNSS	Show the track as recorded by the GNSS positions.
Heading line	Show a straight line that marks the heading according to the GNSS compass.
Altimeter	Show the depth value at regular intervals.
Notes	Show the notes as they are recorded (will not update on deletion or modification in Notes[53] window).
Bottom-track	Show the course as calculated from the bottom-tracking.
Current vectors	If selected, show the average velocity over the measured depth as a velocity vector. The colour of the vector depends on the setting of the Max and Min on the colour scale. Scaling may be used to draw the length of the vectors larger or smaller, if required. The 'interval' sets the spacing between drawing of the vectors. For example: if Interval is set to 6, only every sixth vector is shown.
Show map	Select to show a background map. The 'Map Brightness' slider can be used to set the visibility of the background map.
Automatic center	The map will automatically shift the ship track to the center if it gets too close to the edge.
Rotate on fit	Automatically rotate the map to make best use of the available space when the 'Fit to screen' button is used, keeps north up if disabled.
Allow internet	If a map is not already available on this computer, use the internet connection to collect it. This could be disabled if the computer is connected to internet over low bandwidth connection.
Map selection	The last item in the list is a drop-down box where you can select the source of the map. OpenSeaMapHybrid discourages use of its servers; you may want to use Google or Bing maps. If available (see next section), this can also be a user supplied image in GeoTIFF format.

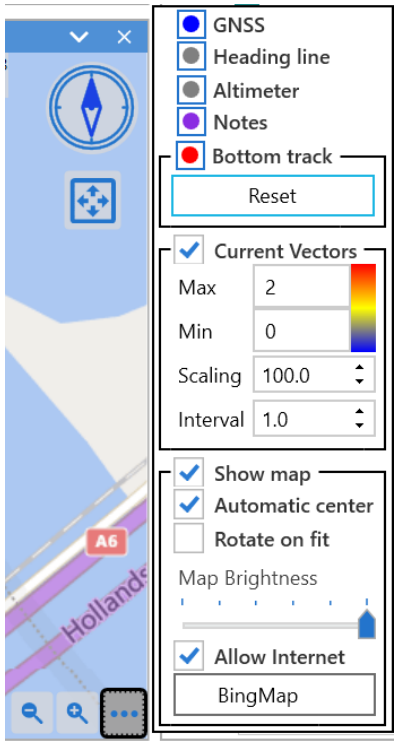


Figure 30: Map display options

5.4.3.1 User defined background map

It is possible to use other images as map background. This requires an image that is stored in either the GeoTIFF or MBTiles format. This file should contain, apart from the image data, details on the geographic location, map projection and the coordinate system. Images as

created in Nortek VM Review via the Map/track 'Save as GeoTIFF' right-click context-menu comply to this standard so they may be used as a basis for creating custom maps.

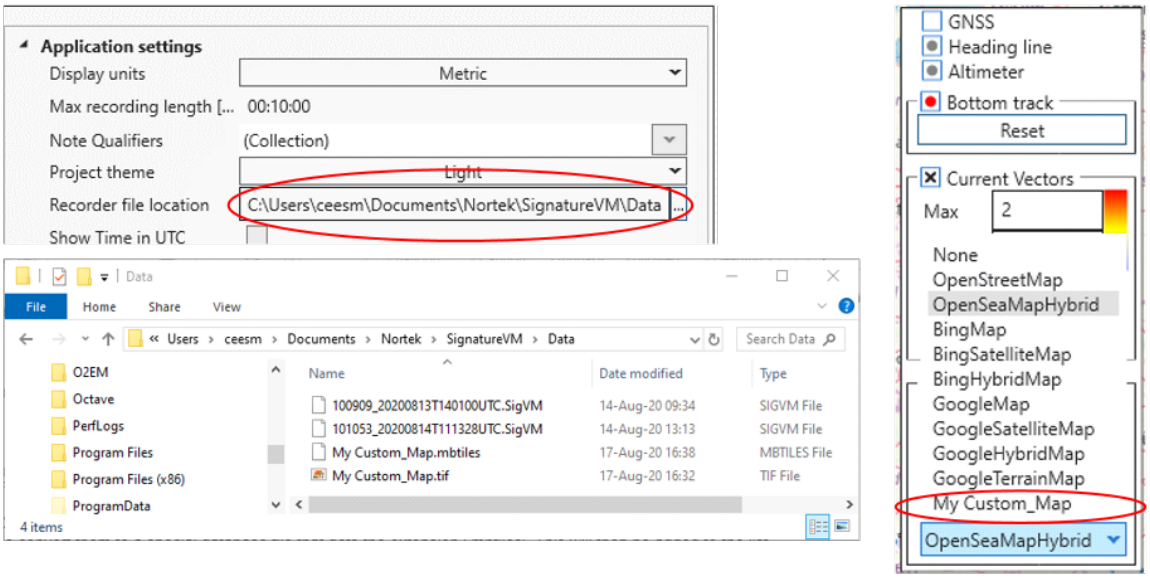


Figure 31: Custom map

The custom maps will be read from the same folder that is specified for saving the recordings.

On start-up the software will look at this folder, check if there are any GeoTIFF images in there and if so, try to convert them to a special database file that gets the extension '.mbtiles'. This will then be added to the list of possible map sources in the dropdown box so it can be selected.

As a shortcut, MBTiles files can also be added directly. This has the added benefit that the MBTiles files can have a set of zoom levels and cover a larger area than GeoTIFF images.

Note that after selecting a new folder for the data, it might take a while before the new maps become available.

5.4.4 Echograms

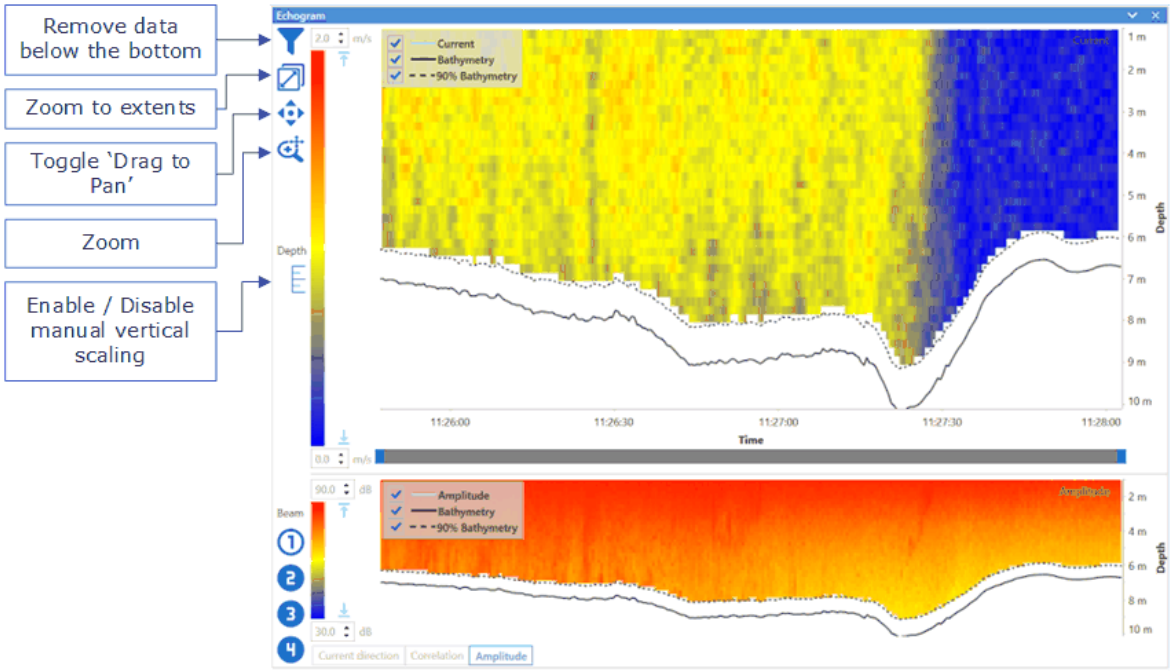


Figure 32: Echograms with displaying options

The chart at the top shows the magnitude (absolute value) of the current velocity. The lower chart can show either 'Direction', 'Correlation' or 'Amplitude' for one of the four beams, or, if available and switched on, one of the 'Echosounder' channels.

The 'filter' icon will show either all data up to the detected bottom, or all data down to the maximum depth.

Default scaling for the vertical axis is automatic. The program tracks the bottom and adjusts the scaling, so all relevant data is in view. If you want to focus on a specific section or just want to see all, click the 'Depth' button (so it shows a hand over the scale, to indicate 'manual'). Now adjust the depth scale by clicking and dragging it with the mouse.

5.4.4.1 Echosounder details

Echosounder operation is an optional feature, available for some types of Nortek VM systems. We refer to echosounder data as the vertical echogram, showing high resolution reflection intensities which may be used to detect biomass, sediment or fish.

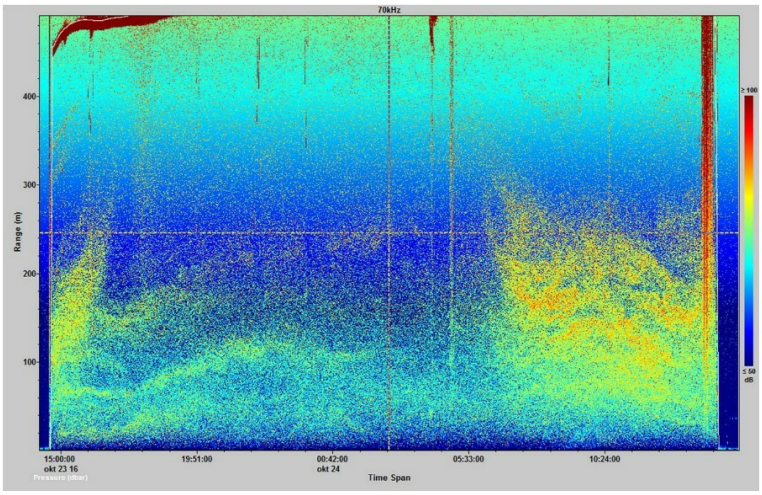


Figure 33: Typical Echosounder image, showing areas that might contain biomass

The Nortek VM Coastal 1000 and 500 use their centre transducer for echosounder measurements, so the echosounder frequency is also fixed to 1000 or 500 kHz. The Signature 100 has a dedicated echosounder transducer that has a wider bandwidth and therefore more frequency options to choose from.

5.4.4.1.1 Pulse Compression

When transmitting a pulse, it is of interest to have it as short as possible, as the length of the pulse affects the range resolution. However, we also want the pulse to be long enough so that the measurement quality is improved. Therefore, there are two ways of processing the signal, either with or without pulse compression.

With pulse compression: With pulse compression enabled, the centre transducer transmits a sound wave (pulse) with a bandwidth of 25% (compared to the normal 6.25%). Each part of the pulse has a unique frequency, and the return pulse can be separated and integrated into a shorter single output pulse. Practically, that means that the return echo is compressed in its pulse duration in special filters, which results in very high-resolution data. Pulse compression thus provides a method to further resolve targets compared to "normal".

Benefits: The best resolution is achieved with pulse compression; minimum resolution is 3mm for Signature 1000 and 6mm for Signature 500. The Signal to Noise Ratio (SNR) increases because the length of the transmit pulse can be increased without affecting the resolution. Pulse compression works best with small scatterers.

Disadvantage: May introduce sidelobes in shallow water or when measuring close to boundaries.

Without pulse compression: Bandwidth of a transmit pulse without pulse compression is approximately 1/T, when T is the transmit pulse length in seconds. The length of the return echo will be a convolution of the rectangular transmit pulse and receive window. If the transmit pulse length is set to BinSize/(c/2) (where c is the speed of sound in water) or nominally BinSize/750, the bins will consist of triangularly weighted echoes, like the classical doppler profiler cells. In this case the resolution depends on both the length of the transmit pulse and the cell size.

The best resolution is achieved with the shortest allowable transmit pulse but still limited by the bandwidth which corresponds to a resolution of 12 mm for the Signature 1000 and 24 mm for the Signature 500.

Benefits: Reduced chance of sidelobe interference with a narrowband pulse when measuring in bottom boundary conditions (where SNR is generally high enough)

Disadvantage: The effective resolution will be limited by the receive filter, so you will see 1.2 cm resolution in the data even though the bin size is 3 mm.

In Nortek VM Acquisition it is possible to enable two Echograms, but only one of them may be using pulse compression.

5.4.4.1.2 Noise level

Echosounder data as shown on the charts is the 'volume backscatter' strength. The raw measured reflection values are corrected for range, transmission losses and absorption. Since part of the returned signal is caused by the inherent noise of the echosounder itself and possibly by surrounding noise-sources, there is an option to enter a value for the noise level so the software can correct for it. If there is a need to see the raw echosounder data this is possible if you check "Unprocessed echosounder"(see figure 34 41).

If known, the noise level can be used to correct the absolute reflection values. If left blank the default value will be used.

The average noise level can be measured using the diagnostics mode (see the Spectrum 82 section). Choose to obtain a spectrum from the echosounder beam, select the bandwidth used for recording and turn on the peak holding feature. After 15 seconds or so you should have a good estimate of the maximum noise level. The maximum signal strength at the center of the central peak can be entered into Processing settings -> Echosounder calibration -> Noise level dB (or in the text box "Noise level", see figure 34 41).

In most circumstances the default range for the color bar does not fit the data. To auto fit the color bar range to the data range, use the buttons next to the top and bottom of the color bar. To manually adjust the maximum and minimum, use the text boxes located above and below the color bar. For heatmaps with different views, the limits can by synced across the views using "Sync heatmap limits"(see figure 34 41).

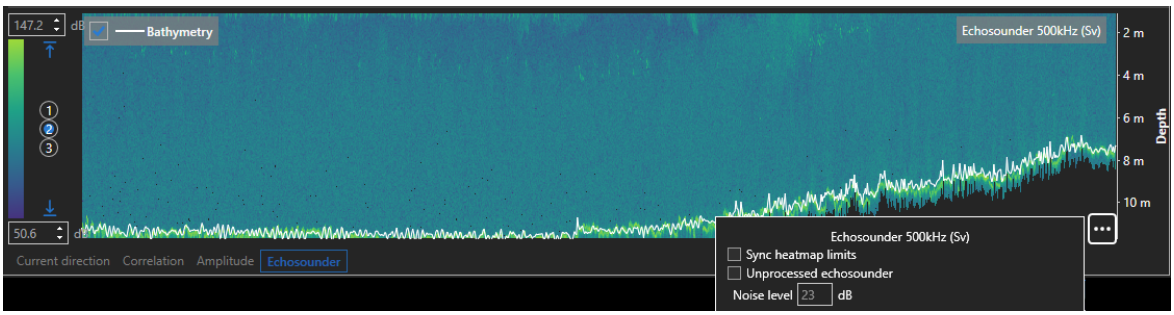


Figure 34: Echosounder image

5.4.4.2 Layer

By default the water velocity data used throughout the application is averaged over the full water column. There is however also an option to create a horizontal layer for water velocity data. This layer can be enabled and modified in the 'Processing settings' section of the 'Configuration'. See figure 35 below.

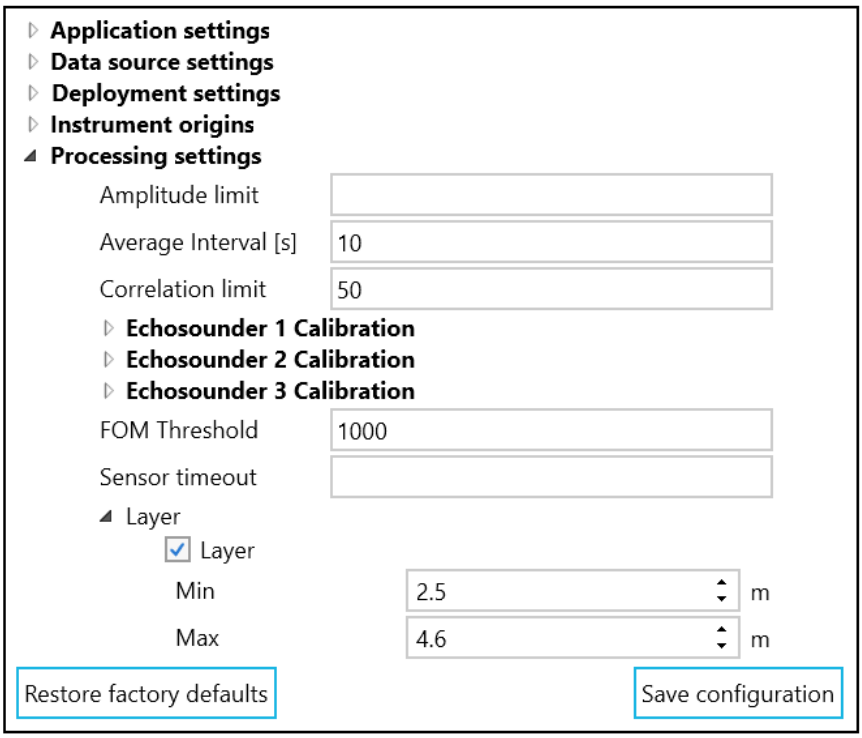


Figure 35: Layer settings

The 'Layer' settings shown in figure 35 allow turning the layer on or off and changing the upper and lower depth limits of the layer. The upper and lower limits can also be changed using the sliders in the current echogram, these are only visible when the layer is enabled.

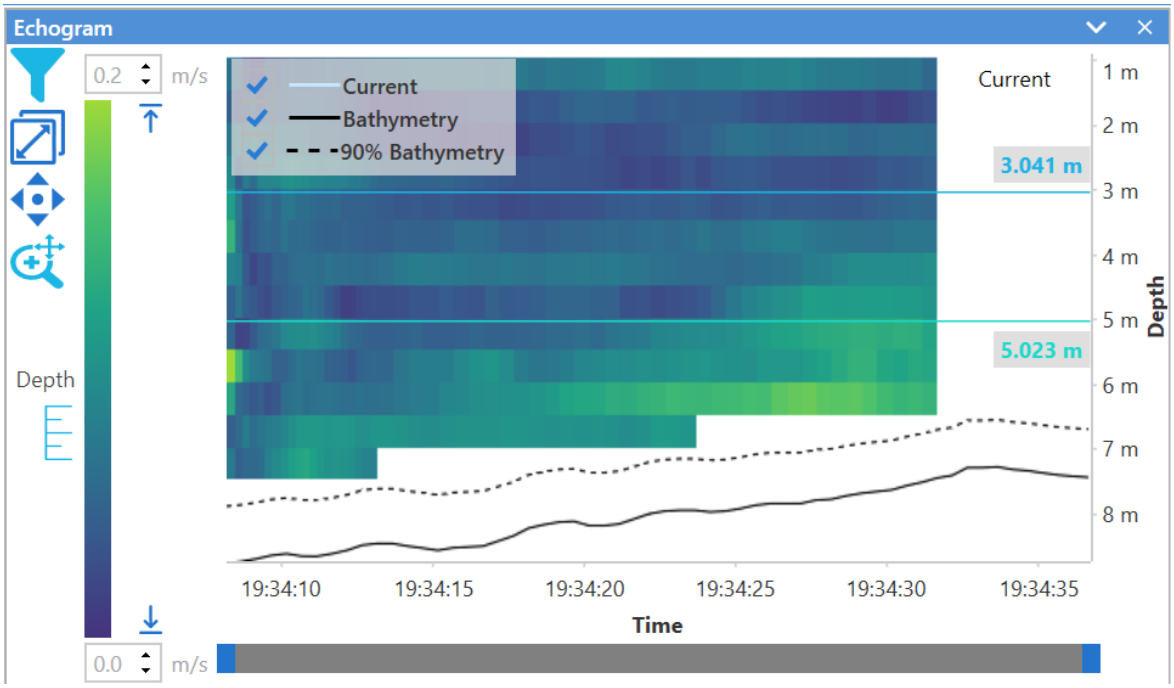


Figure 36: Layer sliders in current echogram

When enabling a layer, the following current related data is affected:

- Current vectors on the map
- Current field in the status panel
- STW field in the status panel
- NMEA messages
  - $VDVDR 68
  - $VDVHW 69
  - $VDVBW 68

5.4.5 Cross track current window

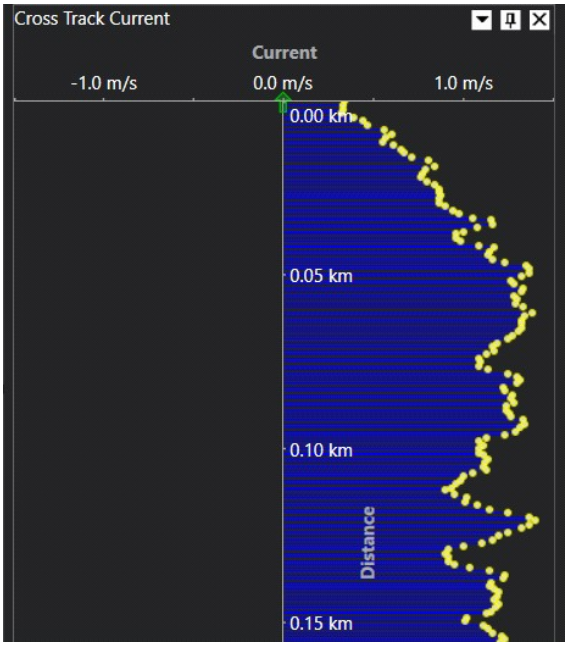


Figure 37: The cross track current window

Figure 37 shows the cross track current window. It shows the component of the current perpendicular to the ship's track. The positive direction is a current component from left to right across the track (facing in the direction of travel).

The top of the window shows the situation at the position the ship is in now. The figure shows the cross track current for previous positions along the ship's track going down in the figure. The vertical scale shows the distance back along the track. (You can choose the units in the configuration settings, see section "Configuration 23 ").

Figure 38 shows an example of the cursor readout that shows when you hover the mouse over the window.

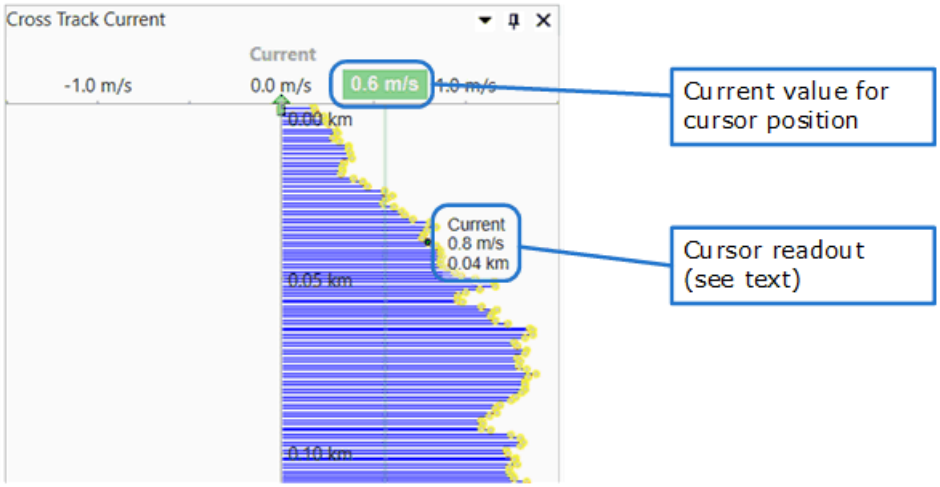


Figure 38: Cross track current cursor readout

Some notes:

- The cursor readout shows the cross track current at the location along the track of the ship that the mouse hovers over.
- The dot indicating the cross track current value at the selected distance back along the track of the ship changes colour from yellow to blue
- The current value that shows in the top axis is the value that corresponds to the cursor location, not the cross track current value at the selected distance.
  (On-screen you can see this better, as a vertical line goes through the cursor position and ends at that value. This line, and the cursor itself, do not show in the screenshot of figure 37.)

When a layer[42] is used instead of the full profile, the cross track current vectors are averaged values from the selected layer. The depth range of the layer can be seen in the title of the cross track current plot.

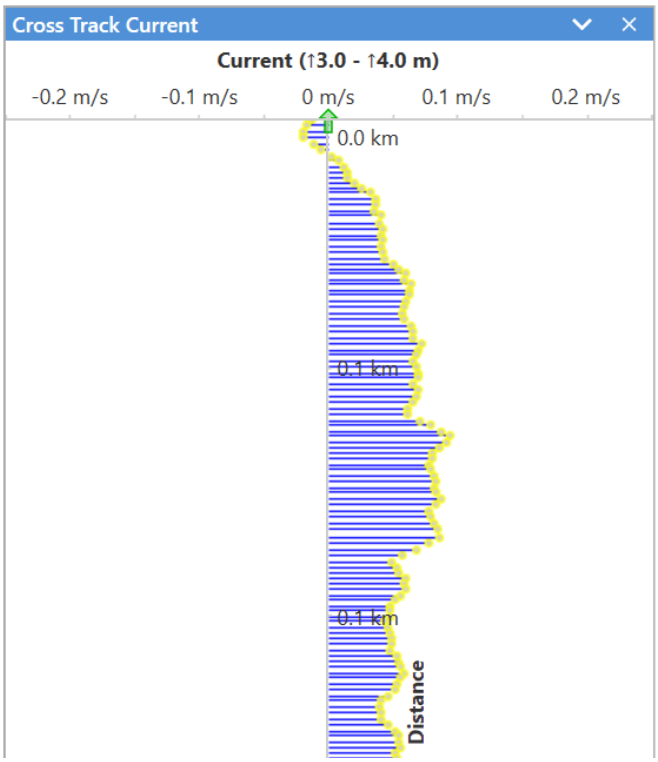


Figure 39: Layer for cross track current

The title of the plot in figure 39 shows that the used layer is 3 - 4 meters deep. It is also possible to lock the layer to the bottom, this will be shown by a change in the direction of the arrows in front of the minimum and maximum values in the title. For example, (↓2 m - ↓ 1 m) would mean a bottom locked layer 1 - 2 meter above the bottom.

5.4.6 Profile window

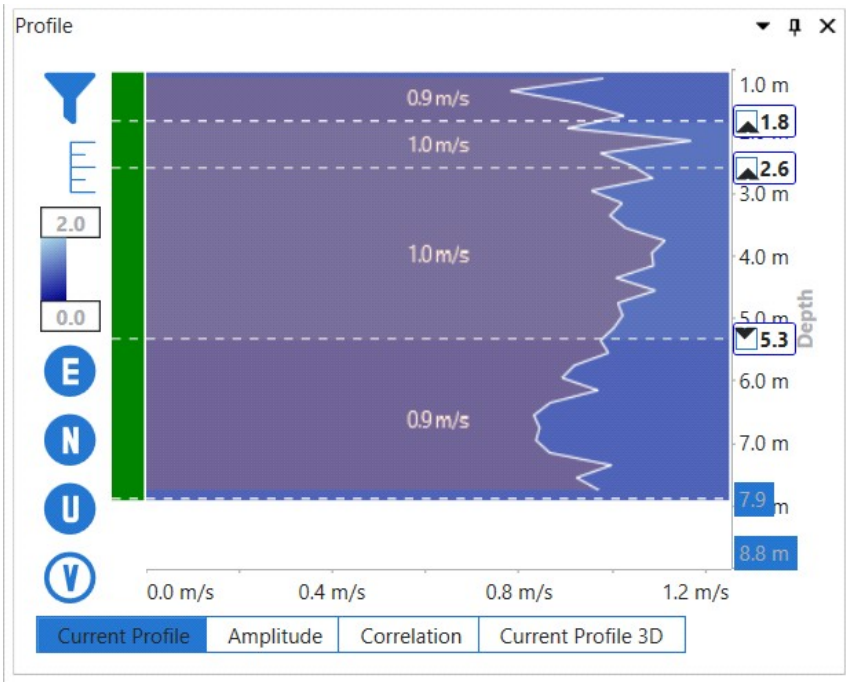


Figure 40: The Profile window, showing the Current profile tab

Figure 40 shows the Profile window. The details this window shows depend on the tab you select. Figure 41 shows a small impression of each of the tabs. The following subsections describe each tab in more detail.

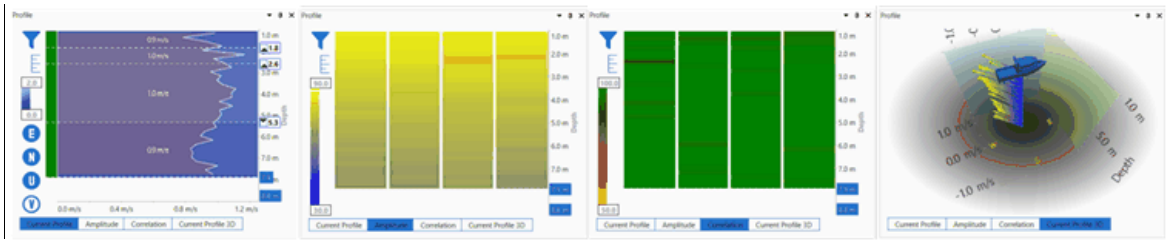


Figure 41: The different tabs of the Profile window

5.4.6.1 Current profile tab

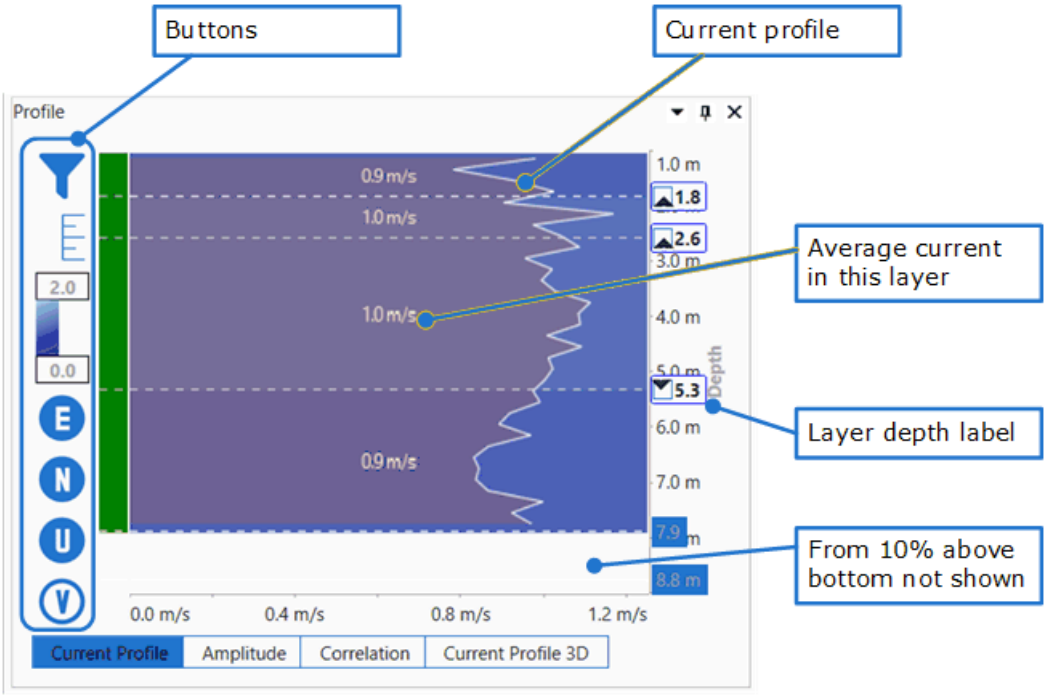


Figure 42: Details of the Current profile tab

The Current profile tab is the most complicated and richest of the tabs in the Profile window. The central plot shows the magnitude of the current (or current component) versus depth, normally omitting the last 10%. The plot also shows the average current in up to four separate layers; you can adjust the levels of these layers. A colour bar at the left of the plot gives an indication of the quality of the data for each layer. Buttons to the left of the central plot allow switching between the details visible in the plot. Table 7 [47] lists the buttons and what they do.

The vertical axis at the right-hand side of the plot shows the depth axis, as well as manipulator labels for the layer boundaries. The numbers in the blue boxes show the bottom depth and the "10% above the bottom" depth.

When you hover the mouse over the plot area a cursor read-out will pop up, showing the current (component) value for that depth, and, in case you selected the full current magnitude (V), its direction. A horizontal line through the cursor position indicates the depth. The depth value shows in a blue box on the depth axis to the right of the plot. Figure 43 shows an example.

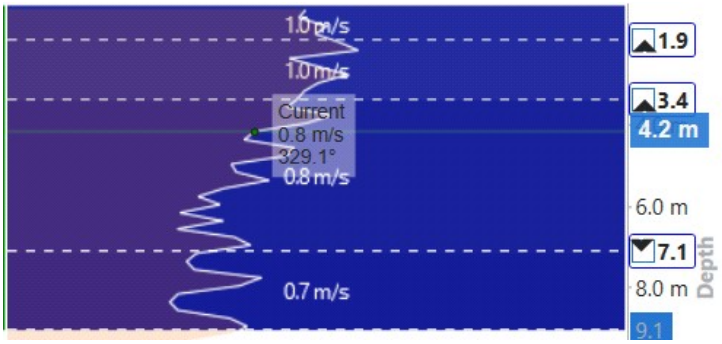


Figure 43: Cursor read-out pops up when hovering over the plot

5.4.6.1.1 Buttons

Table 7: Buttons on the Current Profile tab and their function

Button	Brief description	Description
	Show/hide values below bottom	Toggles between not showing and showing the last 10% of the current profile, and including reflections from below the bottom. Note that this setting is synchronized between all three of the tabs "Current Profile", "Amplitude", and "Correlation".
	Switch between automatic and manual depth scale adjustment	Normally the depth scale adjusts automatically to the maximum depth measured. When switched to manual, you can click-and-drag the depth scale to where you want it. Note that this setting is synchronized between all three of the tabs "Current Profile", "Amplitude", and "Correlation". Also note that you can get the same effect by double-clicking the depth axis.
	Adjust maximum and minimum of colour scale	Adjusts the current values that correspond to lightest (for the highest values) and darkest colours (for the lowest values) in the plot. The value-boxes will display a pop-up showing a slider to adjust the value, as well as a button "Fit" that will select the maximum/minimum value in the plot. You can also just type a number into the box.
	Show East component	These buttons allow you to select which component of the current to show in the plot: East, North, or Up, or the full current magnitude (ignoring direction).
	Show North component	
	Show Up component	
	Show current magnitude (selected)	

5.4.6.1.2 Layer adjustment

You can adjust the boundary between two layers by clicking and dragging the dotted line that indicates this boundary. The number in the label box to the right shows the depth of this line.

The triangle inside the label box indicates whether this boundary is fixed (anchored) relative to the surface (triangle pointing up) or relative to the bottom (triangle pointing down). Click on the triangle to switch between these options. Note that the value in the label still shows the depth of the boundary relative to the surface, whichever of these options you choose.

If you need fewer layers, you can either drag two (or all three) of the boundaries on top of each other, or drag the top or bottom boundary to the edge of the plot. You cannot drag a boundary beyond another boundary. If you have dragged two or all three boundaries on top of each other, this may make it a little confusing to drag them away from each other later, or adjust the depth of the combined boundary. The lower boundary is always on top, so drag that one down first.

If the depth along the track varies, layers may run into each other as the depth becomes more shallow, especially if the lowest layer boundary is anchored to the bottom.

In the latter case, the height of the lowest boundary relative to the bottom remains fixed (for as long as this is possible). The converse also happens: if the water deepens, layer thicknesses may change, in accordance with which boundaries are fixed relative to surface and bottom.

5.4.6.1.3 Selected layer

By default the current values used throughout the application are averaged values over the full depth of the profile. In some cases it might be useful to instead use current values from one of the layers in the Profile[45] window. This is possible by changing the "Layer" field in the "Processing settings" section in the configuration, see figure 44 below.

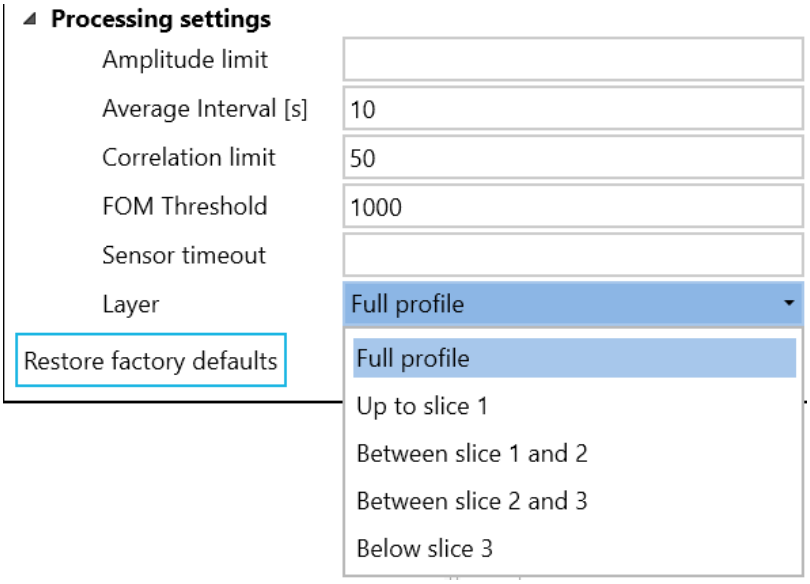


Figure 44: Layer options

When changing the selected layer, the following current related data is affected:

- Current vectors on the map
- Current field in the status panel
- STW field in the status panel
- Current data on the Cross track current window
- Newly added data in the History window
- NMEA messages

- $VDVDR
- $VDVHW
- $VDVBW

5.4.6.2 Amplitude tab

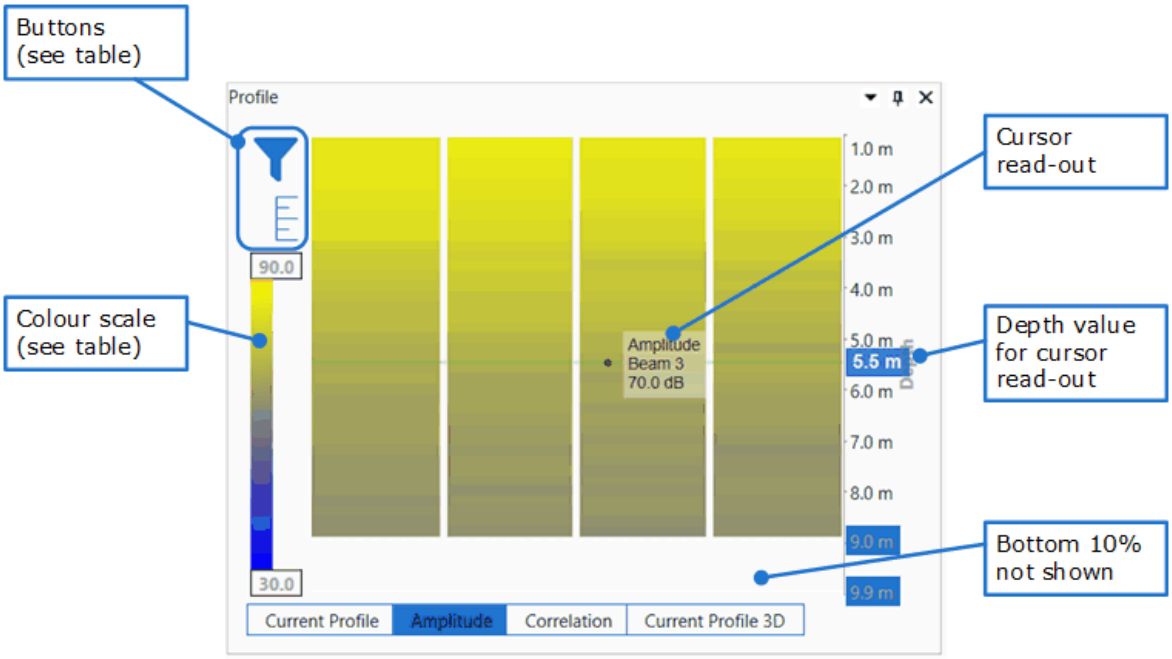


Figure 45: Details of the Amplitude tab

The Amplitude tab shows the received signal amplitude of each of the transducers of the VM-ADCP, as a function of depth. The colour scale indicates the amplitude values in dB. Hovering the mouse over one of the sub-plots shows the beam number and amplitude value in a cursor read-out pop-up. A horizontal line through the cursor position indicates the depth, while a blue box shows the corresponding depth value.

The two buttons at the top left work the same as (and are synchronized with) the corresponding buttons in the Current Profile tab; see table 7 47 in section "Buttons 47 " for details.

Adjusting the colour scale also works the same as in the Current Profile tab; for details see table 7 47 in section "Buttons 47 ".

The amplitude values can ascertain the quality of the sensor measurements. Amplitude values above 35 dB generally give trustworthy results.

5.4.6.3 Correlation tab

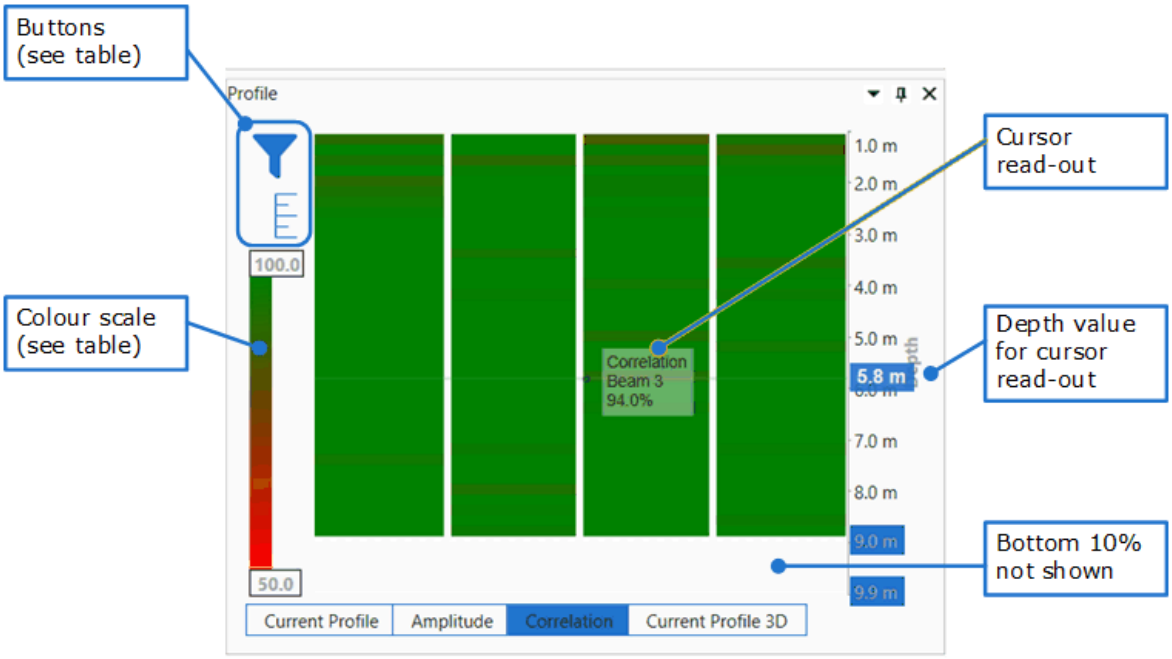


Figure 46: Details of the Correlation tab

The Correlation tab shows the correlation values for each of the transducers of the VM-ADCP, as a function of depth. The colour scale indicates the correlation values as a percentage. Hovering the mouse over one of the sub-plots shows the beam number and correlation value in a cursor read-out pop-up. A horizontal line through the cursor position indicates the depth, while a blue box shows the corresponding depth value.

The two buttons at the top left work the same as (and are synchronized with) the corresponding buttons in the Current Profile tab; see table 7 47 in section "Buttons 47 " for details.

Adjusting the colour scale also works the same as in the Current Profile tab; for details see table 7 47 in section "Buttons 47 ".

The correlation values can ascertain the quality of the sensor measurements. Correlation values above 50% generally give trustworthy results.

5.4.6.4 Current Profile 3D tab

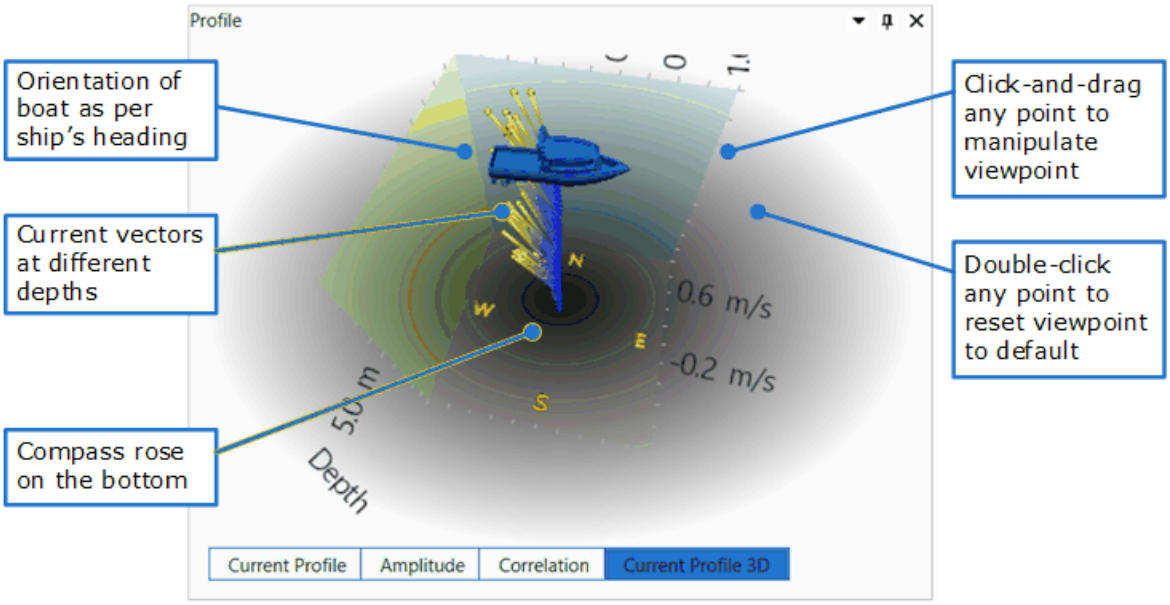


Figure 47: Details of the Current Profile 3D tab

The Current Profile 3D tab shows a three-dimensional impression of the currents underneath the ship. You can change the viewpoint by clicking and dragging any point in the image. You can zoom in and out using the mouse scroll wheel. You can reset the viewpoint (and zoom-level) to the default by double-clicking any point.

The orientation of the boat's image with respect to the compass rose drawn at the bottom corresponds to the real ship's heading.

When you hover the mouse close to one of the current vectors' end point, a cursor read-out pop-up will show the East- and North components of the current, as well as the depth. A set of projection lines show the vector East- and North components, and its depth. Figure 48 shows an example.

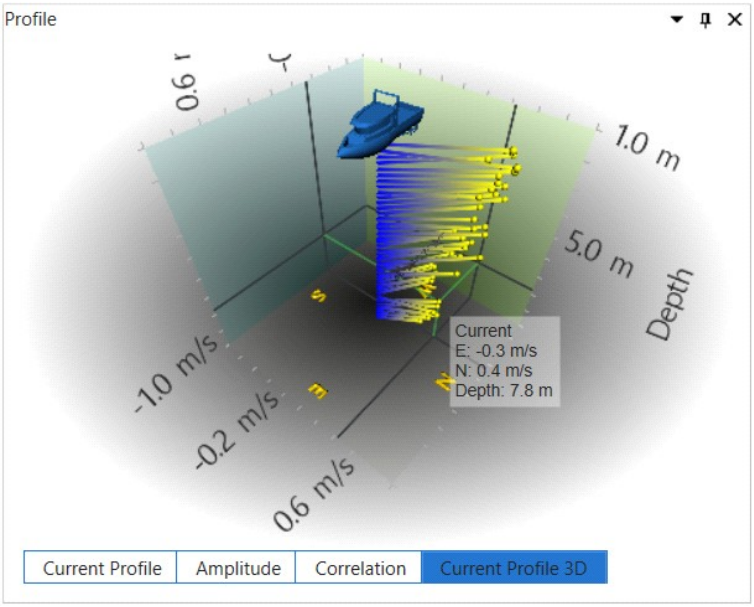


Figure 48: Cursor read-out and current vector component and depth projections when hovering close to a current vector endpoint

5.4.7 History window

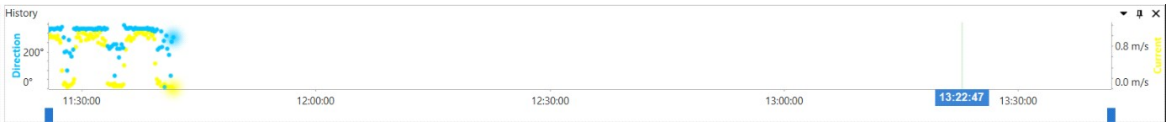


Figure 49: The History window

The History window shows recent values of current magnitude, averaged over the water column or selected layer (yellow dots), and direction (blue dots), as a function of time, progressing from the left-hand side. If available, it also shows current and direction values as measured the day before, from the right-hand side. The purpose of this is to make it possible to take into account tidal variations and similar repetitive variations over time for the area of operation. As mentioned, this information is only available if the ship performed measurements in the same area the day before. Note that this window does not use a tidal model or anything like that: it just shows yesterday's values, if available, as measured by the ship itself.
Hovering the mouse near the dots results in a cursor read-out pop-up, showing values for current and direction, with the corresponding time in a blue box at the axis below. Figure 50 shows an example.

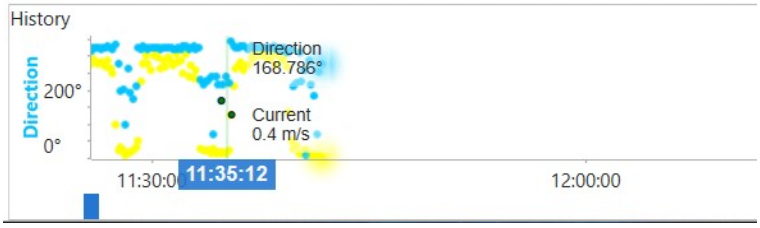


Figure 50: Cursor read-out in the History window

The two blue blocks underneath the time axis allow some manipulation of the time-window for which the values are displayed. Just click-and-drag these sliders to adjust the time-window. Alternatively, you can click-and-drag the time axis itself. Figure 51 shows an example.

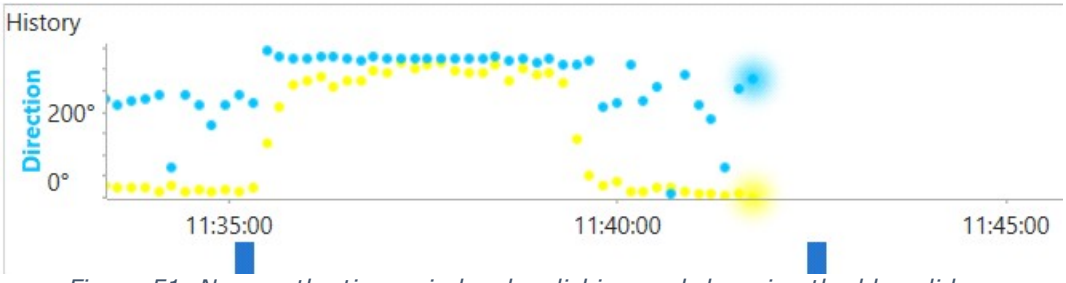


Figure 51: Narrow the time-window by clicking-and-dragging the blue sliders

Note that the history of the current magnitude and direction are from the layer[48] that was used at the time the data point was recorded. Changing the layer will not update previously recorded data points, only newly added data points will be from the changed layer.

5.5 Keyboard Shortcuts

F1	Open this manual
<Tab> and Arrow Keys	Move between settings. Use Spacebar to toggle checkboxes
<Ctrl>-R	Reset bottom-track. Re-Align the bottom-track with the vessel position on the Map
+	Zoom in on the Map
-	Zoom out on the Map
<Ctrl> Arrow Keys	Pan the Map

5.6 Adding Notes

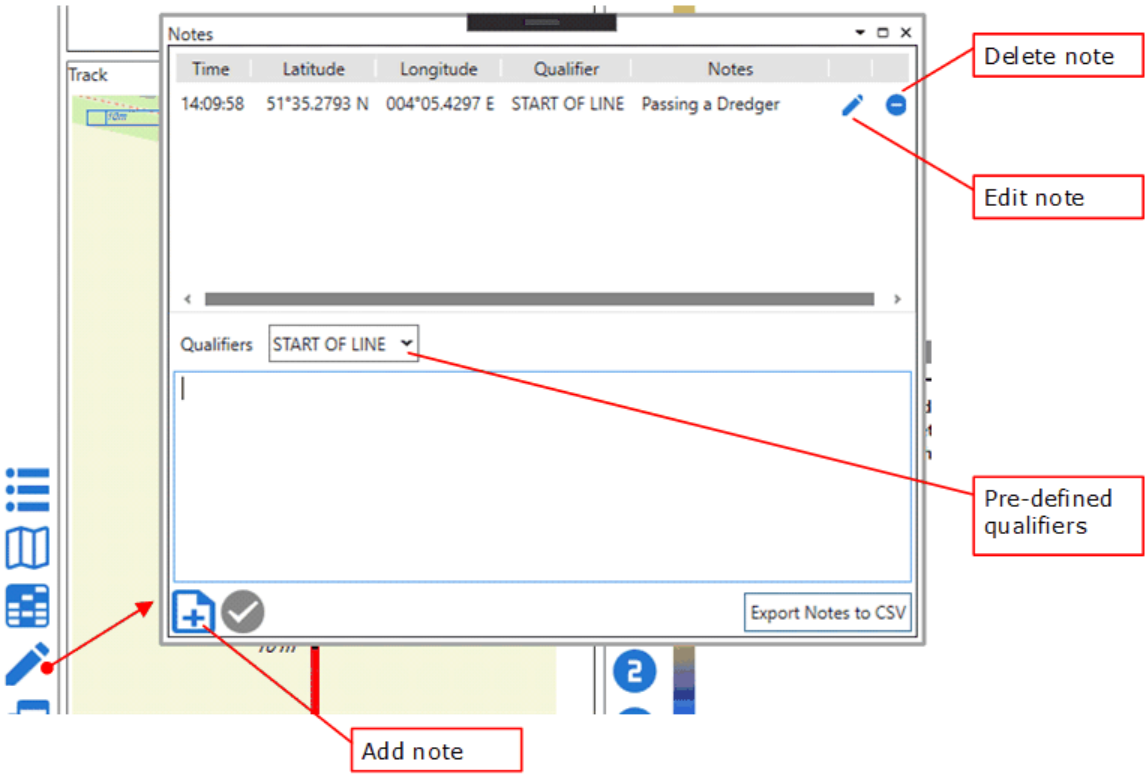


Figure 52: Adding notes

When measuring, it is possible to add notes. Notes will be tagged automatically with the time and position and are stored in the data file. To add a note, click the 'Pencil' icon. This will open the notes window where you can enter text in the lower part. This text will be saved, with the time and position data, when you click the '+' note button (or press CTRL+enter). The saved notes will be visible in the top section and can be edited or deleted by clicking the pencil or delete icon next to the message.

Also included in every note is an (optional) 'Qualifier'. This is a pre-defined text that can be selected from the 'qualifiers' drop-down box. The qualifier texts are defined in the 'General Settings' window. There is an entry named 'Note Qualifiers' followed by a textbox '(Collection)'. Click the text box to open an edit field where you can add or modify the list of qualifiers. Make sure to click 'Save Settings' afterwards.

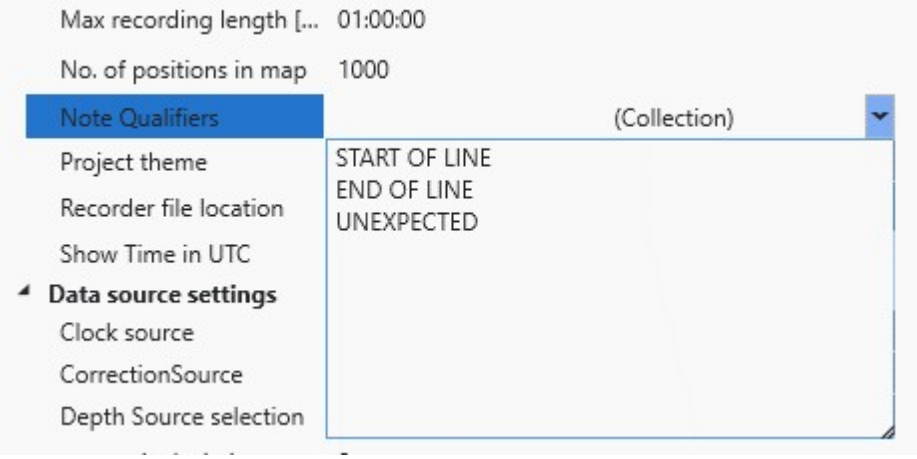


Figure 53: Adding the Notes-Qualifiers

Notes are stored in the .SigVM data file (for details see the 'Export formats' section in the Nortek VM Review manual). The notes in the current recording directory (excluding the current, "live"

recording) can be exported to a text file by clicking 'Export Notes to CSV'. After data collection all notes can be exported to a single file using the Notes processing option in Nortek VM Review.

5.7 Error Messages

Occasionally the system may show error messages after starting the VM-ADCP. These messages are displayed as sent by the instrument and in general have the following structure:

```
NUM=n, STR="<Error Message>", LIM="<Limits as exceeded>"
```

The 'NUM' is the numeric value of this error, 'STR' is the human readable description and 'LIM' are the limits that were exceeded leading to the error. Usually the text will give the user a hint as to where or why the error occurred. The most common error is the following:

```
'NUM=9,STR="PTP clock not synchronized",LIM=""
```

This indicates that there is no PTP (Precision Time Protocol) signal present. This signal should come from the GNSS, so this either may not be connected yet, or the GNSS has not locked into any satellites and therefore has not found the correct time.

6 Offsets

Before starting the actual measurement, it is important to align all sensors. The configuration contains two sub-sections for entering the offsets between the sensor and the GNSS relative to the vessel. All calibration factors can still be changed in post processing without further consequences.

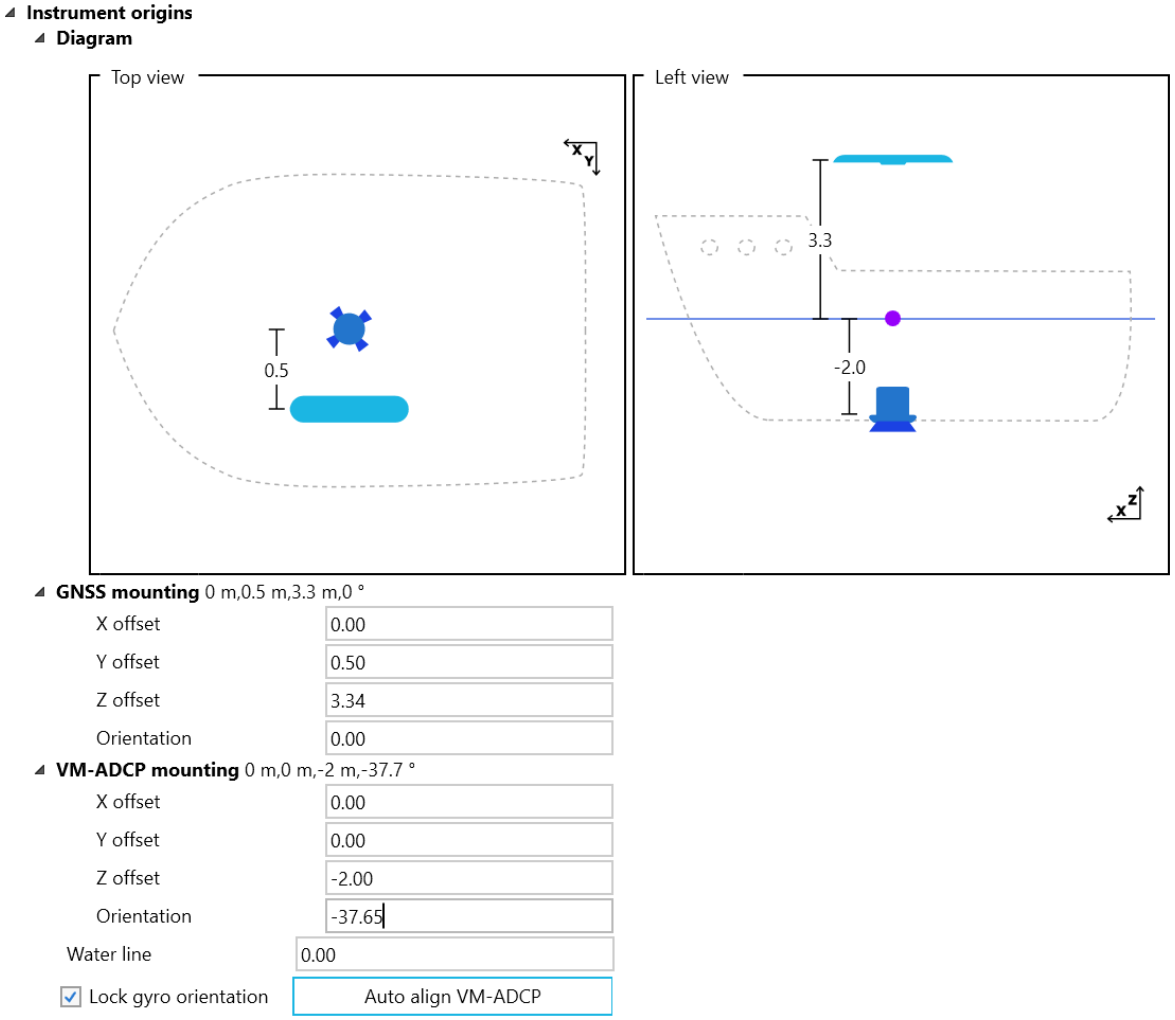


Figure 54: Signature and GNSS mounting offsets

6.1 Vessel Coordinate system

The coordinates for permanent mounted systems are only required to be set once during the installation on the vessel and are set and documented during the STW, HAT or SAT phase. The illustration below visualizes a pole mount installation but the same applies to any permanent sea chest, blister, drop keel or gondola mounts.

As shown in the illustration (figure 55 56) there are three different coordinate systems that apply.

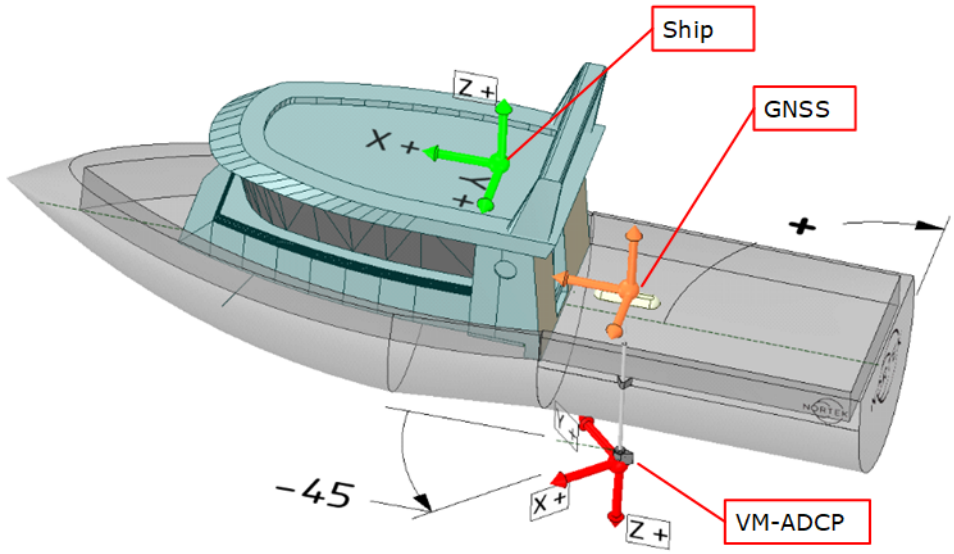


Figure 55: Vessel coordinate system

First there is the ship itself, to which everything should be aligned. The centre axis is the X-Axis, and forward is positive. The angles are right-hand, so positive angles are clockwise.

Second is the GNSS. In case the survey GNSS is a true heading GNSS it is advised to have it aligned with the vessels centerline pointing to the bow so that the readings of the survey GNSS are equal to that of the calibrated heading sensor used for navigation. This is not strictly required as we use the survey GNSS to define the heading of the X-axis of the VM-ADCP, not the vessels X.

Last, the VM-ADCP which by default has 45 degrees offset if installed according to the instructions in the Nortek VM Hardware and Installation Manual. It is worth noting that the VM-ADCP is essentially mounted 'upside-down'. The offset as entered in the software is the rotation as related to the vessel, so it is minus 45 degrees in this case.

*Note that there is an exeption for the Signature 333, here the 45° orientation is taken into account in the instrument firmware. For the Signature 333, the orientation to be entered in the software is therefore 0° (barring a small misalignment).

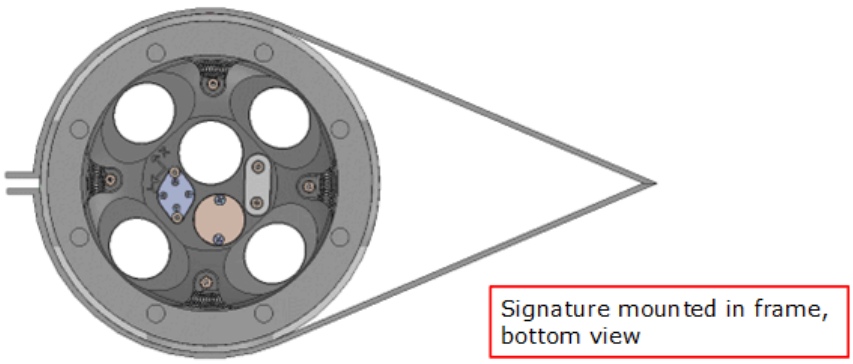


Figure 56: VM-ADCP mounted in frame (bottom view; Signature 1000 shown)

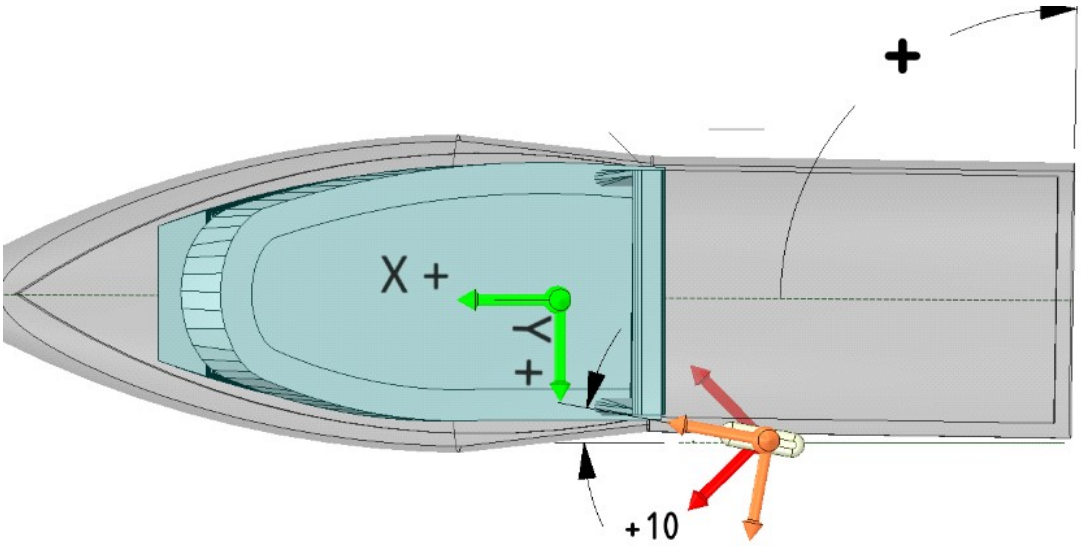


Figure 57: VM-ADCP and GNSS mounting coordinates

To illustrate the GNSS orientation offset it is shown here (figure 57[57]) at 10 degrees as an example. This offset should be as small as possible, and only if it is not possible to get it exactly to 0 correct it in the software.

6.2 Horizontal and vertical offsets

The easiest way to have everything aligned is to mount the VM-ADCP and GNSS on a single pole so they are on the same vertical axis, as shown in figures 55[56] and 57[57]. This way there is no need to enter X and Y offsets. If, however this is not possible, X Y and Z offsets may have to be entered like in the example below (figure 58[58]) where the GNSS is mounted on the roof of the vessel. When entering X, Y and Z offsets it is important to start from deciding what is the actual reference point.

On professional work vessels the Center Of Gravity (COG) is known and can be used as a reference point (0,0,0), in this case both the VM-ADCP and GNSS offsets need to be entered.

In other situations you could take the VM-ADCP as a reference. This simplifies things as you only have to enter offsets for the GNSS.

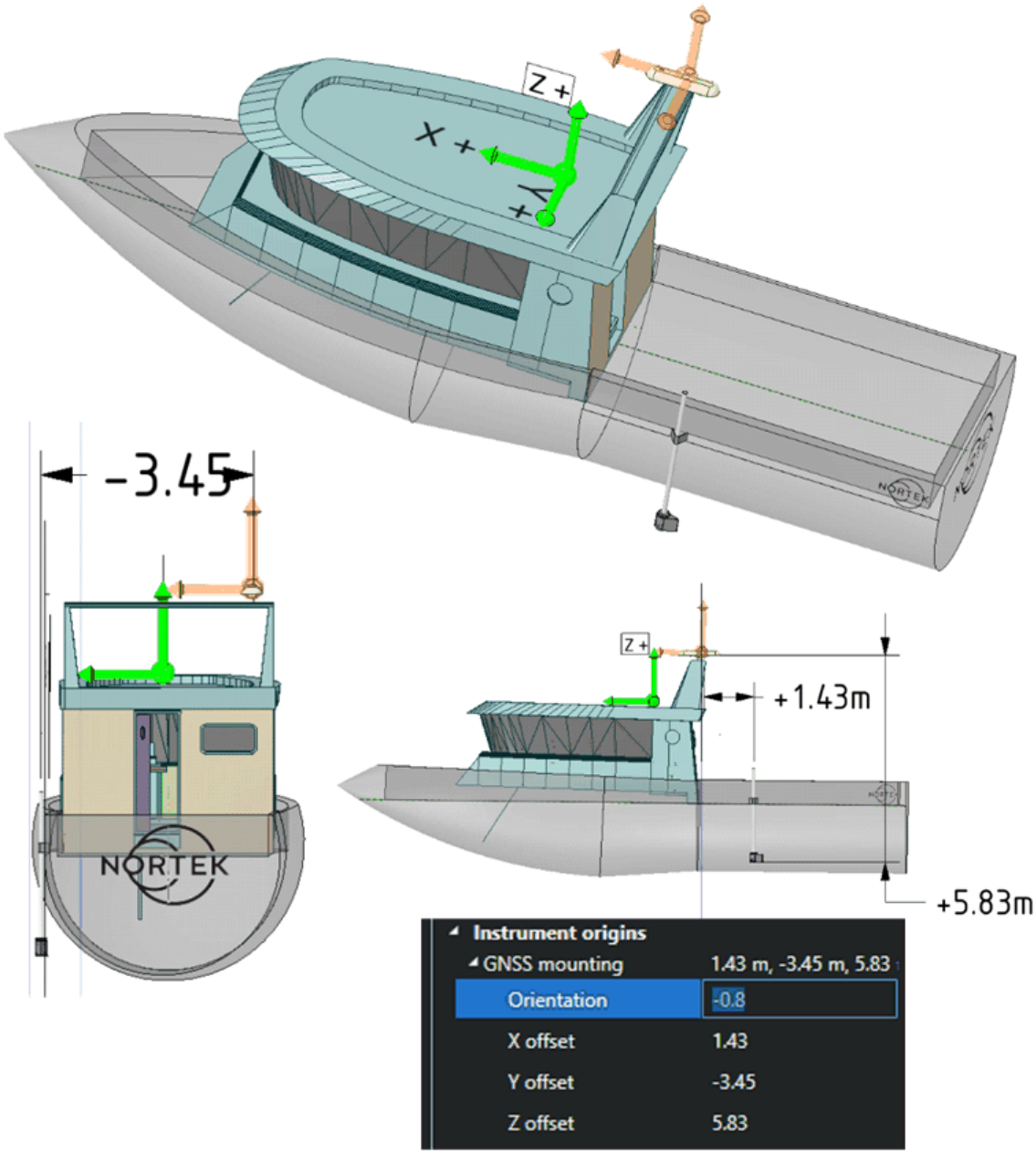


Figure 58: Offsets from the GNSS to the VM-ADCP

In the example the Y offset from the VM-ADCP to the GNSS is -3.45 m and the X Offset is +1.43 m (since the VM-ADCP is the reference (point 0,0,0) and we are entering the offsets FROM the VM-ADCP TO the GNSS).

6.3 Orientation of the GNSS and VM-ADCP

6.3.1 Automatic alignment

For a quick alignment of the VM-ADCP and the GNSS you can use the automatic alignment tool in the 'Configuration' menu under 'Instrument origins', see figure 59[59]. This tool uses the difference between the bottom-track direction and GNSS direction to compute the valid orientation of the VM-ADCP. For instructions on how to manually set the orientation of the VM-ADCP and GNSS, please refer to section Manual heading alignment[60].

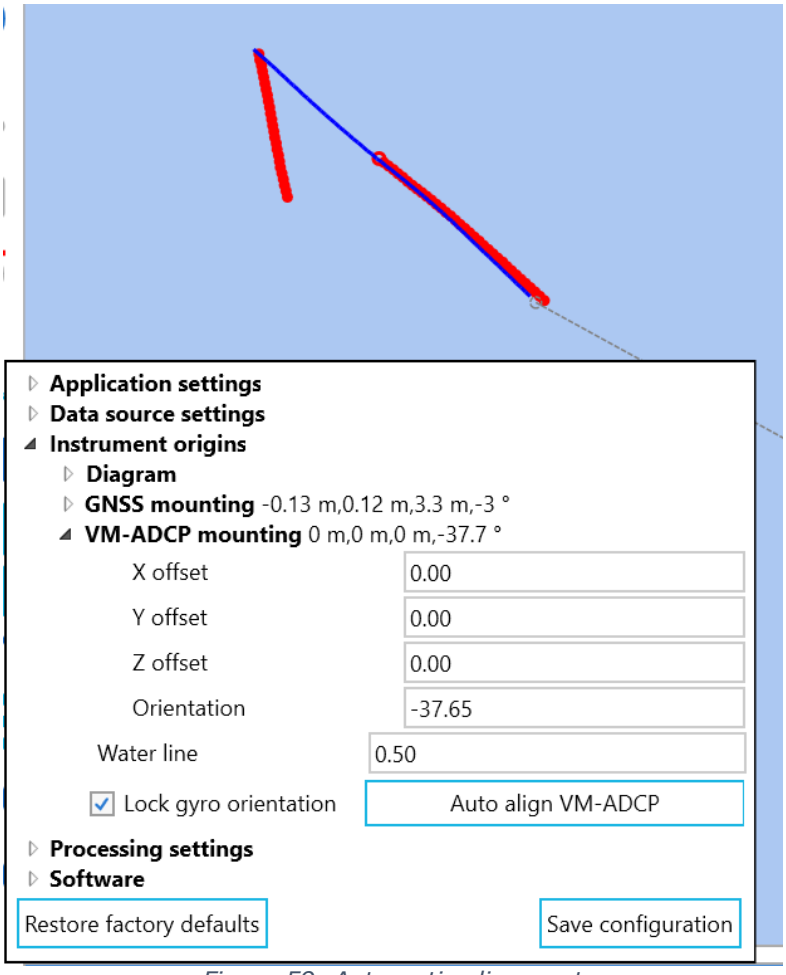


Figure 59: Automatic alignment

To be able to automatically align the instruments you need to be measuring and both bottom-track and GNSS data should be available. Ideally you sail a straight line for a few hundred meters and then press the 'Auto align VM-ADCP' button. The VM-ADCP orientation will automatically be set to the correct value and the bottom-track will reset. You should see the bottom-track points overlap with the GNSS data on the track. Make sure to save the configuration if you are happy with the alignment, otherwise changes will not be saved to the recording.

The list of data points used by the automatic alignment tool is cleared when pressing the auto align button. The button is disabled until there are enough data points for a new alignment calculation. This means that if you wish to use a certain track section for the alignment, you can press the auto align button at the start of the section to reset the tool and at the end of the section to apply the calculated orientation from the track section.

Unchecking 'Lock gyro orientation' makes the software calculate a GNSS orientation as well. This is not recommended in most cases since it can result in wrong orientations when there is a cross-wind or cross-current.

Note that this tool is meant to quickly get a reasonably good alignment. Using the Alignment tool in Nortek VM Review together with the procedure described in the Nortek VM Review manual might yield better results. An other alternative is using the manual alignment procedure below.

6.3.2 Manual heading alignment

As mentioned its not stricktly required to have the survey heading antenna (X-axis) perfectly aligned with the vessels X-axis. Note, we should know the difference between the X-axis (heading) of the true heading survey GNSS and the X-direction of the VM-ADCP, which we can find performing automatic alignment 58 or using the procedure below.

In case the vessel is equipped with a calibrated non-magnetic gyro, the survey GNSS alignment can quickly adjusted for the difference between both. Note that there are several other ways to perform a heading/compass calibration on board of vessels and can be found in general marine literature. One way of these is to compare the course over ground with the heading. However this assumes no crabbing/leeway of the vessel during the calibration line. This can be prevented to sail the line into the current and wind direction.

Figure 60: Adjusting GNSS orientation and settings

The HDG (magnetic vessel heading) and Speed Over Ground (SOG) heading values in the status panel should match in the case there is no leeway present from current or wind. In other words, the direction the GNSS points should match the direction traveled.

Don't forget to click 'Save Configuration'!

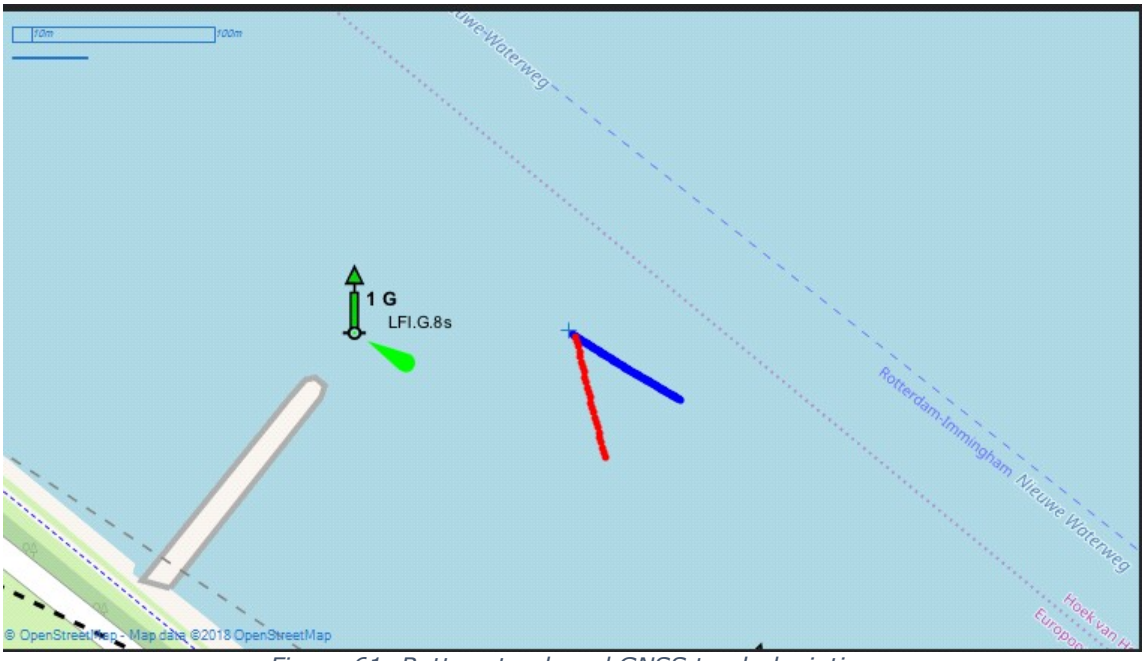


Figure 61: Bottom track and GNSS track deviation

The bottom-track velocity and direction are measured relative to earth by the VM-ADCP. The GNSS velocity and direction should match. In the example shown in the status screen (figure 62 61) this is not the case. This also shows up very clearly in the track plot (figure 61 60). The blue line shows the track according to the GNSS, the red line according to the bottom-tracking. It's clear that the bottom-track direction is about 45 degrees off, which is due to the 45 degrees offset of the VM-ADCP.

To correct for this, open 'Configuration' and adjust 'Orientation' for the VM-ADCP mounting, in this case to -45 degrees. The correction will be applied immediately after pressing 'Enter' or 'Tab'.

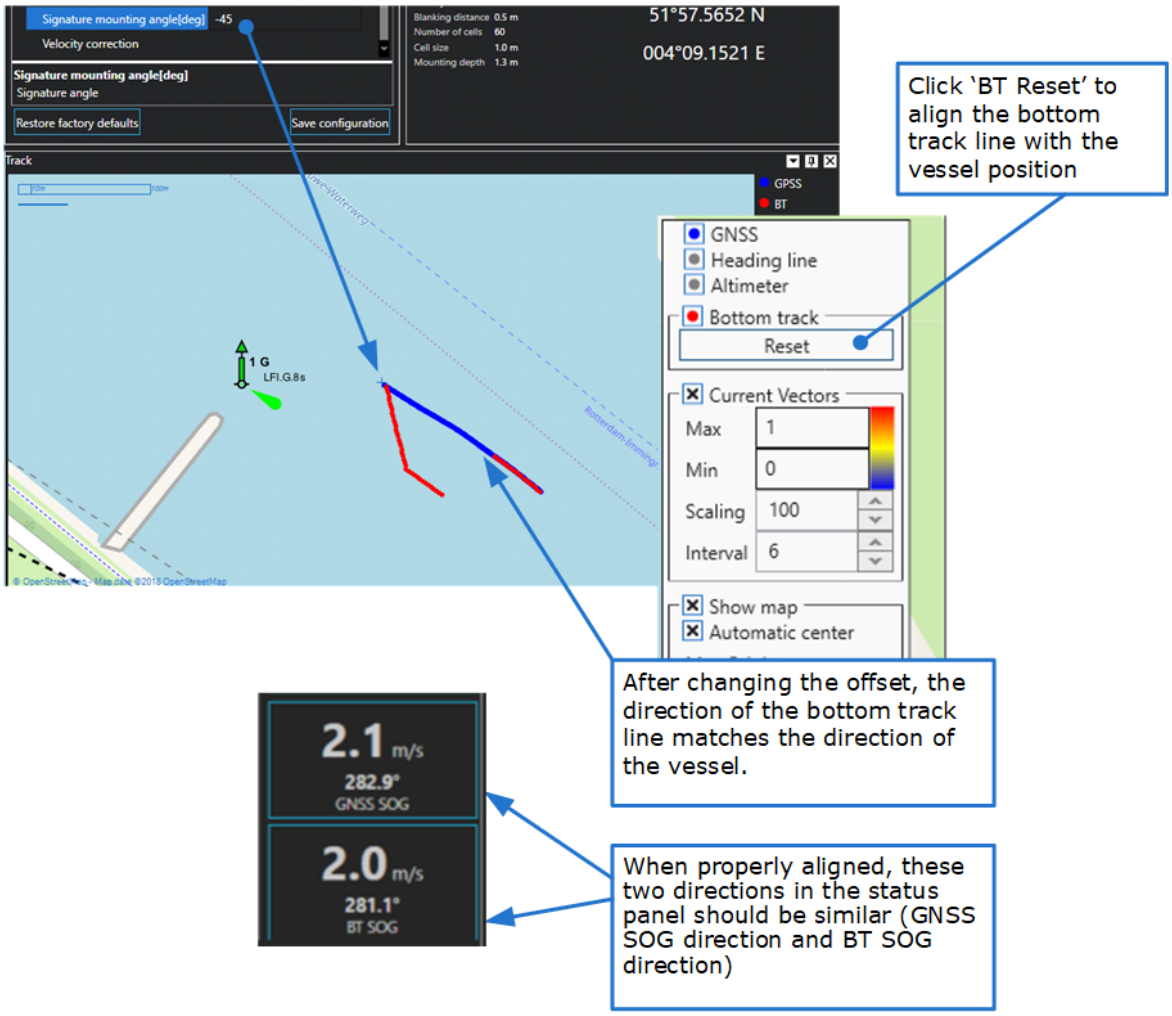


Figure 62: Aligning for bottom track

Don't forget to click 'Save Configuration'!

7 Data output

The Nortek VM Acquisition software can output data in different forms: NMEA, or (binary) AD2CP data with embedded NMEA (if available).

To enable data output, first set 'Output channel' in the Configuration window under Data source settings to the number of desired channels (see figure 63)62. If this is enabled, the 'Output' options in the connection details will be visible when clicking the 'Show Details' button (see figure 6462). The details available in the 'Output(s)' section will change in accordance with selections you make. Configure each of the outputs to the desired configuration.

Use the save configuration in the Configuration window to make the settings permanent.

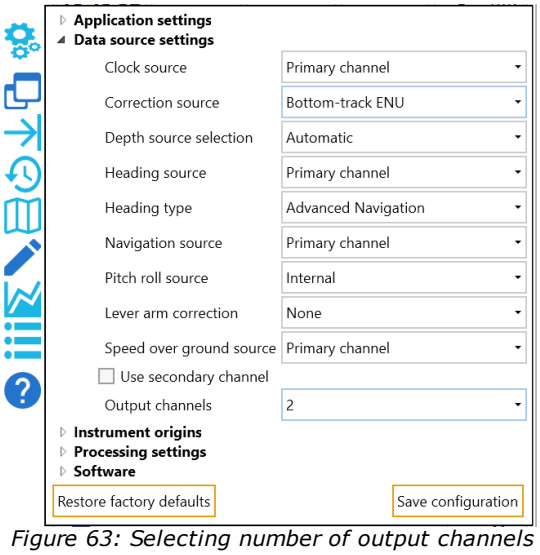


Figure 63: Selecting number of output channels

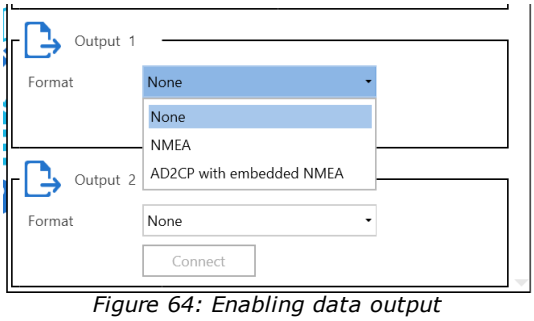


Figure 64: Enabling data output

7.1 NMEA format

NMEA compatible output may be sent to a user specified destination.

All messages conform to the NMEA-0183 version 3.01 format, with an optional IEC61162-450-timetag. Without the time tag an NMEA message starts with a $ and ends with a carriage return and line feed. Data fields follow comma (,) delimiters and are variable in length. Null fields still follow comma (,) delimiters, but contain no information.

An asterisk (*) delimiter and checksum value follow the last field of data contained in an NMEA-0183 message. For details on calculation of the checksum, see, e.g., https://en.wikipedia.org/wiki/NMEA_0183. (Note that the official NMEA 0183 Interface Standard document is a copyrighted document; see https://www.nmea.org/nmea-0183.html.)

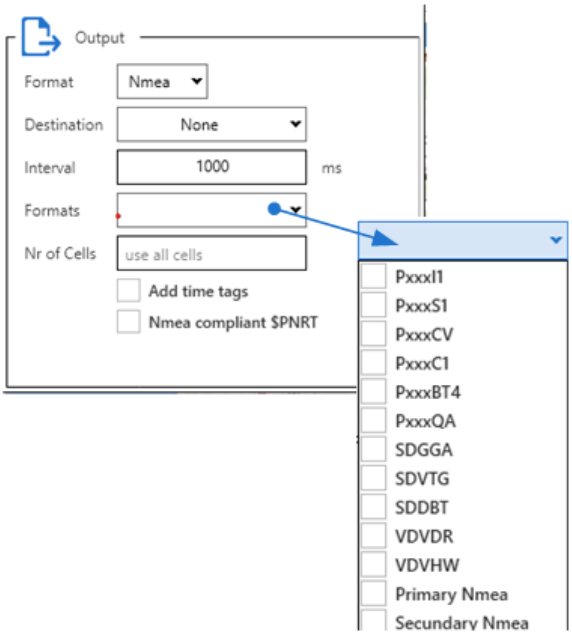


Figure 65: NMEA message options

In the NMEA options window (see figure 65[63]) you can select the required messages in the dropdown menu "Formats". Sections "$SDDBT –Echosounder- Depth Below Transducer[66]" through to "$P---VL – Velocity data per layer[74]" provide details of the data fields and formats of the different messages. Note that if specific data is not available, no message will be sent.

The options 'PrimaryNMEA' and 'SecondaryNMEA' allow for replication of the primary and/or secondary NMEA input stream to the destination selected. Invalid NMEA will not be forwarded, but other than that, the forwarded NMEA data will not be altered.

If you select the option to add time tags, IEC61162-450 time tags will be added to the NMEA messages. In this case, NMEA messages are prefixed by a \c followed by a time tag (in Unix epoch notation) followed by a checksum (surrounded by an asterisk (*) and a backslash (\)). The remainder of the NMEA message is unaffected.

An example of a NMEA message with an IEC61162- 450-timetag:

\c:1582266519*58\$SNDBT,471.3,f,143.6,M,78.5,F*37

When you select the NMEA output format, fields are available to supply an interval for the output messages, and a cell limit.
The interval determines how often the data is sent. The cell limit determines the number of data cells reported in the $PNORCV and $PNORC1 messages.

When "NMEA compliant $PNRT" is checked the proprietary messages are sent with a $PNRT prefix; when it is unchecked the messages are sent with a $PNOR prefix. Note that the $PNOR prefix is not compliant with the NMEA standard (as it is not our officially registered manufacturer's mnemonic code) and can cause attached instruments to misinterpret the message as being originated from a non-Nortek instrument.

7.2 AD2CP format

The AD2CP data format is a binary format developed by Nortek. Details of the format can be found in the "Integrator's Guide – Signature"

https://support.nortekgroup.com/hc/en-us/articles/360029513952-Integrators-Guide-Signature

The AD2CP format is enhanced with optional IEC61162-450-timetagged NMEA navigation information. This is only available if a classic NMEA navigation source is connected to the system. At this moment there is no support for the Advanced Navigation GPS binary format.

7.3 Output destinations

The output of Nortek VM Acquisition can be sent to different types of destinations. Selection of a destination option will result in additional configuration fields to become visible, specific to that option. Destination options for NMEA output and AD2CP output are identical, so they will be described only once. (Do note that the dialog windows for NMEA and AD2CP output will look different overall, due to the extra configuration options for NMEA output; see figure 66[64] and 67[64].)

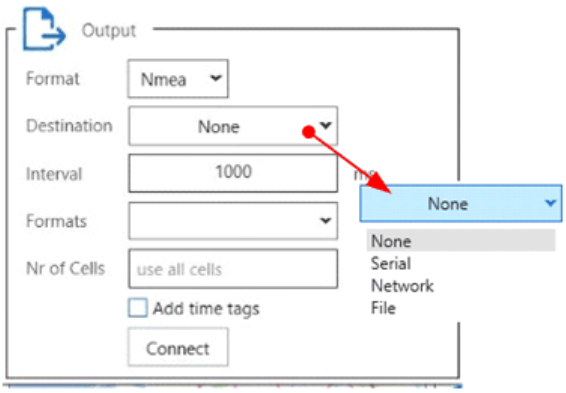


Figure 66: Output destination options

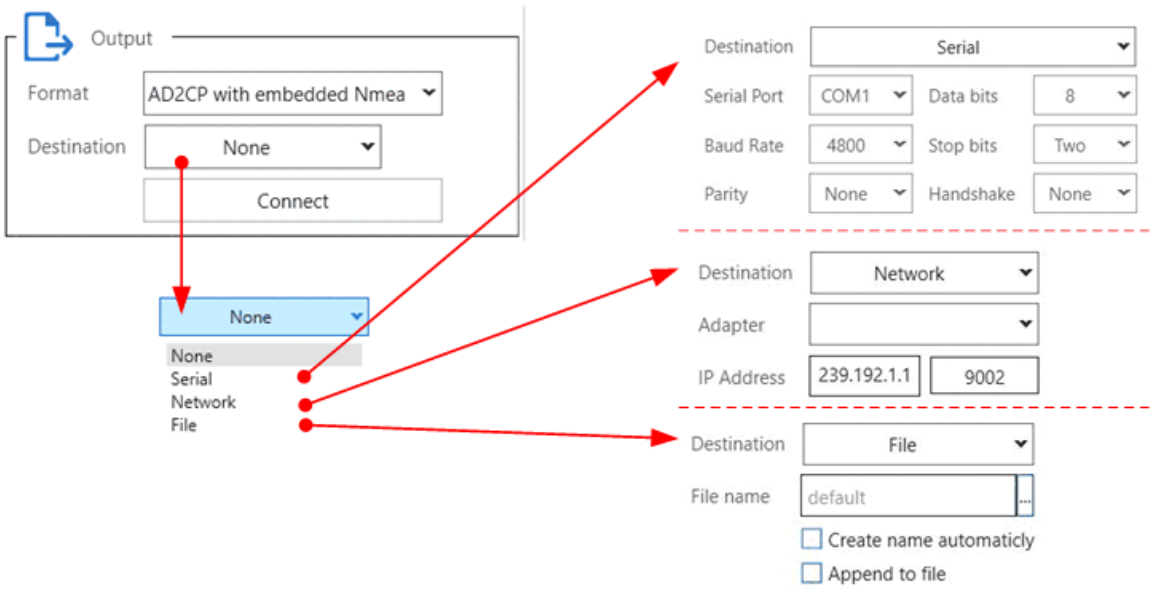


Figure 67: Configuration options for different output destinations

7.3.1 Serial output

The serial output format is considered a stream: there is no begin or end synchronization.

The configuration options for serial output are assumed to be well known. The relevant part of figure 67[64] shows the configurable parameters; each parameter has a drop-down list. (The only thing to be aware of is the possible absence of a serial port.)

7.3.2 Network output

The data is sent to the selected network address and port as UDP messages. The UDP protocol is a connectionless network protocol; this means that the destination does not need to be active or even present. UDP sends its messages whether they are received or not (and does not attempt resending).

There are two distinct ways to use the UDP output:

UDP Broadcast – in this case the UDP packets are delivered to any pc on the network. This can cause an unwanted and unnecessary amount of network traffic as the data packets are also delivered to computers on the network that are not interested in it.

UDP Multicast – this uses an IP destination address in the range 224.0.0.0 to 239.255.255.255 and is sent only to computers that have subscribed to the multicast group. This is more efficient than the UDP broadcast.

The default is to use UDP Multicast on address 239.192.1.1, using port 9002.

The destination IP address can be a specific destination like '192.168.1.123', a broadcast address like '10.0.0.255' or it can be a multicast address as show in the example. In general addresses in the 239.x.x.x range are known as multicast addresses and can be received by multiple computers on the network. Broadcast addresses can be received by computers on the same network with the same network-mask.

For the NMEA output the UDP network destination is considered a stream. There is no special handling of a begin or end condition.

For ADCP output the internal deployment record of the connected instrument is sent every 30 seconds. This allows clients to do a late join and still have access to all necessary information to process the data.

7.3.3 Data rates

Please be aware of the data rate for serial output. Even relatively simple NMEA sentences quickly outpace the standard setting of 9600 baud. Sending out multiple NMEA sentences over a single serial connection will very likely result in dropped details if attempted at 9600 baud (due to buffer overflows).

A hard and fast rule for an acceptable baudrate setting cannot be given here. Please look up the NMEA message details in terms of number of characters sent (see section NMEA message details 62), combined over the messages you want to send. From this you can determine the required baudrate.

7.3.4 File output

For file output there are four different modes of operation, resulting from independent selection or de-selection of the options "create name automatically" and "append to file". In the following descriptions, "multiple file operation" results from selection of "create name automatically".

- Single file operation with append
  All data is written into a single file as selected by the user. The current and later recordings are all added to this file. For this mode of operation, uncheck "create file automatically" and check "append to file".

- Single file operation without append
  Data is written to a single file, but later stop and start operations result in overwriting the existing data. For this mode, uncheck "create file automatically" and uncheck "append to file".

- Multiple file operation with append
  All data is written to a file, where the filename is generated by the system based on the date and time. The location of the file is specified by the user. Later recordings are written into separate files. To select this mode, check "create file automatically" and check the "append to file" box.

- Multiple file operation without append
  Data is written to a file, where the filename is generated by the system based on the date and time. The location is specified by the user. Every "interval" a new file is created - this is the interval specified for NMEA output. To select this mode, check

"create file automatically" and uncheck the "append to file" box. (This mode can be used with other software that detects and reacts to creation of a file in a specified directory.)

Please note that for single file operation you need to supply a file name, whereas for multiple file operation you need to supply a file path. The label "File name" / "Directory" will change corresponding to the state of the "create name automatically" checkbox. The edit field following the "File name" / "Directory" label allows specification of the file name or location by the user; the ellipses-button ("...") allows selection by means of a standard file/directory selection dialog window. Note that the default location is the one specified in the Configuration window as "Recorder file location" (see section "Configuration 23 " of this manual).

7.4 Compliant NMEA

Option	*Default*	*Description*
NMEA Compliant	Yes	Use our officially registered manufacturer's mnemonic code for proprietary NMEA sentences ($PNRT); deselect this tickbox ("no") to use the historical mnemonic code ($PNOR), for compatibility (but note that this code is not registered to Nortek, hence using this code is not compliant; see also section "Proprietary NMEA sentences 69 " for details, and figure 65 63 in section "NMEA format 62 " for the location of this tickbox).

7.5 Approved NMEA sentences

7.5.1 $SDDBT –Echosounder- Depth Below Transducer

Field	*Description*	*Data Format*
Depth, feet	Depth below transducer in Feet	dd.dd
f	The letter 'f 'for feet	
Depth, meters	Depth below transducer in Meters	dd.dd
M	The letter 'M 'for Meter	
Depth, fathom	Depth below transducer in Fathom	dd.dd
F	The letter 'F' for Fathom	

Example:

$SDDBT,32.81,f,10.00,M,5.47,F*39

7.5.2 $SDGGA - Global Positioning System Fix Data

Field	*Description*	*Data Format*
Time	Time in UTC, 0-24H, 0.01 second resolution	HHmmss.ss

Field	Description	Data Format
Latitude	Geographical Latitude	dddd.dd
N or S	The letter 'N' or 'S' for North or South	
Longitude	Geographical Longitude	ddddd.dd
E or W	The letter 'E' or 'W' for East or West	
Quality	GPS Quality Indicator	N
Nr Of Satellites	Number of satellites in view, 00 - 12	NN
HDOP	Horizontal Dilution of precision (meters)	dd.d
Altitude	Antenna Altitude above/below mean-sea-level (geoid) (in meters)	dd.dd
M	Units of antenna altitude, Meters	
Separation	Geoidal separation, the difference between the WGS-84 earth ellipsoid and mean-sea-level (geoid), "-" means mean-sea-level below ellipsoid	dd.dd
M	Units of separation, Meters	ddd.ddd
Differential Age	Age of differential GPS data, time in seconds since last SC104 type 1 or 9 update, null field when DGPS is not used	N
Reference Station	Differential reference station ID, 0000-1023	NNNN

Example:

$SDGGA,121816.244,5134.6213945,N,00405.4297275,E,0,00,0.0,-10.0,M,0.0,M,,*7A

7.5.3 $SDVTG - Track made good and Ground speed

Field	Description	Data format
Track Degrees	Heading in degrees North	ddd.dd
T	The letter 'T' for True North	
Track Degrees	Heading, magnetic north	ddd.dd
M	The letter 'M' for Magnetic North	
Speed Knots	Speed over ground in Knots	dd.dd
N	The letter 'N' for knots	

Field	Description	Data format
Speed km/h	Speed over ground in km/h	dd.dd
K	The letter 'K' for kilometres per hour	
mode	Single letter mode indicator, can be one of the following: A: Autonomous mode D: Differential mode E: Estimated (dead reckoning) mode M: Manual Input mode S: Simulator mode N: Data not valid	

Example: $SDVTG,75.0,T,,M,1.94,N,3.6,K,A*06

7.5.4 $VDVBW - Dual gound / water speed

The VBW sentence contains the longitudinal and transverse ground and water speed.

By default the water speed is averaged over the full water column, when a layer[42] is enabled, the water speed is the speed through water in the selected layer.

Field	Description	Data format
Longitudinal water speed	Negative means astern, in knots	d.d
Transverse water speed	Negative means port, in knots	d.d
Status	A is valid	A
Longitudinal ground speed	Negative means astern, in knots	d.d
Transverse ground speed	Negative means port, in knots	d.d
Status	A is valid	A
Stern transverse water speed	Not filled	
Status	Not filled	
Stern transverse ground speed	Not filled	
Status	Not filled	

7.5.5 $VDVDR – Current Speed and Direction

The VDR sentence contains the corrected current speed and direction. These are the same values as shown as current sticks in the Track plot, i.e. averaged over time and profile. When a layer[42] is used however, the current is averaged in the selected layer.

Field	Description	Data format
Direction	[degrees true North]	ddd.d
"T"	Marker for True North	T
Direction Magnetic	<empty>	
"M"	Marker for Magnetic heading	M
Speed	Current Speed in knots	dd.dd
"N"	Marker for Knots	N

7.5.6 $VDVHW – Vessel through water Speed and Direction

The VHW sentence contains the speed and direction of the vessel relative to the water. By default this is the vessel speed relative to the water speed averaged over the full water column. When a layer[42] is enabled, the STW is the speed through water in the selected layer.

Field	Description	Data format
Direction	Heading degrees true North]	ddd.d
"T"	Marker for True North	T
Direction Magnetic	Heading degrees Magnetic	ddd.d
"M"	Marker for Magnetic heading	M
Speed	Vessel speed, relative to water knots	dd.dd
"N"	Marker for Knots	N
Speed	Vessel speed, relative to water km/h	dd.dd
"K"	Kilometers	

7.6 Proprietary NMEA sentences

The following messages are a subset of the messages as used by the Nortek DVL (Doppler Velocity Log), but the 'Tagged NMEA' versions are not supported (e.g. $PNRTS2,DATE=083013,TIME=132455,EC=0, SC-34000034…).

By default the NMEA messages are sent with the $PNRT prefix, these messages are compliant with the NMEA IEC61162-1 standard. For compatibility with existing equipment that uses the nonstandard $PNOR messages the output format can be changed (see figure 65[63] in section "NMEA format[62] " for details). The difference is only in the prefix, otherwise the message details are the same. (However, the checksum will be different, due to the difference between NRT and NOR.)

Note that "NOR" is not our officially registered manufacturer's mnemonic code, but has been used historically.

In the next sections, "$P---" can be either "$PNRT" or "$PNOR", dependent on the compliance selection. (The examples show the $PNOR variant; see the remark about the checksum, earlier.)

7.6.1 $P---BT4 – Speed over ground and depth

Field	*Description*	*Data format*
DT1	Time from trigger to bottom echo (NOT USED)	d.ddd
DT2	NOT USED	d.ddd
Speed Over Ground	[m/s]	d.ddd
Direction	[degrees true North]]	d.d
Figure Of Merit	#	dd.ddddd
Distance to Bottom	[m]	dd.d

Example:

$PNORBT4,0,0,1.234,23.4,12.34567,12.3*09

7.6.2 $P---C1 – Velocity data per Cell

Field	*Description*	*Data format*
Date	Date	MMDDYY
Time	Time in UTC, 0-24H, 0.01 second resolution	Hhmmss
Cell Number	#	Dd
Cell Position	Distance from sensor to centre of the cell[m]	dd.dd
Velocity East	[m/s]	dd.ddd
Velocity North	[m/s]	dd.ddd
Velocity Up	[m/s]	dd.ddd
Amplitude Beam 1	[dB]	ddd.d
Amplitude Beam 2	[dB]	ddd.d
Amplitude Beam 3	[dB]	ddd.d
Amplitude Beam 4	[dB]	ddd.d
Correlation Beam 1	[%]	dd
Correlation Beam 2	[%]	dd

Field	Description	Data format
Correlation Beam 3	[%]	dd
Correlation Beam 4	[%]	dd

Example (DF101, 4 beams)

$PNORC1,072623,075212.85,1,1.25,0.499,-0.001,-0,35.5,35.5,35.5,35.5,95,95,95,95*63

7.6.3 $P---CV – Velocity data per Cell

Field	Description	Data format
Date	Date	MMDDYY
Time	Time in UTC, 0-24H, 0.01 second resolution	Hhmmss.ss
Cell Number	#	Dd
Cell Position	Distance from sensor to centre of the cell[m]	dd.dd
Velocity East	[m/s]	dd.ddd
Velocity North	[m/s]	dd.ddd
Velocity Up	[m/s]	dd.ddd
Velocity Up2	[m/s]	dd.ddd
Speed	[m/s]	dd.ddd
Direction	[degrees]	ddd.dd
Amplitude Units	D=dB	D
Amplitude Beam 1	[dB]	ddd.d
Amplitude Beam 2	[dB]	ddd.d
Amplitude Beam 3	[dB]	ddd.d
Amplitude Beam 4	[dB]	ddd.d
Correlation Beam 1	[%]	dd
Correlation Beam 2	[%]	dd
Correlation Beam 3	[%]	dd
Correlation Beam 4	[%]	dd

Example:

$PNORCV,201419,112049.21,59,29.7,-2.464,-
3.178,0.55,0.396,4.022,217.788,D,33,33.5,33,32.5,12,32,34,21*78

7.6.4 $P---I1 – General Information

Field	*Description*	*Data format*
Instrument Type		N
Head Id	Serial number of instrument	N
Number of Beams		N
Number of Cells	Number of valid cells	N
Blanking Distance	[m]	dd.dd
Cell Size	[m]	dd.dd
Coordinate System	Always E(ast) N(orth) U(p) for Nortek VM	ENU

Example: $PNORI1,4,123456,3,30,1.00,5.00,ENU*5B

7.6.5 $P---QA – Quality and performance figures

The QA sentence contains data that may be used for monitoring the quality of the recorded measurements.

Amplitude and Correlation figures are averaged over the approved cells only, so they do not include bottom reflections.

Field	*Description*	*Data format*
Date	Date	MMDDYY
Time	Time in UTC, 0-24H, 0.01 second resolution	hhmmss.ss
Valid cells	Valid cells as used to calculate the averages	dd
Error Code	Signature error code (16 bits)	Hex
Status Code	Signature status code (16 bits)	Hex
Quality Status	Quality status string (8 characters; see table below for details).	"xxxxxxxx"
Amp1	Average amplitude beam1 [dB]	ddd.d
Amp2	Average amplitude beam2 [dB]	ddd.d
Amp3	Average amplitude beam3 [dB]	ddd.d
Amp4	Average amplitude beam4 [dB]	ddd.d

Field	Description	Data format
Corr1	Average correlation beam1 [%]	dd
Corr2	Average correlation beam2 [%]	dd
Corr3	Average correlation beam3 [%]	dd
Corr4	Average correlation beam4 [%]	dd
FOM1	Figure Of Merit beam1	ddddd
FOM2	Figure Of Merit beam2	ddddd
FOM3	Figure Of Merit beam3	ddddd
FOM4	Figure Of Merit beam4	ddddd

Quality Status: String with status letters: G, M or D or -:

(G)ood, (D)egraded, (M)issing or '-' for not enabled. Example: GGDGGM-G

Character nr	Measurement	Source
1	Position	GNSS
2	Heading	GNSS
3	Speed over ground	GNSS
4	Time	GNSS
5	Heading pitch roll	GNSS
6	Bottom-track	VM-ADCP (G or M)
7	Velocity	VM-ADCP velocity burst
8	Echo	Echosounder (G or M)

7.6.6 $P---S1 – Sensor Data

Field	Description	Data format
Date	Date	MMDDYY
Time	Time in UTC, 0-24H, 0.01 second resolution	Hhmmss.ss
Error Code	See Signature manual for details	N
Status Code	See Signature manual for details	N

Field	Description	Data format
Battery Voltage	[V]	dd.d
Sound Speed	[m/s]	dddd.d
Heading	True Heading [deg]	ddd.d
Heading Std Dev.	[deg] (Not Used, always 0)	dd.dd
Pitch	[deg]	dd.d
Pitch Std Dev.	Standard Deviation [deg]	dd.dd
Roll	[deg]	dd.d
Roll Std Dev.	Standard Deviation [deg]	dd.dd
Pressure	[dBar]	ddd.ddd
Pressure Std. Dev.	Standard Deviation [dBar]	dd.dd
Temperature	[deg C]	dd.dd

Example (DF101):

$PNORS1,083013,132455,0,34000034,23.9,1500.0,123.4,0.02,45.6,0.02,23.4,0.02,123.456,0.02,24.56*39

7.6.7 $P---VL – Velocity data per layer

Field	Description	DataFormat
Date	Date	MMDDYY
Time	Time in UTC, 0-24H, 0.01 second resolution	hhmmss.ss
layer number	#	dd
Layer Size	Size of the layer[m]	dd.dd
layer Position	Distance from sensor to centre of the layer[m]	dd.dd
Velocity East	[m/s]	dd.ddd
Velocity North	[m/s]	dd.ddd
Velocity Up	[m/s]	dd.ddd
Velocity Up2	[m/s]	dd.ddd
Speed	[m/s]	dd.ddd

Field	Description	DataFormat
Direction	[degrees]	ddd.dd

8 Triggering and time-synchronization

When using the VM-ADCP in an environment with other acoustic instruments that operate in the same frequency band, instrument activity needs to be staggered, usually by means of triggering, to prevent interference.

The VM-ADCP itself, and the Nortek VM Acquisition software, offer several options for triggering. Figure 68 shows the different options from the software perspective; the drop-down box behind "Triggering" in the VM-ADCP connect dialog shows the options. Triggering also has hardware aspects. Section Triggering 76 and its subsections provide further details on the various options for triggering, including the hardware aspects where relevant.

There are several options for time-synchronization; see the drop-down box behind "Clock source" in figure 68. Section Time synchronization 81 provides further details on these options. To use the PTP or NTP option, an appropriate time-source needs to be available on the network. The Advanced Navigation GNSS that is part of the Nortek VM Coastal system functions as a PTP clock-source.

Note that for both Triggering and for Clock source, the contents of the Connect Dialog will change depending on the selections you make. The figures in the relevant sub-sections illustrate this.

Also note that these screen-shots show the DF21 and DF22 output options. These are licensed options, and only show if the license is present. (See section Additional Options 20.)

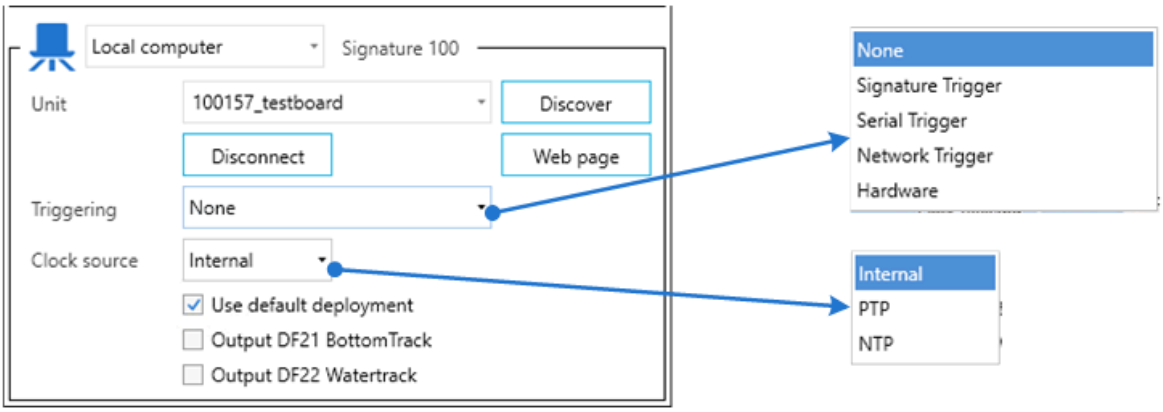


Figure 68: Trigger and clock source optoins in the VM-ADCP connection dialog window

8.1 Triggering

There are two distinct triggering mechanisms: via direct communication with the VM-ADCP itself, or through communication with the Nortek VM Acquisition software via the Processing Unit the software runs on.

Triggering through direct communication with the VM-ADCP itself we call "ping-based" triggering. In this case, the trigger signal is either an RS485 signal or a network signal, directly to the VM-ADCP.

In "ping based" triggering, every single ping that is part of a measurement cycle (ensemble) needs a separate trigger. "Ping based" triggering corresponds to the option "VM-ADCP trigger" in the drop-down menu of figure 68. Section Ping-based triggering (VM-ADCP triggering)) 77 explains this in more detail.

Triggering through communication with the VM software we call "ensemble-based" triggering. For this, the trigger signal can be serial, a network message, or a dedicated hardware connection, to the Processing Unit that runs the Nortek VM Acquisition software and controls the VM-ADCP.

In "ensemble-based" triggering, a single trigger will initiate all of the pings that are needed for a measurement cycle (ensemble). All of the options "Serial Trigger", "Network Trigger", and "Hardware" fall in this category. Section Ensemble-based triggering 78 provides further details.

8.1.1 Ping-based triggering (VM-ADCP triggering)

Ping-based triggering or "VM-ADCP triggering" is the VM-ADCP's built-in triggering mechanism, using direct communication with the VM-ADCP itself. (Note: This is not available on the Signature 333.)

Upon receiving a trigger, the instrument will do one transmit and receive cycle (one ping). This means that if the instrument is configured for multiple bursts per measurement, multiple triggers will be required for a full measurement cycle. For Nortek VM Acquisition, which requires at least one velocity and one bottom-track ping per measurement, this means it needs two triggers for every full cycle. If you add altimeter or echosounder bursts it will need more triggers to complete the measurement.

When this method is used there is a risk that the individual triggers are too much separated in time and thus do not produce an optimal result when the data of the individual pings is combined. On the VM-ADCP it can take 8-16 triggers to complete a measurement cycle.

To put the VM-ADCP into this triggering mode, use the Nortek VM Acquisition software and select "VM-ADCP trigger". After this, the Connect dialog will show extra drop-down boxes for "Mode" and "Options" (see figure 69). See the next sub-sections for details on the different menu selections.

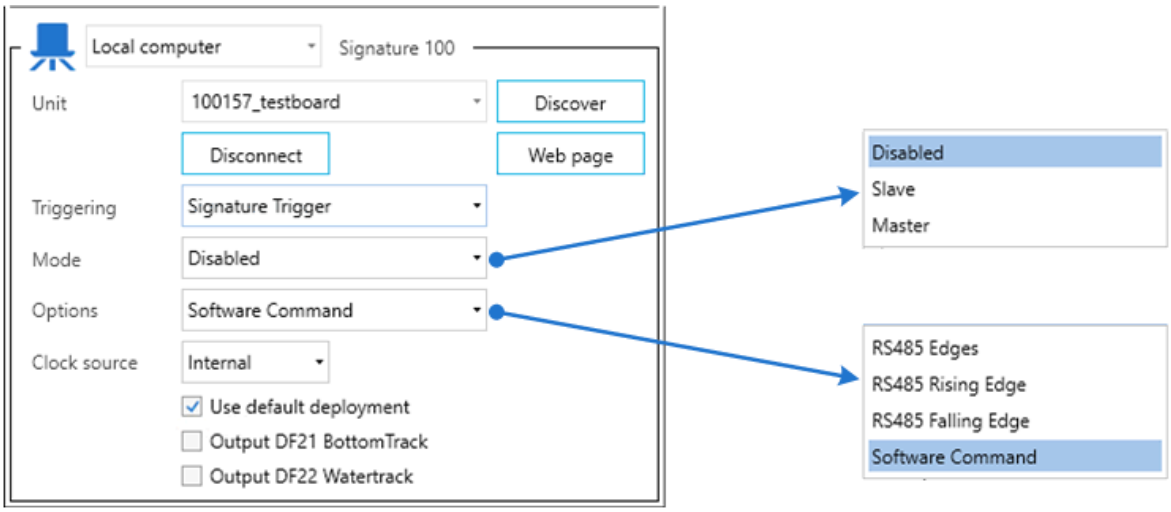


Figure 69: Mode and option menus for "VM-ADCP trigger" style triggering.

8.1.1.1 VM-ADCP Triggering: Slave mode

To send an external trigger coming from an external source, the instrument must be set to 'Slave'. After receiving a trigger signal, the instrument will perform one transmit and receive cycle (a.k.a. a single ping).

8.1.1.2 VM-ADCP Triggering: Master mode

"Trigger mode: Master" enables master trigger output. After performing a transmit and receive cycle itself, the instrument sends out a trigger signal, to allow other instruments to perform a measurement.

Note that this mechanism only works in specific circumstances. The Integrator's Guide mentions:

"RS485EDGE trigger must be used with this option. This enables several instruments to be synchronized together through RS485 with one of the instruments acting as master. Only continuous measurement configurations are supported in this mode, and all synchronized AD2CP instruments must be of the same frequency and have the same deployment configuration."

8.1.1.3 VM-ADCP Triggering: RS-485 options

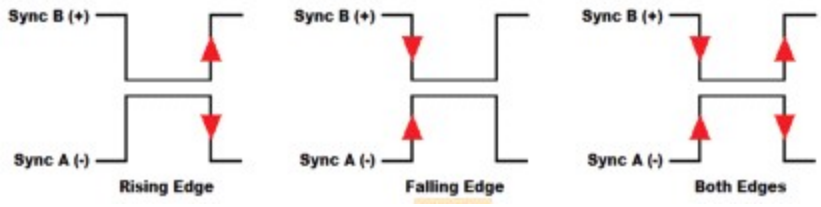


Figure 70: RS-485 trigger signal details

An RS-485 signal can be used to trigger the VM-ADCP, either Rising Edge, Falling Edge or Both Edges of a RS-485 Signal. Figure 70 78 shows the polarities of the differential RS-485 signal pair for the trigger types. When triggered the instrument will perform a complete ping (transmit and receive) before it goes back to monitoring the trigger. Any triggers asserted during an ongoing ping will be ignored. The pulse length should be at least 1 ms.

The signal should be applied to Pin 7 and 8 of the 8-Pin Subconn connector.

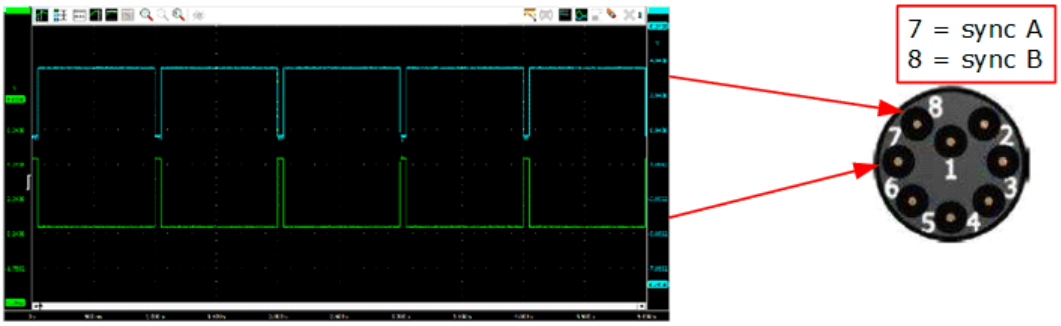


Figure 71: RS-485 triggering oscilloscope trace and connection pins

8.1.1.4 VM-ADCP Triggering: Software command

"Trigger mode: Command" allows the VM-ADCP to be triggered by a command. Sending the TRIG<CR><LF> command to ethernet port 9000 or 9001 on the IP address of the instrument will trigger it. The actual moment of triggering is right after it receives the <LF> (LineFeed) character.

By default, the Nortek VM Acquisition software connects to the instrument on port 9000, so it is possible to make a second connection on port 9001 and send the TRIG command to that. After the instrument receives the trigger it will do one transmit / receive and return the data for that specific transmission on both data ports.

8.1.2 Ensemble-based triggering

The ensemble based triggering mechanism is built into the Nortek VM Acquisition software. After receiving an external trigger, the software will take care of the amount of triggers the VM-ADCP needs to complete a measurement cycle.

Ensemble triggering supports three different types of interfaces: hardware based, and two software-based protocols (UDP or serial).

Additionally, the ensemble-based triggering supports handshaking. For both hardware and software triggering, after receiving a trigger, the Nortek VM Acquisition software will acknowledge the start of its active state by sending a busy signal. For software triggering, it will also send a ready state signal when done.

When the system is offline it will not respond to a trigger command, in general the busy indicator will be sent within 100 ms.

When using Triggering the Sensor timeout can be adjusted to prevent false “missing data” detection (red indicator in the status panel) .

8.1.2.1 Hardware trigger

Hardware trigger is primarily intended for use with the Ocean/Operations Processing Unit model 4420. DIN-rail mounted connectors provide access to signal lines "trigger" and "busy" (as well as signal ground and chassis ground). These signal lines are connected to the CTS (trigger in) and RTS (busy) lines of COM1. Figure 72 shows the connectors, including the labels.

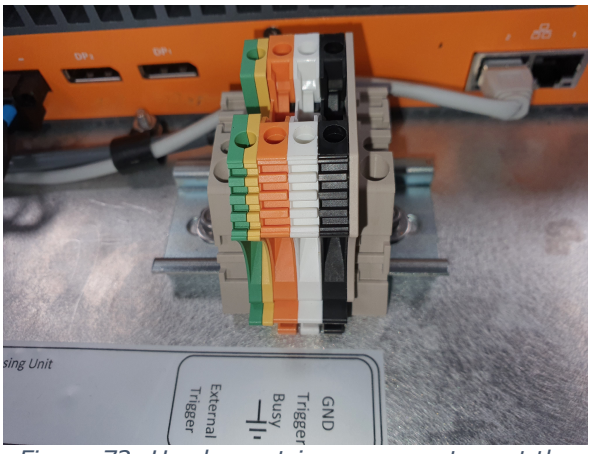


Figure 72: Hardware trigger connectors at the back of the Processing Unit model 4420.

Figure 73 shows the extra drop-down menus in the Connect dialog upon selecting "Hardware" as the Triggering option.

For the hardware handshake the trigger signal happens by activating the "trigger" (CTS) line of the serial port. The busy state is indicated by the "busy" (RTS) line.

The default settings for hardware trigger are a rising edge for the trigger moment, and a high level (in terms of voltage) to indicate the busy state. Table 8 gives on overview of the options for the trigger and busy signals.

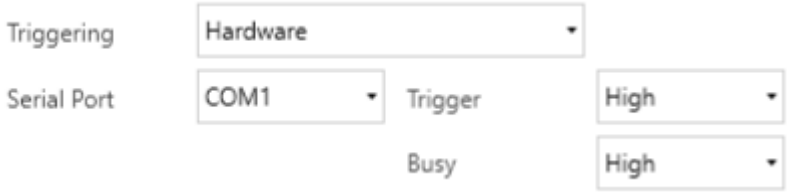


Figure 73: Hardware trigger options

Table 8: Possible settings for the hardware trigger

Signal	***Signal level selection from drop-down box***	
	High	Low
Trigger	Trigger on the rising edge	Trigger on the falling edge
Busy	High voltage indicates the system is busy	Low voltage indicates the system is busy

Notes

- The voltage levels are RS-232 levels: high voltages between +3 and +15 V, low voltages between -3 and -15 V.
- The software and this manual do *not* refer to the RS-232 logic 0 and logic 1 levels. (Where we mention "a high level in terms of voltage", we do mean +3 .. +15 V)
- The busy signal level is only valid while the measurement is running (i.e., the "Start" button in the "Start measurement" dialog window has been pressed; see section Start measuring) 29. Before start of the measurement, and after stopping a measurement, the voltage level will go back to a default low voltage, irrespective of the "High" or "Low" selection for "Busy".

8.1.2.2 Software trigger

For software trigger there are two options: a network UDP based trigger or a serial connection. For both networking and serial triggering, the trigger is initiated by sending a "TRIG\n" command to the VM Coastal or VM Ocean/Operations Processing Unit, where the system will respond with "BUSY\n". When the measurement cycle is complete the software will send back a "READY\n" command. ("\n" is the newline character, hexadecimal 0x13h.)

Figure 74 shows the options for the Network Trigger choice: primarily the network adapter on which it should listen for the trigger messages, and the UDP port number. The default IP Address as shown is a reserved, special purpose IP Multicast address.

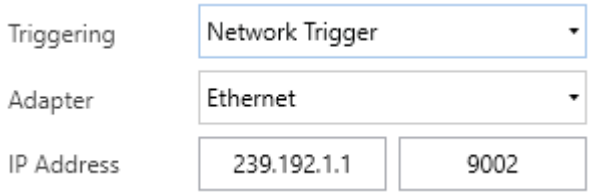


Figure 74: Network trigger options

Figure 75 80 shows the various extra drop-down menus that show when selecting the Serial Trigger options. These are all typical serial communication parameters, that should be selected to match those of the serial trigger provider.

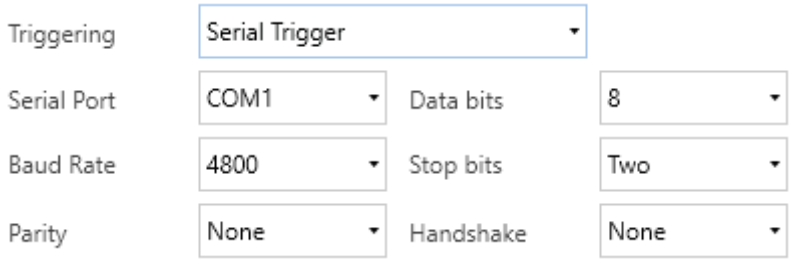


Figure 75: Serial triggering options

It is worth noting that neither the VM Coastal, nor the VM Ocean/Operations Processing Unit, have accessible serial ports. To use the Serial Trigger option, you would have to provide a USB-to-Serial converter. In that case, you also need to be careful about selecting the correct COM-port: both the VM Coastal and the VM Ocean/Operations Processing Unit will list several other COM-ports.

The VM Coastal Processing Unit has several COM-port connections on the motherboard. None of them is physically accessible, but they will be listed.

The VM Ocean/Operations Processing Unit has two COM-ports on the outside of the PC; the first one is in use for the Hardware Trigger option. The other one is not accessible due to space constraints in the hardware.

Also note that if you would want to use the MOXA Serial server that is part of the VM Ocean/Operations Processing Unit for triggering purposes, this serial server actually connects through the internal network in the Processing Unit. So from the software perspective, you would need to handle this as a Network Trigger, and make sure you configure the port you want

to use on the serial server appropriately (see the relevant section in the Nortek VM Hardware and Installation Manual).

8.2 Time synchronization

Nortek VM Acquisition has different possibilities to synchronize the clock of the VM-ADCP: Internal, PTP (Precision Time Protocol), or NTP (Network Time Protocol). For information arriving from other sources i.e. Heading, Position etc., the VM system timestamps the moment the data is received. For this purpose it maintains an internal clock reference that is synchronized with the Time message (ZDA for NMEA) from the GNSS.

8.2.1 Internal clock

When internal is used, Nortek VM Acquisition synchronizes the clock of the VM-ADCP with the PC clock at the start of the deployment. Due to limitations of the VM-ADCP (in setting the clock), the accuracy in the timing is +/- 0.5 sec.

8.2.2 PTP

When using PTP, the VM-ADCP updates its internal clock continuously from the external PTP source to adjust for small clock drifts; the accuracy in timing is down to the sub microsecond level.

8.2.3 NTP

When using NTP, the VM-ADCP updates its internal clock continuously from the external NTP source to adjust for small clock drifts; the accuracy in timing is down to the millisecond level. The PC running the VM software can be configured as NTP server. For more information see: Use Windows 10 as NTP Server – Nortek Support Center (nortekgroup.com).

For an external NTP server the IP address of the Server needs to be supplied (see figure 76 81). The NTP server used by the PC can be found by typing "`w32tm /query /status`" in a command console.

The synchronization with NTP can take a relative long time when the system is synchronized for the first time after powerup.

Figure 76: NTP server IP address

9 Spectrum

For noise interference troubleshooting the software allows you to record a frequency spectrum. This can be used when you notice issues with the data received from the VM-ADCP to further narrow down the issue.

9.1 Instructions

In order to be able to record a spectrum, a VM-ADCP should be connected.

Steps:

1. Open the Nortek VM Acquisition software
2. Turn on the Diagnostics mode by clicking on the stethoscope icon
3. Connect[19] your VM-ADCP
4. Start collecting a spectrum by clicking the play button in the Diagnostics window (please note it may take up to 15 seconds for the sampling to start)

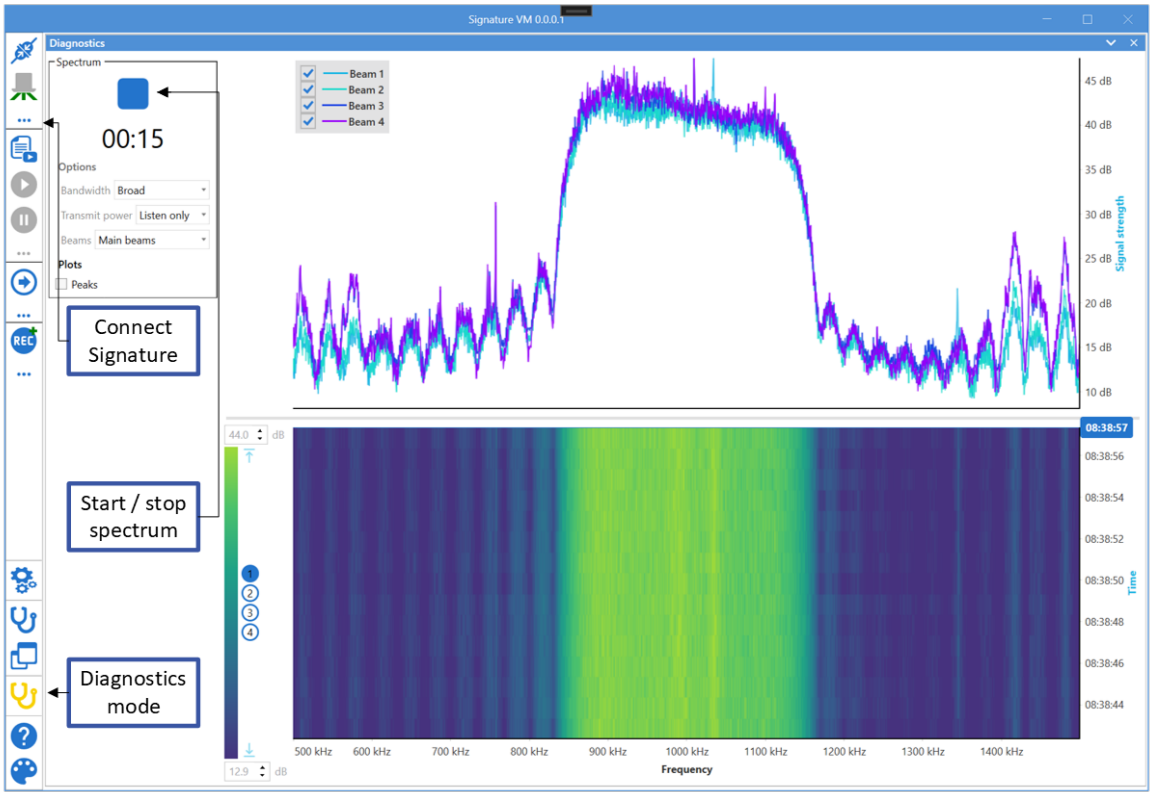


Figure 77: Recording a spectrum

The recording will get a .VMDiag extension which you can open in Nortek VM Review.

9.2 Options

A spectrum can be recorded in different bandwidth modes. Generally, it is recommended to use the bandwidth that is also used when surveying, usually broadband. In some cases it might be useful to study a wider spectrum, in this case full bandwidth can be selected.

The transmit power should be set to "Listen only" when identifying noise issues. Since when the instrument transmits a pulse the noise floor is disturbed significantly, reducing the chance of seeing externally introduced noise.

If your instrument has an echosounder, the spectrum of the echosounder beam can be collected instead of the spectra of the main beams. This can be useful for calculating the noise level[41] of the echosounder.

9.3 Interaction

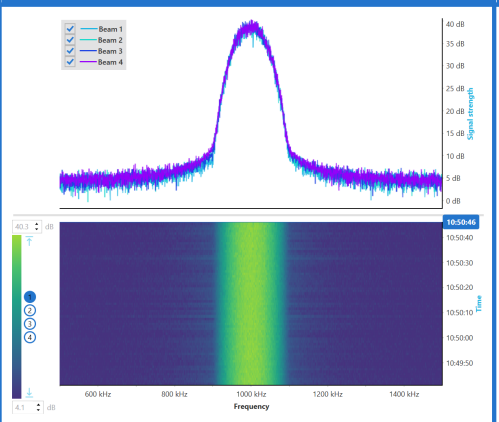
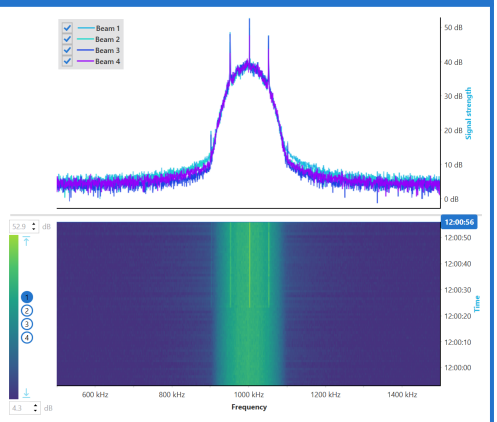
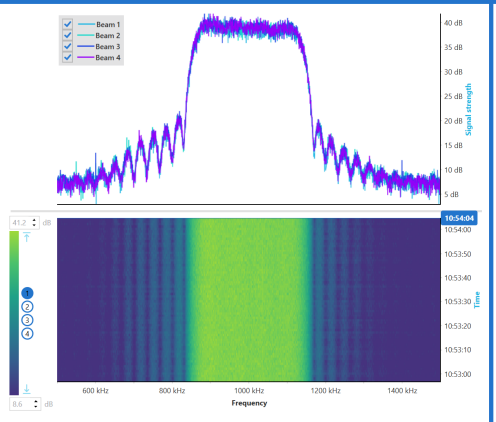
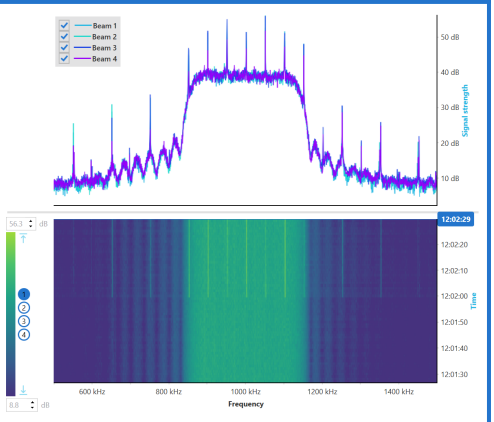
The spectrum is shown in two different plots. The bottom heatmap shows the spectrum over a period of time, the top line plot shows a instant spectrum for the time selected using the horizontal line in the bottom heatmap. The horizontal line can be moved (by means of the time-label on the right-hand side) to show the detailed line spectrum at a different point of time.

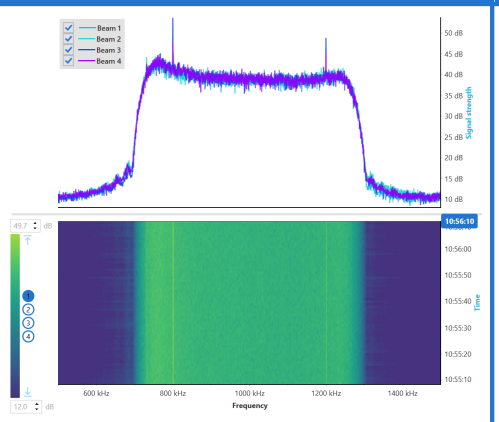
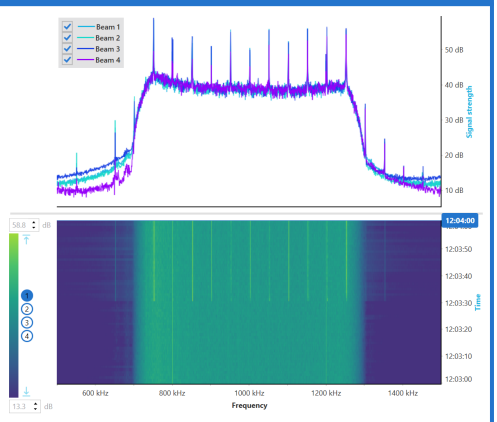
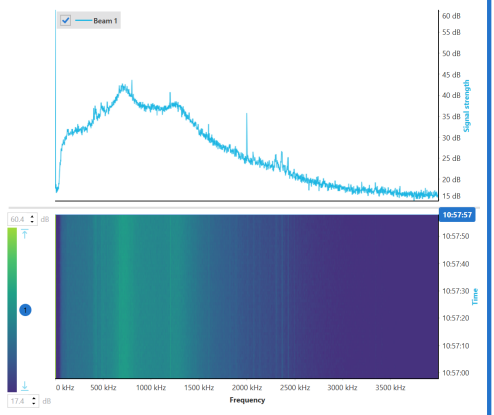
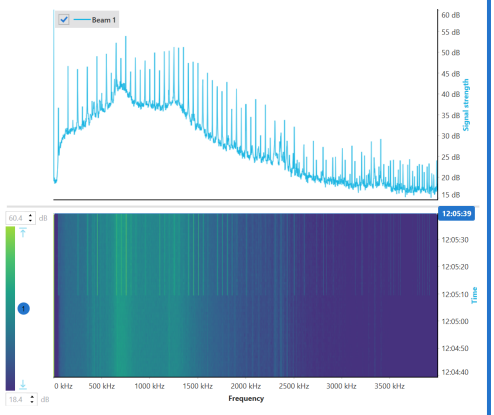
Use the "Peak hold" check-box to show the maximum values in the top line plot.

9.4 Example spectra

Table 9[83] shows examples of clean and noisy spectra from a Signature 1000 instrument. The noisy spectra are polluted with a 50 kHz square wave from about halfway through the recording, the clean spectra show little pollution.

Table 9: Example spectra

Bandwidth	Clean	Noisy
Narrow		
Broad		

Bandwidth	Clean	Noisy
Ultra		
Full		

A clean spectrum should have a well defined peak around the instrument frequency with a low noise floor and show no changes over time. The noisy spectra in table 9 83 show narrow peaks at multiples of the introduced frequency of 50 kHz. A square wave, produced in for example switching power supplies, produces these many peaks. Clean sine waves show up as one single frequency. Single, or multiple narrow peaks are a sign of noise pollution.

10 Troubleshooting

This section contains information on where to start looking if an instrument does not behave as intended. If you encounter a problem, you should:

1. Get a good overview of the problem; make notes during the troubleshooting process
2. Work in a systematic way and do not neglect the obvious. Start by looking at simple causes, such as power not connected, bad connections, etc.
3. If the setup uses custom cables, power supply, etc. first assemble and test the instrument using the cable and battery (if applicable) that originally came with the instrument. You can always return to the standard setup, which is the easiest way to get the system to work, to confirm that the problems are not caused by a faulty instrument.
4. If your instrument behaves strangely try updating both your software and firmware to the latest versions. There may be incompatibilities between an older version of firmware and newer version of software, and vice versa. The latest versions of firmware and software can be downloaded from our support page (https://www.nortekgroup.com/software).

To help us give good support if you need to get in touch (via support@nortekgroup.com), please:

1. Be specific about the error - a screenshot is often helpful
2. Include a raw sample file or a collected data set showing the error
3. Include information about firmware and software version used
4. Include serial number or order number
5. Include a support file (through the button in the taskbar)

10.1 Remote Support through TeamViewer

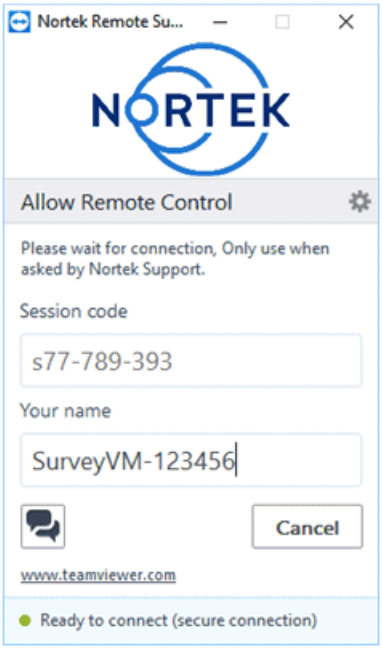


Figure 78: Starting the TeamViewer session

In general, every Nortek VM Acquisition computer comes with the TeamViewer software. This allows the user to give a Nortek support engineer access to the computer so he or she can check what might be wrong with your software or configuration. Make sure you have a working internet connection, and when requested by the Nortek engineer, click the TeamViewer icon to start a session.

Note that every time a TeamViewer session is started, a notification will be sent to Nortek.

When the program has started successfully, and the 'Ready to connect' message is visible no further action is necessary. The Nortek engineer can now connect to your computer and try to solve your problem.

11 Glossary

Accuracy A value giving the degree of closeness of a velocity measurement to the actual velocity. Refer to the data sheet for specific minimum accuracy.

AD2CP Nortek's broadband signal processing platform.

AHRS Attitude and Heading Reference System. Provides attitude information and replaces the traditional tilt and magnetometer. AHRS is especially useful in dynamic environments. Note that this feature also requires additional hardware.

Altimeter Measures the distance to the surface (or, in the case of a vessel-mounted system, the distance from the instrument to the bottom)

Amplitude See signal strength 88

ASCII output Data is displayed in ASCII format (plain text).

Bandwidth Wider signal bandwidth is used to get more information and improve the velocity precision. Reduced bandwidth is used in long range mode (only relevant when current profiling) to increase range. This bandwidth reduction makes the measurements less precise.

Beam coordinates In beam coordinates, a positive velocity is directed in the same direction as the beam points. For most instruments, beam 1 is marked with an "X" on the head.

Blanking Specifies the distance from instrument head to the start of the measurement cell, where no measurements take place, to give the transducers time to settle before the echo returns to the receiver. The size of the blanking area is user selectable in the software using the "start of profile" parameter (a.k.a. the "blanking distance").

Break A break command is used to change between the various operational modes of the instrument and to interrupt the instrument regardless of which mode it is in. When break is received in command mode, you can see that the LED is switched off for a short time (LED is present on most instruments).

Broadband In this context it means using a more complex transmit pulse to improve the measurement accuracy in each ping.

Cell One measurement cell represents the average of the return signal for a given period. The cell size corresponds to the distance travelled during the transmit pulse. The cell is shaped like a triangle due to convolution; this is indicative of the weighting of the measurement.

Coarse profile Instrument setup that prioritizes achieving the maximum range at the expense of reduced resolution.

Command mode An instrument in command mode is powered up and ready to accept your instructions. If no commands are received for about five minutes, it automatically goes into Power Down Mode, unless Ethernet power is connected. LED is lit constantly when in command mode (LED is present on most instruments).

Compass calibration Each compass system has been calibrated at the factory to quantify the characteristic response of the individual components and of the system as a whole. When it leaves the factory, each system can measure its tilt and the direction of its magnetic field vector accurately. However, users may disturb the magnetic field near the instrument when they deploy. Adding a battery pack and mounting the instrument with deployment hardware adds magnetic materials that change the earth's field at the instrument. The compass calibration procedure quantifies this magnetic hard iron disturbance, and the instrument's compass algorithm then corrects for it to obtain accurate heading.

Correlation (nominal) Nominal correlation is a function of cell size and velocity range. Nortek recommends using 50% of the max correlation as a cut-off value, beyond this point the validity of your data is questionable.

ENU coordinates Polar magnetic coordinates; east, north and up. A positive east velocity goes toward east. This is a right-handed orthogonal system.

Fine profile Instrument setup that prioritize the highest possible resolution at the expense of the maximum range achievable.

Firmware Internal software of the instrument, as opposed to the instrument software running on a PC. New firmware is posted on the Nortek site. You will need to register to get access, but access is otherwise free of charge.

Frequency spectrum See spectrum 88

Internal sampling rate Rate of sampling for internal sensors. Refer to the specific instrument brochure for details.

LED (available on most instruments) Light Emitting Diode, visible from the outside of the instrument. The LED can be set to blink for every sample (On), blink for the first 24 hours of deployment (On for 24h), or never (Off).

License Different capabilities of the instrument are protected under licenses which can be purchased. Contact your sales representative for more information.
Licenses that are ordered with the instrument are already registered.

You will not need a new license when updating the firmware version.

NMEA Standard data format defined by the (USA's) National Marine Electronics Association

Noise floor The amplitude of the internal noise of the instrument. This will limit the minimum detectable signal that can be received.

Ping Same as a single transmit pulse.

Precision The value given is a theoretical estimate of the precision of the velocity measurements based on how the instrument is set up. The nominal value is given for the horizontal components in a default instrument acoustic beam configuration. In order to improve the precision, the user may consider one of the following options: (1) larger cell sizes, (2) longer average interval (3) reduced velocity range, or (4) increased measurement load

Sampling rate Specifies the rate at which data is output

SDU coordinates Speed - Direction - Up.

Sidelobe The acoustic beams focus most of the energy in the centre of the beams, but a small amount leaks out in other directions. Transducer sidelobes are rays of acoustic energy that go in directions other than the main lobe. Because sound reflects stronger from the water surface (and "hard" bottoms) than it does from the water, the small signals that travel straight to the surface (or bottom) can produce sufficient echo to contaminate the signal from the water.

Signal strength Strength of return signal, presented in dB.

Signature Commercial name of the Nortek VM-ADCP sensor itself. In some cases with the instrument frequency added to it e.g. Signature 1000.

Sleep mode The instrument is not actively collecting data

SNR SNR is the Signal-to-Noise ratio and is a data quality indicator

Spectrum Graphical view of signal strengths at different frequencies

XYZ coordinates Cartesian coordinate system. A positive velocity in the X-direction goes in the direction of the X-axis arrow (for most instruments indicated on the instrument). The X-axis points in the same direction as beam 1. Use the right-hand-rule to remember the notation conventions for vectors. Use the first (index) finger to point in the direction of positive X-axis and the second (middle) finger to point in the direction of positive Y. The positive Z-axis will then be in the direction that the thumb points.

Figures

Figures

Tables