NORTEK AS

VECTOR
CURRENT METER

USER MANUAL
AUGUST 2005

N300-100 • Rev. H

VECTOR
CURRENT METER

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NORTEK AS

Software updates and technical support

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Here you will find software updates and technical support.

Your Feedback is appreciated

If you find errors, misspelled words, omissions or sections poorly explained, please do not hesitate to contact us and tell us about it at:

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We appreciate your comments and your fellow users will as well.

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If you have comments, application tips, suggestions to improvements, etc. that you think will be of general interest you should register on Nortek's Forums at

www.nortek-as.com/cgi-bin/ib/ikonboard.cgi

and post your message there. The Forums also offer a great opportunity to share your experience using Nortek sensors with other users around the world, and to learn from their experience.

Communicating with us

If you need more information, support or other assistance from us, do not hesitate to contact us:

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OVERVIEW

What's in this Manual?

Chapter 1 – Getting Started

Here we introduce you to the Vector documentation, suggest which chapters it is a must to read, and detail the warranty conditions.

Chapter 2 – Main Data

This chapter provides the technical specifications.

Chapter 3 – Technical Description

In this chapter you'll find a description of the Vector's functional principles, some of the theory behind the Doppler principles, and practical aspects such as the cable pin-outs.

Chapter 4 – Initial Preparation

An important part of the manual dealing with receiving control, installation of the accompanying software and hints and tips making you sure that everything works as intended *before* you deploy your Vector.

Chapter 5 – Setting up for Operation

Here you'll find a recommended procedure for data collection including deployment planning and mounting guidelines.

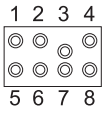
Chapter 6 – Autonomous Deployments

This chapter discusses how to deploy a Vector – specifically how to start and stop the deployment.

Chapter 7 – Real Time Monitoring

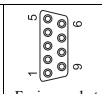
You may find it more suitable for you to use the Vector in a real time monitoring system with online connection to a remote computer. This little chapter presents what you need to know to start and stop the measurements.

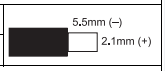
RS232 cable with analogue inputs



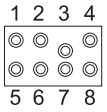
Pin numbers, looking at the pins

Underwater connector		Purpose		Termination	
Pin number	Wire color			Pins	Description
3	Black	RS232 Tx	twisted pair	2	9-pin Dsub, female
4	White	RS232 Rx		3	
5	Black	RS232 ground	twisted pair	5	
6	White/purple	power output		Red wire	
7	Black	analogue input 2	twisted pair	Green wire	
8	White/orange	analogue input 1		Yellow wire	
1	Black	power ground	twisted pair	Black wire	
2	White	power positive		Red wire	
Screen	Bare	ground	3 bare wires for grounds, connected internally to power ground		





RS232 cable with Synch in/out

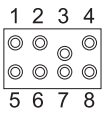


Pin numbers, looking at the pins

Underwater connector		Purpose		Termination	
Pin number	Wire color			Pins	Description
3	Black	RS232 Tx	twisted pair	2	9-pin Dsub, female
4	White	RS232 Rx		3	
5	Black	RS232 ground	twisted pair	5	
5	Black	RS232 ground	twisted pair	Black wire	
6	White/purple	sync in		Green wire	
7	Black	sync out	twisted pair	Red wire	
8	White/orange	not used		White/orange wire	
1	Black	power ground	twisted pair	Black wire	
2	White	power positive		White wire	
Screen	Bare	ground	3 bare wires for grounds, connected internally to power ground		

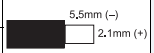
RS232 cable with option for analogue outputs

*)Optional version outputs pressure instead of Z-velocity

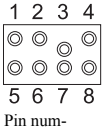


Pin numbers, looking at the pins

Underwater connector		Purpose		Termination	
Pin num-ber	Wirecolor			Pins	Description
3	Black	RS232 Tx	twisted pair	2	9-pin Dsub, female
4	White	RS232 Rx		3	
5	Black	Ground	twisted pair	5	
6	White/purple	Analogue Z*		Red wire	
7	Black	Analogue X	twisted pair	Green wire	
8	White/orange	Analogue Y		Yellow wire	
1	Black	Power ground	twisted pair	Black wire	
2	White	Power posi-tive		Red wire	
Screen	Bare	Ground	3 bare wires for grounds, connected internally to power ground		

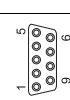


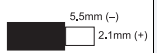
Wiring of 8-conductor cable for RS422 communication



Pin num-bers, looking at the pins

Underwater connector		Purpose		Termination	
Pin number	Wire color			Pins	Description
3	Black	RS422 Tx+	twisted pair	2	9-pin Dsub, female
4	White	RS422 Tx-		3	
7	Black	RS422 Rx-	twisted pair	1	
8	White/orange	RS422 Rx+		9	
5	Black	Synch out	twisted pair	Black wire5	
6	White/purple	Synch in		Green wire	
1	Black	Power ground	twisted pair	Black wire	
2	White	Power positive		Red wire	
Screen	Bare	Power greound	three ground lines through shield		





Note: Tx and Rx refer to the Vector – not to the PC!

Functional Description

This section briefly describes some of the underlying principles that control the operation and application of the Vector Current meter.

The Vector has three different modes of operation:

- **Command mode.** A Vector in command mode is powered up and ready to accept your instructions. If it gets no commands for about five minutes, it automatically goes into Power Down Mode.
- **Power Down Mode.** The Power Down Mode saves power during deployments and prevents your battery from dissipating between deployments. The Vector automatically powers down from command mode after about five minutes of inactivity.
- **Data Acquisition Mode.** The Vector enters data acquisition mode when you click any of the **Start** commands (e.g. **Start Recorder Deployment**) in the Vector software. Choose between:
  - **Continuous Data Acquisition** collects data without breaks. When you start continuous data acquisition, it is important to do so with the instrument aligned up or down the same way it will collect data.
  - **Burst Data Acquisition** collects data with breaks at regular intervals. When you start burst data acquisition, the instrument senses whether it is facing up or down at the start of each burst, and it adjusts itself accordingly.

Note: If you set the Vector to collect data, remove power, and then re-apply power later, the Vector will immediately resume data collection. Remember that the date and time may be lost.

Using the Doppler Effect

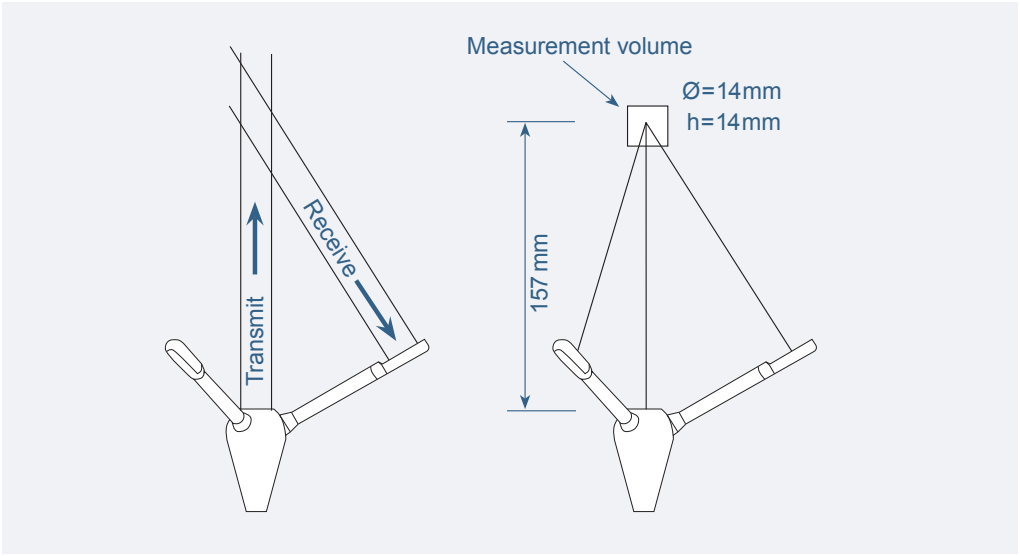
You hear the Doppler effect whenever a train passes by – the change in pitch you hear tells you how fast the train is moving. The Vector uses the Doppler effect to measure current velocity by transmitting short pairs of sound pulses, listening to their echoes and, ultimately, measuring the change in pitch or frequency of the returned sound.

Sound does not reflect from the water itself, but rather from particles suspended in the water. These particles are typically zooplankton or suspended sediment. Long experience tells us that these small particles move with the same average speed as the water – the velocity it measures is consequently the velocity of the water.

Vector Sonar Principles

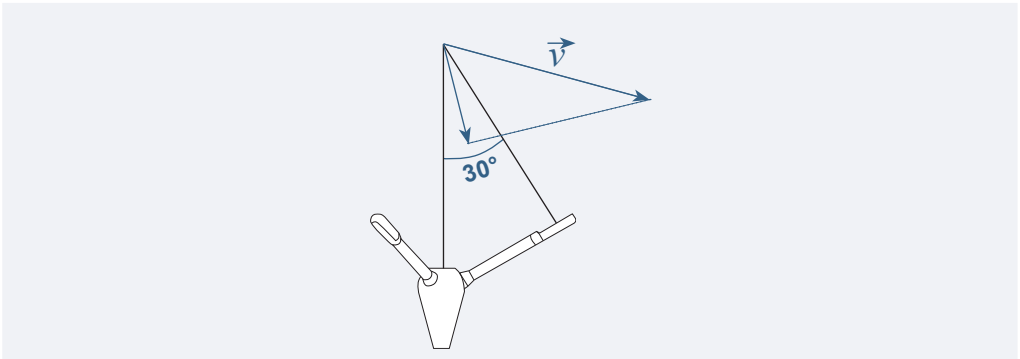
In contrast to standard Doppler profilers and current meters, the Vector is a bistatic sonar. This means that it uses separate transmit and receive beams. It transmits through a central beam and receives through three beams displaced off to the side.

The figure below shows how the beams intersect each other 157mm from the transmitter. The measurement volume is defined by this intersection and by range gating in time. The transmit transducer sends a short pulse that covers only about 4mm vertically, and the receivers listen to an echo that corresponds to about 14 mm vertically. Since the Vector uses three receivers, all focused on the same volume, it obtains three velocity components from that very volume.



The beams intersect at 157mm from the transmitter. The measurement volume is defined by this intersection and range gating in time. The transmitter emits a short pulse covering about 4mm vertically, while the receiver listens to an echo corresponding to about 14mm vertically. Since the Vector uses three receivers (only two are visible in the Fig.) – all focused on the same volume – three velocity components are obtained.

The figure below shows that a transmit/receive beam pair is sensitive to velocity in the direction of the angular bisector between the beams. The arrow indicates a positive velocity.



The transmit/receive beam pair is sensitive to velocity in the direction of the angular bisector between the beams. The arrow indicates a positive velocity. Since the receive beams are slanted at 30°, all three beam pairs measure velocity that is only 15° away from the transmit beam.

Since the receive beams are slanted at 30°, all three receivers measure the velocity that is slanted about 15° from the transmit beam.

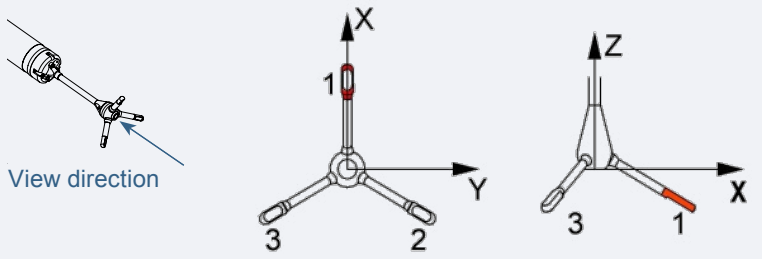
This means that the Vector is more sensitive to the Z-velocity (the component parallel to the transmit beam) than it is to the X- or Y-velocity. Consequently, the Z-velocity component yields a lower measurement uncertainty.

Coordinate System. The Vector measures velocity components parallel to its three beams, or in beam components. It reports data in any one of the coordinate systems, Beam, XYZ or ENU. The three ENU coordinates are:

- **E**ast
- **N**orth
- **U**p

To get to ENU components, it first converts the measured data to XYZ coordinates as defined in the Fig. below.

The XYZ coordinates are combined with compass and tilt data to calculate the position as ENU data. The Fig shows how the XYZ are defined. While older versions of the Vector used a red marking to indicate the X-direction, newer models have the direction engraved in the probe end bell itself (see also more on the following page).



The XYZ coordinates are relative to the probe and independent of whether the Vector points up or down. The Vector uses its compass and tilt measurements to convert velocity to components relative to earth, or ENU coordinates.

In XYZ coordinates, a positive velocity in the X-direction goes in the direction of the X-axis arrow. In ENU coordinates, a positive east velocity goes toward east.

Moorings sometimes allow the Vector to tilt and rotate freely. The probe measures its tilt and heading and uses this information to convert the data to true earth coordinates.

Tip: Detailed information about the coordinate transformation equations used in the Vector can be found on the Nortek WEB forum.

Velocity Uncertainty. The Vector velocity is an average of many velocity estimates (called *pings*). The uncertainty of each ping is dominated by the *short-term error*. We reduce the measurement uncertainty by averaging together many pings. There is a limit to how much you can reduce your uncertainty. We call this limit the long-term bias.

Tip: Which direction is the X-direction?

For older probes (above), the X-direction is in the direction of the red marking. However, if the marking is no longer visible, the X-direction is in the direction of the arm opposing the pressure sensor holes of the probe end bell.

For newer probes (below), the X-direction is engraved in the probe end bell itself

The long-term bias depends on internal signal processing, especially filters, and on your beam geometry. The long-term bias in the Vector is typically a fraction of 1 cm/s. *The Vector software predicts errors based on the short-term error of a single ping and the number of pings averaged together.* The short-term error of a single ping depends on the size of the transmit pulse and the measurement volume, and it depends on the beam geometry. Averaging multiple pings reduces errors according to the formula:

$$\sigma_{Vmean} = \frac{\sigma_{Vping}}{\sqrt{N}}$$

in which σ is the standard deviation and N is the number pings you average together.

Note: The Vector software predicts the instrumental error only. In many situations, the environmental turbulence or surface waves will dominate the short term velocity fluctuations.

Data Handling

The Vector software creates binary files, which can be converted to ASCII format files, using the Vector software.

- The *.hdr file is a self-documented table. Please note that this file contains the detailed data format of all the other ASCII files.
- The *.dat files contains velocity and pressure data at the full sample rate.
- The *.sen files contains system data such as the time/date, compass, tilt, temperature, battery voltage, etc. These data are sampled once per second.

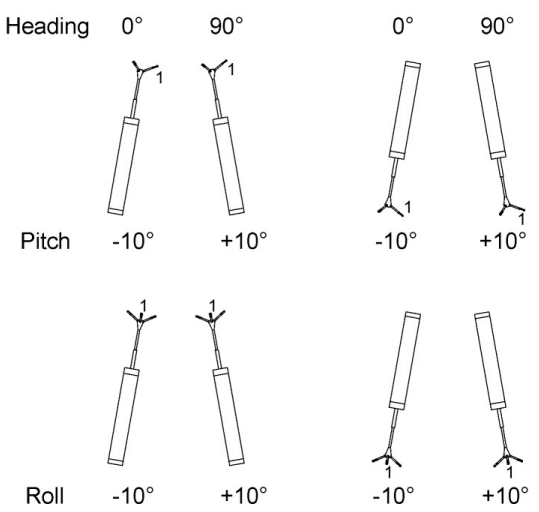
You will find the ASCII files easy to import into most spreadsheets and data analysis programs. NORTEK recommends the use of a specially developed program for turbulent data analysis. The program is called ExploreV. See *Appendix 2 – Optional configurations and features* for more on this.

Interpreting and Analyzing the Data

We strongly recommend the use of our internet pages to gain access to the latest technical notes and user-experience regarding data analysis and related matters.

If the data looks different from what you expected and you have reason to believe that this is instrument or deployment related, consult *Chapter 10 – Troubleshooting* before taking other actions.

Heading, Roll and Pitch definitions



The heading, pitch and roll definitions.

For the two leftmost columns the Vector is drawn facing up, and for the two rightmost columns, the Vector is drawn facing down.

Observe that for the roll definitions, probe arm 1 points towards the viewer.

ASCII formats

The ASCII data format is subject to change, but the current format is always described in the header (**.hdr**) file generated by the data conversion function.

Col. = Column

Sensors data (.sen)			
Col	**Type**	**Unit**	**Remarks**
1	Month		
2	Day		
3	Year		
4	Hour		
5	Minute		
6	Second		
7	Error code		Explained in a separate table
8	Status code		Explained in a separate table
9	Battery	V	
10	Sound speed	m/s	
11	Heading	°	
12	Pitch	°	
13	Roll	°	
14	Temperature	°C	
15	Analogue input		
16	Checksum		1= failed, 0=OK

Col. = Column

Burst header data (.vhd)		
Col.	**Type**	**Unit**
1	Month	
2	Day	
3	Year	
4	Hour	
5	Minute	
6	Second	
7	No. of velocity samples	
8	Noise amplitudes (beam 1)	counts
9	Noise amplitudes (beam 2)	counts
10	Noise amplitudes (beam 3)	counts
11	Noise correlation (beam 1)	%
12	Noise correlation (beam 2)	%
13	Noise correlation (beam 3)	%

Col. = Column

SNR = Signal-to-noise ratio

Velocity data (.dat)		
Col.	**Type**	**Unit**
1	Burst counter	
2	Ensemble counter (0–65535)	
3	Velocity (beam 1, x or east)	m/s
4	Velocity (beam 1, y or north)	m/s
5	Velocity (beam 1, z or up)	m/s
6	Signal strength (beam 1)	counts
7	Signal strength (beam 2)	counts
8	Signal strength (beam 3)	counts
9	SNR (beam 1)	dB
10	SNR (beam 2)	dB
11	SNR (beam 3)	dB
12	Correlation (beam 1)	%
13	Correlation (beam 2)	%
14	Correlation (beam 3)	%
15	Pressure	m
16	Analogue input 1	
17	Analogue input 2	
18	Checksum	1= failed, 0=OK

Correcting for Sound Speed Errors

If you enter the wrong salinity, the Vector will compute the wrong sound speed. You can correct velocities (**V**) for sound speed errors using the following equation:

$$V_{NEW} = V_{OLD} \cdot \frac{\text{New sound speed}}{\text{Old sound speed}}$$

Error Codes and Status Codes

The below tables describe how the bits should be interpreted.

Error codes			
Bit	**Description**	**0**	**1**
7	Coordinate transformation	OK	Error
6	Tilt reading	OK	Error
5	Beam No.	OK	Error
4	Flash	OK	Error
3	Tag bit	OK	Error
2	Sensor data	OK	Error
1	Measurement data	OK	Error
0	Compass	OK	Error

Status codes			
Bit	**Description**	**Details**	
7 6	Power level	00 = high 01 = no used	10 = low 11 = not used
5 4	Wakeup state	00 = bad power 01 = power applied	10 = break 11 = RTC alarm
3	Roll	0 = OK	1 = out of range
2	Pitch	0 = OK	1 = out of range
1	Scaling	0 = ×1mm/s	1 = ×0.1mm/s
0	Up/Down	0 = up (probe points downwards)	1 = down (probe points upwards)

RTC = Real Time Clock

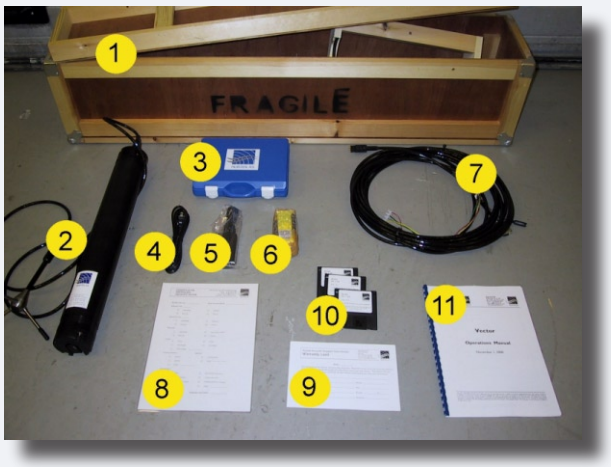
CHAPTER 4
Initial Preparations

We recommend the following procedure to prepare your new Vector Current Meter for future successful operation:

1. Verify that you have received all parts.
2. Install the internal battery pack.
3. Install the Vector Software on a PC.
4. Perform a functional test of your new Vector.
5. When you are ready to make your measurements, mount the Vector in accordance with the guidelines provided in *Mounting guidelines* (in this chapter).

Inspect the Received System

We strongly recommend that you check that the equipment shown here is included in the delivery. A list of all items is provided overleaf.



The following should be included in the Vector Shipment:

1 Transportation box
2 Vector current meter
3 NORTEK equipment storage box
4 240V power cable
5 AC adaptor (100–240VAC to 15VDC)
6 Extra battery pack (there is one installed in the Vector already)
7 External power/signal cable
8 Packing list
9 Warranty card
10 Vector software CD
11 Vector user manual

Note! Do not hesitate to contact NORTEK if you find that parts of the delivery are missing.

Installing the Vector PC Software

To install the Vector software:

1 Insert the CD.
2 Follow the on-screen instructions. Accept the default settings.
3 Restart your PC if prompted to, to finalize the installation process.

Verifying Proper Operation

Run a Functionality Check

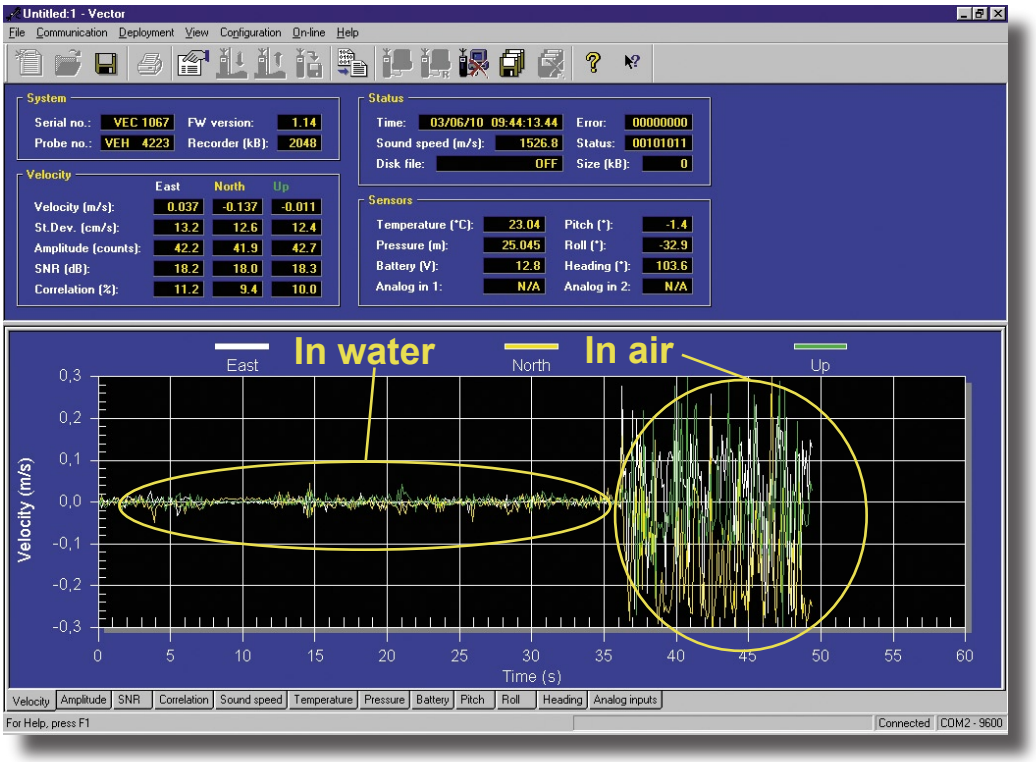
To run a functionality check:

1 Plug in the AC adaptor and connect the Vector to the PC serial port.
2 Select **Serial Port** from the **Communication** menu to specify the port number to use.
3 Accept the default baud rate settings (9600 baud), which is also the default instrument baud rate.
4 Check the instrument communication and verify that the instrument is alive by activating the **Terminal Emulator** window and press the **Send Break** button to send a **BREAK** signal over the serial port. A break causes the instrument to report an identification string.

Note! If the instrument fails to respond, the software can autoconnect to the instrument. Press **Stop Data Collection** and wait until the instrument is found. The correct serial port must be chosen.

5 Fill a bucket with water and a little dirt (sound scattering material).

6 Start the Vector software. Click **Online** > **Start data collection**. When the transducers are in air, the velocity measurements will look like random noise.



The velocity in water (left part of the graph) and in air (right part of the graph).

7 Put the transducers in the water and observe the amplitude, the SNR (Signal-to-Noise Ratio) and the correlation. The three tabular values should rise noticeably. Also watch the graphical view of the velocity as the probe goes in and out of the water. In air the graphs are noisy, while in water they should be smooth. Note that the difference depends on the size, shape and material of the bucket. If the velocity graphs remain weak with the probe in water, try varying the position of the probe or add some seeding to the water in the form of dirt or small particles.

8 Check sensor readings:

- Verify the tilt sensor – see *Verifying the Tilt Sensor* later in this chapter.
- Temperature should be close to your room temperature, assuming the Vector has been in the room for a while. To calibrate the temperature sensor – see *Verifying and Calibrating the Temperature Sensor* later in this chapter.

- Check the reported pressure, the pressure should be near zero. Check the pressure sensor in a bucket 50 cm deep, or put your mouth over the pressure sensor and blow to create a pressure of around 0.5–1m. If you need to cahnge the setting, see *Verifying the Pressure Sensor* later in this chapter.
- Battery voltage shall be greater than 13VDC (new battery).

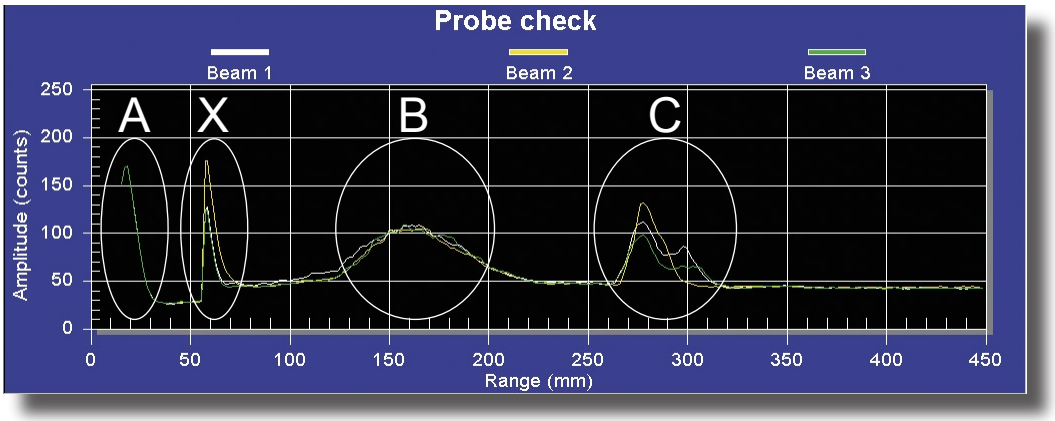
The Probe Check Feature

Designed to act as a measurement quality assurance tool, the Probe Check function in the Vector software lets you inspect the region where the Vector makes its measurements by showing how the signal varies with range.

To start the probe check:

1 Make sure the probe is submerged in water.

2 Click **Online** > **Start Probe Check**. You can use it to diagnose and correct problems and to optimize data collection.



The probe check function shows how the signal varies with range.

A is the transmit pulse.

B is the area around the measurement volume.

C is a bottom echo.

X is a shift introduced by the switching electronics, but since it is outside the measurement region, its contribution will be insignificant.

The three coloured graphs correspond to each of the three vector receive beams. Graphs are scaled in mm distance from the transmit transducer, parallel to the transmit beam. One amplitude count corresponds to 0.45dB in signal strength.

The letters correspond to the following:

A The transmit pulse.
B The part of the range, which contains the receive volume.
C The bottom echo.

The actual sensing volume is a relatively narrow region within the broad peak indicated by **B**. It is centred at sample 100–105 and normally extends across ±3 counts from the centre.

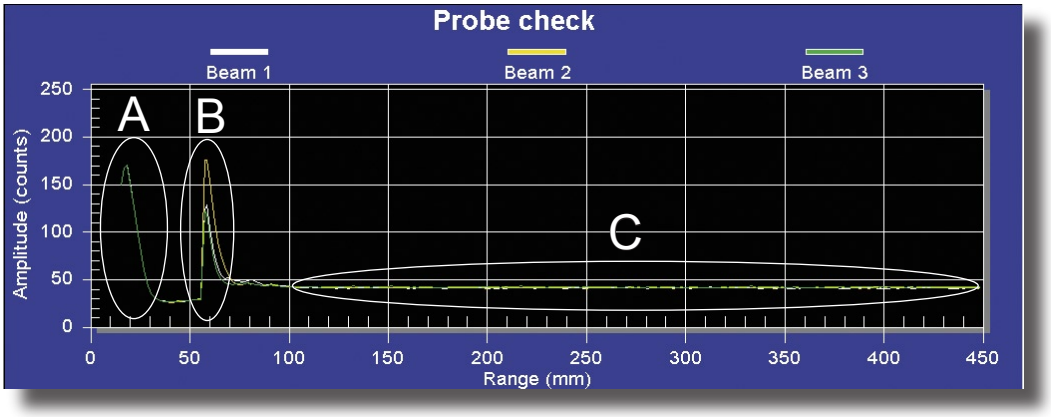
Probe Check Output in Air

Probe check in air:

A: Transmit pulse. You should see roughly the same transmit pulse irrespective of whether the probe is in water or in air.

B: This part of the curve is variable and not important for troubleshooting.

C: Noise level should be within 5 amplitude counts of 50.



If the probe check outputs look very different from above, see the chapter *Troubleshooting* before taking further action.

Counts – a Few Words on the term

For signal strength, Nortek frequently make use of the word *counts*, which obviously seem to be connected to the decibel term, but how and why?

Inside the Vector there are circuitries for the amplification of input signals. The number of counts is an indicator of how much gain we must apply to a signal – the less gain needed, the higher the input signal level is. The number of counts is inversely proportional to the logarithm of the gain setting, which means that a higher number of counts reflects a need for less amplification than a lower number of counts will do.

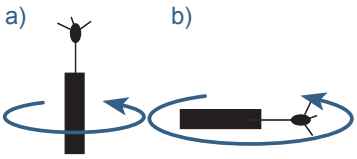
Strong signals have a higher noise immunity and they correlate much better than weak signals do.

For the Vector signal processing, 1 count ≈ 0.4– 0.45dB. The term counts can also be used in other contexts (viz. the analogue inputs) with a different relationship, not related to dB.

Verifying operation with a radio

You can easily check that the Vector is running with a radio. The Vector transmits energy at 6MHz, and a radio will pick up signals at this frequency and at sub-harmonics such as 3MHz, 1500kHz and 750kHz. Both 1500 and 750kHz are inside the AM radio band. Be sure to listen first with the Vector on the bench to choose the best frequency and to learn to identify the Vector's distinctive sounds.

Verifying the Tilt Sensor



Turn canister 180° as shown, to rule out effects from a non-level surface when checking the tilt indicator.

Fig. a) applies to standard units, while Fig. b) applies to units delivered with horizontal tilt.

To verify proper operation of the tilt sensor:

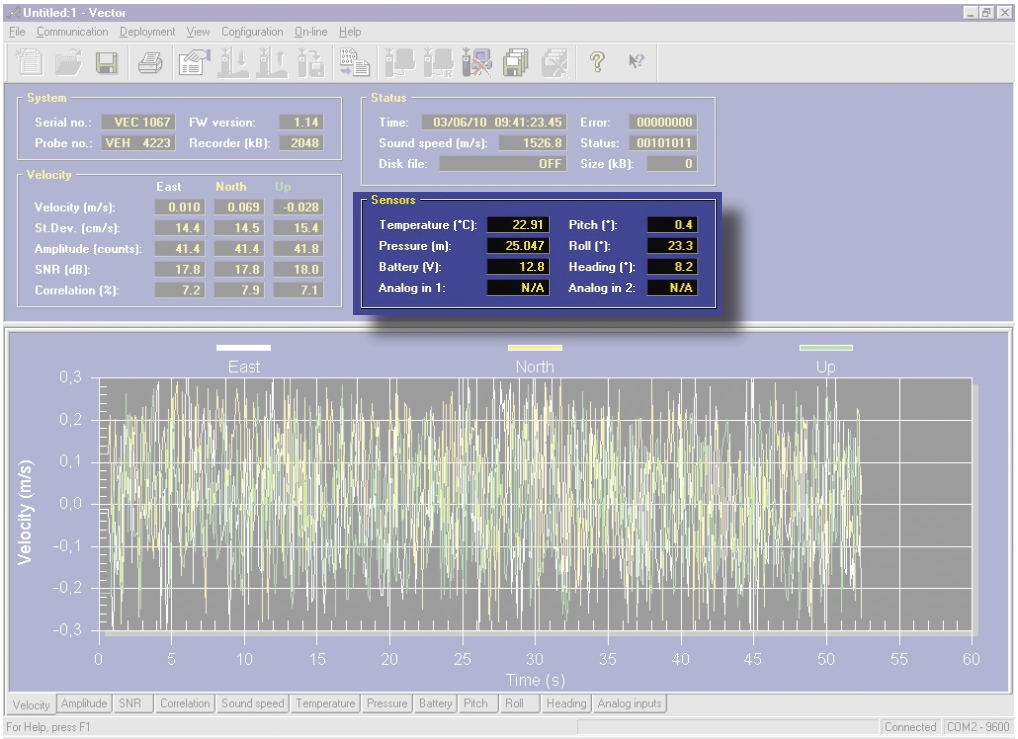
1 If your Vector is a standard unit, make sure the vector canister is in an upright position (like this:). If it has been equipped with horizontal tilt, make sure it lies down (like this:).

2 Watch the pitch and roll, which should be as close to 0° as possible.

3 It may happen that the surface is not completely level. You should therefore turn the canister 180° (in the horizontal plane) to see if any deviations now change their sign (e.g going from + to – or vice versa).

Uncertain about whether your Vector is with vertical or horizontal tilt? If the tilt (pitch and/or roll) as indicated in the Sensors' pane is unrealistically far from 0° when you place the canister (upright or lying down) on a table, your Vector is of the other type.

The Sensors pane contains the tilt, temperature, and pressure data.



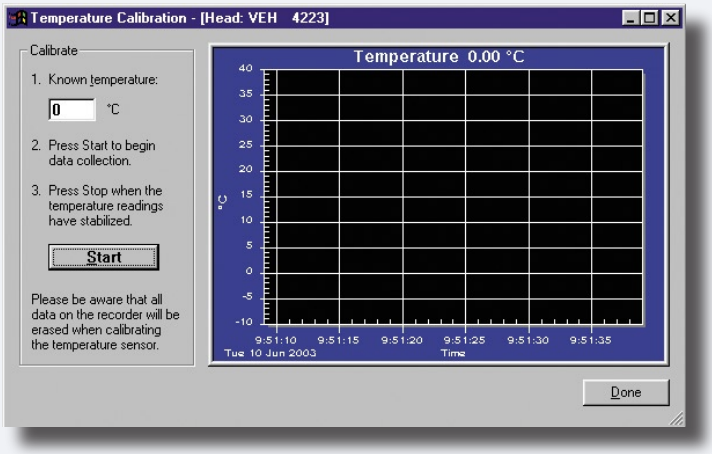
Verifying and Calibrating the Temperature sensor

To verify proper operation of the temperature sensor:

1 Submerge the *canister* in water.

2 Read the temperature. Observe that the temperature sensor's time constant is approximately 5 minutes, so patience may be required here.

3 If you need to calibrate the temperature sensor, click **Online** > **Temperature** calibration and follow the instructions given in the dialogue box.



The **Temperature calibration** dialogue box contains complete instructions on how to calibrate the temperature sensor.

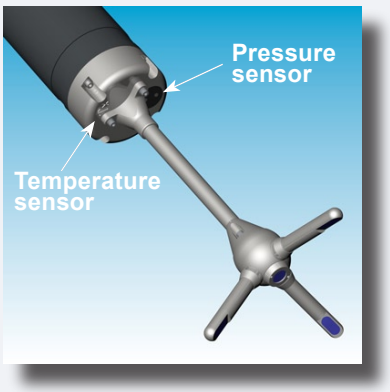
Verifying the Pressure Sensor

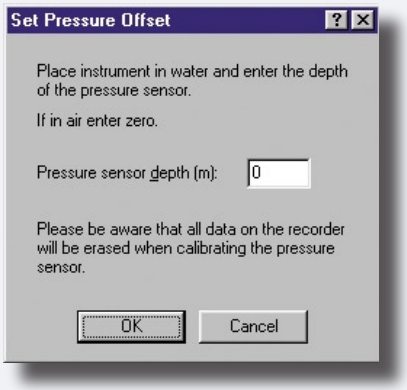
The pressure sensor is located inside the canister as shown in the Fig below. If you submerge the canister so that the end bell is just below the surface, the pressure should be equivalent to 0.6m (the length of the canister).

To change the pressure setting:

1 Click **Online** > **Set pressure offset** to produce the below dialogue box.

2 Follow the on-screen instructions.





Right: Locating the pressure and temperature sensor.

Far right: The **Pressure Offset** dialogue box lets you change the pressure offset setting.

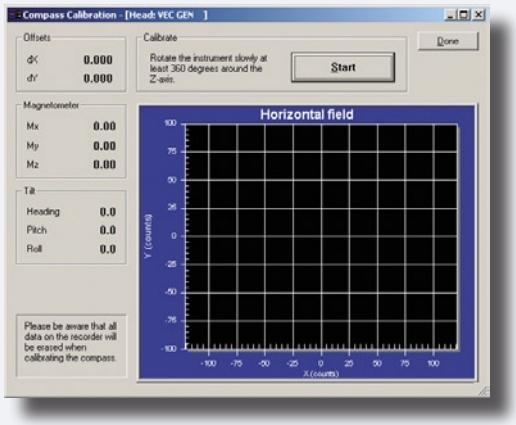
Calibrating the Compass

Once mounted in a frame or near magnetic structures, you'll need to calibrate the compass to ensure that the instrument compensates for the presence of magnetic materials, including the internal battery, if not degaussed.

To calibrate the compass:

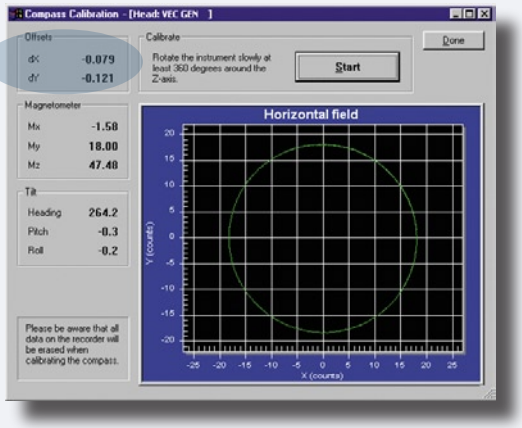
1 Mount the Vector as required for your application.

2 Click **Online** > **Compass Calibration** to produce the below menu.



The Compass calibration submenu contains complete instructions on how to calibrate.

3 Click **Start** and rotate the Vector and the frame 360°. The Vector must be rotated in the same manner as for the tilt sensor verification (see *Verifying the Tilt Sensor* in this chapter for more on this). Any magnetic fields stemming from the mounting frame will now be spotted and compensated for. The display will typically look like shown below:



Example of the Compass calibration submenu after a succesful calibration. The **dX** and **dY** offset values indicate detected origin offset due to extraneous magnetic fields.

Testing the Recorder Function

You can test the recorder with the same setup as above.

To test the recorder function:

1. Start data collection with **Online > Start With Recorder.**
2. Write a name to use for the file you will record internally.
3. After a few minutes retrieving your data, stop the data collection.
4. Retrieve your data by clicking **Deployment** > **Recorder Data Retrieval**.
5. Convert it to ASCII by clicking **Deployment > Data Conversion**.
6. Review the collected data with an ASCII text editor (i.e. Notepad).

Starting with an Empty Memory

To erase the Vector's contents of data:

1. Make sure that you have transferred all the data you want to retain to your computer (if applicable) and that the data is in good shape.
2. Click **Deployment** > **Erase Recorder**.

CHAPTER 5
Setting up for Operation

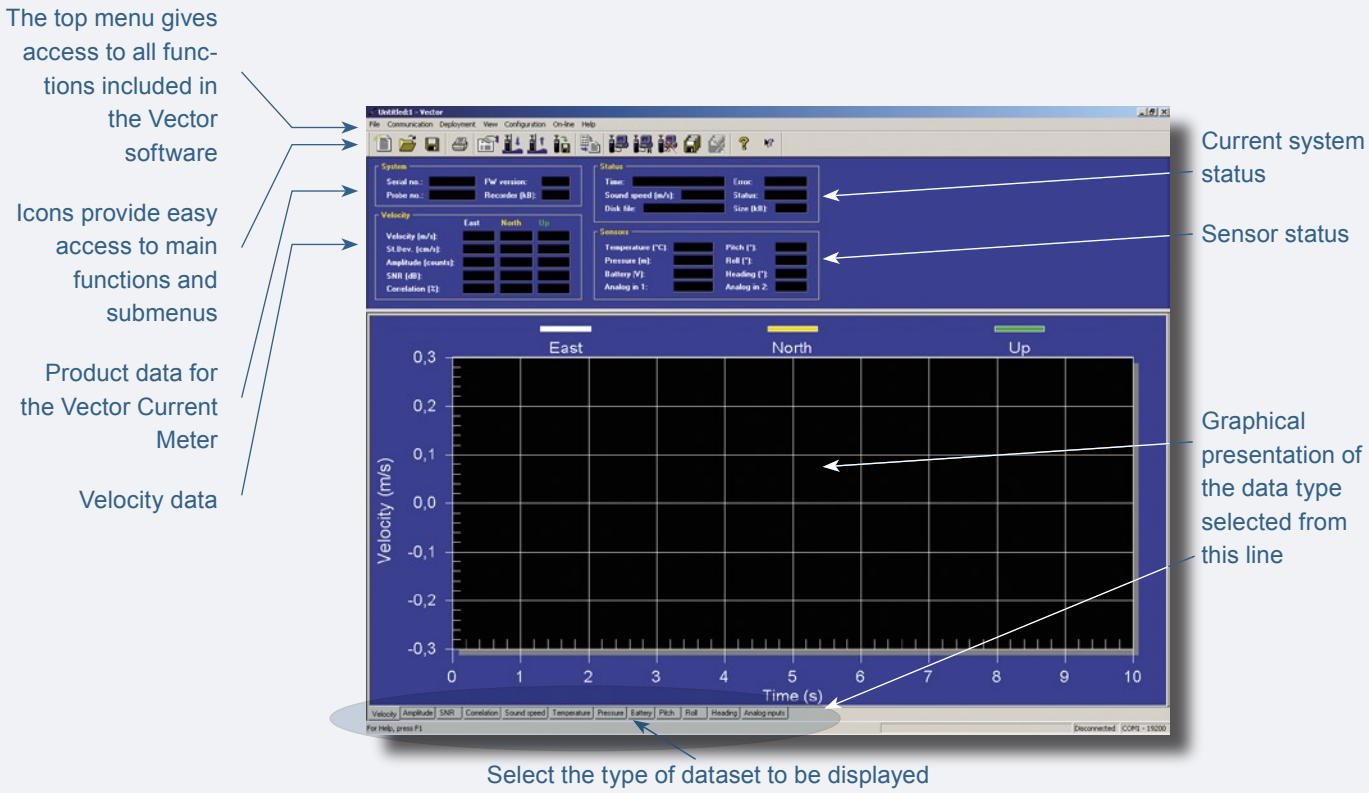
The Vector software program has been designed to aid you in the planning, execution, recovery and processing of autonomous Vector deployments. The software also contains a test section, including all functions required to operate the Vector in real time applications (where the operation and data acquisition is monitored from a computer).

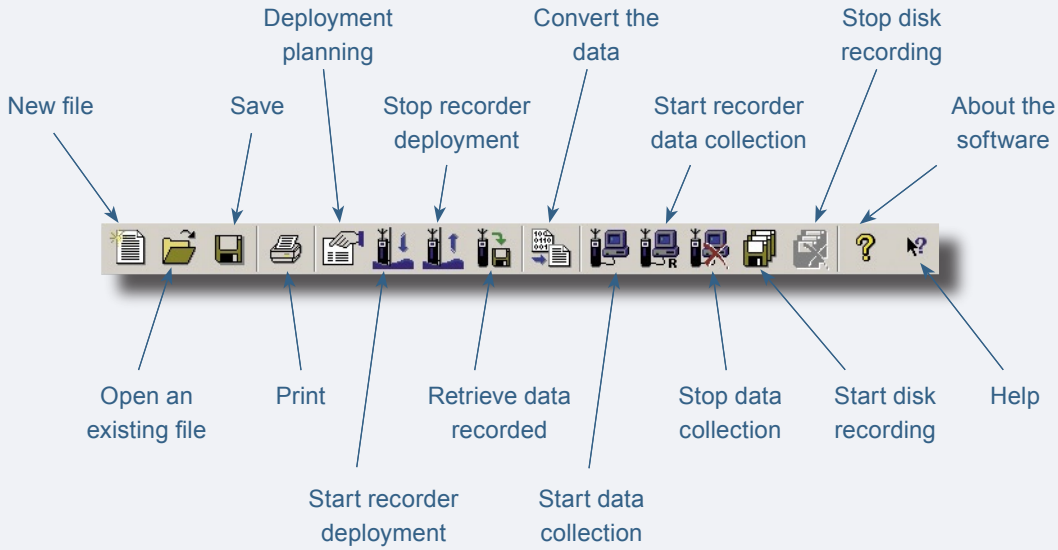
Whether you intend to use the Vector in autonomous or real time monitoring applications, the setup procedure is essentially the same.

Autonomous Deployment vs. Online Monitoring

Although designed primarily for autonomous deployments, the Vector may just as well be used in monitoring applications with online connection to a remote computer. You may then set up the Vector to record a copy of all data acquired to the internal recorder, in addition to have the data transferred to the remote computer. This is called **Recorder Data Collection**, as opposed to just **Data Collection**. The Vector may also be used together with other sensors or with a controller. When used with other Vectors, the Vector may act as *master* (controlling the sampling of the other sensors) or as *slave* (sampling controlled by another Vector). When used with a controller, the controller may serve as an external storage device (if applicable) and it may provide power and sampling control creating a very sophisticated system. All this is treated in detail in *Chapter 9 – Use with Other Instruments*.

The main screen of the Vector software program





Verifying Performance Prior to Actual Deployment

You probably want to verify that your configuration works well and that you are going to record meaningful data *before* you deploy the Vector and leave it on its own. For this you may use the data collection mode.

Do not forget to erase any data recorded by the Vector before the deployment is started, if storage capacity is crucial.

Data Collection – a Recommended Procedure

A discussed in *Autonomous deployment vs. online monitoring* the Vector system allows for both self-recording and real-time data collection (monitoring applications). However, both applications share the same procedure for deployment planning (i.e. instrument configuration).

A typical sequence includes:

1. Install and/or plug in battery pack. See *Installing/Replacing batteries* in *Chapter 11* for details.
2. Install new desiccant, if necessary. See *Replacing desiccant* in *Chapter 11.*
3. Run a compass calibration. See *Calibrating the Compass* in *Chapter 4.*
4. Test Vector as described in *Run a functionality check* in *Chapter 11.*
5. Set the real time clock in your PC (the correct time of day).
6. Use the Vector software to plan the deployment.
   Click **Deployment** > **Planning.**
7. Erase recorder. Click **Deployment** > **Erase Recorder.**
8. Start deployment. Click **Deployment** > **Start Recorder Deployment.**
9. Enter a 6-character deployment name.
10. Set the Vector real time clock to PC time.
11. If appropriate, set a delayed start-up time.
12. Disconnect cable and install dummy plug. Insert plug pins with silicone spray.
13. Verify pinging with an AM radio just prior to deployment (unless, of course, you use a delayed startup time). See *Verifying operation with a radio* in *Chapter 4.*
14. Install on site. Ensure that the acoustic beams point where you want and that they are not obstructed. If you use a cable probe with compass, please remember that the probe and the main housing need to be aligned.

Deployment Planning

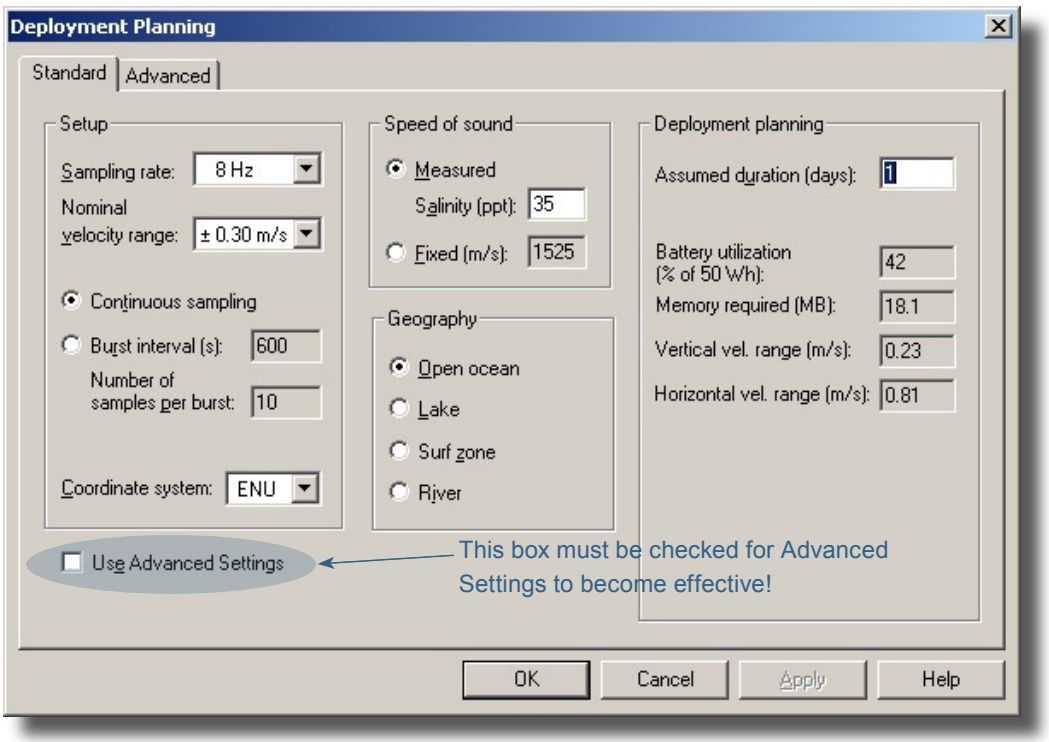
To begin planning a deployment:

- From the main menu, select **Planning** from the **Deployment** pull-down menu or press the **Deployment Planning** icon to produce the deployment planning menu. See the previous page for a presentation of the icons.

  The **Deployment Planning** pull-down menu displays three options that may serve as a starting point for your deployment planning.

The following options are available:

- **Use Existing** lets you start with the previous settings (This selection corresponds to the **Deployment Planning** icon).
- **Load From File** is used to read settings from a deployment (**.dep**) file.
- **Load From Instrument** is used to read settings from the instrument.



The Deployment dialogue box has two levels – Standard and Advanced. The two are accessed by clicking the corresponding tab. This screenshot shows the contents of the Standard tab panes.

The above menu contains all parameters required to specify the operation of the instrument. The **Deployment planning pane** (the right part of the menu) also includes performance information, which is updated automatically as you change the parameter settings. When finished, click **OK** to accept the changes. By using

the **Open/Save** commands in the **File** menu (or by clicking the corresponding icons) the deployment parameters can be saved to file at any given time and re-loaded when it is time to actually deploy the instrument.

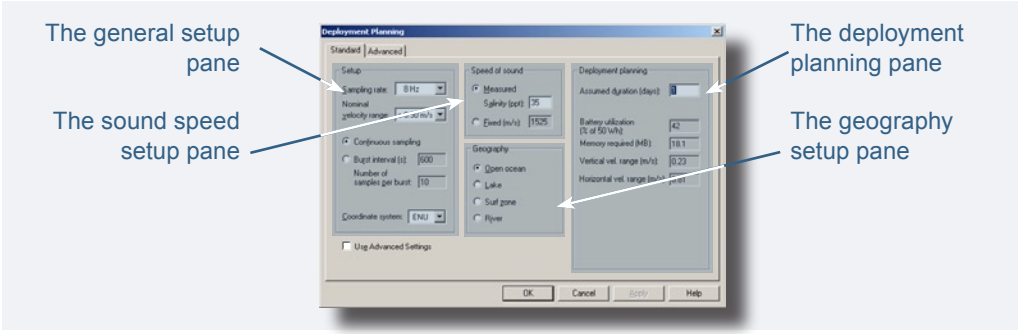
The deployment planning dialogue box allows you to specify the instrument operation at two levels.

To configure the instrument operation settings:

- Use the **Standard** tab to configure the system with default settings for various environments and mounting arrangements.
- Use the **Advanced** tab to fine-tune the operation parameters.

Deployment Details – the Standard Tab

The **Standard** tab of the **Deployment Planning** dialogue box contains the basic setup tools and it has been divided into four panes.



The four panes of the Standard tab part of the deployment setup menu, and the check boxthat must be checked if the advanced settings are to become effective.

The general setup pane:

- **Sampling rate**. Sets the output rate for the velocity, amplitude, correlation, and pressure data. The output rate for all other sensors (temperature, compass, tilt, etc.) is fixed to 1 second.

  This rate is the same as the rate at which data are recorded internally or to disk.

- **Nominal velocity range.** The maximum velocity you expect to measure during the deployment or experiment. This is a nominal velocity range (the actual values are shown in bottom right hand corner of the planning screen). Measurement uncertainty is roughly proportional to the nominal velocity range – smaller velocity ranges give you better measurement uncertainty.

  Typically, sampling at 16Hz will provide data with an uncertainty of 1% of the velocity range.

To minimize noise, the velocity range should be set as low as possible, while you at the same time make sure the actual velocities do not exceed the range set. Please observe that the maximum velocity is not the same for the horizontal and the vertical velocity – see the bottom right hand corner of the display for the exact values.

Note! If the actual velocities exceed the maximum velocity, your data will be impaired and may become unusable.

- **Continuous sampling.** Sets the instrument to collect data continuously, without pause. Only recommended for online applications.

Note! In continuous sampling mode the Vector checks for up/down orientation at the beginning of the sampling interval only.

- **Burst interval/Number of samples per burst.** Sets the instrument to collect a number of samples at the specified sampling rate. The burst interval is the time between each measurement burst. The instrument will go to sleep to conserve power and recorder capacity after each burst. This is the preferred configuration for autonomous deployments.

Note! In burst sampling mode the Vector checks for up/down orientation at the beginning of each burst interval.

- **Coordinate system.** The coordinate system can be selected to **Beam**, **XYZ**, or **ENU**. **Beam** means that the recorded velocity will be in the coordinate system of the acoustic beams. **XYZ** means that the measurements are transformed to a fixed orthogonal XYZ coordinate system of the probe, and **ENU** means that the data are converted to geographic coordinates once per second.

The sound speed setup pane:

- **Speed of sound.** Speed of sound can be set by the user (**Fixed**) or calculated by the instrument based on the measured temperature and a user-input value for salinity (**Measured**). The salinity is 0 for fresh water and typically 35 for the ocean.

The geography setup pane:

- **Geography.** Choose the setting that best fits your deployment. The setting determines the Vector transmit level. The difference between the lowest and the highest setting is approximately 7dB. To see the consequence of the different choices watch the effect on battery utilization.

Tip! Because the surf zone and rivers normally have high backscatter, these choices reduce transmit power (and therefore battery utilization). If you are working in a river or stream, which you know has a low backscatter – select **Lakes** instead.

The deployment planning pane:

- **Assumed duration.** Enter the number of days you would like to collect data. This value, together with the other deployment parameters and the hardware configuration, will be used for calculating the battery utilization and the recorder memory requirements.

  This value has no effect on the actual deployment configuration and the system *will not stop* after the number of days entered here.

The rest of the fields of this pane appear ghosted in the menu to indicate that they are not subject to user inputs. Instead, these fields list performance information calculated by the Vector software based on your inputs.

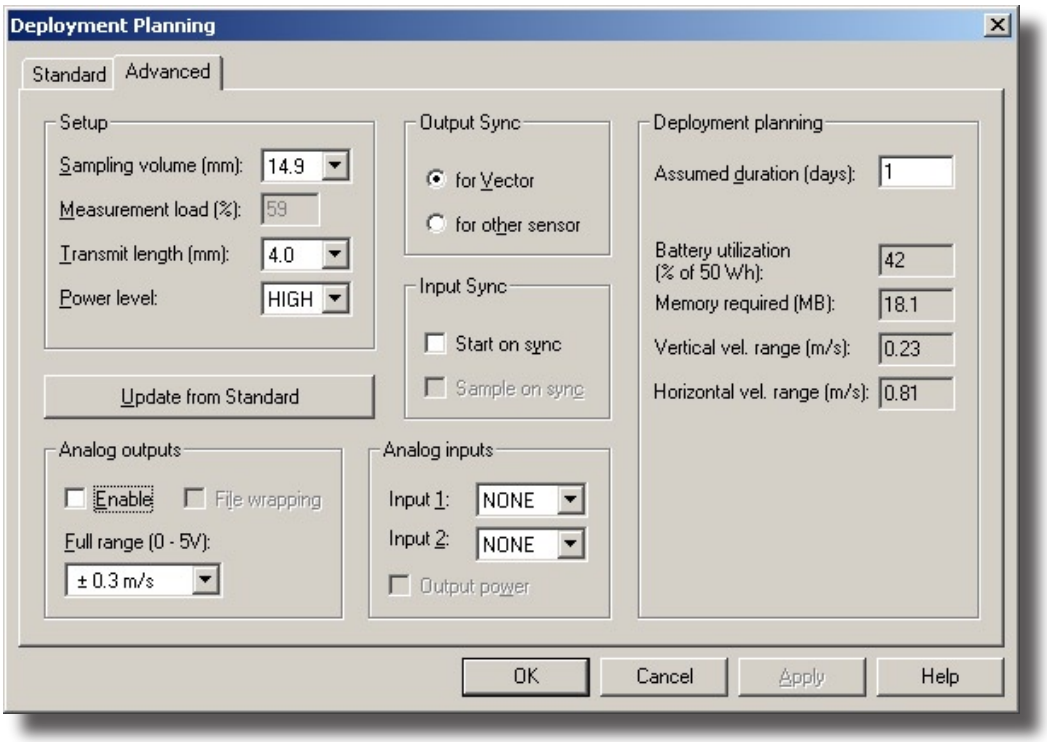
- **Battery utilization.** The expected battery life based upon total battery capacity, current duty cycle, and assumed duration.

Caution! The basis for the battery utilization calculations is an unused (fully charged) 50Wh battery. If you are using a partly deployed battery, the calculated percentage will be incorrect.

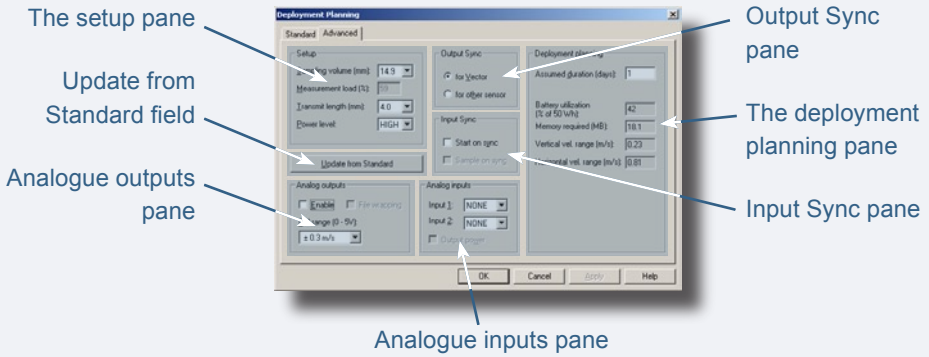
- **Memory required.** The recorder memory required to fulfil the planned deployment as entered by the user configuration parameters and the planned length of the deployment.
- **Vertical/Horizontal velocity range.** A theoretical estimate of the actual velocity range along the vertical axis (along the transmit axis) and in the plane perpendicular to the transmit axis (usually the horizontal plane). The estimates are based on probe geometry and serve to help you set the correct velocity range.

Deployment Details – the Advanced Tab

The **Advanced** tab of the **Deployment Planning** dialogue box lets you fine-tune the setup.



The Advanced tab settings of the Deployment dialogue box.



The six panes of the Advanced tab part of the deployment setup menu, and the *Update from Standard tab* field – see text for details.

Note! The **Use Advanced Settings box** (**Standard** tab) must be checked for the advanced settings to be effective.

Some changes made in the **Standard** tab (like changing the **Geography** setting) will have consequences for the settings in the **Advanced** tab. To make sure these changes are incorporated in the **Advanced** settings, refresh the Advanced settings by pressing the **Update from Standard** button (**Advanced** tab).

The setup pane:

- **Sampling volume.** When reducing the sampling volume size, the total number of samples used for the velocity calculation is reduced. The effect of this reduction is that the precision of the measured velocity is reduced. This is particularly useful close to boundaries because the maximum vertical extent is limited by the acoustical beam geometry.
- **Measurement load.** Within each second, the instrument can either be in active mode (collecting data) or in idle mode (not collecting data). The Measurement load is the relative time spent in active mode within each second and can have value from 0 (no data collection) to 100 (always in active mode).
- **Transmit length.** The effect of increasing the transmit length is that the signal-to-noise ratio is increased. When changing the transmit length the available sampling volumes sizes is also changed. You may reduce the transmit pulse length as a means of reducing the sampling volume and/or get closer to boundaries. You may increase the pulse length to increase the signal strength (and thus the SNR – the Signal-to-Noise-Ratio) in clear water.
- **Power level.** The power level bar sets how much acoustic energy the instrument transmits into the water. The difference between the highest level and the lowest level is about 7dB. Unless you know your environment has high backscatter, you should generally use **HIGH** power.

The analogue outputs pane:

- **Analogue outputs.** When analogue output is enabled, the 3D velocity (or 2D velocity + pressure for the optional version of the Vector) is output as a 0–5 V continuous signal over a separate set of three wires, one for each velocity component. **Full range** specifies the velocity range that will correspond to the full analogue output range.

  The use of analogue outputs requires a special internal harness. Some systems are equipped with this at the time of purchase, but you may purchase the harness separately and have the Vector upgraded.
- **File wrapping.** If checked, data is logged to the internal instrument recorder in ring-buffer mode. This ensures that the recorder always holds the latest data. If not checked, data logging will stop when the recorder is full.

The analogue inputs pane:

- **Analogue inputs.** The instrument can read two analogue inputs at the same time. Select **FAST** to sample data at the same rate as the velocity. Select **SLOW** to sample data at 1Hz. Note that only one SLOW input is allowed. The input range is 0–5V, where 0V equals 0 counts, 5V equals 65 535 counts and 2.5V equals 32 768 counts.

Check the **Output power** box to supply power from the instrument to your external sensor. The voltage output is fixed at the time of production to either 5V, 12V or to the instrument voltage.

The use of analogue inputs requires a special internal harness. Some systems are equipped with this at the time of purchase, but you may purchase the harness separately and have the Vector upgraded.

The deployment planning pane:

- **Deployment planning** is described under the previous section for the **Standard tab**.

The Output Sync pane:

- **Output Sync for Vector** is used when this Vector is to be synchronized with other Vectors – using this Vector as master. See *External Synchronization* in the chapter *Use with Other Instruments* for details.
- **Output Sync for other sensor** is used when the Vector is to be synchronized with other (non-Vector) instrumentation – using the Vector as master. See *External Synchronization* in the chapter *Use with Other Instruments* for details.

The Input Sync pane:

- **Start on Sync** is used when starting this Vector is to be controlled from remote (from another sensor or other external instrumentation). See *External Synchronization* in the *Chapter 9 – Use with Other Instruments* for details.
- **Sample on Sync** is used when this Vector's sampling is to be controlled from remote in addition to the start (from another sensor or other external instrumentation). See *External Synchronization* in *Chapter 9 – Use with Other Instruments* for details.

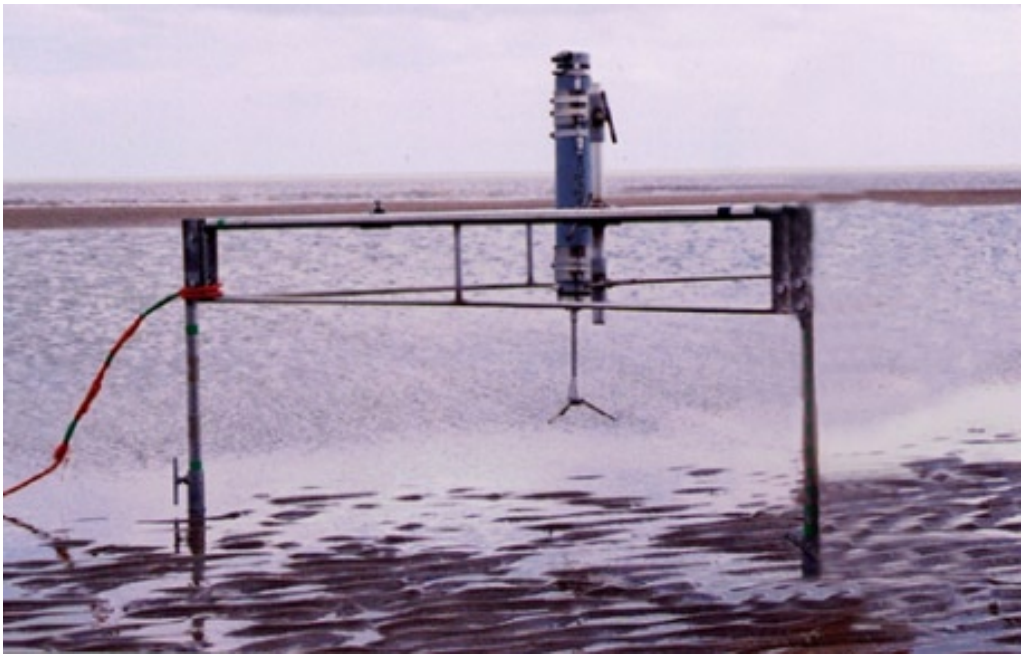
Note! If you leave the Vector collecting data, it will continue running until the batteries are dead. Always make sure to stop data collection when testing is complete. This puts the Vector into command mode and it will then enter into a sleep state (the lowest possible power consumption) after 5 minutes of inactivity.

Starting with an Empty Memory

To erase the Vector's contents of data:

1. If applicable, make sure that you have transferred all the data you want to retain to your computer and that the data is in good shape.
2. Click **Deployment** > **Erase Recorder**.

Mounting guidelines



Tip! Mount the Vector to a fixed structure using a clamp around its pressure case. The fixed probe is not strong enough to serve as the only mounting point!

The following guidelines should be observed:

- When mounting the Vector near large obstructions (bridges, piers, walls, etc.), ensure that there are no obstructions between the sensor and the focal point (sampling volume) located about 15cm from the transducers. Obstructions directly behind the sampling volume may corrupt the data.
- Keep the Vector compass away from magnetic materials. Consider the frame or cable holding the Vector, and the structure it is mounted on. Nearby magnetic materials could cause the compass readings to be in error. If magnetic materials are nearby, the best recommendation is to use XYZ coordinates, as the Vector then does not use the compass.
- Consider the effects of large objects on the flow itself. A rough rule of thumb is that objects disturb the flow as far as 10 diameters away from the object. Flow disturbance is greatest directly downstream in the wake behind the object.
- All acoustic transducers must be submerged during data collection. Operating with the transducers out of water will not cause damage, but your data will be meaningless.

"Weak Spots"

For down-looking Vector probes, the presence of a boundary close to the Vector sampling volume may give rise to problems. This is especially the case if the boundary is hard (rocks, concrete, glass, etc.) and/or the water echo is weak.

For each velocity range, there are one or two distances that give rise to problems. The existence of these *weak spots* can be identified in the data record by a decrease in the correlation and an increase in the velocity variance. This is mostly seen in flumes with a hard bottom but has also been observed in the field, especially at the higher velocity ranges.

The phenomenon is related to the spatial separation between the pulse pairs transmitted by your Vector. To be more precise, it occurs when the first pulse hits the bottom as the second pulse goes through the sampling volume. The position is thus deterministic and can be calculated.

For a standard Vector, the distances from the sampling volume to the boundary that should be avoided are:

Range	"Weak spots"
7 m/s:	2 cm and 4 cm
4 m/s:	3 cm and 6 cm
2 m/s:	5 cm and 9 cm
1 m/s:	8 cm and 20 cm
0.3 m/s:	20 cm
0.1 m/s:	46 cm
0.01 m/s:	312 cm

The distances are approximate and have a vertical extent of about 1 cm.

The problem is less acute at the lower ranges and this – by itself – is a good reason to avoid the higher ranges unless needed. Another way out of the problem is to use side-looking probes; the issue goes away if there are no boundaries in the path of the transmit pulse.

Using Long Cables

RS 232 data communication at 9 600 baud will normally work fine for cables up to 10–50m of length, depending on the environment. If you want to run a longer cable, you can switch to RS 422 by installing an RS 422 harness available from NORTEK.

You can also try using RS 232 with longer cables by reducing the baud rate. Keep in mind that RS 422 is a more reliable means of communication than RS 232 – changing environmental conditions could cause RS 232 communications to fail over a long cable without apparent reason.

Changing the Baud Rate

You may specify two separate baud rates for the Vector. The primary baud rate setting applies to normal communication and data transfer. You can also set a second, separate baud rate for data download and firmware upgrades (the **download/configuration baud rate**). A higher baud rate speeds up large file transfers and is appropriate when you have a short serial cable and a relatively noise-free environment.

The standard baud rate is 9 600, and we recommend that you use this baud rate unless you have a good reason to change it. However, for 64Hz data collection, you will need to use 19 200 baud.

To change the baud rate and make it permanent, do the following:

1. Set up the Vector and connect it to your computer.
2. Set the baud rate in **Communication** > **Serial Port** to the baud rate you prefer. Press Stop Data Collection. The software will change the baud rate and make it permanent.

If you remove power and reapply it, the Vector will re-awake with the new baud rate.

Note! If data download is interrupted, the Vector may be left with a baud rate setting other than the one used for normal communication. When the software tries to establish communication in such cases, it may spend a few moments searching for the correct baud rate to use.

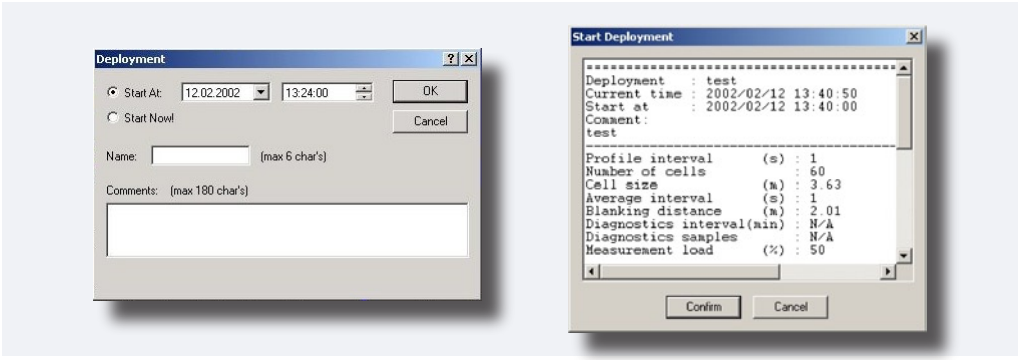
CHAPTER 6
Autonomous Deployments

Before you deploy the Vector you should have gone through the initial preparations, see *Chapter 4 – Initial Preparations* for details on this. You should also go through the *Deployment Planning* described in *Chapter 5 – Setting up for Operation*.

To start an autonomous deployment:

1 Define a new deployment configuration or load a saved configuration from memory. To define a new deployment configuration, see *Chapter 5 –Setting up for Operation* for details.

2 Click **Deployment** > **Start Recorder Deployment**, and enter a short deployment name (used for the internal data file). The program allows you to set the Vector's internal clock (see below), and then gives you a final review of the instrument setup, just before you start it up. The software creates a log file using your deployment name with the setup parameters. You should keep this file in your records.

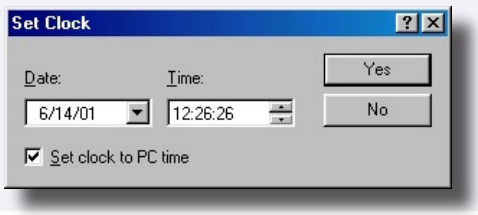


Set the deployment start time by clicking **Deployment** > **Start Recorder Deployment** (right). A log file (far right) is generated using the file name you assigned. We recommend that this file is retained for future reference.

Note! The log file is stored in the folder where you last opened or saved a deployment file, or in the installation folder. We recommend that you always save the deployment file when you deploy the instrument. This makes it easier to keep track of the log file as it then will be stored in the same folder.

Setting the Time and using Delayed Start-up

The software allows you to set the Vector time and a delayed start-up time when you start the deployment. The easiest way to set the Vector time is to make sure the PC time is set correctly before you start the deployment. Important reasons to set the correct time may be to synchronize a group of Vectors or to synchronize a Vector with other sensors. See *Chapter 9 – Use with Other Instruments* for details on synchronization.



Setting the Vector's real time clock.

To set the real time clock of the Vector:

- Click **On-line** > **Set clock** to gain access to the clock setting menu.

Use a delayed start-up either to make sure the Vector starts data collection on the hour or to conserve batteries for a deployment that starts some time in the future. You can start a Vector deployment well in advance of when you plan to install it on site, and use a delayed start-up to conserve the Vector's battery and recording resources for the actual deployment.

Once the deployment time is set, the Vector should be powered at all times. Otherwise, the instrument may loose the clock information.

Stopping the Recorder Deployment

Before you tell the Vector to stop collecting data, you should verify that the computer time is accurate. The software will compare the computer time with the Vector time, and you can use this information to quantify clock drifts.

To stop the recorder deployment:

1. Connect the Vector to your computer,
2. Click **Deployment** > **Stop Recorder Deployment** or click the corresponding icon (the shortcut button).

Once the program tells the Vector to stop collecting data, both the Vector's real time clock and the computer's real time clock will be displayed as well as the difference between the two – as shown to the left. We recommend that you keep a record of the differences.

Note! If the Vector collects data in **wrap mode**, it is important that data collection is stopped as soon as the system is retrieved. Otherwise you risk overwriting good data.

CHAPTER 7
Real Time Monitoring

Before you start the Vector for real time monitoring, you should have gone through *Chapter 4 – Initial Preparations* and *Chapter 5 – Setting up for Operation*.

To start a real time monitoring session:

1 Define a new deployment configuration or load a saved configuration from memory. See *Chapter 5 – Setting up for Operation* for details.

2 Click **Online** > **Disk Filename** and define a root folder in which your acquired data will reside.

The disk files dialogue box allows you to specify a file name for online data recording to disk.

Base Name and Folder. Specify the full path and name of the file you want to use for data recording.

Browse. Displays a file selection dialogue box where you can specify the name of the file you want to use for data recording.

Automatic Filename. This option causes the program to automatically append the current date and time to the selected base name when starting data recording.
Format: basename_YYYYMMDDhhmmss.ext.
Example: mydata_19980115142036.vec

Max Size: Specify the maximum file size in minutes when using automatic file name generation. A new file will be opened for data recording each time the specified interval has elapsed.

3 Click **Online** > **Start Disk Recording**, to ensure that all files generated by the Vector are captured by the computer.

4 Click **Online** > **Start Data collection** to begin the real time monitoring process. If you want the Vector to generate its own copy of the acquired data, click **Online** > **Start with Recorder** instead.

Note! If you fail to click **Start Disk Recording** before you click **Start Data Collection**, no Burst Header Data will be stored on the computer for the first burst (burst mode) or for the entire measurement (continuous mode). However, if you use **Start with Recorder**, the a copy of the Burst Header Data will exist in the Vector itself, and it may be downloaded from there.

Stopping the Online (Real Time) Monitoring

To stop an ongoing real time monitoring:

- Click **Online** > **Stop Data Collection**.

For an overview of data interpretation, turn to the chapter *Getting Data Out of the Vector*.

CHAPTER 8
Retrieving Data from the Vector

Use the Vector software to retrieve data from the instrument.

To retrieve data from the Vector:

1 Click **Deployment** > **Recorder Data Retrieval** or click the shortcut button.

Within a moment, you will see a list of the recorded data files – the most recent file is the last one listed.

2 Highlight the file(s) you want, click **Retrieve** and select the location for the file. The software collects the files you select and transfers them to your hard disk drive.

3 Convert the data into ASCII format by clicking **Deployment** > **Data Conversion** or click the shortcut button.

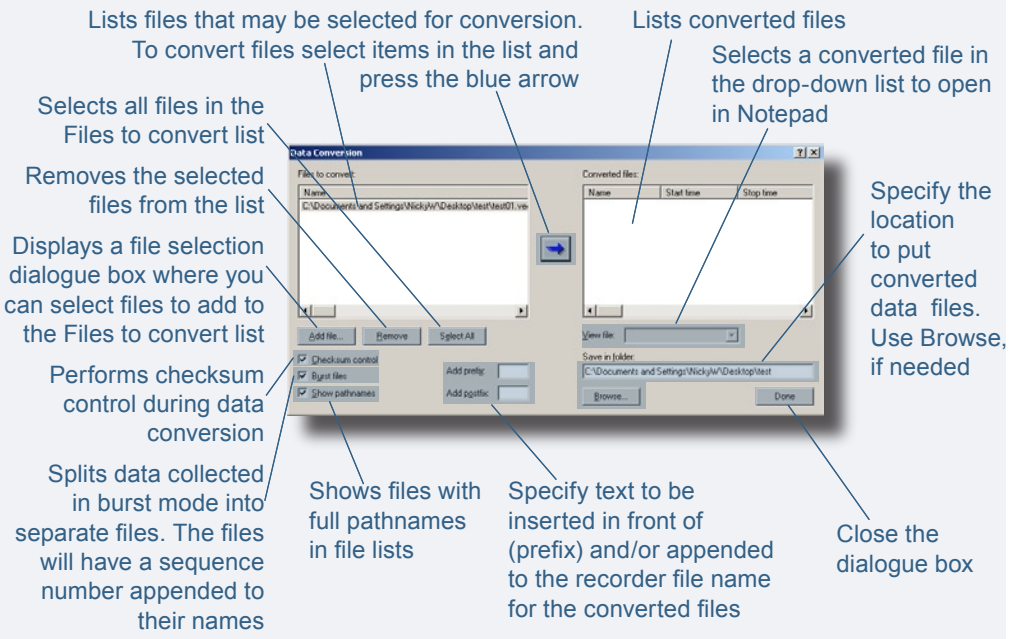
4 The left pane of the dialogue box will now show files qualifying for a conversion. Click on a file to tag it. Repeat for other files, if applicable. Click the blue arrow to transfer the file to the pane containing files to be converted. See overleaf for dialogue box options and details.

5 Once you press the blue arrow another dialogue box will prompt you to specify the type of data files to convert – see overleaf for more.

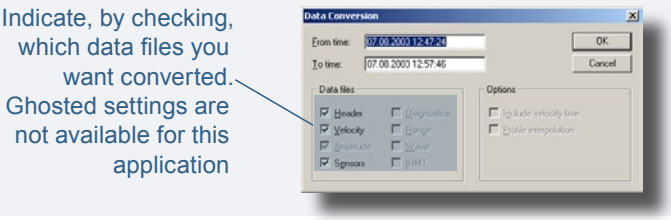
When the conversion is complete, you will find four file types on your hard drive:

- Data file (**.dat**)
- Header data (**.hdr**) including setup parameters
- System data (**.sen**).
- Burst Header data (**.vhd**)

The data conversion dialogue box



Data conversion details



Note for real time monitoring applications! If you failed to click **Start Disk Recording** before you clicked **Start Data Collection**, no Burst Header Data will be stored on the computer for the first burst (burst mode) or for the entire measurement (continuous mode). However, if you used **Start with Recorder**, a copy of the Burst Header Data will exist in the Vector itself, and it may be downloaded from there.

Finalize Operations

To stop data collection:

- Use one of the **Stop** buttons before you put the Vector back on the shelf. Make sure the Vector is not in acquisition mode, as this will consume power from the batteries.

CHAPTER 9
Use with Other Instruments

Your Vector has been designed to be deployed on its own as well as together with other instrumentation. Your Vector may serve as master for other Vectors or sensors, or its sampling may be controlled by other sensors. In addition, you may connect other instruments to the Vector's analogue input and convey their output data through the Vector to a remote computer or record them in the Vector for future download. The Vector is equipped with 2 analogue inputs.

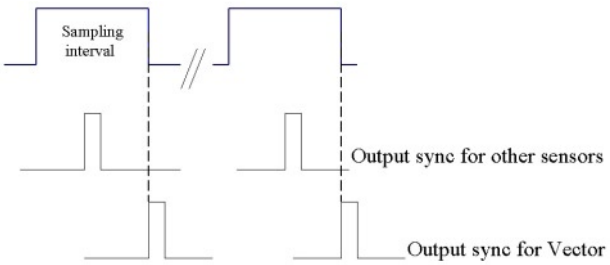
If you connect a controller to the Vector, you may set up a fairly sophisticated system, in which the controller may power the Vector and provide it with sync pulses to control the sampling accurately. The controller may serve as an external storage device or you may rely on the internal storage capacity of the Vector. You may set up the controller to read the serial port or to make use of the analogue outputs of the Vector. What to choose in a given case will depend on the deployment time and the amount of data generated.

Synchronizing with Other Instruments

The Vector can be synchronized with other instruments via the **SyncIn** and **SyncOut**. The synchronization option requires that the correct communication harness is installed in your system and that you have firmware version 1.14 or above, and software version 1.25 or above.

The **SyncOut** signal consists of 1.95 ms long, 3.3V pulses that can be configured for two different schemes of output synchronization. The selection of the type of SyncOut signal is made on the **Advanced** tab in deployment planning. If **Output**

Sync for other sensor is selected, the SyncOut pulse will be output in the middle of each velocity-sampling interval. If **Output Sync for Vector** is used, the SyncOut pulse will be output at the completion of each sampling interval. In addition one SyncOut pulse will be output when the sampling of velocities is started.



The **SyncIn** signal permits external control of the sampling.

Two options are available:

- Initiation of the Vector sampling upon receipt of an input pulse
- Full external control of the data collection rate.

Typically, the other instrument will provide TTL pulses required to trigger the data collection or the signal can be used as a remote switch that allows the operator to start data collection at the push of a button.

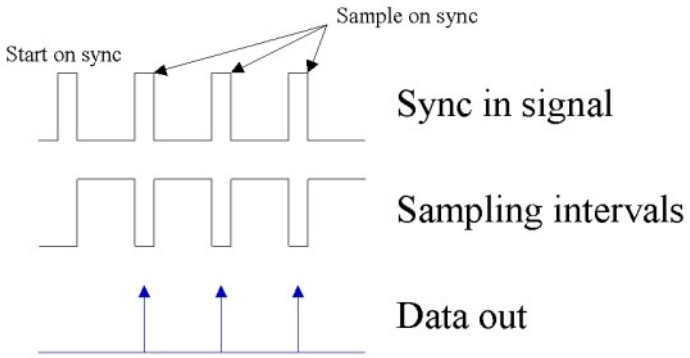
The SyncOut signal is always generated by the Vector. The SyncIn signal is treated differently depending on the settings in the **Advanced** tab in the **Deployment Planning** menu.

There are three possible modes of operation that can be set for *Input Sync:*

- **No Sync.** In this mode, the Vector ignores the SyncIn signal and data collection starts under software control only.
- **Start on Sync.** In this mode, the Vector starts data collection on the rising edge of the SyncIn signal. Sampling of velocities then proceeds at the set sampling rate. After data collection is started the SyncIn is ignored. The first velocity sample is completed one sample interval (which equals 1/SAMPLING RATE) after SyncIn becomes "high".
- **Sample on Sync.** In this mode, the Vector outputs a sample after every rising edge of SyncIn. To use this mode, the Start on Sync mode must be used as well. Therefore, the first rising edge starts the averaging process for the first sample only. The first data sample is output on the second rising edge of SyncIn. The output data at each rising edge of SyncIn will correspond to an average since the previouis rising edge of the SyncIn. The Vector must be configured with the setup software for a sampling rate that is equal to or higher than the sampling rate that will be used. For example, if the signal on the SyncIn input to the Vec-

tor is generated to correspond to a sampling rate of 25Hz, the Vector should be configured in software for a sampling rate of 32Hz.

In most cases it will be sufficient to synchronize different Vectors using Start on Sync. Instruments shipped after November 2000 are fitted with a real time clock with an accuracy of ±1 min/year over a temperature range of 0–40°C. Over a burst period of for example 1 hour, the maximum clock drift between two Vectors will then be 13.7ms. Since they will operate at the same temperature the clock drift is likely to be even smaller. At 8Hz sampling rate this will be ⅒ of a sampling interval over one hour of measurements.



Output of the Vector system data (compass, tilt and temperature) is not synchronized between different Vectors through the use of the SyncIn signal. Instead, the start on the sync edge that is present in both synchronization modes is used to start the 1Hz output of the system data. Each Vector will then output its system data based on its internal real time clock. This implies that the number of system data outputs may vary slightly from one instrument to another. Note that this is not a problem for the synchronization of the velocity measurements. The compass and tilt data are used internally in the Vector to ensure correct transformation of the velocities to earth coordinates when ENU is selected as coordinate system.

In detail, each Vector configured for **Start on Sync** will output system data in a certain order at the start of continuous measurement and at the start of each burst when configured for burst measurements.

The system data are output in the following order:

1. Output header containing noise measurements and date/clock.
2. Output one sample of system data.
3. Wait until external trigger is detected and then start to output system data at a 1Hz rate based on the local clock. Velocity data will be output according to the configured synchronization scheme.

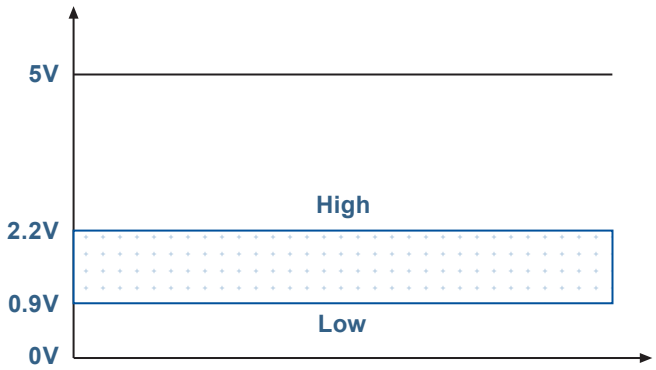
Specifications of Signal Levels

The SyncIn input voltage must be between 0V and 5.0V. The SyncIn is a Schmitt Trigger input with a pulldown resistor of 100kΩ to ground.

The input threshold values for the SyncIn are:

- V_{t+} input positive threshold, 2.2V
- V_{t-} input negative threshold, 0.9V

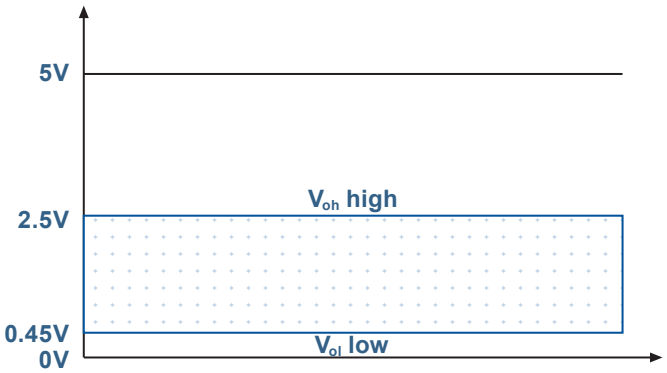
For the SyncIn voltage to be considered as high, it must exceed 2.2V. Similarly, it must be 0.9V or lower to be considered as low.



The output voltage levels for the SyncOut are:

- V_{oh} high level output voltage, min 2.5V
- V_{ol} low level output voltage, max 0.45V

For the SyncOut voltage to be considered as high, it must exceed 2.5V. Similarly, it must be 0.45V or lower to be considered as low.



There is spike protection on both signal ports but there is no filtering on the input port. It is important to consider noise issues (ground-loops, etc) as noise may cause an unwanted start on sync trigger.

Example 1 Running three Vectors with synchronized sampling of velocities in continuous mode.

Connect the SyncOut line from one Vector to the SyncIn line on the two other Vectors. Connect the ground cables together. Choose **Output Sync for Vector** for the first Vector. This will be the master. In the setup for the two other Vectors that will be slaves, check both boxes in the Input Sync (**Start on sync** and **Sample on sync**). With the rest of the setup identical for the three instruments start the two Vector slaves first. When the master Vector then is started, it will trigger the start of the other two Vectors.

Example 2 Running three Vectors with synchronized sampling of velocities in burst mode.

Connect the SyncOut line from one Vector to the SyncIn line on the two other Vectors. Connect the ground cables together. Choose **Output Sync for Vector** for the first Vector. This will be the master. In the setup for the two other Vectors that will be slaves, check both boxes in the Input Sync (**Start on sync** and **Sample on sync**). Use identical setup for the rest of the configuration parameters for all three instruments.

Synchronize the clocks in all the Vectors. Start Recorder Deployment for the master Vector setting the deployment time to the time when you want the instrument to start (for example 4.00.00 p.m. or 16.00.00 – exact time format depends on your computer's settings).

Start Recorder Deployment for the two slave Vectors setting the deployment time to the deployment time of the master Vector minus 10 seconds (in this example 3.59.50 p.m.).

The two slave Vectors will now wake up in each burst 10 seconds ahead of the master Vector. After outputting the burst header and one set of system data they will then wait for the start on sync trigger from the master Vector so that all three instruments will start the data acquisition simultaneously (in this example at 4.00.00 p.m.). The two slaves will then continue taking data at the identical rate of the master Vector as they receive the sample on sync triggers from the master Vector.

The same procedure can of course be used if only synchronized startup is required. The only difference is that the **Sample on sync** box in the Input Sync configuration must be left unchecked.

Example 3 Starting three Vectors simultaneously from another instrument

Connect the SyncIn signals from the three Vectors together with the sync output line from the instrument providing the start on sync signal. Ground all the four instruments together. Using identical and desired setups for the three Vectors, start all of them with the **Start on sync** option configured. Generate the start on sync trigger from the other instrumentation.

Attaching External Sensors

You may connect external sensors to the two analogue inputs of the Vector. They may even be powered from the Vector and their data output may be stored in the Vector during a deployment or downloaded in real time (if the Vector is used in real time monitoring applications).

The following should be observed:

- The input impedance of the analogue inputs is 470kΩ/100nF
- If you want to power the external sensor from the Vector you must check the **Output power** box. The output power is configured in hardware by Nortek and can be *raw* (i.e. battery power), +5V, or +12V.

  To activate powering of the external sensor from the Vector:

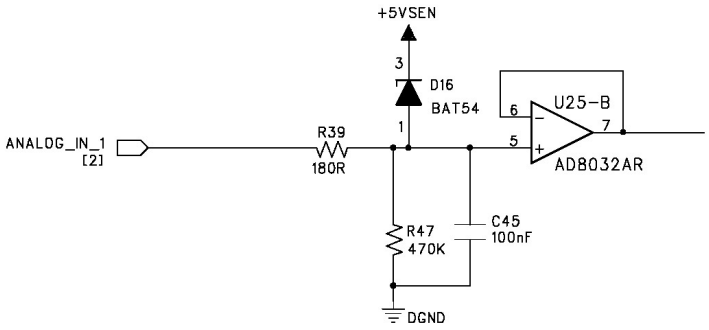
  1. In the Vector software click **Deployment** > **Planning** > **Use existing**.
  2. Click **Use Advanced** and go to the **Advanced** tab.
  3. Define which analogue input (1, 2 or both) to use. **FAST** is used to sample data at the same rate as the Vector itself, while **SLOW** samples once per second. Only one **SLOW** input is permitted.
  4. Check the **Output power** box.

- The data from the external sensor will not be affected by the Vector data quality. For example, the external sensor's data will be totally unaffected even if the Vector is out of water and thus measuring velocity data noise only.
- No powering of the external sensor will take place when the Vector is in sleep mode. This helps reducing the system's power consumption significantly.

  Consequently, the external sensor used must be capable of automatically resuming its duties once the power comes back and it must do this within 1 sec after power up in order to provide correct data for the first sample..

- Our efforts to reduce the system's power consumption includes a non-constant sampling of the external sensor.

  The input section of the Vector's analogue input looks like this:



The Vector's analogue input circuitry – see text for details on functionality

To protect the Vector circuitry against external sensors providing an output voltage in excess of +5.0V, there is a clamping diode on the input with a current limiting resistor in series. The diode will conduct at voltages above approximately 5.3V.

To achieve stable conditions during testing, the +5V_SEN net can be powered up from command mode by sending the hex command **435001C4**.

CHAPTER 10
Troubleshooting

Noisy Data

You may experience that the Vector works as it should, but that there is a lot of noise in the velocity.

Noisy data may be caused by:

- Not enough particles in the water
- The velocity range set too high
- The sampling volume located beyond the bottom (typically if your test bucket is too small)
- Reflection and reverberation conditions at the bottom creating pulse-to-pulse interference between acoustic pulses. Try moving the Vector probe up or down relative to the bottom
- Probe malfunction. Test the probe (**Online > Start Probe check**). If the probe really is malfunctioning, report the probe check result to NORTEK.

My Data Does Not Look Right

The Vector cannot measure velocity properly if the water has too few scatterers. Your data will be questionable when signal levels are down around the noise level (less than 60 counts). For an explanation of the terms *counts*, see *Counts – a Few Words on the term* in the chapter *Initial Preparations*.

Grounding Problems

Tests in laboratory tanks can sometimes lead to grounding problems, which show up as elevated noise levels, but only after the instrument is placed in the water. You will not automatically see the increased noise level in your data if your signal from the water is above the noise, but the increased noise level could look like signal. One way to tell the noise level in the tank is to collect with the transmitter out of the water but the receiver arms in the water.

You may be able to reduce your problems by coiling your power and data cable into a tight bundle and raising the cable above the floor (i.e. placing it on a chair). Also, feel free to call NORTEK for further guidance. Keep in mind that grounding problems occur around man-made structures, but is not normally a problem in the field. Grounding problems disappear when you disconnect the Vector from the computer and from the external power supply. Collecting data to the internal recorder using batteries can be an option to remove possible grounding problems even in indoor environments.

Mooring Tilt

Sometimes moorings tilt excessively or even fall over. If the Vector's tilt reading is 30º or less, your data should be okay. Tilt readings greater than 30º mean that the Vector is no longer able to read the tilt accurately which means that your data may be unrecoverable.

Mooring Vibration

Excessive mooring vibration can adversely affect your data. Vibration introduces spurious velocities and interferes with the proper operation of the tilt sensor. You may be able to detect intervals of excessive vibration by looking closely at your data. If you discover that mooring vibration is a problem, you should try to find ways to reduce the vibration.

Initial Problems? Did You Check This?

Believe us, most initial problems can be traced to problems like:

- You have forgotten to power the system.
- The DB-9 connector has fallen out of the computer.
- You are using the wrong serial port.
- You have forgotten that new Vectors ship with the battery disconnected.
- Computers don't always behave as they should and not all of them have serial ports available. If one computer is giving you a problem, try another one instead.

No Detection of the Vector on the Serial Port

If you cannot connect to the instrument, first try sending a break to the Vector. Send a break by clicking **Communication** > **Terminal emulator**, and then clicking the **Send Break** button. If the Vector is powered and properly connected, and if the terminal is set to use the correct serial port, you will see the Vector's wake-up message.

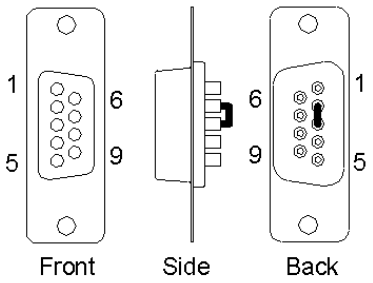
If you see a response consisting of garbled text or strange characters, the Vector and terminal program are probably using different baud rates. Try other baud rates (to autodetect the baud rate use **Online** > **Stop Data Collection** as described in *Changing the Baud Rate* in *Chapter 5*). If you have reason to believe that your computer is having problems, don't hesitate to try a different computer! May we also recommend that you verify your serial port and cable with a *serial loop-back test.*

The serial loop-back test serves to verify that the serial port can receive the same characters as it sends.

To run a serial loop-back test:

1 First, make a loop-back connector and plug it into your serial port.

Make a serial loop-back connector by soldering pins 2 and 3 together, as shown



Now, run the test with the Vector's built-in terminal emulator, and if that doesn't work, try **HyperTerminal** instead (a terminal program that comes with Windows).

2 Type characters – whatever you type should be echoed to the screen. Once you remove the connector, the characters stop echoing back.

To test your interface cable:

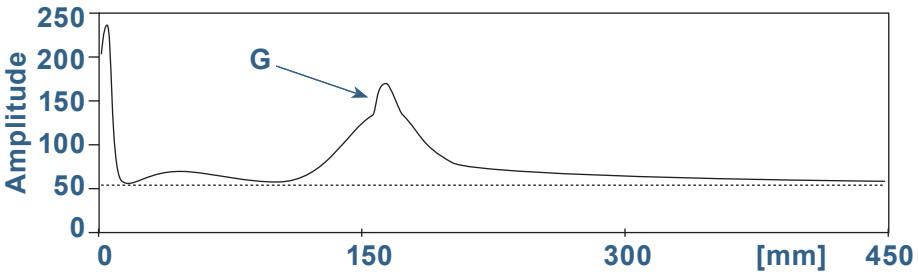
- Plug the cable into the computer and put a loop-back connector on the end of the cable.

  If your serial cable passes the test and you still cannot wake up the instrument, there is a chance that your cable is a null modem cable – if so, it crosses wires 2 and 3. You can test this by substituting a different cable or by using a null-modem adaptor in series with the cable (which crosses the wires 2 and 3 back).

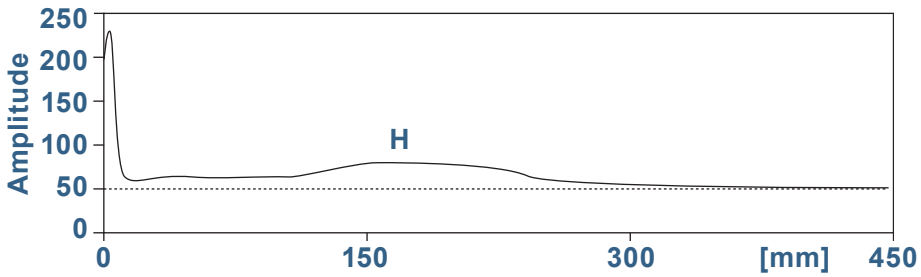
Diagnostic Testing Using the Probe Check Function

The figs below show you Probe Check displays resulting from different problems. All of the following apply for probes in the water, unless otherwise noted.

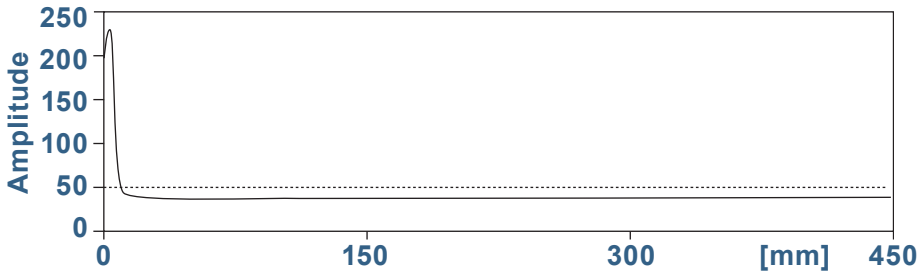
Boundary too close
The leading edge (**G**) of the boundary echo should be no closer than 110 sample counts. If the boundary is close to the sample volume, scrutinize the velocity to make sure it is OK.



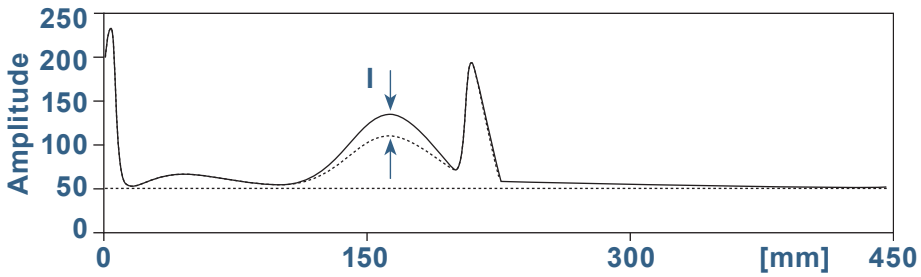
Too little backscatter
The signal level (**H**) should reach at least 70 counts.



Broken probe indicated by flat signal around 40 counts
Return the Vector to the factory!

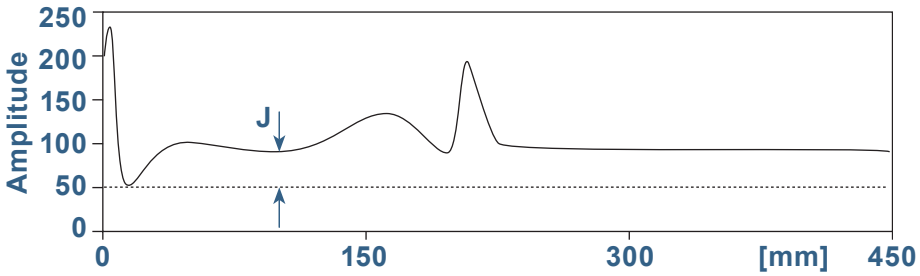


Weak or non-functioning receive transducer
If one receiver differs from the others by more than 20 counts (I), clean the receive transducer and make sure it is not blocked. If this does not rectify the problem, return the Vector to the factory.



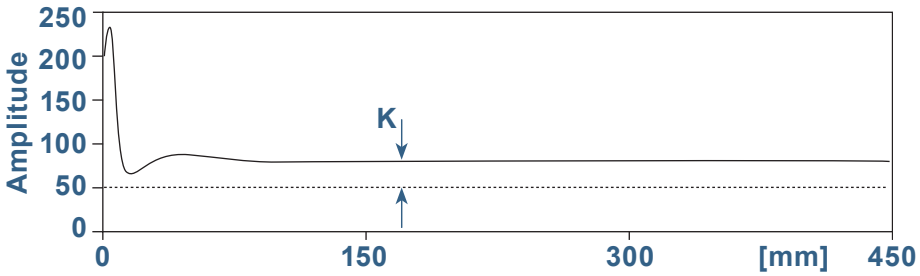
Noise level is too high indicating a possible grounding problem

If the average signal in the area marked (**J**) is more than 80 counts, you may have a grounding problem – see *Grounding Problems* in this chapter of the manual.



Grounding problem

This illustrates a testing of the probe by placing the receivers in water, but leaving the transmitter out of water. The grounding problem in indicated by the signal in region K being above 70 counts – see *Grounding Problems* in this chapter of the manual.



CHAPTER 11
Maintenance

Before you assemble a system that involves custom cables, power supplies or the like, first assemble and test the Vector using just the cables and battery that came with the system. This is the easiest way to get the system up and working, and if you have trouble you can always return to this setup to confirm that problems are not caused by a faulty instrument.

Preventive Maintenance

Preventive maintenance is your primary tool to keep your Vector in shape and ready for action and deployment.

Cleaning

Perform regular cleaning of the Vector Current Meter. Use a mild detergent to clean the Vector. Pay special attention to the transducers.

Check the pressure sensor and remove any dirt in the two front holes. Rinse the area with fresh water.

Replacing the Desiccant

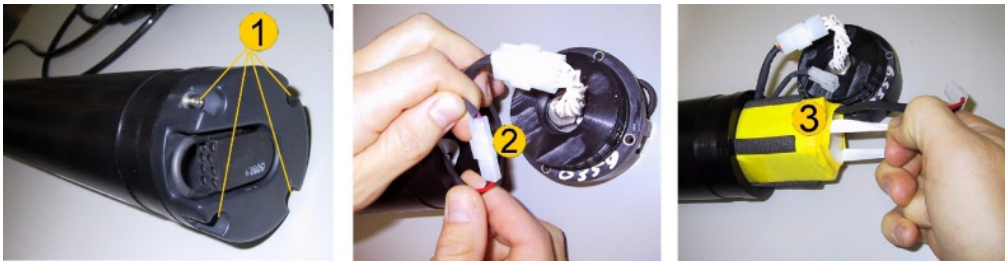
Keep water out of the open pressure case. Both fresh and salt water can corrode the circuitry.

At least once a year, replace the desiccant, which is located behind the internal battery. Refer to the battery installation procedure for detailed information.

Installing and Replacing the Batteries

Batteries should be degaussed before you use them in your instruments – you can do this yourself by placing the padded end of the battery up against the centre of your PC's CRT monitor (it doesn't work with LCD screens) and using the monitor's degaussing function.

Always be sure to include desiccant in the pressure case. Humid air can condense enough water to damage the electrical circuitry.



Replacing the batteries. Always degauss batteries before inserting them – see text for details.

To replace the batteries:

1 Remove the four screws ❶ and washers holding the end cap to the pressure case and remove the pressure case.

2 Disconnect the 2-pin connector ❷ and pull the old battery ❸ out of the pressure case.

3 Slide in a new battery and connect it to the 2-pin connector.

4 Insert the end cap to the pressure case and mount the four screws and washers.

Caution! Take care not to damage the O-ring and the O-ring surfaces!

5 Tighten the screws carefully to avoid damaging the threads in the pressure case. Tighten the screws only until the end-cap touches the pressure case and you can just feel that they are seated. Keep in mind that ocean pressure holds the end cap in tightly – all the screws have to do is to keep the end cap from falling out when the system is above water.

6 Test communication with the Vector's built-in terminal emulator program by sending a 'break' command to the instrument. If it is wired correctly then you should see the Vector's wake-up message on the screen (it will give you the model of your instrument plus the firmware version number). If you get a string of garbage characters try another baud rate setting.

7 When the instrument responds to a 'break' properly, the communication lines are correctly connected. An easy alternative to using the terminal emulator is to read the configuration file directly from the instrument (**Deployment** >

Planning > **Load from file…**). If the instrument is set for a different baud rate than the software expects, the software will search for the correct baud rate and connect automatically.

8 Test the instrument by collecting data without using an external power source to ensure that the battery is properly connected. Make sure to stop data collection so that the instrument will power down after you are through testing it.

9 Check and/or reset the clock if necessary.

10 Because the battery pack uses standard alkaline batteries, you do not normally need to observe any special precautions when you dispose of old batteries.

Caution! Lithium batteries require that you take care and disposal of such batteries requires special precautions and/or procedures. If your Vector has been equipped with lithium batteries, make sure you comply with local legislation when disposing them.

Corrective Maintenance

Only qualified personnel are allowed to perform corrective maintenance activities. Please refer to the separate service manual or contact NORTEK for further assistance.

Appendix 1
Optional Issues

Optional products available for the Vector from Nortek include the ExploreV data analysis software and ActiveX® components.

The ExploreV Software

The ExploreV data analysis software has been developed to ease and improve the Vector data analysis. The program comes in two flavours; The LITE and the PRO versions.

The following functions are covered:

- Display of all the Vector velocity data and pressure
- Creation of data plots and the ability to print them out
- Velocity data filtering
- Histogram plotting
- Calculation of velocity autocorrelation and spectra (PRO version only)
- Calculation of velocity cross spectra (PRO version only)
- Quadrant analysis (PRO version only)
- Assignment of data files to grid points that can be plotted (PRO version only)

For further information contact Nortek.

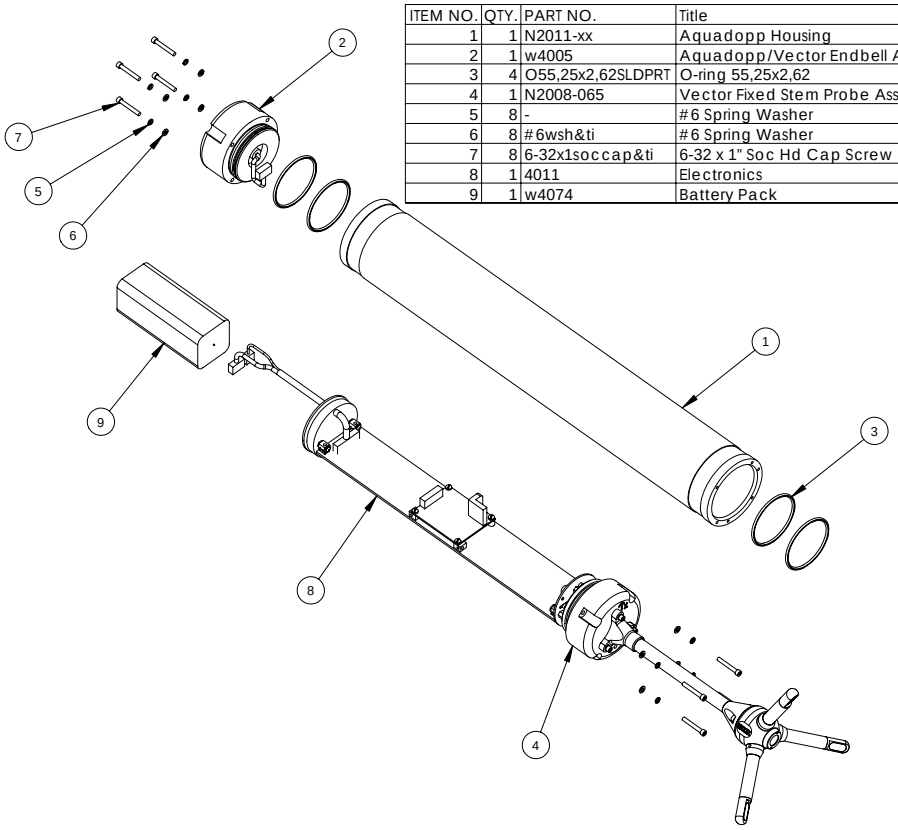
ActiveX® Components

If you want to create your own real time software to control and operate the Vector, you will find our ActiveX® control modules attractive. These software modules give you full control over the Vector and its data structures, and will greatly simplify your software development job.

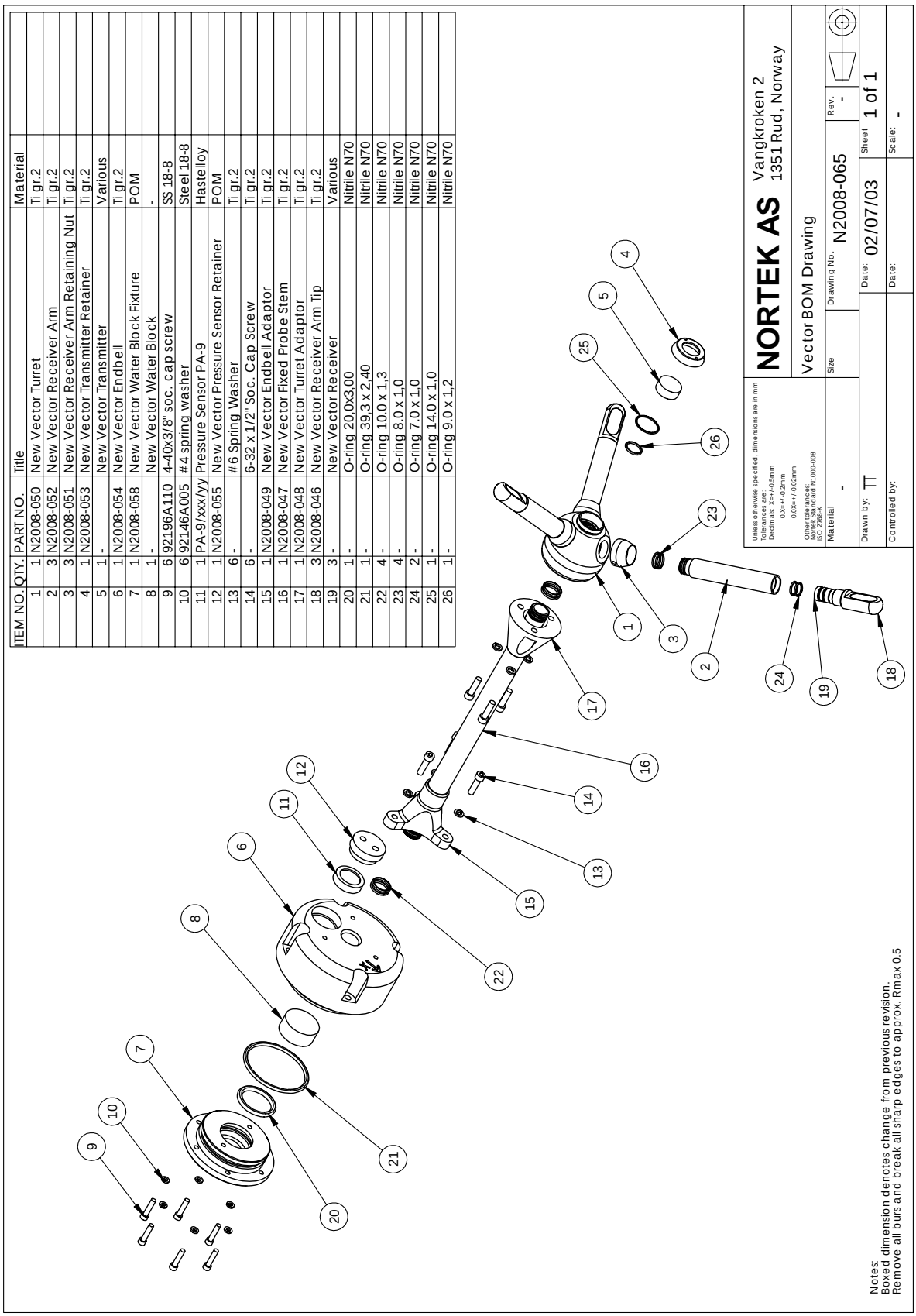
They are easily integrated into Windows® based software, and – best of all – they may be obtained *free of charge* directly from Nortek AS.

Appendix 2
Spare Parts

Below and to the right you will find drawings and spare parts lists applying to the Vector. Always refer to the spare part numbers (whenever applicable) when ordering spare parts from NORTEK.



ITEM NO.	QTY.	PART NO.	Title	Material
1	1	N2011-xx	Aquadopp Housing	POM
2	1	w4005	Aquadopp/Vector Endbell Assy.	-
3	4	O55,25x2,62SLDPRT	O-ring 55,25x2,62	Nitrile N70
4	1	N2008-065	Vector Fixed Stem Probe Assy.	-
5	8	-	#6 Spring Washer	Ti gr.2
6	8	#6wsh&ti	#6 Spring Washer	Ti gr.2
7	8	6-32x1soccap&ti	6-32 x 1" Soc Hd Cap Screw	Ti gr.2
8	1	4011	Electronics	-
9	1	w4074	Battery Pack	-



ITEM NO.	QTY.	PART NO.	Title	Material
1	1	N2008-050	New Vector Turret	Ti gr.2
2	3	N2008-052	New Vector Receiver Arm	Ti gr.2
3	3	N2008-051	New Vector Receiver Arm Retaining Nut	Ti gr.2
4	1	N2008-053	New Vector Transmitter Retainer	Ti gr.2
5	1	-	New Vector Transmitter	Various
6	1	N2008-054	New Vector Endbell	Ti gr.2
7	1	N2008-058	New Vector Water Block Fixture	POM
8	1	-	New Vector Water Block	-
9	6	92196A110	4-40x3/8" soc. cap screw	SS 18-8
10	6	92146A005	#4 spring washer	Steel 18-8
11	1	PA-9/xxx/yy	Pressure Sensor PA-9	Hastelloy
12	1	N2008-055	New Vector Pressure Sensor Retainer	POM
13	6	-	#6 Spring Washer	Ti gr.2
14	6	-	6-32 x 1/2" Soc. Cap Screw	Ti gr.2
15	1	N2008-049	New Vector Endbell Adaptor	Ti gr.2
16	1	N2008-047	New Vector Fixed Probe Stem	Ti gr.2
17	1	N2008-048	New Vector Turret Adaptor	Ti gr.2
18	3	N2008-046	New Vector Receiver Arm Tip	Ti gr.2
19	3	-	New Vector Receiver	Various
20	1	-	O-ring 20,0x3,00	Nitrile N70
21	1	-	O-ring 39,3 x 2,40	Nitrile N70
22	4	-	O-ring 10.0 x 1,3	Nitrile N70
23	4	-	O-ring 8.0 x 1,0	Nitrile N70
24	2	-	O-ring 7.0 x 1,0	Nitrile N70
25	1	-	O-ring 14.0 x 1,0	Nitrile N70
26	1	-	O-ring 9.0 x 1,2	Nitrile N70

Unless otherwise specified, dimensions are in mm
Tolerances are:
Decimals: X=+/-0.5mm
0.X=+/-0.2mm
0.0X=+/-0.02mm
Other tolerances:
Nortek Standard N1000-008
ISO 2768-f

NORTEK AS Vangkroken 2 1351 Rud, Norway

Vector BOM Drawing

Material	Size	Drawing No.	Rev.
-		N2008-065	-

Drawn by: TT Date: 02/07/03 Sheet 1 of 1

Controled by: Date: Scale: -

Notes:
Boxed dimension denotes change from previous revision.
Remove all burs and break all sharp edges to approx. Rmax 0.5

Appendix 3
Returning Vector for Repair

Before any product is returned for repair you must have obtained a Return Merchandise Authorization (RMA) in writing from Nortek AS.

Copy the Proforma Invoice template or make your own, but be sure to include all the information requested in the Proforma invoice.

Also, be sure to include a copy of all shipping and export documents inside the freight box.

Important! Freight insurance on repairs is *not* covered by Nortek AS. You must make sure your goods are properly insured before shipment. Nortek AS is by no means liable if the instrument is damaged or disappear while being shipped to Nortek AS for repair. Likewise, Nortek AS is not liable for consequential damages as a result of instruments becoming damaged or disappearing while being shipped to Nortek AS for repair.

Nortek AS will insure the instrument upon returning the goods to you and invoice you for this, along with the repair- and freight costs.

If the instrument is under warranty repair, the transport and freight insurance from Nortek AS to you will be covered by Nortek AS.

Proforma Invoice

To fill in form, select the hand tool and position cursor in a textbox. Use Tab or mouse to move between boxes. When ready click OK, print out the form, sign it and send it with the returned mechandise. Press reset to start all over again.

SENDER (Exporter)	
Name:	
Address:	
City:	
Country:	
Tel.:	
Fax:	
Ref.:	

RECEIVER	
Name:	Nortek AS
Address:	Vangkroken 2
City:	NO-1351 Rud
Country:	Norway
Tel.:	+47 67174500
Fax:	+47 67136770
E-mail:	inquiry@nortek.no
Contact:	Jonas Røstad

About the Goods

Date:

No. of Units: **Weight:**

Delivery Terms:

Customs Account No.: 28605-56

Description of Goods:

Origin: NO **Value:**

Total Value:

Nortek RMA No:

Reason for Export:

Date:

Exporter's signature

Reset OK

Nortek AS, Vangkroken 2, NO-1351 Rud, Norway. Tel +47 67 17 45 00. Fax +47 67 13 67 70. inquiry@nortek.no. www.nortek-as.com