NORTEK AS

VECTRINO
VELOCIMETER

USER GUIDE
OCTOBER 2004
Rev. C

VECTRINO
VELOCIMETER

Software updates and technical support

Find us on the world wide web:

www.nortek-as.com, www.nortek.no

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:

inquiry@nortek.no

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

Nortek Forum Support

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:

Nortek AS
Vangkroken 2
NO-1351 RUD, Norway
Phone: +47 6717 4500, Fax: +47 6713 6770
e-mail: inquiry@nortek.no

OVERVIEW
What's in this Manual?

Chapter 1 – Getting Started

Here we introduce you to the Vectrino 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 Vectrino'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 start using your Vectrino.

Chapter 5 – Setting up for Operation

Here you'll find a description of the controlling software as well as mounting guidelines.

Chapter 6 – Use with other instruments

The Vectrino may be used with other Vectrinos, as a master (controlling the sampling), or as a slave (having the sampling controlled from the outside). This chapter describes what to consider when setting up a multisensor system.

Appendices

Appendix 1 – Troubleshooting Does your data look different from what you expect? This chapter provides some answers to why they do..

Appendix 2 – Spare Parts Here you'll find contains tips on how to keep your Vectrino in good condition throughout its life..

Appendix 3 – Returning the Vectrino for Repair. In the unlikely event of the need for a return for repair – the procedure to follow is given here.

DETAILS
The Table of Contents

CHAPTER 1
Getting Started

Thank you for purchasing a Nortek Vectrino Velocimeter! The Vectrino has been designed to provide you with many years of safe, reliable service.

Your approach to the Vectrino documentation depends on what you want to do and how much you already know. Depending on your requirements you may find that you use some parts of this manual regularly and others not at all.

However, before you start to use the system we do recommend that you look through this user manual.

To get you up and running:

- Before you start using the Vectrino, please familiarize yourself with the instrument by reading the chapters 2 and 3 of this user guide.

- Verify that you have received all parts and run a functional test of the Vectrino according to the procedures given in chapter 4.

- Start using the Vectrino according to procedures in chapter 5.

Warranty

In order to stay up-to-date and receive news and tips from the factory you should register at our web site. Use the Internet and go to http://www.nortek-as.com/newsletter.php. Enter your name, e-mail address and topics of interest.

We also recommend our User Forum where you may post questions and discuss with other people in the oceanographic community. To get to the User Forum enter http://www.nortek-as.com and click on Forum. If you have no internet access or, if you – for any other reason – prefer traditional mail or telefax, you may fill in and return the registration part of the warranty sheet accompanying your Nortek product.

Nortek AS grants a one year limited warranty that extends to all parts and labour and covers any malfunction that is due to poor workmanship or due to errors in the manufacturing process. The warranty does not cover shortcomings that are due to design, nor does it cover any form of consequential damages as a result of errors in the measurements.

In the unlikely event of trouble with your Nortek product, first try to identify the problem by consulting the documentation accompanying your Nortek product. If you need further assistance when trying to identify the problem, please contact your local Nortek representative or the factory.

Please make sure you receive a Return Merchandise Authorization (RMA) *before* any product or module is returned. An RMA can be obtained using our e-mail address: inquiry@nortek.no or our Fax No.: +47 67 13 6770. See also *Appendix 3*.

CHAPTER 2
Main Data

The Vectrino Velocimeter measures water speed 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 Vectrino uses the Doppler effect to measure current velocity by transmitting a short pulse of sound, listening to its echo and measuring the change in pitch or frequency of the echo.

The Vectrino velocimeter operating principle. A pulse is transmitted from the centre transducer, and the doppler shift introduced by the reflections from particles suspended in the water, is picked up by the 4 receivers.

Sampling volume

Specifications

WATER VELOCITY MEASUREMENT
Range: ±0.01, 0.1, 0.3, 1, 2, 4m/s (software selectable)
Accuracy: ±0.5% of measured value ±1mm/s
Sampling rate (output) 1–25Hz, 1–200Hz (Vectrino+ firmware only)
Internal sampling rate: 200–5000Hz

SAMPLING VOLUME
Distance from probe: 0.05m
Diameter: 6mm
Height (user selectable): 3–15mm

DOPPLER UNCERTAINTY (noise)
Typ. uncertainty at 25Hz: 1% of velocity range

ECHO INTENSITY
Acoustic frequency: 10MHz
Resolution: 0.45dB
Dynamic range: 60dB

SENSORS
Temperature (thermistor embedded in probe)
Range: –4ºC to 40ºC.
Accuracy/Resolution: 1ºC / 0.1ºC.
Time response: 5min

DATA COMMUNICATION
I/O: RS-232
Baud rate: 300–115200
User control: Handled via Vectrino WIN32® software, ActiveX function calls, or direct commands
Analogue outputs: 3 channels standard, one for each velocity component. Output range is 0–5V, scaling is user selectable
Synchronization: SynchIn and SynchOut

SOFTWARE (Vectrino)
Operating system: Windows®98, Windows NT® 4.0, Windows®2000, Windows®XP
Functions: Instrument configuration, data collection, data storage. Probe test modes.

POWER
DC Input: 12–48VDC
Peak current: 2.5A at 12VDC (user selectable)
Max consumption @ 200Hz: 1.5W

CONNECTORS
Bulkhead: IP68 connector or MCBH-12-FS, bronze (Impulse), (see also Options below)
Cable: IP68 or PMCIL-12-MP (see also Options below)

MATERIALS
Standard model: Delrin housing. Stainless steel (316) – probe and screws

ENVIRONMENTAL
Operating temperature: –5ºC to 45ºC
Storage temperature: –15ºC to 60ºC
Shock and vibration: IEC 721-3-2

DIMENSIONS
Cylinder: 70 mm
Length: 388 mm.

OPTIONS
• Standard or Vectrino+ firmware (upgrade to Vectrino+ firmware is also available as retrofit)
• 4-beam down-looking probe on 40-cm stem
  or 4-beam probe on 1-m cable
• Upgrade kit from NDV or ADV™
• 12-pin IP68 waterproof (1h@20m)
  or Impulse 12-pin underwater connector
• 10, 20, 30 or 50 m cable with choice of connectors (IP68 or Impulse underwater connector)
• RS-232-to-USB converter (one-to-one, four-to-one or eight-to-one)
• Combined transportation and storage case

CHAPTER 3
Technical Description

Vectrino Components

Rigid stem shown, cable probe available

POM (Delrin) instrument housing and endcaps

Recesses for clamping

Integrated shape zinc anode

Underwater mateable connector shown
Low cost lab-type connector available

Miniature 4-beam stainless steel probe with temperature sensor
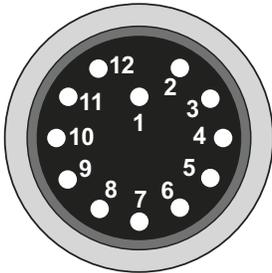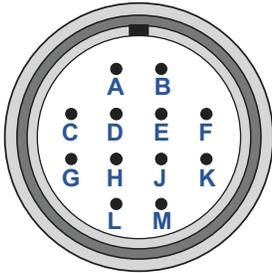5cm distance to sampling volume
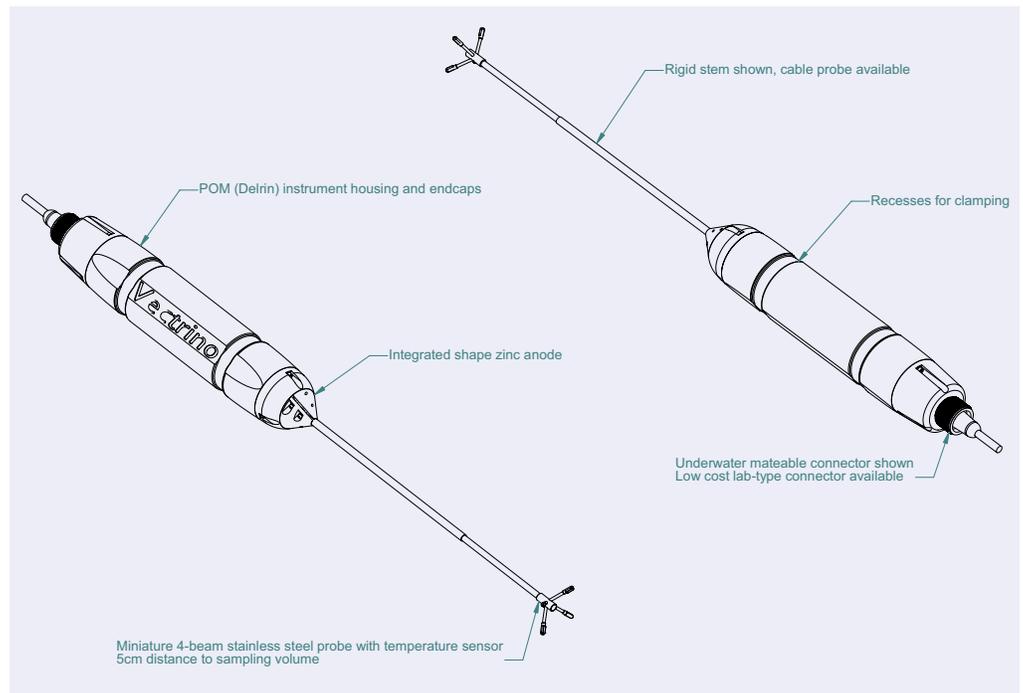
Probe with Transducers

The probe is mounted either on a fixed stem connected to the main housing through the probe end bell or a cable connected to the main housing through the same probe end bell.

The probe consists of four receive transducers, each mounted inside a *receiver arm*, and a transmit transducer in the centre. The transducers are each covered with a hard epoxy and the probe is otherwise titanium.

External view

End bell with connector

Temperature Sensors

The temperature sensor is located inside the probe head.

Electronics Module

The electronics module is located inside the pressure case, and is a single board that holds the power transmitter, analogue and digital signal processing, power conditioning and the standard data recorder.

IP68 connector
(external view)

Impulse connector
(external view)

Power & Communication Cable

The power and communication cable is connected to the end bell connector. The cable supplies external DC power (12–48V), connects an external computer to the Vectrino for 2-way serial communication, for analogue output of the three velocity components, and furthermore it provides synchronization options (Vectrino can be used both as master and as slave to synchronize measurements with other Vectrinos and/or other transducers).

Cable Wiring. The Vectrino comes standard with a 12-conductor connector and cable. The connector type is either IP68 connector or MCBH-12-FS, bronze (Impulse). The Vectrino power lines are diode protected, so you don't have to worry about wiring the Vectrino power backwards – this will not damage your instrument. The pin-out is shown in the side bar.

Pin No.		Function
1	A	Analogue out 1
2	B	Analogue out 2
3	C	Analogue out 3
4	D	Analogue out 4
5	E	Gnd
6	F	SynchIn
7	G	SynchOut
8	H	Gnd
9	J	Tx
10	K	Rx
11	L	Gnd (Power –)
12	M	Power + (12–48V)

The two connectors available for the Vectrino and the corresponding pin-outs.

Functional Description

This section briefly describes some of the underlying principles that control the operation and application of the Vectrino Velocimeter.

The Vectrino has two modes of operation:

- **Command mode.** A Vectrino in command mode is ready to accept your instructions.

- **Data Acquisition Mode.** The Vectrino enters data acquisition mode when you click any of the **Start** commands (e.g. **Start Data Collection**) in the Vectrino software. The Vectrino collects data without breaks.

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 Vectrino 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.

Vectrino Sonar Principles

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

The figure below shows how the beams intersect each other 50 mm 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 3–15 mm vertically (user adjustable), and the receivers listen to an echo that corresponds from this volume. The diameter of the volume is 6 mm. The Vectrino uses four receivers, all focused on the same volume, to obtain the three velocity components from that very volume.

The beams intersect at approximately 50 mm from the transmitter. The exact position varies from one Vectrino to another, but all Vectrinos are individually measured and calibrated before leaving the factory. This exact position is then stored in each Vectrino's head configuration file. The Vectrino uses four receivers – all focused on the same volume – to obtain the three velocity components. See also the text for more on this.

Approximately 50 mm · 3–15 mm (user adjustable)
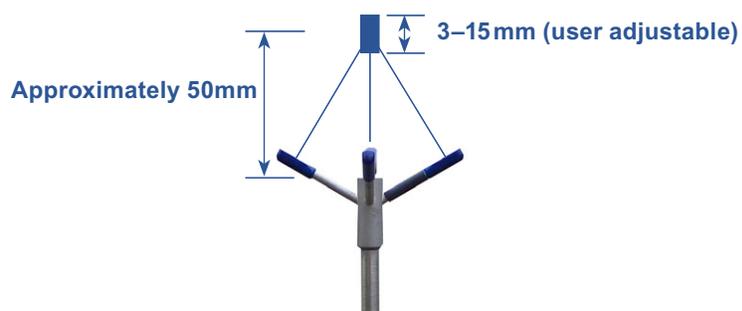
The figure below shows that a transmit/receive beam pair is sensitive to velocity in the direction of the angular bisector between the beams. The arrow indicates a positive velocity.

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 Vectrino 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 Vectrino measures velocity components parallel to its three beams, or in beam components. It reports data in Beam or XYZ coordinate systems.

Defining the XYZ coordinates. The arm with the marking defines the X-direction. The Z-direction is towards the elctronics of the Vectrino.
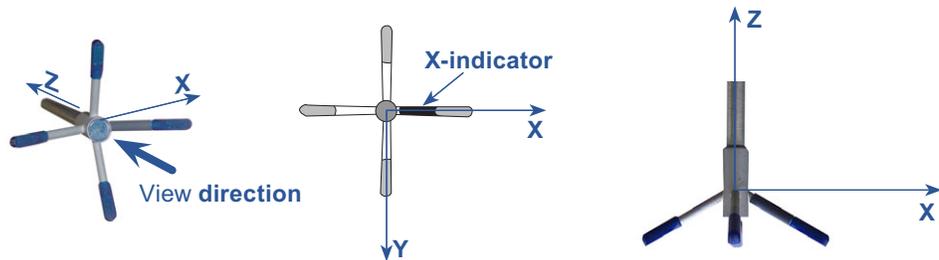
The XYZ coordinates are relative to the probe and independent of whether the Vectrino points up or down.

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

Velocity Uncertainty. The Vectrino 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.

The long-term bias depends on internal signal processing, especially filters, and

on your beam geometry. The long-term bias in the Vectrino is typically a fraction of 1 cm/s. *The Vectrino 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 Vectrino 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 Vectrino software creates binary files, which can be converted to ASCII format files, using the Vectrino 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.

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.

Velocity Data Header		
Col	Type	Unit
1	Distance	m
2	Quality	counts
3	Lag1 used	counts
4	Lag2 used	counts
5	Noise amplitude (Beam1)	counts
6	Noise amplitude (Beam2)	counts
7	Noise amplitude (Beam3)	counts
8	Noise amplitude (Beam4)	counts
9	Noise correlation (Beam1)	%
10	Noise correlation (Beam2)	%
11	Noise correlation (Beam3)	%
12	Noise correlation (Beam4)	%
13	Temperature	°C
14	Soundspeed	m/s

Velocity Data		
Col	Type	Unit
1	Status	
2	Ensemble counter	
3	Velocity (Beam1|X)	(m/s)
4	Velocity (Beam2|Y)	(m/s)
5	Velocity (Beam3|Z)	(m/s)
6	Velocity (Beam4|Z2)	(m/s)
7	Amplitude (Beam1)	(counts)
8	Amplitude (Beam2)	(counts)
9	Amplitude (Beam3)	(counts)
10	Amplitude (Beam4)	(counts)
11	SNR (Beam1)	(dB)
12	SNR (Beam2)	(dB)
13	SNR (Beam3)	(dB)
14	SNR (Beam4)	(dB)
15	Correlation (Beam1	(%)
16	Correlation (Beam2)	(%)
17	Correlation (Beam3)	(%)
18	Correlation (Beam4)	(%)

Correcting for Sound Speed Errors

If you enter the wrong salinity, the Vectrino 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

e	x	v	c	c	c	b	b

beams – 1

cells – 1

velocity scaling (0 = mm/s, 1 = 0.1mm/s)

not used

error (0 = no error, 1 = error condition)
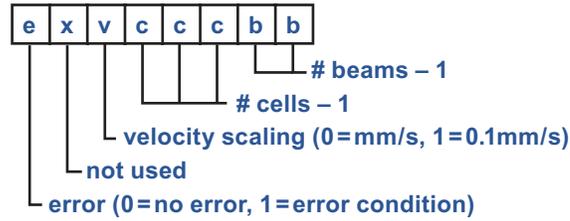
CHAPTER 4
Initial Preparations

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

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

Inspect the Received System

The following should be included in the Vectrino Shipment:

1 Transportation box
2 Vectrino current meter
3 Tool kit
4 Power cable
5 Power supply
7 Signal cable
8 Packing list
9 Warranty card
10 Vectrino software CD
11 Vectrino User Guide

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

Installing the Vectrino PC Software

To install the Vectrino software on a PC running Microsoft® Windows®:

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 Connect the Vectrino to the PC serial port and to the power supply.

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 **Communication** > **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 Vectrino software. Click **Data collection** > **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).
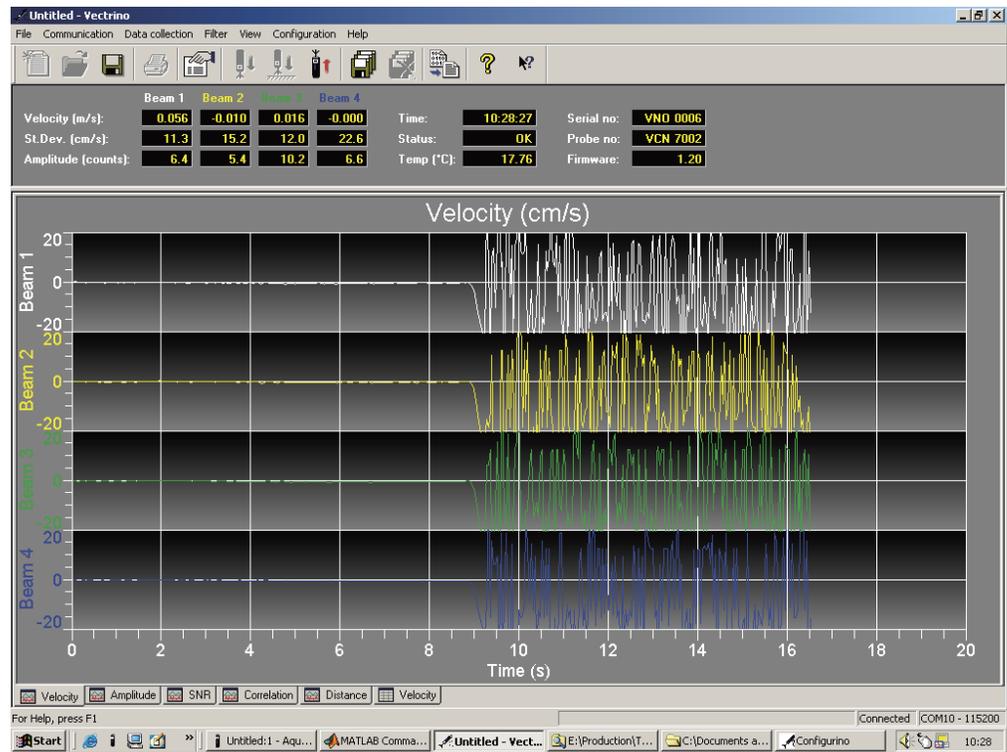
7   Put the transducers in the water and observe the velocity, the standard devia-
tion and the amplitude in counts. Watch the graphical view of the velocity as
the probe goes in and out of the water. In air the graphs are noisy, while in
water they should be smooth. Note that the difference depends 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:

• Temperature should be close to your room temperature, assuming the Vec-
trino has been in the room for a while. To calibrate the temperature sensor
– see *Verifying and Calibrating the Temperature Sensor* later in this chap-
ter.

The Probe Check Feature

Designed to act as a measurement quality assurance tool, the Probe Check function in the Vectrino software lets you inspect the region where the Vectrino 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 **Data collection** > **Start Probe Check**. You can use it to diagnose and correct problems and to optimize data collection.

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 0.45 dB in signal strength.

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.
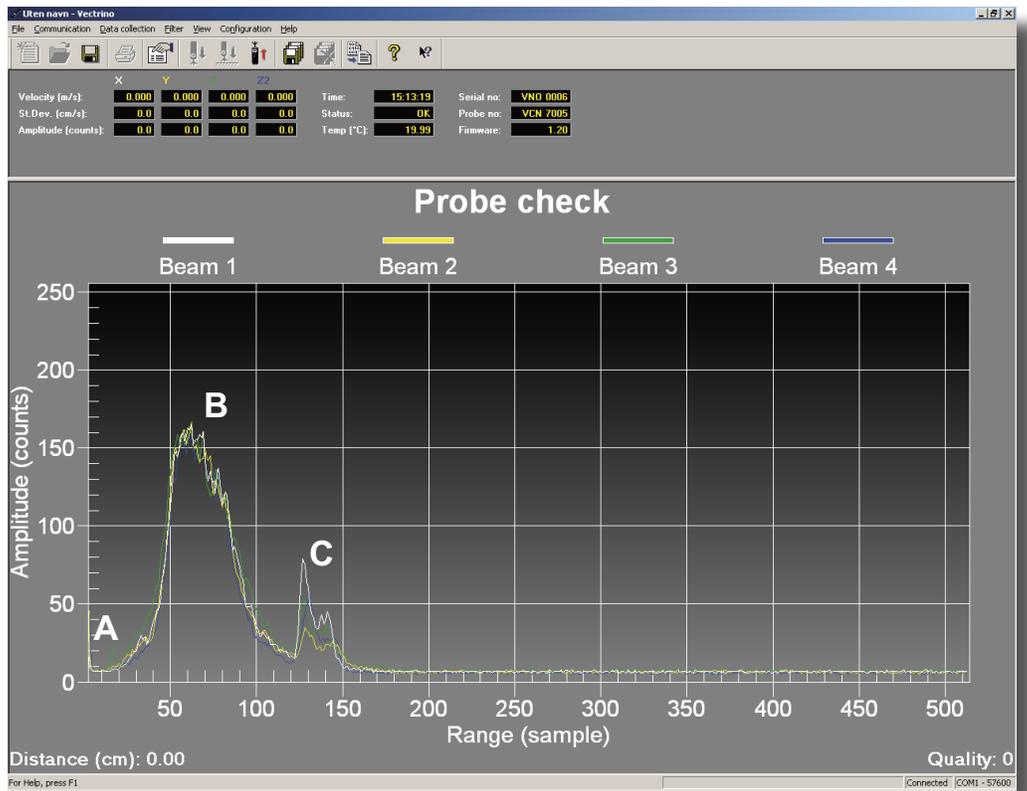
The letters correspond to the following:

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**.

Signal-to-noise ratio – a definition

The signal-to-noise ratio (SNR) is defined as follows:

$$SNR = 20\log_{10}\left(\frac{Amplitude_{signal}}{Amplitude_{noise}}\right)$$

Strictly speaking, we are unable to measure the signal without the noise present, so $Amplitude_{signal}$ should read $Amplitude_{signal+noise}$. However, for SNR values in the magnitude applicable to typical Vectrino situations, the difference is negligible.

CHAPTER 5
Setting Up for Operation

The Vectrino software program has been designed to set up and read back data acquired by the Vectrino.

Configuration

To configure your Vectrino velocimeter:

1 Connect the Vectrino to power and to the COM port of the PC.

2 Start the Vectrino software.

3 Select **Data collection** > **Configuration** followed by **Use existing**, **Load from file** or **Load from instrument**, depending on which setting you would like to start from when editing the configuration.

4 This will produce the **Configuration settings pane**, as shown overleaf. The actual settings may differ from the pane shown. Each user controllable part of the pane is explained below.

The Vectrino comes in two flavours; Vectrino and Vectrino⁺. The latter provides a wider range for some the settings than the standard version does.

To gain access to the
Configuration setup,
select **Data collection** >
Configuration
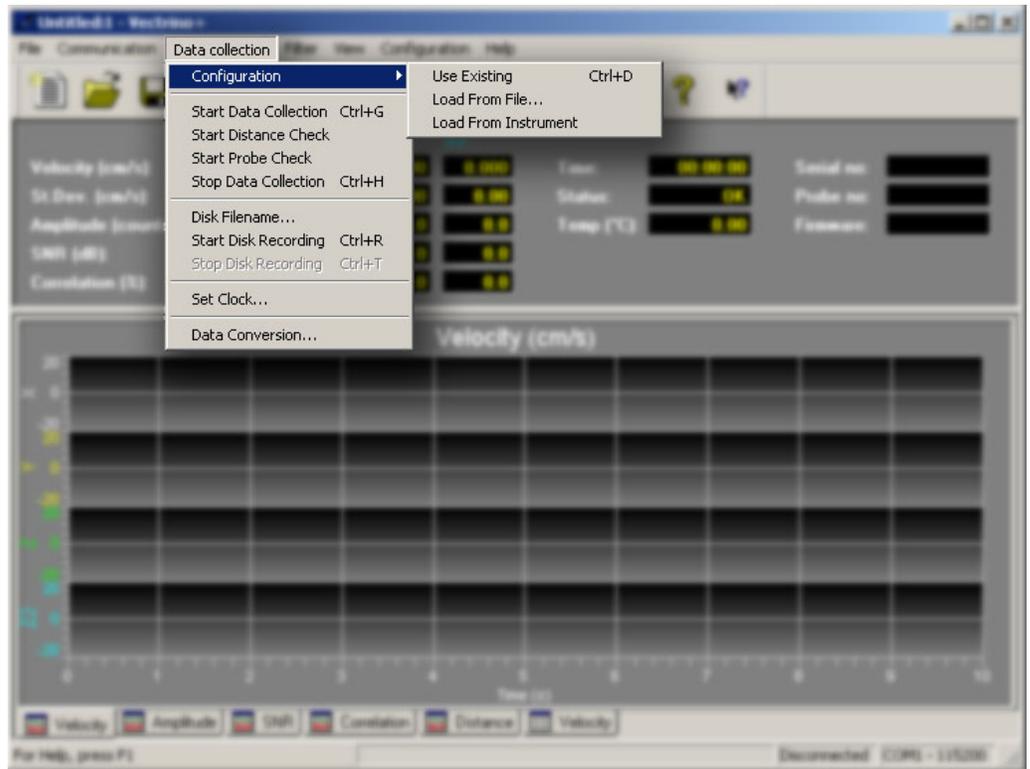
The **Configuration** setup pane
lets you set up all accessible
Vectrino parameters. Note that
the 200 Hz sampling rate applies
to Vectrino⁻ versions only.
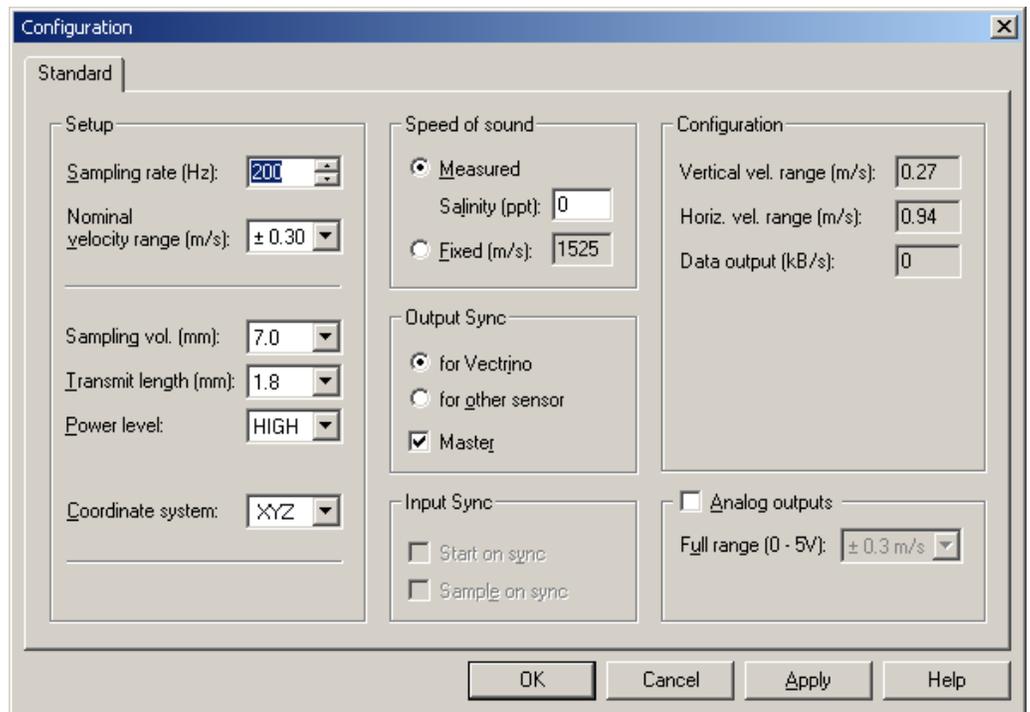
The Configuration Settings

Sampling Rate

Sampling rate sets the output rate for the velocity, amplitude, correlation, and pressure data. This rate also determines the rate at which data are recorded internally or to disk.

The available sampling rate intervals are:

- Vectrino: 1–25 Hz
- Vectrino⁺: 1–200 Hz

Nominal Velocity Range

Velocity range should be set to cover the range of the velocities anticipated during the data collection. A higher velocity range give more noise in the data and vice versa. The true velocity range can be found in the performance pane. You may have to make a trial measurement to find the best setting to use.

The available nominal velocity range settings are:

- Vectrino: ±0.01, ±0.1, ±0.3, ±1, ±2, ±4 [m/s]
- Vectrino⁺: ±0.01, ±0.1, ±0.3, ±1, ±2, ±4 [m/s]

Sampling Volume Height Setting

The sampling volume is cylindric with a fixed diameter of 6 mm. The height is user adjustable. When reducing the sampling volume size, the total number of samples that are being used for the velocity calculation is reduced. The effect of this reduction is that the precision of the measured velocity is reduced.

The available height settings are:

- Vectrino: 3–15 mm
- Vectrino⁺: 3–15 mm

Transmit Length

The effect of increasing the transmit pulse length is that the signal-to-noise ratio is increased. You may reduce the transmit pulse as a means of reducing the sampling volume and/or get closer to boundaries. Note that when changing the transmit length the available sampling volumes sizes are also changed.

The available height settings are:

- Vectrino: 0.3, 0.6, 1.2, 1.8, 2.4 [mm]
- Vectrino⁺: 0.3, 0.6, 1.2, 1.8, 2.4 [mm]

Power Level

The power level bar sets how much acoustic energy the instrument transmits into the water. Select between HIGH and LOW (for both versions). The difference between the highest level and the lowest level is about 7dB.

Coordinate System

The coordinate system can be selected to Beam or XYZ. Beam means that the recorded velocity will be in the coordinate system of the acoustic beams, about 15 degrees with respect to the vertical. XYZ means that the measurements are transformed to a fixed orthogonal XYZ coordinate system.

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.

Output Sync

The SyncOut signal consists of 1.95 ms long, 3.3V pulses that can be configured for two different schemes of output synchronization.

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 Vectrino** 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.

Input Sync

The SyncIn signal permits external control of the sampling. Two options are available; initiation of the Vectrino sampling upon receipt of an input pulse, or full external control of the data collection rate. Typically, another 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.

Select **Start on sync** to have the Vectrino start 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 (1/Samplingrate) after SyncIn becomes 'high'.

Select **Sample on sync** to have the Vectrino output 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 only starts the averaging process for the first sample. 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 last rising edge of the SyncIn. The Vectrino 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.

Vertical/Horizontal Velocity Range

This is 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).

Analogue Outputs

When analogue output is enabled, the 3D velocity is output as 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 analog output range.

Mounting Guidelines

The following guidelines should be observed:

- When mounting the Vectrino near large obstructions (bridges, piers, walls, etc.), ensure that there are no obstructions between the sensor and the focal point (sampling volume) located about 5cm from the transducers. Obstructions directly behind the sampling volume may corrupt the data.

- 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.
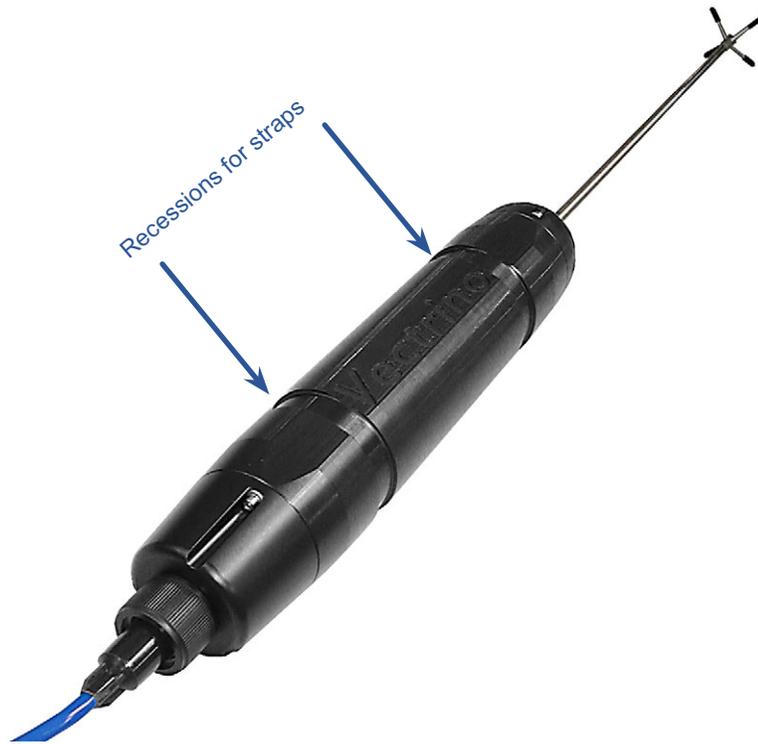
When mounting the Vectrino, use the recessions to strap it to the structure. Never use the probe stem as mounting point.

Communication Between Vectrino and PC

The Vectrino computer interface is of the RS 232 type. However, if you are going to use more than one Vectrino at the time, you will easily run out of serial ports on your PC. What to do then?

Enter USB interface. By using a USB hub accepting serial interfaces at one end and USB at the other, you may connect a multitude of Vectrinos to your PC. The USB interface will appear transparent; both the Vectrino and the PC will regard the connections as standard RS 232, so baud rate will retain its meaning even in the case of USB connections.

USB cables should not be too long, a common recommendation sets the upper limit to approximately 5 m, so in practical cases the major part of the cable length used will be of the RS 232 type.

Using Long Cables

Default RS 232 baud rate setting is 19 200 baud for the Vectrino and 57 600 for the Vectrino⁺.

Keep in mind that changing environmental conditions could cause RS 232 communications to fail over a long cable without apparent reason. If you experience

problems, try such things as moving the cable away from other installations, reducing the baud rate and do not hesitate to try another PC.

Changing the Baud Rate

You may specify two separate baud rates for the Vectrino. 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 **Upgrade 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.

Baud rate	Max sampling rate
300	1 Hz
600	2 Hz
1200	4 Hz
2400	8 Hz
4800	16 Hz
9600	32 Hz
19200	64 Hz
38400	128 Hz
57600	200 Hz

Table showing the highest permissible sampling rate for a given baud rate.

Given the amount of data transferred, there are limitations on the maximum sampling rate permissible for a given baud rate. The sidebar table applies.

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

1 Set up the Vectrino 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 Vectrino will re-awake with the new baud rate.

Note! If data download is interrupted, the Vectrino 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

Use with Other Instruments

Some applications call for a number of Vectrinos used in a single set of measurements. It is then often desirable to be able to synchronize all the instruments.

Your Vectrino may serve as master for other Vectrinos, or its sampling may be controlled by other sensors.

If you connect a controller to the Vectrino, you may set up a fairly sophisticated system, in which the controller may power the Vectrino and provide it with sync pulses to control the sampling accurately. The controller may serve as a storage device.

Synchronizing with Other Instruments

The Vectrino can be synchronized with other instruments via the **SyncIn** and **SyncOut**.

The synchronization utilizes RS 485, which is a balanced half duplex transmission standard.

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

Two options are available:
- Initiation of the Vectrino 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 Vectrino. 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 Vectrino ignores the SyncIn signal and data collection starts under software control only.

- **Start on Sync.** In this mode, the Vectrino 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 ⅛ SAMPLING RATE) after SyncIn becomes "high".

- **Sample on Sync.** In this mode, the Vectrino 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 Vectrino 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 Vectrino is generated to correspond to a sampling rate of 25Hz, the Vectrino should be configured in software for a sampling rate of 32Hz.

In most cases it will be sufficient to synchronize different Vectrinos using **Start on Sync**. All Nortek 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 Vectrinos 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.
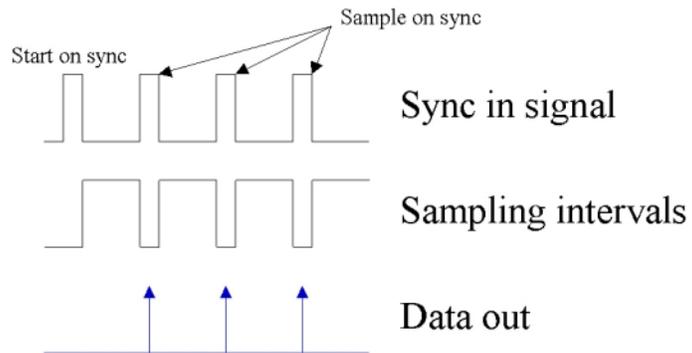
Specifications of Signal Levels

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.
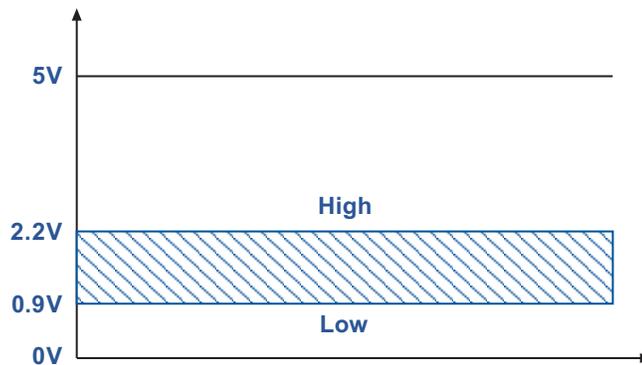
The output voltage levels for the SyncOut are:

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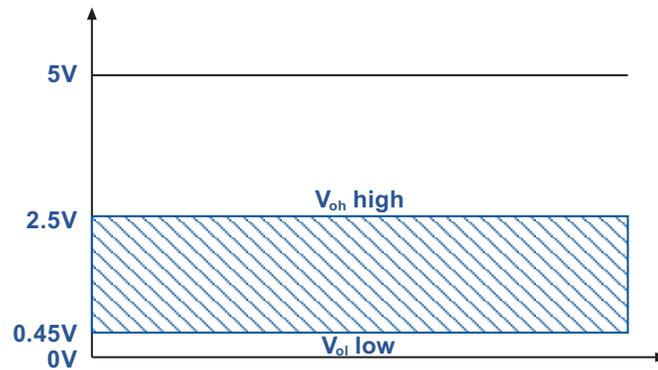
There is spike protection on both signal ports but there is no filtering on the input port. It is important to consider noise issues (ground-loops, etc) as noise may cause an unwanted start on sync trigger.

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

Connect the SyncOut line from one Vectrino to the SyncIn line on the two other Vectrinos. Connect the ground cables together. Choose **Output Sync for Vectrino** for the first Vectrino. This will be the master. In the setup for the two other Vectrinos 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 Vectrino slaves first. When the master Vectrino then is started, it will trigger the start of the other two Vectrinos.

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

Connect the SyncOut line from one Vectrino to the SyncIn line on the two other Vectrinos. Connect the ground cables together. Choose **Output Sync for Vectrino** for the first Vectrino. This will be the master. In the setup for the two other Vectrinos 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 Vectrinos. Start Recorder Deployment for the master Vectrino 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 Vectrinos setting the deployment time to the deployment time of the master Vectrino minus 10 seconds (in this example 3.59.50 p.m.).

The two slave Vectrinos will now wake up in each burst 10 seconds ahead of the master Vectrino. After outputting the burst header and one set of system data they will then wait for the start on sync trigger from the master Vectrino 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 Vectrino as they receive the sample on sync triggers from the master Vectrino.

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 Vectrinos simultaneously from another instrument

Connect the SyncIn signals from the three Vectrinos 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 Vectrinos, start all of them with the **Start on sync** option configured. Generate the start on sync trigger from the other instrumentation.

Appendix 1
Troubleshooting

Noisy Data

You may experience that the Vectrino 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 Vectrino probe up or down relative to the bottom

- Probe malfunction. Test the probe (**Data collection** > **Start Probe check**). If the probe really is malfunctioning, report the probe check result to NORTEK.

My Data Does Not Look Right

The Vectrino 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 Vectrino 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.

Vibration in Mounting Fixture

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.

- 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 Vectrino on the Serial Port

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

If you see a response consisting of garbled text or strange characters, the Vectrino 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.

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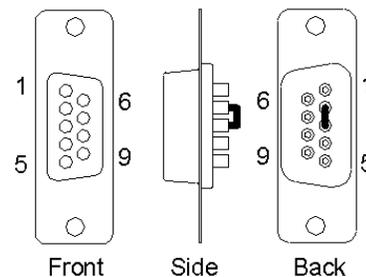
Make a serial loop-back connector by soldering pins 2 and 3 together, as shown

Now, run the test with the Vectrino'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.
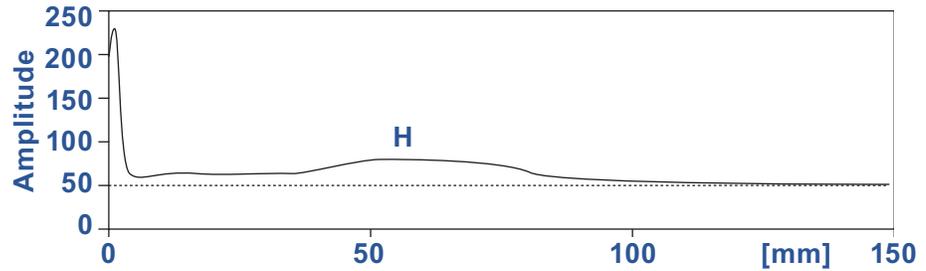
Boundary too close
The leading edge (**G**) of the boundary echo should be no closer than 110 sample counts. If the boundary is close to the sample volume, scrutinize the velocity to make sure it is OK.
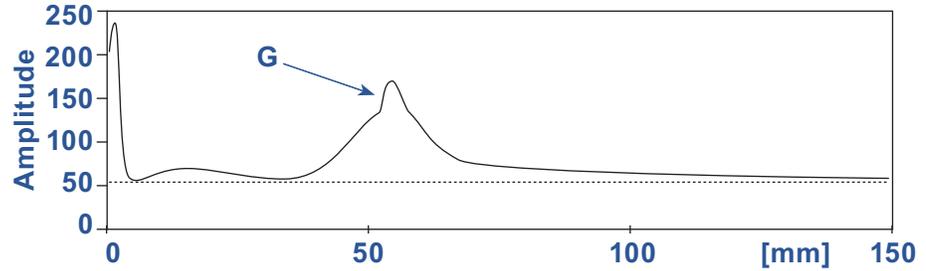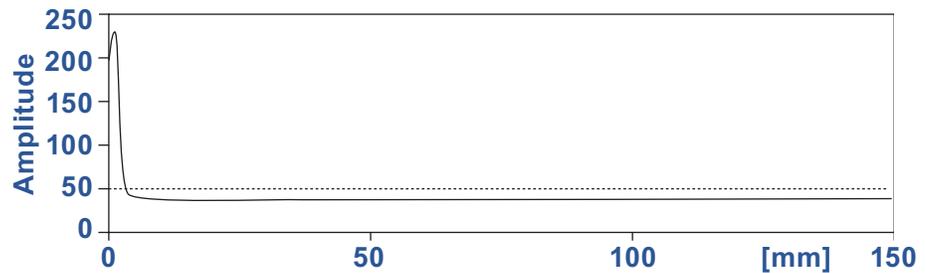
Too little backscatter
The signal level (**H**) should reach at least 70 counts.

Broken probe indicated by flat signal around 40 counts
Return the Vectrino 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 Vectrino to the factory.
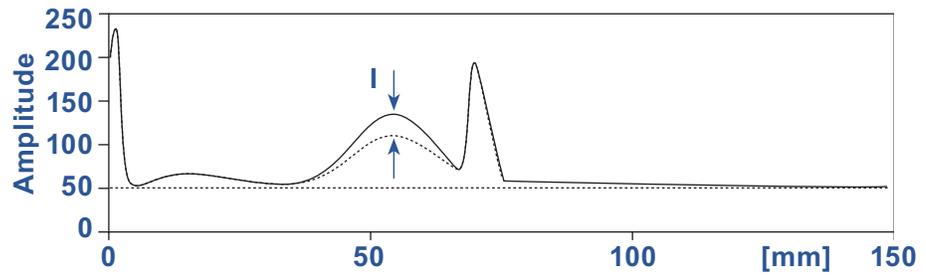
Noise level is too high indicating a possible grounding problem
If the average signal in the area marked (**J**) is more than 80 counts, you may have a grounding problem – see *Grounding Problems* in this chapter of the manual.
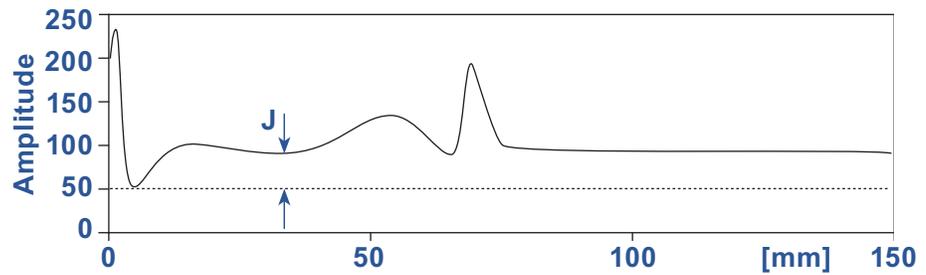
Grounding problem
This illustrates a testing of the probe by placing the receivers in water, but leaving the transmitter out of water. The grounding problem in indicated by the signal in region K being above 70 counts – see *Grounding Problems* in this chapter of the manual.
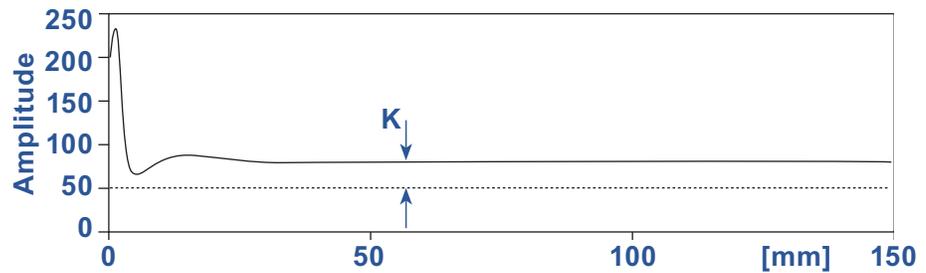
Appendix 2
Maintenance

Before you assemble a system that involves custom cables, power supplies or the like, first assemble and test the Vectrino 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 Vectrino in shape and ready for action and deployment.

Cleaning

Perform regular cleaning of the Vectrino Velocimeter. Use a mild detergent to clean the Vectrino. Pay special attention to the transducers.

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 3
Returning Vectrino 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

NORTEK AS

SENDER (Exporter)		**RECEIVER**	
Name:		**Name:**	Nortek AS
Address:		**Address:**	Vangkroken 2
City:		**City:**	NO-1351 Rud
Country:		**Country:**	Norway
Tel.:		**Tel.:**	+47 67 17 45 00
Fax:		**Fax:**	+47 67 13 67 70
Ref.:		**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