AQUADOPP CURRENT METER

USER MANUAL

www.nortek-as.com

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1. INTRODUCTION

Thank you for purchasing a NORTEK Aquadopp Current Meter.

The Aquadopp 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. You hear the Doppler effect whenever a train passes by - the change in pitch you hear tells you how fast the train is moving.

Getting started

- Before you start using the Aquadopp, please familiarize with the Current Meter by reading sections 1, 2 and 3 of this user manual.
- Perform reception control and functional test of the Aquadopp according to procedures in section 4.

- Start using the Aquadopp according to procedures in section 5.
- Perform regular maintenance according to procedures in section 6.

1.1. Software updates and technical support

Please visit our website for software updates and technical support:

www.nortek-as.com

1.2. 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.

1.3. 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.

1.4. Warranty

The Aquadopp is covered under a one year limited warranty that extends to all parts and labor 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 the design, nor does it cover any form of consequential damage as a result of errors in the measurements.

If there is a problem with your Aquadopp, first try to identify the problem by following the procedure outlined in the troubleshooting section of this manual.

Please contact your representative or NORTEK AS if the problem is identified as a hardware problem or if you need additional help in identifying the problem. Please make sure you receive a Return Merchandise Authorization (RMA) number before the Aquadopp or any module is returned to the factory.

NOTE: Detailed instructions for repairs (RMA) on page in this manual.

For systems under warranty, NORTEK AS will attempt to ship replacement parts before the malfunctioning part is returned. We encourage you to contact us immediately if a problem is detected and we will do our best to minimize the downtime.

Every effort has been made to ensure the accuracy of this manual. However, NORTEK AS makes no warranties with respect to this documentation and disclaims any implied warranties of merchantability and fitness for a particular purpose. NORTEK AS shall not be liable for any errors or for incidental or consequential damages in connection with the furnishing, performance or use of this manual or the examples herein. The information in this document is subject to change without notice.

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2. MAIN DATA

2.1. Weight and outline dimensions

Transport weight: 7 kg (transport box, all inclusive)

Transport box dimensions: 38 x 70 x11 cm

Weight in air: 3.5 kg

Weight in water: Neutral

Length: 550 mm with batteries or 450 mm without

Diameter: 75 mm

2.2. Environmental

Operating temperature:	- 5°C to 45°C
Storage temperature:	-15°C to 60C°
Shock and vibration:	IEC 721 - 3 - 2
Pressure rating:	300 m (pressure sensor OK to .5*range)

2.3. Power

DC Input:	9-16 VDC
Peak current:	2 amp at 12 VDC (user adjustable)
Max consumption at 1 Hz:	0.2-1.0 W
Max consumption at 0.02 Hz:	0.1 W
Max consumption at 0.002 Hz:	0.01 W
Sleep consumption:	0.0013 W
Battery capacity:	50 Wh
New battery voltage:	13.5 VDC
Data collection (alkaline):	6 months at 10-min, ± 1.0 cm/s noise

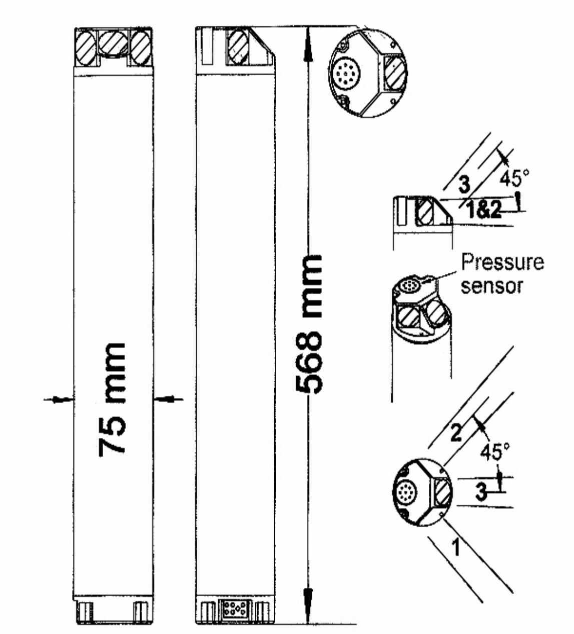
Data collection (lithium):	12 months at 10-min, ± 1.0 cm/s noise

The battery is able to sustain sleep state for 4 years (RS232 only). The AC power adapter requires a 100-240VAC 50/60Hz voltage supply.

External Power
You can supply external power to the Aquadopp. If you use an internal battery to backup data collection, an external supply of 15 VDC provides a higher voltage than the battery pack, which prevents the internal pack from discharging. Then, if external power fails, the internal battery pack takes over and sustains operation.

CAUTION: Be careful not to exceed maximum voltage supply (16 VDC).

2.4. Dimensions and Beam Locations



Aquadopp "mooring head" with two beams in the horizontal plane and one slanted 45 degrees with respect to the vertical.

2.5. Materials

Standard model: Delrin and polyurethane plastics with titanium screws

2.6. Sensors

Temperature (thermistor embedded in head)

Range:	-4°C to 40°C
Accuracy/Resolution:	0.1°C/0.01°C
Time response:	10 min

Compass (flux-gate with liquid tilt)

Maximum tilt:	30°
Accuracy/Resolution:	2°/0.1°

Tilt (liquid level)

Accuracy/Resolution:	0.2°/0.1°
Up or down:	Automatic detect

Pressure (piezoresistive)

Range:	0-200 m (standard)
Accuracy/Resolution:	0.25% / Better than 0.005% of full scale per sample

2.7. Data Communication

I / 0:	RS232 or RS422
Baud rate:	300-115200
User control:	Handled via WIN32 software, ActiveX function calls, or direct commands

2.8. Water Velocity Measurement

Range:	± 5 m/s (inquire for higher ranges)
Accuracy:	1% of measured value ± 0.5 cm/s
Max sampling rate (output):	1 s
Internal sampling rate:	23 Hz

2.9. Measurement area

Measurement cell size (user selectable):	0.75 m
Measurement cell position (user selectable):	0.3-5.0 m
Default position (along beam):	0.3-1.8 m

2.10. Doppler uncertainty (noise)

Typical uncertainty for default configurations:	0.5-1.0 cm/s
Uncertainty in U, V at 1 Hz sampling rate:	1.5 cm/s

2.11. Echo intensity

Acoustic frequency:	2 MHz
Resolution:	0.45 dB
Dynamic range:	90 dB

2.12. Analog inputs

Number of channels:	2
Voltage supply:	12V. Hardware can be modified to provide 5V or battery voltage.
Voltage input:	0-5V
Resolution:	16 bit A/D

2.13. Software

Operating system:	WIN95/98, NT 4.0, WIN2000
Functions:	Deployment planning, start with alarm, data retrieval, ASCII conversion. Online data collection and graphical display. Test modes.

2.14. Data Recording

Capacity (standard):	2 MB, expandable to 22 MB or 78MB
Data record:	40 bytes
Diagnostic record:	40 bytes

2.15. Connectors

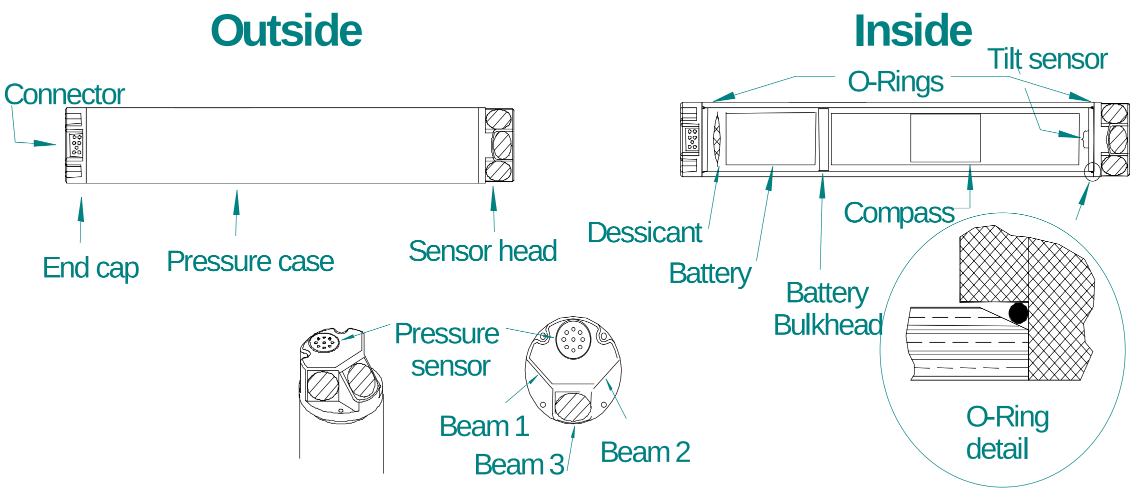
Bulkhead (Impulse):	LPMBH-5-FS (bronze, titanium optional)
Cable:	LPMIL-5MP on 5-m neoprene cable

2.16. Options

Acoustic beams:	Several different sensor heads available. See separate specification sheet
Battery:	Rechargeable Ni-Mn and Lithium available
External battery:	4 battery packs in 75 mm diameter, 500mm length. External canister
Connectors:	LPMBH-8-FS with PLPMIL-8-MP on 10-m polyurethane cable for optional RS 422 systems

3. TECHNICAL DESCRIPTION

3.1. Aquadopp components



The figure above shows a standard Aquadopp, and particular models can vary from the above. The list below describes the major system components.

3.1.1. The Sensor head

Head Configurations
The sensor head contains three acoustic transducers and a pressure sensor, all visible from the outside. The sensor head also holds the following sensors:

Tilt sensor
The tilt sensor is on a small round daughter board attached to the head, inside the case. The tilt sensor orientation is set in accordance with the system orientation during normal operation. The standard Aquadopp is designed for vertical orientation. Tilt sensors in heads designed for horizontal orientations will be mounted at right angles. The tilt sensor can be inverted 180 degrees - you can use it pointing up or down.

Temperature sensor
The temperature sensor, standard on all Aquadopps, is mounted internally in the sensor head.

Pressure sensor
The pressure sensor is mounted in the Aquadopp sensor head.

3.1.2. Electronics module

The electronics module is a single board that holds the power transmitter, analog and digital signal processing, power conditioning and the standard data recorder.

3.1.3. Compass

The compass measures the earth's magnetic field. Combined with the tilt sensor on the head, the compass enables the Aquadopp to obtain the heading. Without a compass, the Aquadopp still measures tilt. This data enables the Aquadopp to convert velocity measurements to Earth coordinates.

3.1.4. Internal battery pack

The internal battery pack is located inside the pressure case, and enables autonomous deployments of up to a year. It also provides backup power in the event of failure of the external supply. Standard alkaline battery packs use 18 AA cell batteries at a nominal starting voltage of 13.5VDC.

3.1.5. Battery Pack Voltage and Remaining Capacity

NORTEK alkaline battery packs start life at a voltage of 13.5 VDC or higher. The voltage of alkaline batteries falls quickly at the beginning, slowly during most of its life, then again quickly at the end. Thus a 13.5 VDC battery pack will spend the largest part of its life somewhere in a voltage range of 10.5-12.5 VDC.

3.1.6. Power & communication cable

This enables you to supply external DC power (9-16 V) and to connect an external computer to the Aquadopp via 2-way serial communication.

Cable Wiring

The Aquadopp comes standard with a 5-conductor cable, but it can be special ordered with an 8-conductor cable for use with RS422 communication. The tables list the pin assignments for the five-conductor cable, the 8-conductor RS422 cable and the 8-conductor cable with analog inputs & RS232.

The Aquadopp power and battery lines are diode protected, so you don't have to worry about wiring the Aquadopp power backwards - this will not damage your instrument.

Table 1: Wiring of 5-conductor cable for RS232 Communication

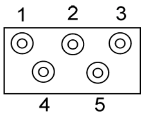
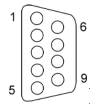
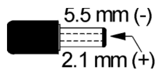
	Underwater connector		Dry-end connect or pin		Connector type	
	Pin number	Wire color				
 Pin numbers, looking at the pins	2	White	2	White	9-pin Dsub, female	 Facing sockets
	4	Green	5	Green		
	5	Blue	3	Blue		
	1	Black	Power ground			
	3	Red	Power positive			

Table 2: RS232 Cable with option for analog outputs

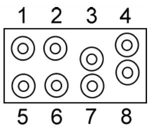
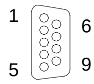
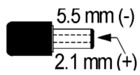
	Underwater connector		Purpose		Termination		
	Pin number	Wire color			Pins	Description	
 Pin numbers, looking at the pins	3	Black	RS232 Tx	twisted pair	2	9-pin Dsub, female	 Facing sockets
	4	White	RS232 Rx		3		
	5	Black	Ground	twisted pair	5		
	6	White/purple	Analog Z		Red wire		
	7	Black	Analog X	twisted pair	Green wire		
	8	White/orange	Analog Y		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			

Table 3: RS232 Cable with analog inputs

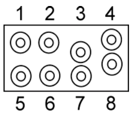
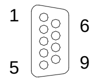
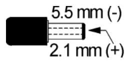
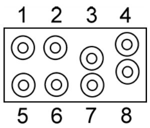
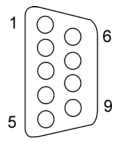
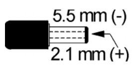
	Underwater connector		Purpose		Termination		
	Pin number	Wire color			Pins	Description	
 Pin numbers, looking at the pins	3	Black	RS232 Tx	twisted pair	2	9-pin Dsub, female	 Facing sockets
	4	White	RS232 Rx		3		
	5	Black	RS232 ground	twisted pair	5		
	6	White/purple	power output		Red wire		
	7	Black	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			

Table 4: Wiring of 8-conductor cable for RS422 communication.

	Underwater connector		Purpose		Termination		
	Pin number	Wire color			Pins	Description	
 Pin numbers, looking at the pins	3	Black	RS422 Tx+	twisted pair	2	9-pin Dsub, female	 Facing sockets
	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 wire		
	6	White/purple	Synch in		Green wire		
	1	Black	Power ground	twisted pair	black wire		
	2	White	Power positive		Red wire		
	Screen	Bare	Power ground	three ground lines through shield			

***Please note** that TX and Rx refers to the Aquadopp and not the PC*

3.2. Functional description

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

3.2.1. Modes of operation

The Aquadopp has three different modes of operation:

- Command Mode
- Data Acquisition Mode
- Power Down Mode

Command Mode
An Aquadopp in command mode is powered up and ready to accept your instructions. If it gets no commands for about five minutes, it automatically powers down and goes into sleep mode.

You cannot send commands directly to the Aquadopp. Instead, you must enter commands through the Aquadopp software. The Aquadopp software and hardware interact with each other using low-level binary data structures. This approach simplifies the design of the Aquadopp hardware and increases its overall reliability.

Data Acquisition Mode
The Aquadopp enters data acquisition mode when you click any of the "Start" commands (i.e. "Start Recorder Deployment") in the Aquadopp software. When you initiate a deployment sequence, the software converts your setup parameters into binary structures, downloads the structures to the Aquadopp and tells it to start data collection.

To get the instrument out of data collection mode, use one of the "Stop" commands in the Aquadopp software. You might notice that sending a break to an Aquadopp in data acquisition mode gets a response, but that data collection does not stop. The purpose of this design is to protect the system from stopping after an accidental break.

Power Down Mode
The Power Down Mode saves power during deployments and prevents your battery from dissipating between deployments. The Aquadopp automatically powers down from command mode after about five minutes of inactivity.

To conserve your battery when the Aquadopp is on the shelf, be sure it is not in data acquisition mode. Stop data collection using one of the "Stop" buttons before you store an Aquadopp.

NOTE: If you set the Aquadopp to collect data, remove power, then reapply power later, the Aquadopp will immediately resume data collection. Remember that the time may be lost.

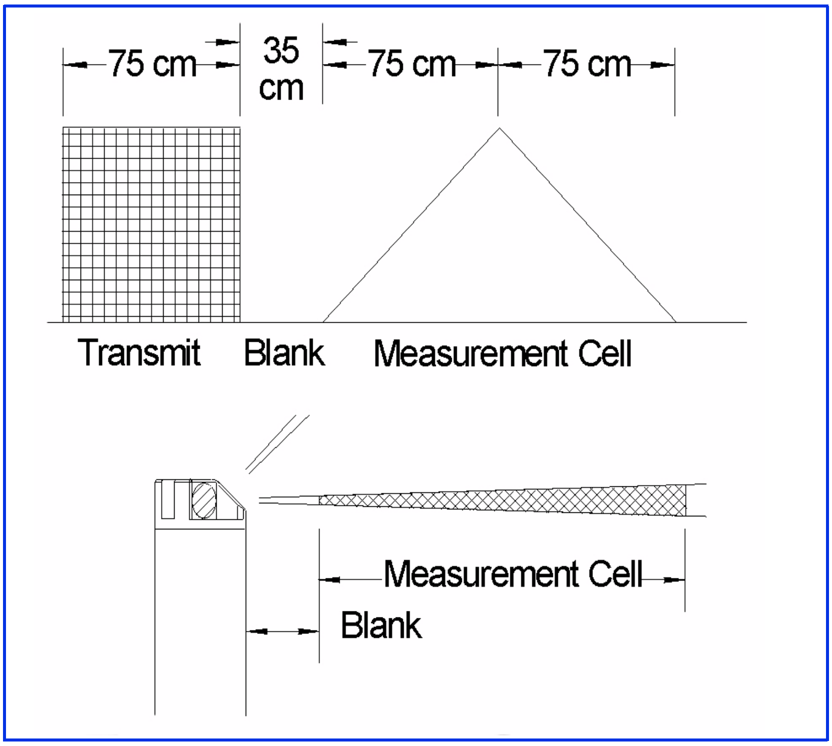
3.2.2. Using the Doppler Effect.

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 Aquadopp 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.

There are many ways to measure the Doppler effect, each with its own advantages and drawbacks. NORTEK implements a narrow-band auto covariance method because it has been established as robust, reliable and accurate.

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 with Doppler current sensors tells us that the small particles the Aquadopp sees move on average at the same speed as the water - the velocity it measures is the velocity of the water.

3.2.3. Doppler Beams.



Measurement cell location. The 75 cm dimension that applies to the transmit pulse and measurement cell is fixed by the Aquadopp software, but you can adjust the blank. Given the default 35 cm blank, the center of the measurement cell is located at 110 cm (=35+75) from the sensor head.

Doppler current sensors use large transducers (relative to the wavelength of the sound) to obtain narrow acoustic beams. The Aquadopp's beams have a beam width of 1.7°. Narrow beams are essential for obtaining good data.

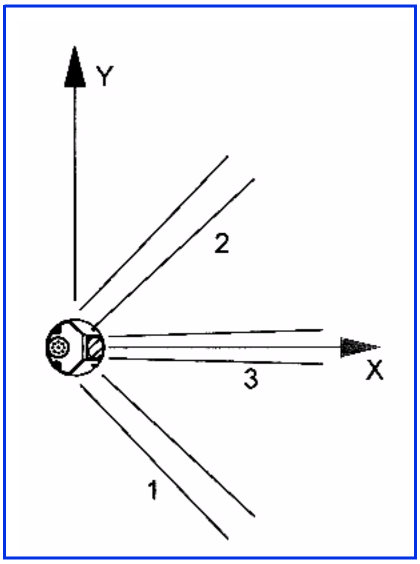
Each beam measures velocity parallel to the beam and does not sense the velocity perpendicular to the beam at all. The Aquadopp senses the full 3D velocity with three beams, all pointed in different directions. The Aquadopp measures horizontal velocity with two horizontal, orthogonal beams, and the vertical component with the beam slanted up (or down) at 45°. If you assume the flow is uniform across the three beams, simple trigonometry is sufficient to compute the vertical velocity.

The measurement cell is shaped like a triangle. The triangular shape means that it is more sensitive to currents in the middle of the cell than at either end. The maximum extent of the cell is double the length of the transmit pulse.

Coordinate System

The Aquadopp measures velocity components parallel to its three beams, or in beam coordinates, but it reports data in east, north and up or ENU coordinates. To get to ENU components, it first converts the data to XYZ coordinates, an orthogonal coordinates system relative to the Aquadopp. The Aquadopp then uses its compass and tilt measurements to convert this velocity to components relative to the earth, or ENU coordinates.

In beam coordinates, a positive velocity along beam 1 goes in the direction beam 1 points toward. 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.



Definition of the XYZ coordinate system for an Aquadopp deployed upright. The Z component is up, along the axis of the pressure case. If the Aquadopp is deployed upside down, the Z axis and Y-axis are reversed relative to the pressure case.

NOTE: Please contact NORTEK if you want detailed information about the coordinate transformation equations used in the Aquadopp.

Attitude Correction.

Typical moorings allow the Aquadopp to tilt and rotate freely. It measures its tilt and heading and uses this information to correct the data to true earth coordinates. Because the compass uses energy, the Aquadopp reads heading only as often as it needs to. In a near-surface mooring, it will read the compass more often than it would on a fixed bottom mount.

Velocity Uncertainty.

The Aquadopp 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 by your beam geometry. The long-term bias in the Aquadopp is typically a fraction of 1 cm/s. *The Aquadopp 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. Beams parallel to the dominant flow will have smaller short-term errors than beams at a steep angle relative to the flow. Averaging multiple pings reduces errors according to the formula:

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

Where σ is standard deviation and N is the number of pings you average together.

NOTE: The Aquadopp software predicts only the instrumental error. In many situations, the environment itself dominates the short-term error.

In a wavy surface and in turbulent flow such as boundary layers and rivers, your data collection strategy should take into account the nature and the time scales of the environmental fluctuations. Here are two examples:

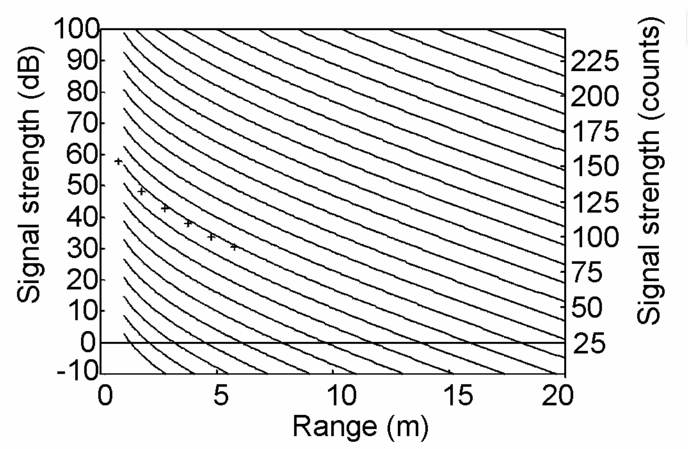
Waves. A good rule of thumb to follow when measuring mean velocities in the presence of waves is that you should sample velocity at roughly ¼ the interval of the dominant wave period, and you should sample through 6-10 wave cycles. If your peak wave velocities tend to be around 5 or 6 s, then sampling at a 1 s interval for a minute would make sense. In this case, you could reduce the measurement load to a relatively small fraction (say 4 or 8%).

Turbulent flow. A rough rule of thumb in boundary layers is that the rms turbulent velocity is 10% of the mean velocity. If, for example, your mean velocity is 1 m/s, you could estimate turbulent fluctuations to be 10 cm/s. Obtaining 1 cm/s rms uncertainty would require at least 100 pings.

3.2.4. Maximum Range to the Measurement Cell

The Aquadopp software sets the default distance to the measurement cell at 0.35-1.1 m from the sensor head, but you can adjust the range out further. The figure shows how signal strength varies with range, based on the sonar equation. Signal strength varies with transmit power, backscatter strength and distance. If you know the signal strength at a given power level and a given range, you can use the figure to predict the signal strength you would have at a different power level and range.

If you keep the same power level and change the range, follow the curve closest to the value you started with. If you change the power level, move up or down one curve for each power level (the curves are 6 dB apart).



Measurement range vs. signal strength at 2 MHz. *The "+" symbols show actual data from a river at power level 2.*

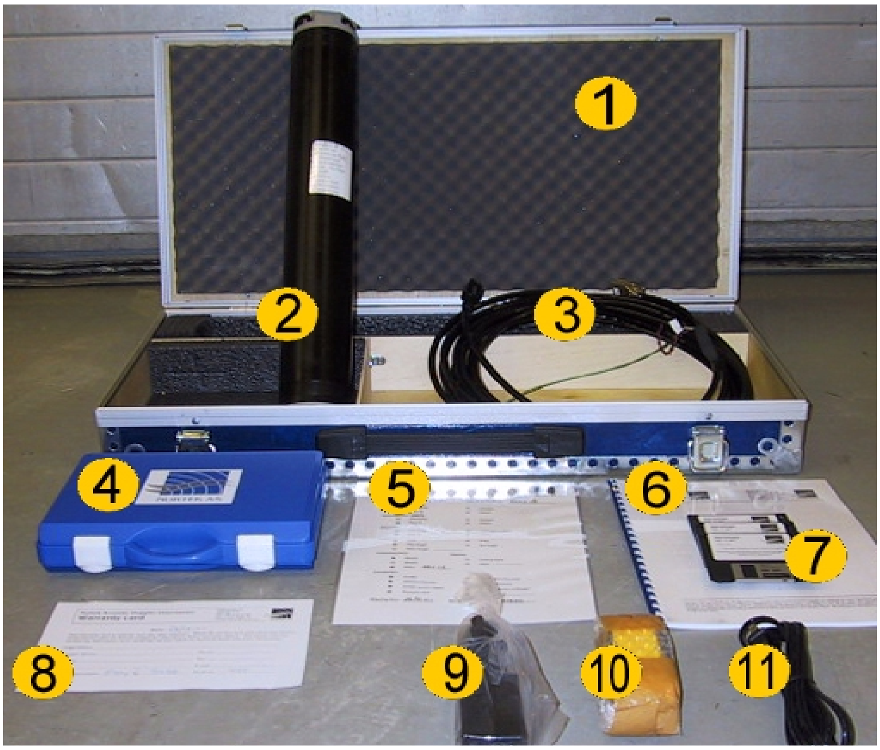
The noise floor is typically found at 20-30 counts. The range figure arbitrarily assigns 25 counts the value 0 dB. Because of the way we compute the signal strength, you can actually obtain good data at signal strengths a few dB below the noise floor. This means the noise floor gives you a conservative cutoff for good data.

4. PREPARATION

Please perform the following procedures to prepare your new Aquadopp for future successful operation:

- Perform a reception control, refer to section 4.1. on page 25.
- Install the internal battery pack, refer to section 6.1.3. on page 47.
- Install the Aquadopp Software on a PC, refer to section 4.2. on page 26.
- Perform a functional test of your new Aquadopp, refer to section 4.3. on page 26.
- When you are ready to perform data acquisition, mount the Aquadopp according to guidelines in section 4.4. on page 28.

4.1. Reception control



Please check that the following equipment is included in the delivery:

1. Transportation box
2. Aquadopp current meter
3. External power/signal cable
4. NORTEK equipment storage box
5. Packing list
6. Aquadopp user manual
7. Aquadopp software
8. Warranty card
9. Voltage transformer (110-230 VAC to 9-16 VDC)
10. Internal battery pack
11. Power cable

Please contact NORTEK immediately if you find parts of the delivery are missing.

4.2. Install the Aquadopp software on a PC

1. Insert Disk 1 and run the Setup.exe file
2. Follow the instructions presented "on-screen". Accept default settings.
3. Restart your PC to finalize the installation process.

4.3. Perform a functional test

1. Plug in the AC adapter and connect the Aquadopp 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.

5. Check the noise level of the instrument. Pinging in air should produce a signal strength (Amplitude) of 22-30 counts. This signal level is called the noise floor. When the instrument pings in air, the velocity measurements will be nothing but noise.Put the instrument in a bucket of water and observe the signal strength and the velocity. The signal strength should rise noticeably (the actual level depends on the size, shape and material of the bucket), and the velocity data should appear less noisy.

6. Check sensor readings

   - Tilt and rotate the Aquadopp to verify that the readings are sensible.
   - Temperature should be close to your room temperature, assuming the Aquadopp has been in the room for a while.
   - 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 50 cm.
   - Battery voltage shall be greater than 13 V DC (new battery).

NOTE: Diagnostics data give you the ability to obtain the in-situ noise floor of the instrument after it is deployed.

4.3.1. Test the recorder function

You can test the recorder with the same set-up as the above.

1. Start data collection with "Test" followed by "Start With Recorder".
2. Write a name to use for the file you will record internally.
3. After a few minutes, stop the data collection.
4. Retrieve your data by clicking "Deployment" followed by "Retrieve Data".
5. Convert it to ASCII by clicking "Deployment" followed by "Data Conversion".

6. Review the collected data with an ASCII text editor (i.e. Notepad).

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

4.4. Mounting guidelines

CAUTION: The best way to hold an Aquadopp to a fixed structure is to clamp it around its circumference.

For mounting Aquadopps on a mooring line, NORTEK provides a fairing called the Aquafin that holds the Aquadopp and allows it to swivel freely around a mooring line to keep its beams oriented into undisturbed flow.

4.4.1. Flow Disturbance.

The Aquadopp's beam geometry is one of its innovative features. A standard current profiler is forced to use its vertically slanted beam geometry in order to obtain profiles. The Aquadopp gives you more flexibility in the beam geometry - this allows you to design your mooring to minimize disturbance caused by the mooring itself. Self-disturbance of flow is a chief source of data contamination with traditional current meters.

A good example is a mooring that places the Aquadopp in a streamlined fin or torpedo can ensure that the beams always point into undisturbed flow. You can choose where to place your measurement volume to gain additional control over flow disturbance.

For example, if you simply attach the Aquadopp directly to a rope or cable, the middle of the standard measurement cell position (about 110 cm) is more than 10 times the diameter of the Aquadopp. While this is acceptable according to a standard rule of thumb, you can increase the ratio by putting the cell even further out (up to 5 m). Keep in mind that increasing the distance to the measurement cell may require an increase in transmit power.

4.4.2. Other Mounting Considerations

The Aquadopp has been designed for easy mounting and deployment. The following guidelines should give you the best possible data.

1. When mounting the Aquadopp near large obstructions (bridges, piers, walls, etc.), ensure that the acoustic beams do not "see" any obstructions.

2. Keep the Aquadopp away from magnetic materials. Consider the frame or cable holding the Aquadopp, and the structure it is mounted on. Nearby magnetic materials could cause the directional readings to be in error. If magnetic materials are near by, the best recommendation is to use XYZ coordinates, as the Aquadopp then do not use the compass.

3. Consider the effects large objects will have 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. Flow disturbance affects your measurements by changing the flow and by making it non-uniform across the Aquadopp's beams.

4. 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.

The pressure sensor can handle pressure that is about double its maximum reading. For example, the standard 200 m pressure sensor can safely withstand 400 m depth, which is also the rating of the plastic housing.

4.5. Using long cables

RS232 data communication at 9600 baud will normally work fine for cables up to 50-100 m long, depending on the environment. If you want to run a longer cable, you can switch to RS422 by installing a kit you can get from NORTEK.

You can also try using RS232 with longer cables by reducing the baud rate. Keep in mind that RS422 is a more reliable means of communication than RS232 - changing environmental conditions could cause RS232 communications to fail over a long wire without apparent reason.

4.5.1. Changing the baud rate

You are allowed to set two baud rates for the Aquadopp. The primary baud rate setting applies to normal communication and data transfer. You can also set a 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 9600, and we recommend that you use this baud rate unless you have a good reason to change it. To change the baud rate and make it permanent, do the following:

- Set up the Aquadopp and connect it to your computer.
- Set the baud rate in "Communication", "Serial Port" to the baud rate you prefer. Start a deployment, and then stop it. The last step makes the new baud rate permanent. If you remove power and reapply it, the Aquadopp will re-awake with the new baud rate.

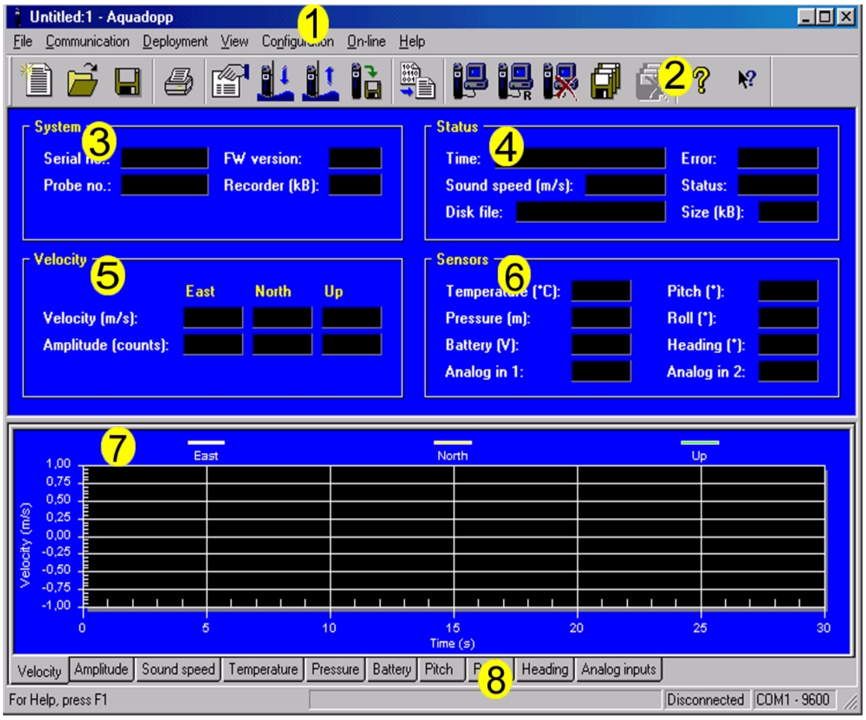
NOTE: If data download is interrupted the Aquadopp may be left with a baud rate setting other than the one used for normal communication. When the software tries to establish communication in such cases, it may spend a few moments searching for the current baud rate.

5. OPERATION

The Aquadopp program is designed to aid in the planning, execution, recovery and processing of autonomous Aquadopp deployments. It also contains a test section, including all functions required to operate the Aquadopp in real-time applications.

5.1. Introduction to the main menu

Operation of the Aquadopp Current Meter is controlled from the main menu:



The main menu is divided into 8 areas:

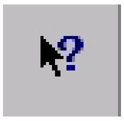
1. The top menu gives easy access to all functions included in the Aquadopp software.
2. The second row contains shortcuts to main functions. Click on the preferred icon to access the preferred function.
3. The system window contains product data for the Aquadopp Current Meter.
4. The status window displays current system status.
5. The velocity window displays velocity data.
6. The sensor data window displays sensor status.

7. The graphic view gives a graphical presentation of data selected in the data selection menu (8).

8. The data selection menu is used for selecting the types of data to be viewed.

NOTE: Please familiarize with the on-line help system integrated in the Aquadopp software.

Click on the symbol below and select a menu item. A detailed explanation of the selected item is presented on-screen.



5.2. Data collection

The Aquadopp system allows for both self-recording and real-time data collection. A typical sequence includes:

1. Install and/or plug in battery pack. Refer to procedure in section 6.1.3. on page 47.

2. Install new desiccant, if necessary. Refer to procedure in section 6.1.2. on page 47.

3. Test Aquadopp according to procedure in part section 4.3. on page 26.

4. Set PC time.

5. Use Aquadopp software to plan deployment. Click "Deployment", "Planning".

6. Erase recorder. Click "Deployment", "Erase Recorder".

7. Start deployment. Click "Deployment", "Start Deployment".

8. Enter 6-character deployment name.

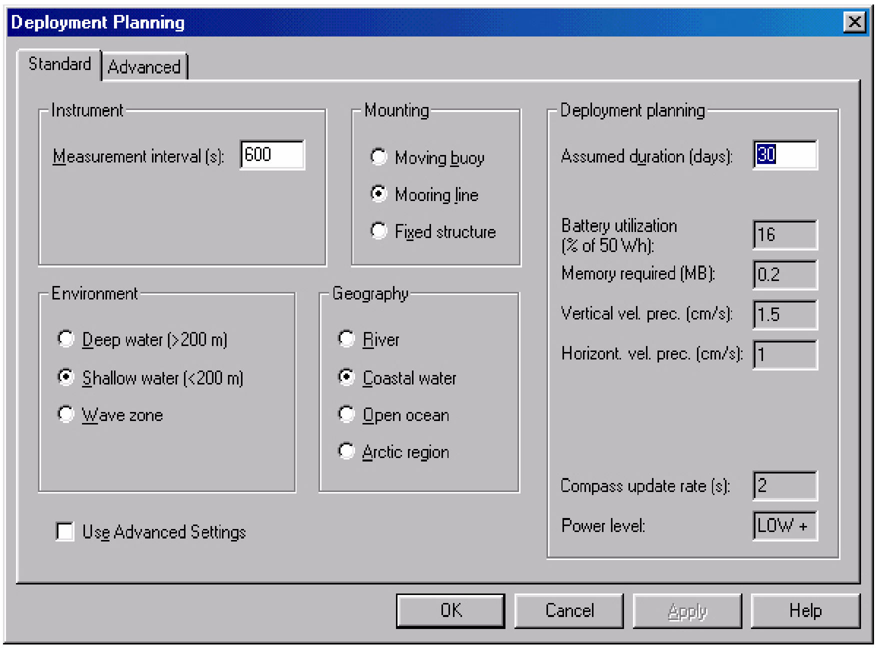
9. Set Aquadopp time to PC time.

10. If appropriate, set a delayed start-up time.

11. Disconnect cable and install dummy plug.

12. Verify pinging with AM radio just prior to deployment.

13. Install on site. Ensure the acoustic beams point where you want and that they are not obstructed.

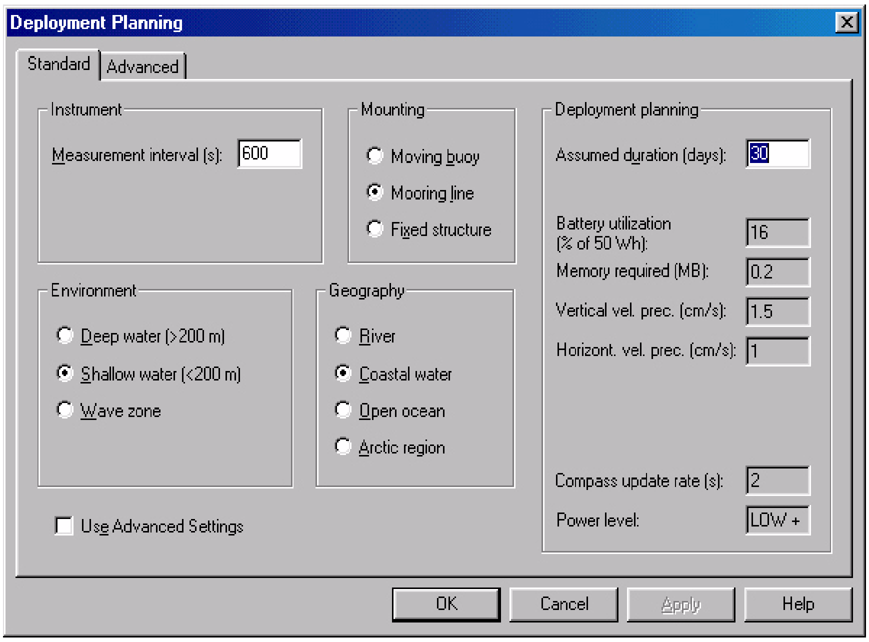


5.2.1. Deployment planning

On the main menu, select **Planning** from the **Deployment** pull-down menu or press the **Deployment Planning** toolbar button to activate the planning dialog box. The **Planning** submenu displays three options that may serve as a starting point for your deployment planning.

- Select **Use Existing** to start with the previous settings (This selection corresponds to the Deployment Planning toolbar button).
- Select **Load From File** to read settings from a deployment (.dep) file.
- Select **Load From Instrument** to read settings from the instrument.

The dialog contains all parameters required to specify the operation of the instrument. The Deployment planning frame on the right hand of the dialog displays performance parameters that are automatically updated as you change the parameter settings. When finished, press **OK** to accept the changes. By using the **Open/Save** commands in the **File** menu (or the corresponding toolbar buttons) 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 dialog allows you to specify the instrument operation at two levels. 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. Note that the **Use Advanced Settings box** (Standard tab) must be checked for the advanced settings to be effective. To show the advanced parameters that correspond with the current standard settings press the **Update from Standard** button (Advanced tab).

NOTE: The Aquadopp software will not enable diagnostics data if there is not sufficient time between normal data collection cycles to enable the Aquadopp to collect the diagnostic data.

Standard tab

Measurement interval

The time between each measurement, i.e. the data output rate.

Environment, Mounting and Geography

Choose the setting that best fits your deployment. The setting determines the Aquadopp transmit level. To see the consequence of the different choices watch the effect on battery utilization. For direct control, use the **Advanced** tab.

NOTE: Because shallow water, wave zone, and coastal waters normally have high backscatter, these choices reduce transmit power (and therefore battery utilization). If you are working in such areas but still know you have low backscatter, select Deep Water and/or Arctic Region instead.

Use advanced settings
Must be checked for the advanced settings to be effective.

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 performance parameters, i.e. battery utilization, recorder memory requirements and velocity range.

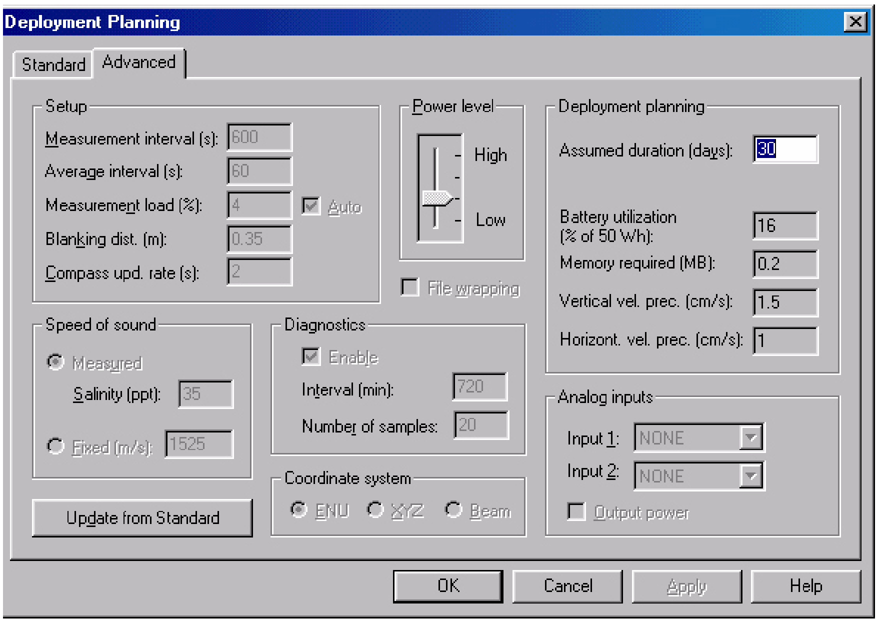
NOTE: This value has no other effect on the actual deployment configuration and the system will not stop after the number of days entered here.

Battery utilization
The expected battery life based upon total battery capacity and current duty cycle.

NOTE: The basis for the battery utilization calculations is an unused battery. If you are using a partly depleted 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 precision
An estimate of the velocity precision along the vertical axis and in the horizontal plane.



<u>Advanced tab</u>

Measurement interval
The line between each measurement, i.e. the data output rate.

Average interval
The period during which the Aquadopp should be actively measuring through the measurement interval. The sensor will be in sleep mode the remaining part of the measurement interval.

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).

Blanking distance
The distance from the sensor to the start of the measurement area. See section 3.2.3. for an illustration of this.

Compass update rate
Sampling the compass consumes energy. It can be done every second but if not needed you can set this to a much longer interval.

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 20dB. Unless you know your environment has high backscatter, you should generally use HIGH power.

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.

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

Analog inputs
The instrument can read two analog inputs at the same time. The input range is 0-5 Volt, where 0 Volt equals 0 counts, 5 Volts equals 65535 counts and 2.5 Volts equals 32768 counts.

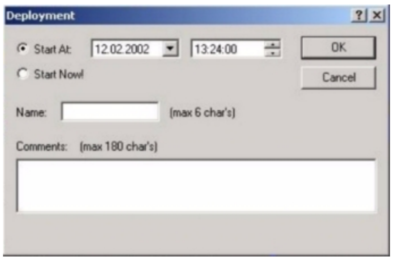
Check the **Output power** box to supply power from the instrument to your external sensor. The voltage output is fixed in production to either 5 Volts, 12 Volts or to the instrument voltage. The use of analog inputs requires a special internal harness. Some systems are equipped with this at the time of purchase. It is also possible to purchase the harness separately and upgrade the Aquadopp.

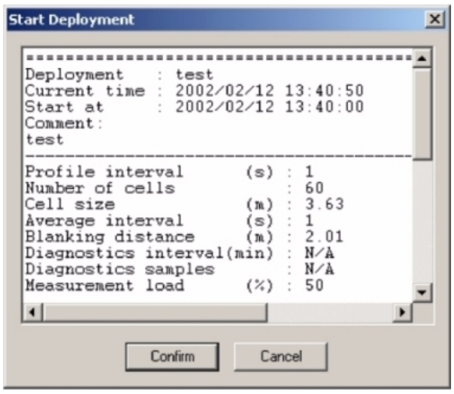
File wrapping
If checked, data are logged to the internal instrument recorder in ring-buffer mode. This ensures that the recorder always holds the latest data. If not checked data logging will stop when the recorder is full.

The **deployment planning** is described under the previous section for the Standard tab.

5.2.2. Start recorder deployment

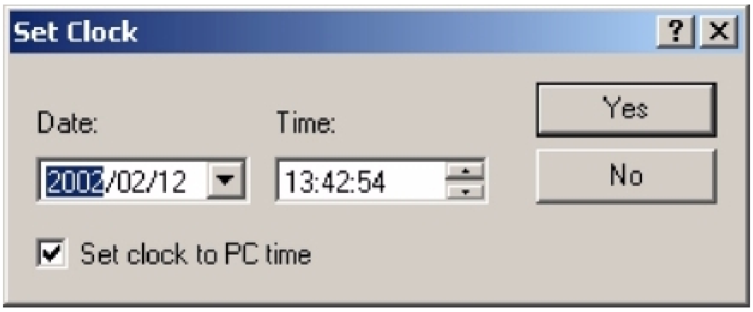
Before you start a deployment, either define a new deployment configuration or load a saved configuration from memory. Then click "Deployment", "Start Deployment", and enter a short deployment name (used for the internal data file). The program allows you to set the Aquadopp's internal clock (see below), and then gives you a final review on the instrument set-up, just before you start it up. The software creates a log file using your deployment name with the set-up parameters. You should keep this file in your records.





<u>Setting the Time and using Delayed Start-up</u>

The software allows you to set the Aquadopp time and a delayed start-up time when you start the deployment. The easiest way to set the Aquadopp time is to make sure the PC time is set correctly before you start the deployment. An important reason to set the correct time may be to synchronize a group of Aquadopps with one another or with other sensors. Refer to the previous section for more information about synchronization.



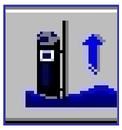
Use a delayed start-up either to make sure the Aquadopp starts data collection on the hour or to conserve batteries for a deployment that starts some time in the future. You can start an Aquadopp deployment well in advance of when you plan to install it on site, and use a delayed start-up to conserve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

Verifying Operation with a Radio

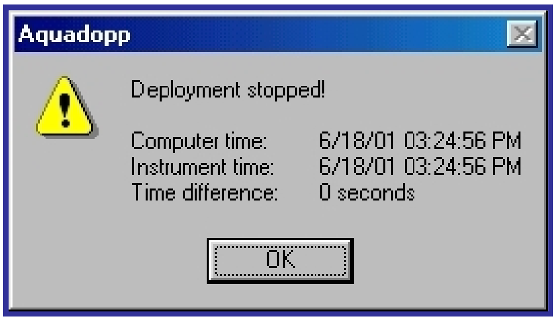
You can easily check that the Aquadopp is running with a radio. The Aquadopp transmits energy at 2 MHz, and a radio will pick up signals at this frequency and at sub-harmonics such as 1 MHz, 500 kHz and 250 kHz. Both 1 MHz and 500 kHz are inside the AM radio band. Be sure to listen first with the Aquadopp on the bench to choose the best frequency and to learn to identify the Aquadopp's distinctive sounds.

5.2.3. Stop recorder Deployment

Before you tell the Aquadopp to stop collecting data, verify that the computer time is accurate. The software will compare the computer time with the Aquadopp time, and you can use this information to quantify clock drifts. After you recover your Aquadopp, use the Aquadopp software to stop recording. After you connect the Aquadopp to your computer, click "Deployment", "Stop Recorder Deployment" or click the following shortcut button:

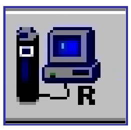


When the program tells the Aquadopp to stop collecting data, it displays both the Aquadopp time and the computer time. Keep a record of the differences.



5.2.4. Recording Data Internally as a Backup

You can set the instrument to record data internally as it sends data out the serial port. To do this, use "Online", "Start with recorder" or click the following shortcut button:

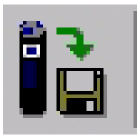


If you have an internal backup battery, then you can record backup data in the event of power failures.

The Aquadopp has two modes of internal recording. The standard mode is to stop recording when the recorder is full. The Aquadopp can also use a wrap-around mode in which it keeps only the most recent data, overwriting the oldest data when the recorder is full. Wrap-around data recording makes good sense when you are backing up external recording against the possibility of power failures.

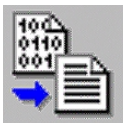
5.2.5. Getting Data out of the Aquadopp

Use the Aquadopp software to retrieve data from the instrument. To do so, click "Deployment", "Data retrieval" or click the shortcut button:



In a moment, you will see a list of the recorded data files - the most recent file is the last one listed. Highlight the file(s) you want, click "Retrieve" and select the location for the file. The software recovers the files you select and puts it on your hard drive.

You can immediately convert the data into an ASCII format by clicking "Deployment", "Data Conversion" or click the shortcut button:



When conversion is complete, you will find three files on your hard drive:

- Data file (".DAT")
- Header data (".HDR") including set-up parameters
- System data (".SYS").

5.2.6. Finish operations

Stop data collection using one of the "Stop" buttons before you store an Aquadopp.

NOTE: To conserve your battery when the Aquadopp is on the shelf, be sure it is not in data acquisition mode.

5.2.7. Erasing Recorded Data

Erase the recorder by clicking "Deployment", "Erase Recorder". Before you do this, make sure that you have recovered your data, that the data file has not been corrupted and that you have stored a backup copy.

5.3. Interpret and analyse Data

NOTE: We highly recommend that you use our internet-page to get access to the latest tech-notes and user experiences regarding data analysis.

5.4. Operational concerns

5.4.1. My data doesn't look right

The Aquadopp 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 (around 20-30 counts).

If your data doesn't look right, particularly if you have unrealistic vertical velocities, consider the possibility that one or more of the beams were blocked. If the blockage is somewhere inside the measurement cell of one beam, you should see elevated signal strength for that beam. If the blockage is closer to the instrument, the signal strength may not look very different from the other beams, or it could be substantially reduced. If you can collect data in real time while the instrument is deployed, run the range check function to see if there are any obvious obstructions in any of the beams.

5.4.2. Boundaries.

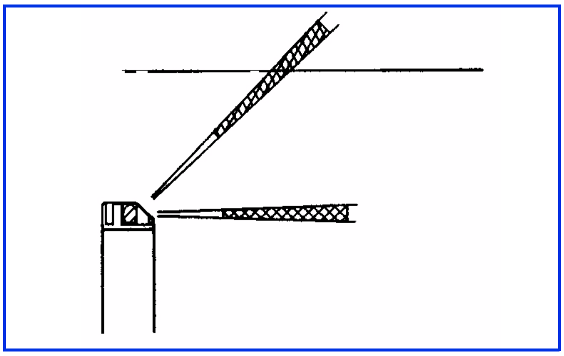
In open waters, boundaries are not a concern, but if you want to use the Aquadopp near the bottom or surface, you should think about the boundaries as you design your experiment.

NOTE: If one of your beams crosses a hard boundary, whether surface, bottom or wall, data from that beam will be bad. There are several different ways to improve the situation:

1. Change the orientation. For example, you can turn the Aquadopp upside down.
2. Use XYZ coordinates instead of ENU and coordinate transform your data later. You could use this approach when the water level changes a lot, and ignore the vertical velocity when the surface is in beam 3. This approach works only if your system is fixed in place and not allowed to move while measurements are taken.

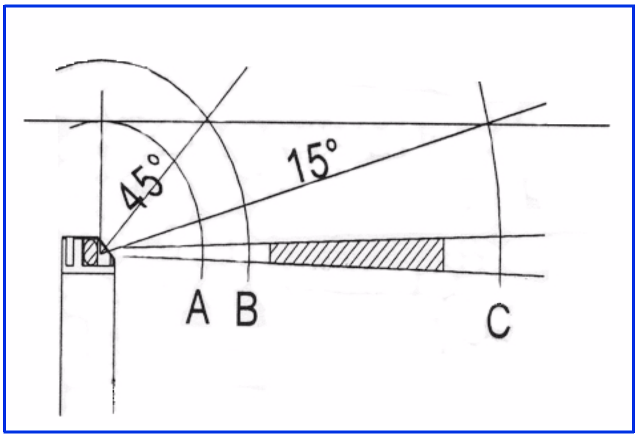
5.4.3. Sidelobes.

Transducer sidelobes are rays of acoustic energy that go in directions other than the main beam. Because the Aquadopp's beams are narrow, sidelobes are not always a factor in your measurements. In general, sidelobes may be unimportant in water with strong backscatter (i.e. sediment-laden rivers), but they may contaminate your data when backscatter is weak.



When the Aquadopp is near a boundary, avoid letting the measurement cell touch the boundary.

If you are concerned about sidelobes, the following figure illustrates how to minimize the influence of sidelobes on your data, when you are near the water surface.



The figure defines three positions along the beam.

1. Position A is where the distance along the beam equals the distance straight up to the surface.

2. Position B is the distance along the beam equal to the distance to the surface along a 45° angle.

3. Position C is the distance along the beam equal to the distance to the surface along a 15° angle.

Sidelobes returning vertically from a smooth water surface (Position A) pose the most likely source of contamination. Even though sidelobes in this direction are very weak, a smooth water surface is the strongest reflector you will encounter - it behaves like a mirror. As the angle increases (i.e. between Positions A and B), the strength of the surface echo weakens substantially. Inside a 15° cone around the beam (Position C and beyond), sidelobes begin to increase and your beam may begin to be affected by surface velocities. This may not be such a problem because the surface velocity is typically close to the velocity just below the surface.

If you turn the picture upside down and place the Aquadopp near the bottom, the situation changes. Echoes vertically from the bottom are typically much weaker than the mirror reflection from the surface, so contamination at Position A will be less serious. However, contamination at Position C could be more serious, for two reasons:

- Backscatter from hard reflectors (i.e. rocks) can be large.
- The bottom does not move.

5.4.4. 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 diagnostic data. The first measurement made using diagnostic data is made without transmitting - its signal strength gives you the noise level directly.

If grounding problems cause elevated noise levels, you may be able to reduce your problems by coiling your 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 are not normally a problem in the field.

5.4.5. Mooring tilt

Sometimes moorings tilt excessively or even fall over. If the Aquadopp's tilt reading is 20º or less, your data should be okay. Tilt readings between 20º and 30° mean that the Aquadopp is no longer able to read the tilt accurately which means that your data may be unrecoverable.

5.4.6. 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 if you record diagnostic data and use this information to identify data that might be questionable. If you discover that mooring vibration is a problem, you should try to find ways to reduce the vibration. Diagnostics data then gives you the means to verify improvement.

5.5. Troubleshooting

5.5.1. Simple Problems

Most initial problems can be traced to forgetting to power the system, the DB-9 connector falling out of the computer, or using the wrong serial port. Remember that new Aquadopps ship with the battery disconnected.

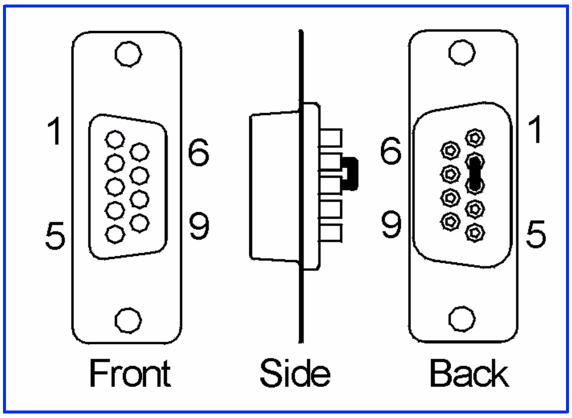
Computers don't always behave as they should and not all of them have serial ports available. If one computer is giving you a problem, try another one instead.

5.5.2. Problems detecting the instrument on the Serial Port

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

If you see a response consisting of garbled text or strange characters, then the Aquadopp and terminal program are probably using different baud rates - you could experiment by trying different baud rates ("Terminal", "Serial port"). If you suspect your computer is having problems, try a different one. You can also verify your serial port and cable with a serial loop-back test.

Serial loop-back test
The serial loop-back test verifies that the serial port can receive the same characters it sends. First, make a loop-back connector (Figure below) and plug it into your serial port. Run the test by typing characters - whatever you type should be echoed to the screen. When you remove the connector, the characters stop echoing back.



Make a serial loopback connector by soldering pins 2 and 3 together, as shown.

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

Test your serial cable the same way. 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 adapter in series with the cable (which crosses wires 2 and 3 back).

6. MAINTENANCE

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

6.1. Preventive maintenance

6.1.1. Cleaning

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

Check the pressure sensor and remove any dirt in the two front holes.

6.1.2. Replacing the desiccant

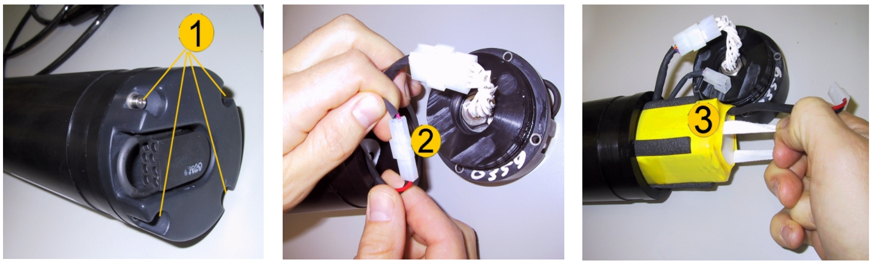
Keep water out of the open pressure case. Both fresh and salt water can corrode the circuitry.

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

6.1.3. Installing/changing batteries

NOTES: 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 center of your PC monitor 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.



The Aquadopp is shipped with a battery pack installed in the pressure case, but disconnected. The following procedure outlines how to connect the battery pack or to install a new one.

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

2. Disconnect the 2-pin connector (2) and pull the old battery (3) 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.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.

   CAUTION: Be careful of the O-ring and the O-ring surfaces.

5. Test communication with the Aquadopp's built-in terminal emulator program by sending a 'break' command to the instrument. If it is wired correctly then you should see the Aquadopp'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. When the instrument responds to a 'break' properly then the communication lines are correctly connected. An easy alternative for using the terminal emulator is to read the configuration file directly from the instrument ("Deployment", "Planning", "Load from instrument"). If the instrument is set for a different baud rate than the software expects, it will search for the correct baud rate and connect automatically.

6. 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.

7. Check and/or reset the clock if necessary.

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

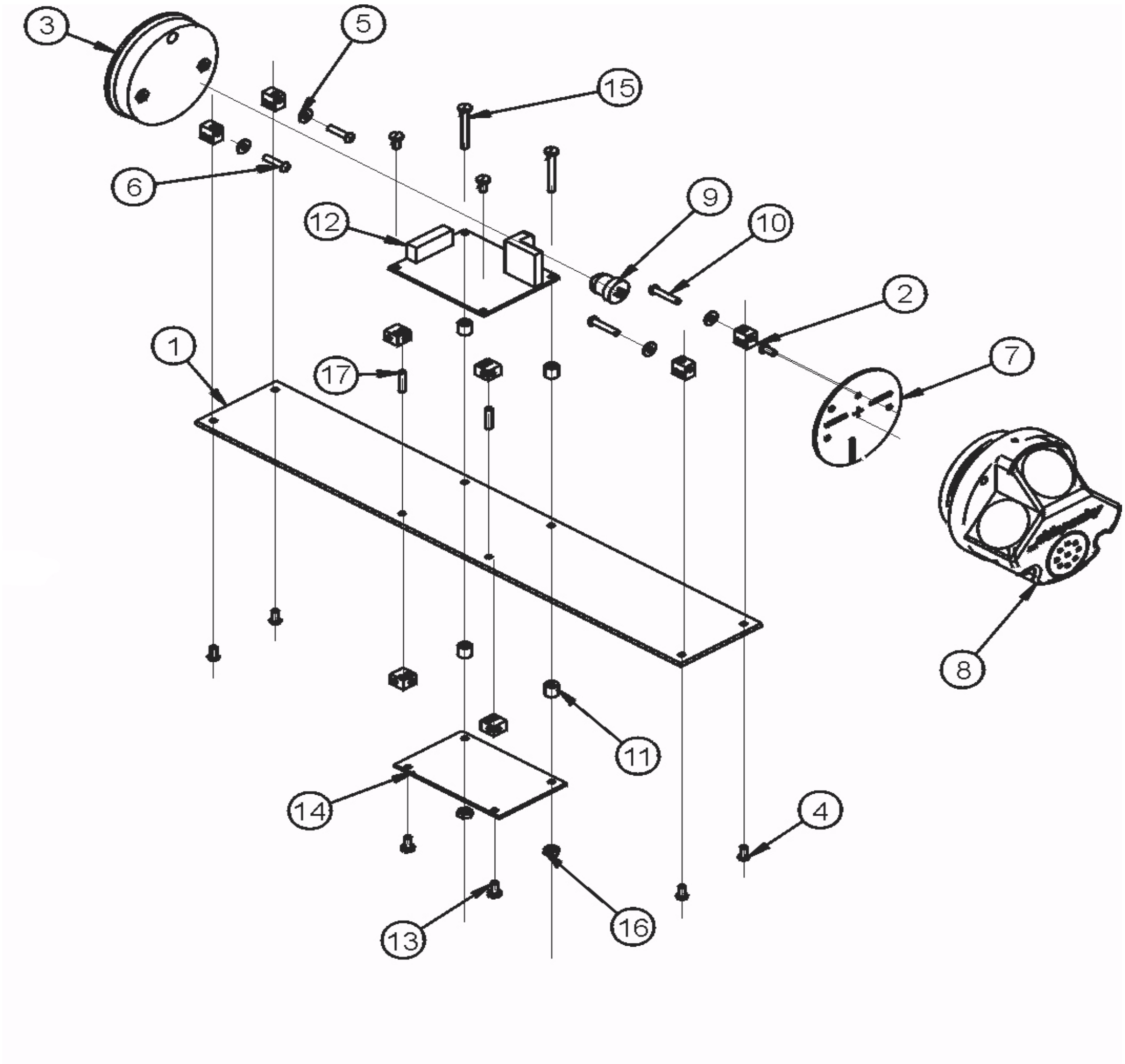
CAUTION: If you have lithium batteries, keep in mind that you must be very careful and that disposal requires special precautions and/or procedures. Rules for disposal of batteries, especially lithium batteries, vary from country to country.

6.2. Corrective Maintenance

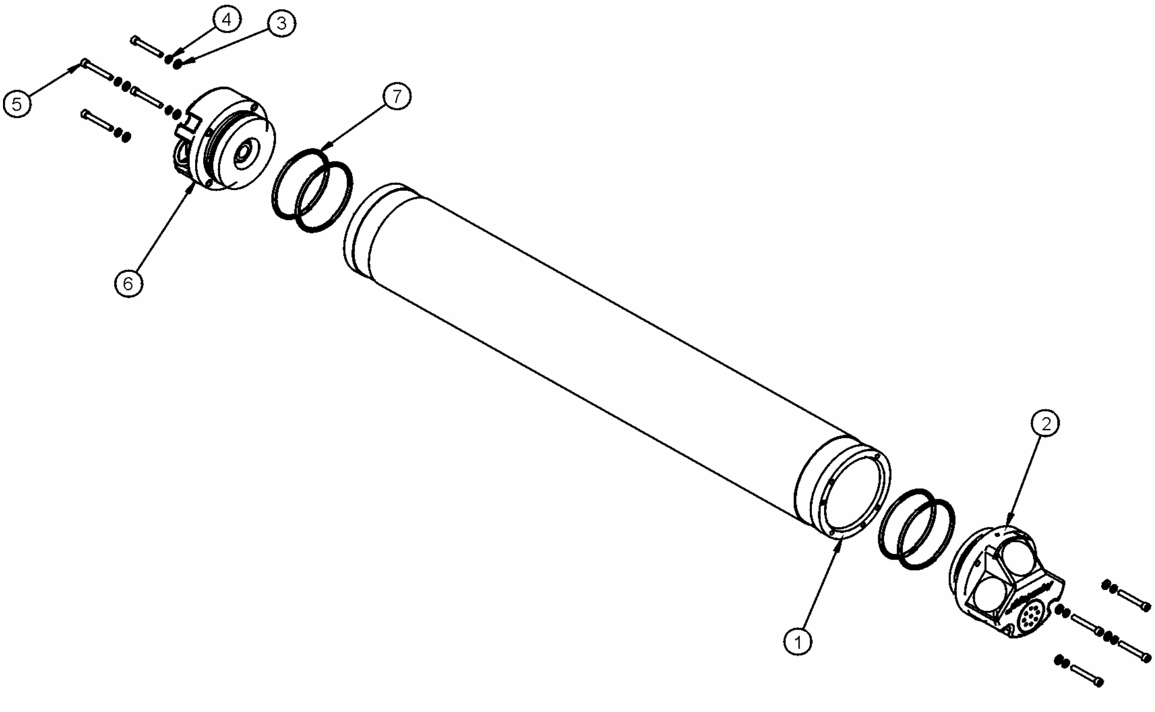
Only qualified personnel are allowed to perform corrective maintenance activities. Please refer to the separate service manual or contact NORTEK for further assistance.

7. SPARE PARTS

Always use the spare part number (next pages) when ordering spare parts from NORTEK.



Item #	Title	Part Number	Material	Quantity
1	Aquadopp Main Board	N2001-003		1
2	PCB mounting block	N2001-008	Delrin POM	8
3	Aqua PCB Bulkhead	N2011-014		1
4	4-40x1/4" Button head	92949A106	18-8 SS	5
5	#4 Flat Washer	92141A005	18-8 SS	4
6	4-40x1/2" Button head	9249A110	18-8 SS	2
7	Paradopp Head PCB	N2002-003		1
8	Aquadopp Std. Head assy.	N2011-005		1
9	Paradopp Tilt Sensor	A166004-B-002		1
10	4-40x5/8" Button head	92949A112	18-8-SS	2
11	#4x1/4" Nylon Binding Hd.	95000A106 Binding	Natural Nylon	4
12	Compass	TCM-2-20		1
13	4-40x1/4" Nylon Binding Hd.	95000A115 Binding	Natural Nylon	4
14	Aqua/Vector Recorder PCB	N2012-003		1
15	4-40x1" Nylon Binding Hd.	95000A115 Binding	Natural Nylon	2
16	#4 Nylon Nut	94812A112	Natural Nylon	2
17	4-40x1/2" Cup Point	92311A110	18-8-SS	2



Item No	Title	Part Number	Material	Quantity
1	Aquadopp Housing	N2011-007	Delrin (POM) Black	1
2	Aquadopp Std. Head Assy.	N2011-005		1
3	#6 Titanium Washer		Titanium gr.2	8
4	#6 Spring Washer		Titanium gr.2	8
5	6-32x1" Titanium Bolt		Titanium gr.2	8
6	Aquadopp Endbell Assy.	N2011-003		1
7	O-ring 55,25 x 2,62		Nitrile N70	4

8. OPTIONAL CONFIGURATIONS AND FEATURES

8.1. Active-X components

If you wish to create real-time software to operate an Aquadopp, NORTEK will provide you with Active-X controls which you can integrate into Windows-based software. These software modules give you full control over the Aquadopp and its data structures, and simplify your software development job.

Please contact NORTEK for further information.

8.2. Available Head Configurations

8.2.1. Symmetric sensor head

Symmetric sensor heads are used to measure above or below the Aquadopp. The geometry assures a precise definition of the vertical extent of sample area. The head is typically used for Aquadopps mounted in bottom frames.

8.2.2. 2D side-looking Aquadopp head

The 2D side-looking Aquadopp head is used to measure 2D flow away from walls or boundaries. Typical applications are river or channel flow monitoring where the Aquadopp is mounted on the channel wall, protected from floating debris but where the actual measurements are made in the free flow.

8.2.3. Asymmetric Aquadopp head

The asymmetric Aquadopp head is used in situations where the sample area is best located above (or below) the instrument and over to the side. An example is buoy mounted Aquadopps, where the measurement area is best positioned both below the hull and away from the anchor chain.

9. RETURNING THE INSTRUMENT FOR REPAIR

1. Please contact Nortek for Return Merchandise Authorization (RMA number).
2. Please use the Proforma Invoice template on the following page or make your own invoice containing the same information.
3. Please enclose copies of all export documents inside the freight box.

IMPORTANT: **NORTEK AS does not cover freight insurance on repairs.** Please make sure your goods are insured before shipping. **NORTEK AS is not liable if the instrument is damaged or disappear during shipping.**

We will insure the instrument upon returning the goods to you and invoice you along with the freight cost.

If the instrument is under warranty repair the return freight and insurance will be covered by NORTEK AS.

PROFORMA INVOICE

SENDER	**RECEIVER**	
Name:	**Name:**	Nortek AS
Address:	**Address:**	Industriveien 33
City:	**City:**	1337 Sandvika
Country:	**Country:**	Norway
Tel.:	**Tel.:**	+4767556200
Fax:	**Fax:**	+4767546150
Ref.:	**Ref.:**	
Date:	**Units:**	
Freight forwarder:	**RMA no:**	
	Customs account no:	28605-56
AWB no.:	**VAT/com-pany no:**	976119185

Description:	**Value:**

Total value:

NOT A SALE - TEMPORARY EXPORT TO NORWAY FOR REPAIR

Place:	**Exporters name:**
Date:	**Exporters signature:**