EASYQ RIVER FLOW MONITOR

USER MANUAL

www.nortek-as.com

NORTEK AS

Nortek AS
Industriveien 33
1337 Sandvika
Norway

Phone: +47 67 55 62 00
Fax: +47 67 54 61 50
E-mail: inquiry@nortek.no
Web: www.nortek-as.com

TABLE OF CONTENTS

1. INTRODUCTION

Thank you for purchasing a NORTEK EasyQ River Flow Monitor.

The EasyQ 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. The water level is detected by measuring the time it takes for an ultra-short pulse to reach the surface.

Getting started

- Before you start using the EasyQ, please familiarize with the Monitor by reading Part 1, 2 and 3 of this user manual.
- Perform tests of the EasyQ according to procedures in Part 4.
- Start using the EasyQ according to procedures in Part 5.
- Perform regular maintenance according to procedures in Part 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 EasyQ 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 EasyQ, first try to identify the problem by using the troubleshooting ideas outlined in 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 EasyQ or any module is returned to the factory.

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 merchant-ability 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.

1.5. Copyright statement

2. MAIN DATA

2.1. Weight and outline dimensions

Transport weight: 7 kg

Transport box dimensions: 38 x 70 x 11 cm

Weight in air: 1.7 kg

Weight in water: 0.7 kg buoyant

Length: 590 mm

Diameter: 75 mm

2.2. Power

DC Input:	9-16 VDC
Typical mean power:	50-500 mW
Transmit power:	0.3-20 W, adjustable over 4 levels
Battery capacity:	18 AA Alkaline cells/50 Wh
New battery voltage:	13.5 VDC
Duration:	40 days at 50 mW

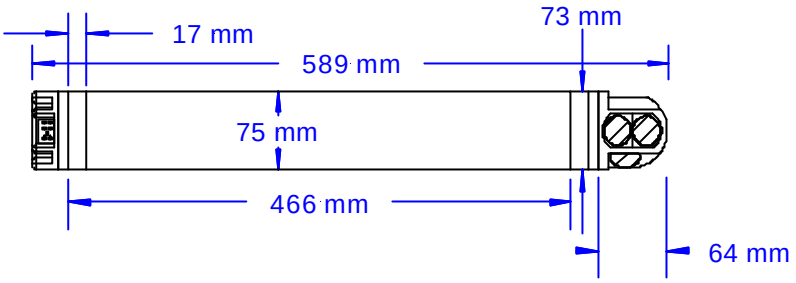
The battery is able to sustain sleep state for 4 years (RS232 only).
The AC power adapter requires a 230V/60Hz voltage supply.

External Power

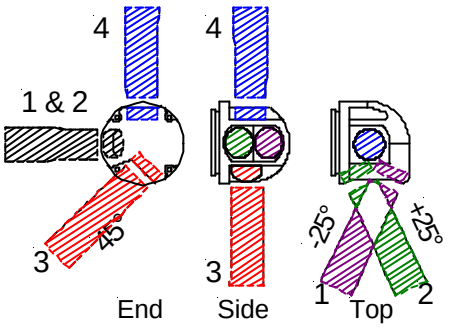
You can supply external power to the EasyQ. If you use an internal battery to backup data collection, an external supply of 15 VDC provides a higher voltage than the battery pack, which prevents the internal pack from discharging. Then, if external power fails, the internal battery pack takes over and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

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

2.3. Dimensions and Beam Locations



EasyQ dimensions



EasyQ beam orientations and numbering.

2.4. Materials

Standard model: Delrin and polyurethane plastics with titanium screws

2.5. Sensors

Temperature (thermistor embedded in head)

Range:	-4°C to 30°C
Accuracy:	0.1°C

Tilt (liquid level)

Accuracy:	0.2° at 0° tilt; 0.5° at 10° tilt

Pressure (piezoresistive sensor)

Range:	0-10 m
Accuracy:	0.025% of full scale
Resolution:	1 mm

2.6. Data Communication

I / 0	RS232, RS422, SDI-12
Baud rate:	9600 standard, 300-115200 (user setting)
User control:	Handled via EasyQ software

2.7. Water Velocity Measurement

Range:	± 10 m/s
Accuracy:	1% of measured value ± 0.5 cm/s
Minimum integrating time:	1 s
Number of cells:	3
First cell starting position:	0.3-10 m
Cell size:	0.4-2 m
Amplitude Resolution:	0.45dB
Dynamic range:	90 dB

2.8. Stage

Range:	0.15-10m
Accuracy:	3 mm
Resolution:	1 mm
Integrating time:	1-120 s
Data quality parameter:	User selectable quality threshold

2.9. Echo sounder (diagnostic mode)

Number of beams:	4
Number of cells:	50
Cell size:	0.2 m

2.10. Transducer

Frequency:	1 or 2 MHz
Beam width:	3.4°/1.7°

2.11. 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.

2.12. SDI-12 mode

Compatible with the SDI-12 protocol, Velocity and stage data accessible with SDI-12 commands. Diagnostic mode or recorder backup not implemented in SDI-12.

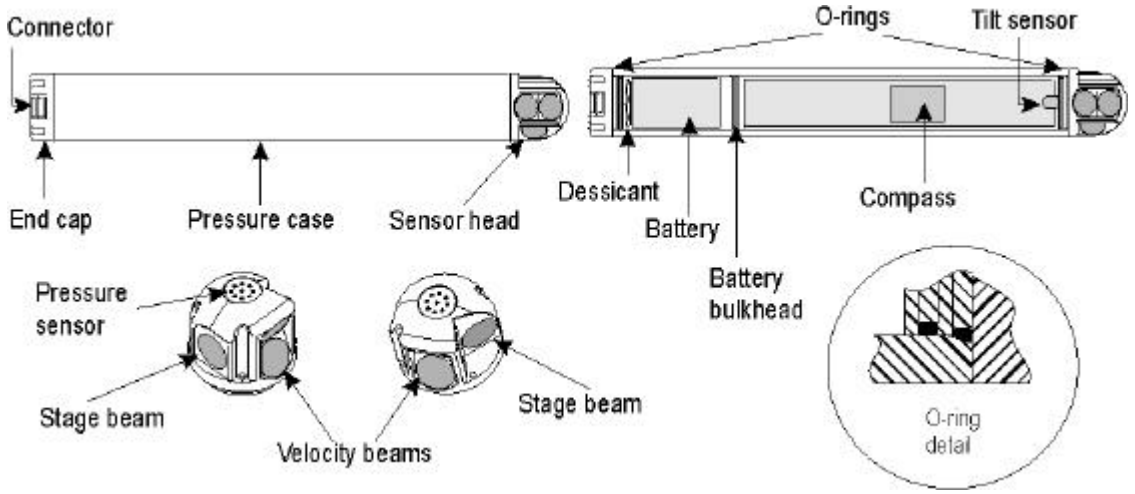
2.13. Data Recording

Capacity:	2 MB, expandable to 21 MB or 78MB
Data record (bytes):	Velocity: 30+6x Ncells
	Stage: 34
	Echo sounder: 234
Modes:	Self-contained recording with internal batteries. Backup during online data collection.

3. TECHNICAL DESCRIPTION

3.1. EasyQ components

Major parts of the Monitor are shown in the figure below:



The figure shows an outside view of a standard EasyQ. 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 four 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 EasyQ is designed for horizontal orientation. The tilt sensor can be inverted 180 degrees - you can use it pointing up or down.

Temperature sensor
The temperature sensor, standard on all EasyQ's, is mounted internally in the sensor head.

Pressure sensor

The pressure sensor is mounted in the EasyQ sensor head, in the center of the transducers.

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. 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.

3.1.4. 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.

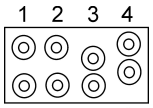
3.1.5. Power and communication cable

The 8-conductor cable enables you to supply external DC power (9-16 V) and to connect an external computer to the EasyQ via RS232 serial communication or data logger via an SDI-12 interface.

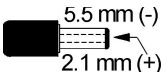
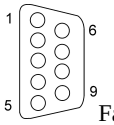
Cable Wiring

The table gives the pin assignments for the EasyQ's 8-conductor cable. Its power and internal battery lines are diode protected, so you don't have to worry about wiring the EasyQ's power backwards - this will not damage your instrument

Table 1: Wiring of 8-conductor cable for SDI-12 and RS232 communication.

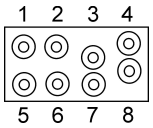


Pin numbers, looking at the pins

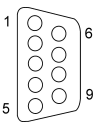
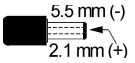
Underwater connector			Termination		
Pin number	Wire color	Purpose			
1	Black	Power ground			
2	White	Power +			
3	Black	RS232 Tx	Pin 2	9-pin Dsub, female	 Facing sockets
4	White	RS232 Rx	Pin3		
5	Black	Data Ground	Pin5		
		SDI-12 Ground	Black wire		
6	White/purple	SDI-12	Green wire		
7	Black	Not used			
8	White/orange				

Tx refers to the transmission from the EasyQ to the PC and RX refers to data transmission from the PC to the EasyQ.

Table 2: Wiring of 8-conductor cable for RS422 communication.

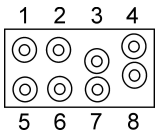
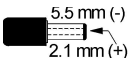


Pin numbers, looking at the pins

Underwater connector		Purpose		Termination	
Pin number	Wire color			Pins	Description
3	Black	RS422 Tx+	twisted pair	2	9-pin Dsub, female  Facing sockets
4	White	RS422 Tx-		3	
7	Black	RS422 Rx-	twisted pair	1	
8	White/orange	RS422 R+		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		

Tx refers to the transmission from the EasyQ to the PC and RX refers to data transmission from the PC to the EasyQ.

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			

Tx refers to the transmission from the EasyQ to the PC and RX refers to data transmission from the PC to the EasyQ.

3.2. Functional description

This section briefly describes some of the underlying principles that control the operation and application of the EasyQ River Flow Monitor.

3.2.1. Modes of operation

- Command Mode
- SDI-12 Mode
- Data Acquisition Mode
- Power Down Mode

Command Mode
An EasyQ 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.

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

SDI-12 Mode
When in SDI-12 mode, the EasyQ will only communicate with an SDI-12 data logger. You must use the standard EasyQ software to prepare the EasyQ for SDI-12 communication, then tell the EasyQ to switch to SDI-12 mode. To get the EasyQ out of SDI-12 mode, you must use the standard software's "Stop Data Collection" command.

Data Acquisition Mode
You can use the EasyQ software to put the EasyQ into any of three data acquisition modes. The three modes include recording data internally, sending data out the serial port, or doing both. When you initiate a deployment sequence, the software converts your setup parameters into binary structures, downloads the structures to the EasyQ and tells it to start data collection.
To get the instrument out of data collection mode, use the "Stop" commands in the EasyQ software. You might notice that sending a break to an EasyQ 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 deployments. The EasyQ automatically powers down from command mode after about five minutes of inactivity.

To conserve your battery when the EasyQ 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 EasyQ.

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

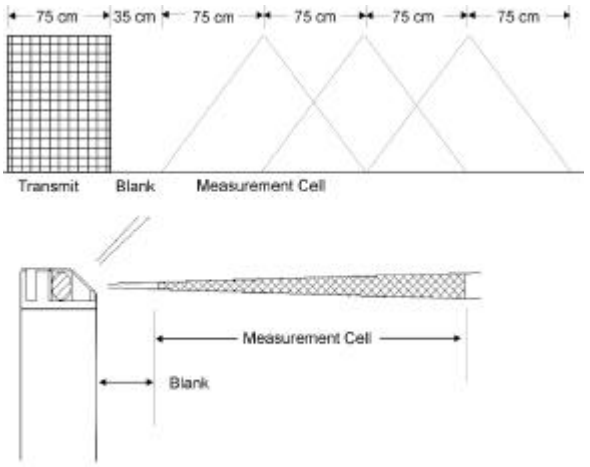
3.2.2. Using the Doppler Effect

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 EasyQ 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, suspended sediment or small bubbles. Long experience with Doppler current sensors tells us that the small particles the EasyQ 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. *With a cell size of 75 cm, and 35 cm blanking, the mid point of the first cell is situated 35 + 75 = 110 cm away from the sensor head. The second cell is 35 + 2 x 75 = 185 cm, and so forth.*

Doppler current sensors use large transducers (relative to the wavelength of the sound) to obtain narrow acoustic beams. The EasyQ's beams have a beam width of 1.7° for 2MHz systems and 3.4° for 1Hz systems. 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 EasyQ measures horizontal velocity with two horizontal beams.

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.

Stage is measured using the vertical beam. Short pulses are sent towards the surface, and the distance is calculated based on the arrival time of the sharp surface echo.

Bottom changes are measured using the slanted beam pointing towards the river bottom, the same way as with stage.

Coordinate System

The EasyQ measures velocity components parallel to its three beams, or in beam components, but it normally reports data in XY components. Assuming the EasyQ is aligned with the flow, the X-component should be downstream and the Y-component across-stream. Keep in mind that, depending on which side of the stream you are on, the downstream velocity may be positive or negative.

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

Velocity Uncertainty.

The EasyQ 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 EasyQ is typically a fraction of 1 cm/s. *The EasyQ 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 EasyQ software predicts only the instrumental error. In many situations, the environment itself dominates the short-term error.

In turbulent flows 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 is an example:

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. Data handling

The EasyQ software creates binary files, which are automatically converted to ASCII format files:

- The *.hdr file is a self-documented table.
- The *.dat files contains velocity and pressure data at the full sample rate. To minimize the storage requirements, the EasyQ only samples the velocity and pressure data at the user specified sampling rate.
- The *.sys files contains system data such as the time/date, compass, tilt, temperature, battery voltage, etc. Data are only sampled once per second.

You will find that the ASCII files are easy to import into most spreadsheets and data analysis programs.

NOTES: You can synchronize the .dat and .sys files by counting N dat records for each .sys record (where N is the sample rate in Hz.).

If you need to know the detailed binary format, ask us for a copy of our *Paradopp Interface Manual.*

3.2.5. SDI-12 Data Logging

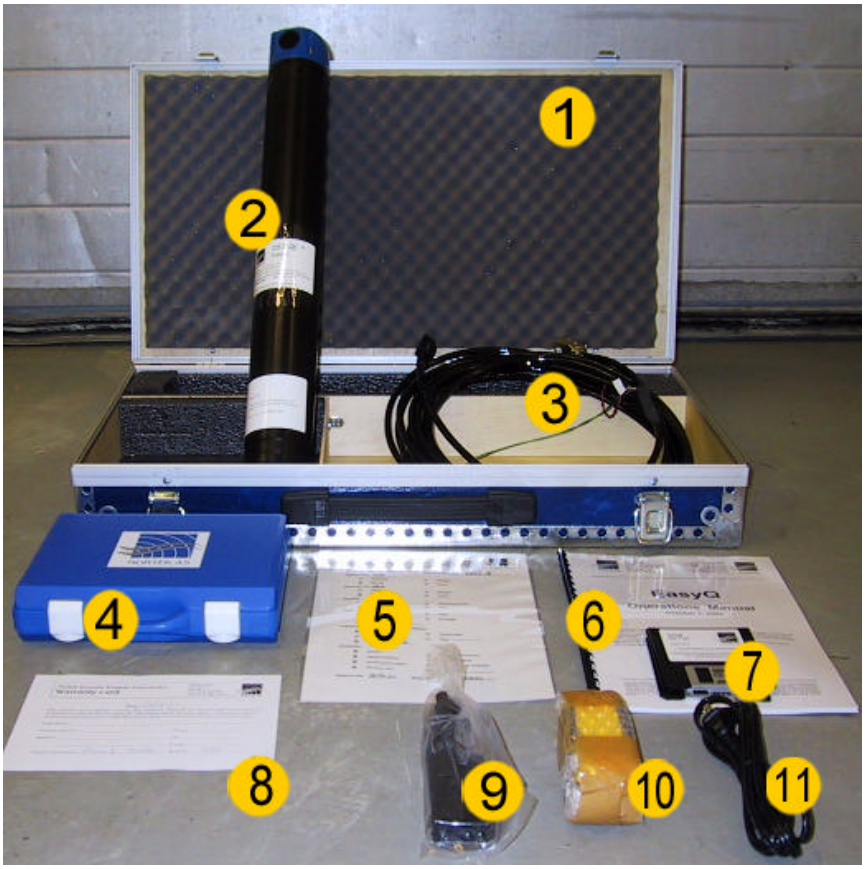
The EasyQ implements all SDI-12 commands except for concurrent measurement commands (C). The EasyQ has two data collection commands, one for velocity and one for stage. You can get an up-to-date SDI-12 specification, including a description of how to use the SDI-12 commands, from http://www.sdi-12.org. You can obtain the version 1.2 specification from NORTEK.

4. PREPARATION

Please perform the following procedures to prepare your new EasyQ River Flow Monitor for future successful operation.

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

4.1. Reception control



Please check that the following equipment is included in the delivery (next page):

1. Transportation box
2. EasyQ current meter
3. External power/signal cable
4. NORTEK equipment storage box
5. Packing list
6. EasyQ user manual
7. EasyQ 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 EasyQ 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 EasyQ 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 EasyQ to verify that the readings are sensible.
   - Temperature should be close to your room temperature, assuming the EasyQ 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).

4.3.1. Calibration

The only sensor that you can calibrate is the pressure sensor. You can calibrate its offset, either at atmospheric pressure or after you install it. Calibrate it by clicking "Test", "Pressure Sensor Offset".

4.3.2. Preparation for Running In-situ Tests

Start the planning module by clicking "Deployment", "Planning", "Use Existing". The main purpose of the initial setup is to set the EasyQ's power levels and the stage threshold it uses for testing. Use the following sequence:

1. If the Advanced Menu is showing, select the Standard Menu instead and deselect the check box: "Use Advanced Settings".
2. Check the box to select external power (vs. battery power).
3. Enter the "Estimated Maximum Depth" of water, above the EasyQ, in meters.
4. Set the Stage "Quality Threshold" to 100.

When you set the estimated maximum depth to less than 5 m (about 16'), the program uses the lowest power setting for its stage measurement. Low power is better for stage measurements in shallow depths because the strong echo from the surface can saturate the receiver electronics. Because you are not limited by power, the Standard Planning menu always uses the highest power level for velocity. High power will not hurt velocity data quality, and it will give you the longest possible range.

4.3.3. Stage Check Test

The Stage Check assists you to adjust the EasyQ's tilt, pressure offset and stage threshold. The Stage Check uses the power and threshold settings set in the planning menus, but updates every second. The figure shows a typical Stage Check display. Here is a good sequence to follow to tune up your installation:

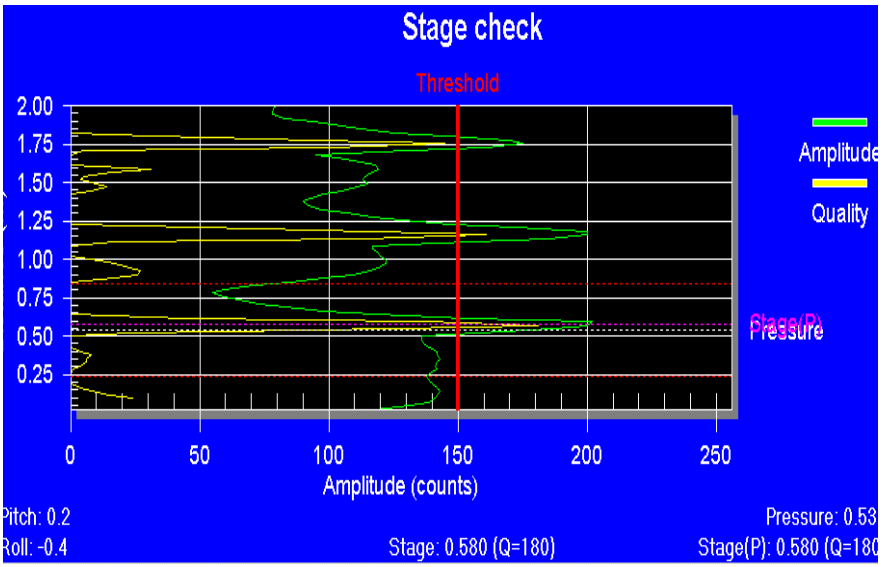
1. Adjust the total tilt to around 1° if possible, 3º maximum. Total tilt = $(Pitch^2 + Roll^2)^{½}$

2. Adjust the pressure offset to make it match the stage reading to within around 0.05 m. If you know that the barometric pressure is higher or lower than normal, you can adjust the pressure reading accordingly. If the air pressure is higher than normal by 1" of mercury, or 33 mbar, increase the pressure reading by 0.33 m. Remember that the pressure sensor sets a ±0.3 m window within which the EasyQ looks for the stage peak. Also remember that the pressure reading varies with the atmospheric pressure in addition to water level.

3. Adjust the threshold. The stage algorithm rejects data where the stage quality parameter falls below the threshold. A high threshold is less likely to be fooled by debris in the water while a low threshold makes it more likely that the EasyQ will not be able to measure stage at all. At the time of writing this manual, the best range for the threshold appears to be around 80-120, but we expect to learn more in the future.

Stop the Stage Check test by clicking "Test", "Stop Data Collection".

Adjust the pressure offset by clicking "Test", "Set Pressure Offset". After you enter the approximate depth output by the stage sensor, the EasyQ software will run through a short calibration before it changes the pressure sensor's offset.

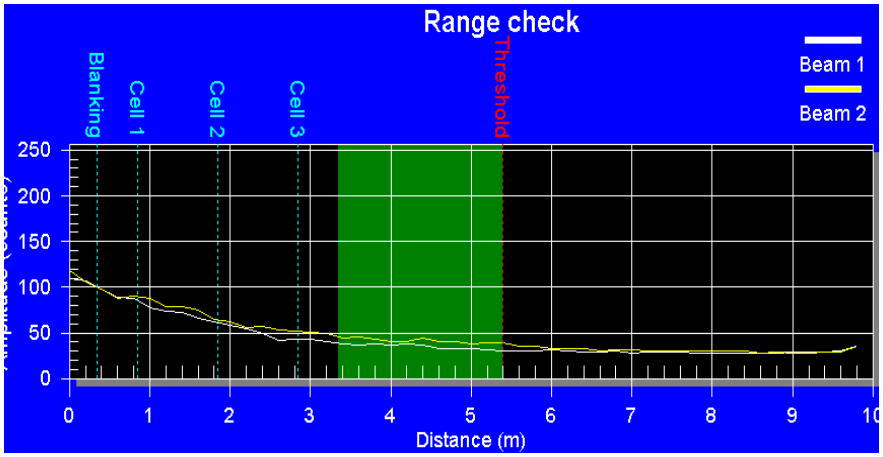


Example display from a Stage Check test. This display shows three successive echoes. The surface is located at a distance of 0.58 m above the EasyQ, in the lowest of the three echoes. The position of the Stage reading is indicated with a horizontal white dashed line. The second and third echoes are multiple bounces. A dashed magenta line shows the depth, based on the pressure sensor, and two red dashed lines show the bounds set around the pressure sensor. The dashed green line, labeled "Amplitude", shows the echo intensity and the dashed yellow line, labeled "Quality", shows the stage quality factor. The heavy vertical red line indicates the threshold quality value. The EasyQ will only accept stage measurements that rise above this threshold.

4.3.4. Range Check Test

The Range Check lets you check the channel to make sure that there are no obstructions in the beams and that you have sufficient backscatter to measure your velocity data. The figure shows a typical Range Check display. In this display, the centers of the three velocity cells are shown with dashed lines, and the region beyond the velocity cells in which you could profile is indicated with the green area. If backscatter is too weak within the velocity cells to allow good velocity data to be collected, the bad region will be shown with a red area. You would then have to reduce your cell size or blanking to keep the cells within the profiling range.

Stop the Stage Check test by clicking "Test", "Stop Data Collection".



Range Check display. The dashed lines show the end of the blanking region and the center of the three velocity cells. The signal strengths from the two velocity beams are shown with white and yellow lines. The EasyQ can collect good data as long as the echo amplitude remains above about 25 counts. The green region shows where velocity data could be collected.

Test communication with the EasyQ's terminal emulator program by sending a 'break' command to the instrument. If it is wired correctly then you should see the wakeup 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 what the software expects, it will search for the correct baud rate and connect automatically.

4.4. Mounting guidelines

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

Grooves are provided at either end of the EasyQ for this purpose, but you can clamp it anywhere along the length of the instrument, so long as you do not obstruct the beams. Protect the instrument by wrapping with a thin sheet of rubber. NORTEK can supply polyethylene clamps that fit into the grooves, which you can adapt to different mounting requirements.

NORTEK supplies some fixtures and clamps, and can provide you with a list of companies who can also produce high quality mounting fixtures and hardware.

4.4.1. Other Mounting Considerations

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

1. When mounting the EasyQ near large obstructions (bridges, piers, walls, etc.), ensure that the acoustic beams do not "see" any obstructions.
2. The EasyQ does not use a compass, so it is not sensitive to nearby magnetic materials.
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 EasyQ's beams.
4. The stage sensor requires at least 150 mm (6") above it to measure water level. 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.
5. The pressure sensor can handle pressure that is about double its maximum reading. For example, the standard 20 m pressure sensor can safely withstand 40 m depth. The plastic housing is safe at depths exceeding 300 m.

4.5. Using long cables

The SDI-12 specification limits cable lengths to 60 m (200').

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 different wiring harness you can get from NORTEK. Install the harness inside the EasyQ between the end cap and the circuit board. Keep in mind that RS422 will require more power.

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.

You should consider the voltage drop across the cable, particularly if you use High power. Design your power supply and cable so that the voltage stays below 16 VDC and never falls below 9 VDC.

4.5.1. Changing the Baud Rate

You are allowed to set two baud rates for the EasyQ. 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 you should 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:

1. Set up the EasyQ and connect it to your computer.
2. Set the baud rate in "Communication", "Baud Rate" to the baud rate you prefer.
3. Start a deployment, and then stop it.

The last step makes the new baud rate permanent. If you remove power and reapply it, the EasyQ will reawake with the new baud rate.

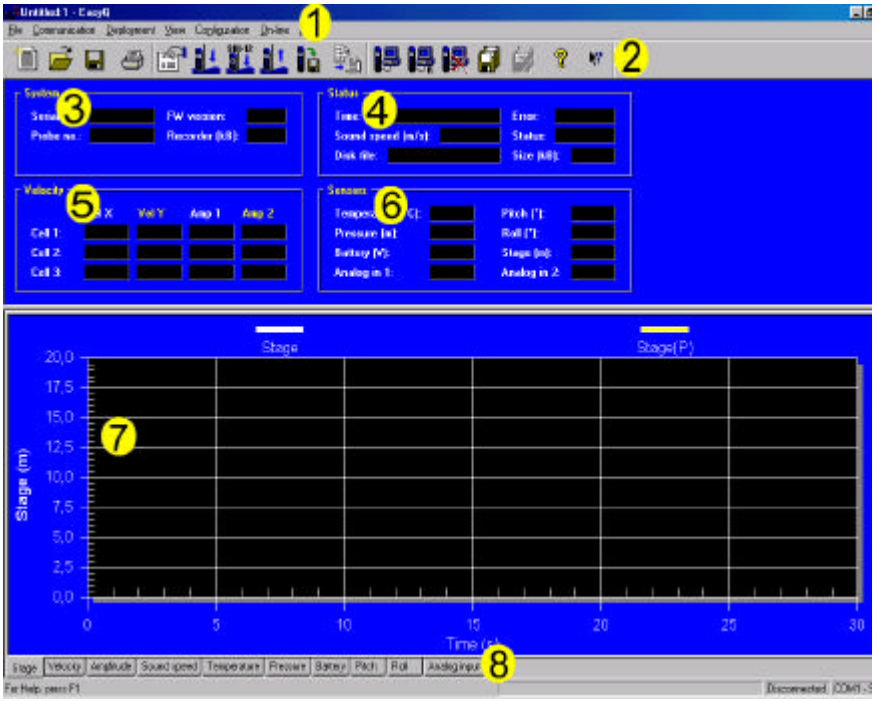
NOTE: If data download is interrupted the EasyQ could be left with a baud rate setting other than the one used for normal communication. Then, when the software tries to connect to the EasyQ, it may spend a few moments searching for the current baud rate.

5. OPERATION

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

5.1. Introduction to the main menu

Operation of the EasyQ River Flow Monitor 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 EasyQ 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 EasyQ River Flow Monitor.
4. The status window displays current system status.
5. The velocity window displays velocity and amplitude 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.

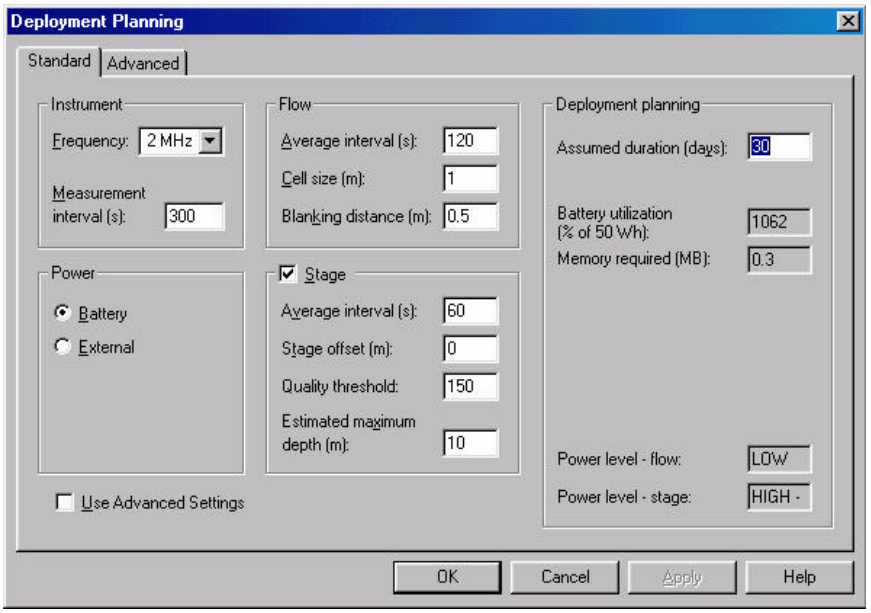
NOTE: Please familiarize with the on-line help system integrated in the EasyQ software.

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

5.2. Data collection

The EasyQ 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 part 6.1.3.
2. Install new desiccant, if necessary. Refer to procedure in part 6.1.2.
3. Test EasyQ according to procedure in part 4.3.
4. Set PC time.
5. Use EasyQ 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 EasyQ time to PC time.
10. If appropriate, set a delayed start-up time.
11. Disconnect the cable and install dummy plug. Insert plug pins with silicone grease.
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. Refer to section 4.4.

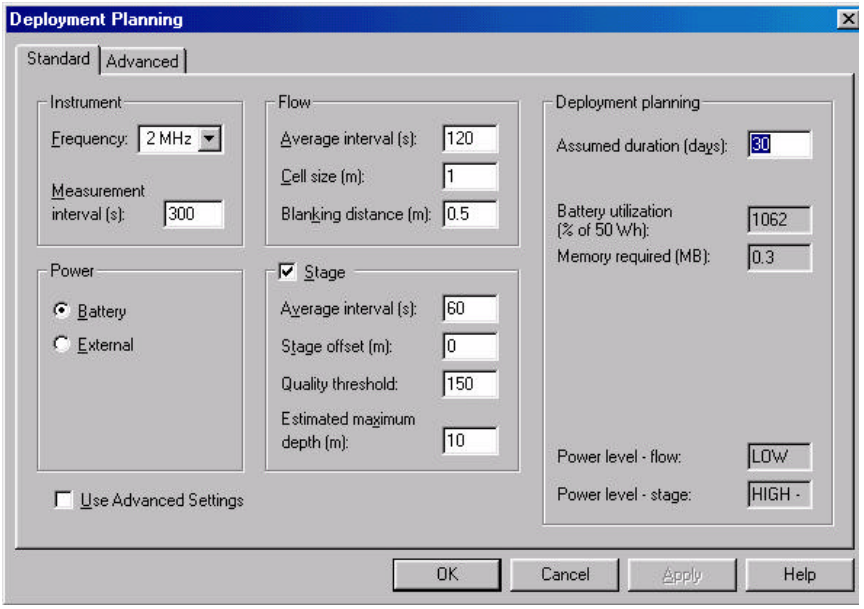


5.2.1. Deployment planning

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).

Standard tab

Measurement interval (s)
The time between successive recorded mean current values. When data are recorded internally or to a PC using the EasyQ software, each recorded sample includes both velocity and stage (if the Stage box is checked). When using SDI-12 mode, velocity and stage measurements are controlled separately, so you can use the measurement interval to represent the approximate time required for the SDI-12 logger to get both velocity and stage values.

Average interval (s)
The time during which the measurement is made. The stage measurement requires 6 seconds in addition to its average interval, so the measurement interval must be at least as long as the sum of the velocity and stage measurement interval, plus 6 seconds.

Cell size (m)
The width of each measurement cell in meters.

Blanking distance (m)
The distance to the beginning of the first measurement cell.

Stage offset (m)
The value you enter here is added to the stage measurement after stage is computed. The stage algorithm first compares measured stage to pressure, and then adds the offset.

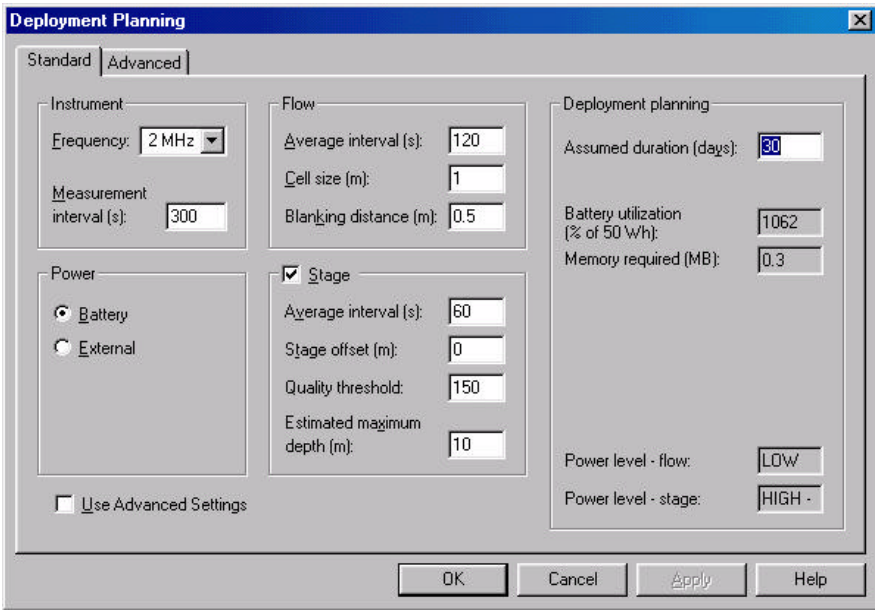
Quality threshold
The stage algorithm looks for the first echo peak for which its quality crosses above this threshold. Stage p looks for the first peak within the window set by the pressure sensor.

Estimated maximum depth (m)
The estimated maximum depth is used to set the appropriate transmit power for stage measurements. Low power is better for small ranges, to prevent the receivers from saturating in response to the strong surface echo. High power gives the EasyQ more reach when water depths get larger.

Battery power, External power
If you select external power, the planning software assumes that your power source is not limited, so it uses high power for velocity profiling. If you select battery power, it assumes that you prefer to minimize energy consumption, so it chooses the lowest power level that should (in typical riverine environments) provide good velocity data. Acoustic energy used for stage measurement is relatively small, so data quality is the only factor considered in stage power level.

Stage (check box)
If you remove the check from this box, an EasyQ will measure velocity only.

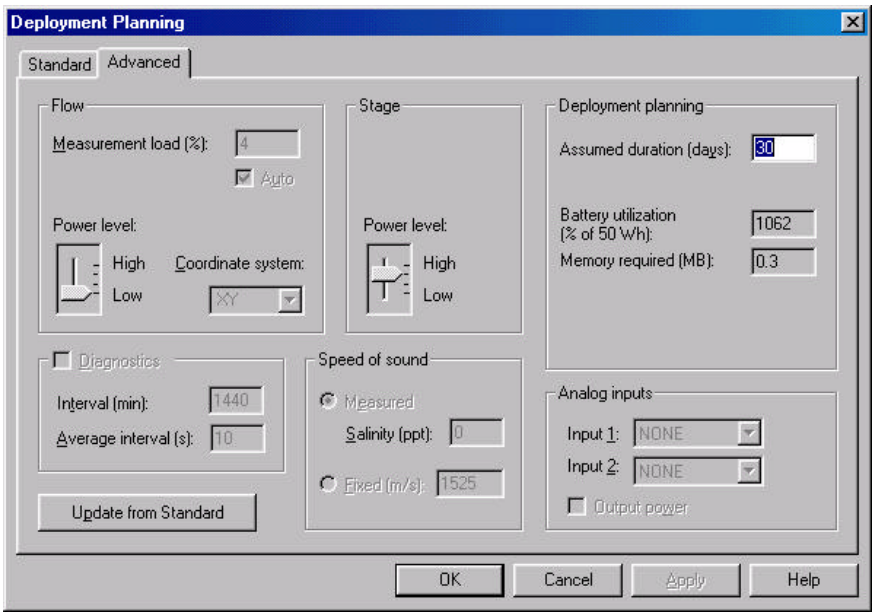
Assumed duration (days)
The time you enter is used to estimate the energy you use and the memory required to store your data.



Battery utilization (%)
Tells you how much energy you will use from a standard 50 WH battery pack.

Memory required (MB)
Tells you how much memory you need for your deployment.

Power level - flow, Power level - stage
These displays tell you the power level set for the velocity and stage measurements. The EasyQ sets power differently for stage and velocity measurements. It can adjust its acoustic power over a range of 18 dB, nearly a factor of 100. Each step increases power by a factor of 6 dB, or a factor of 4.



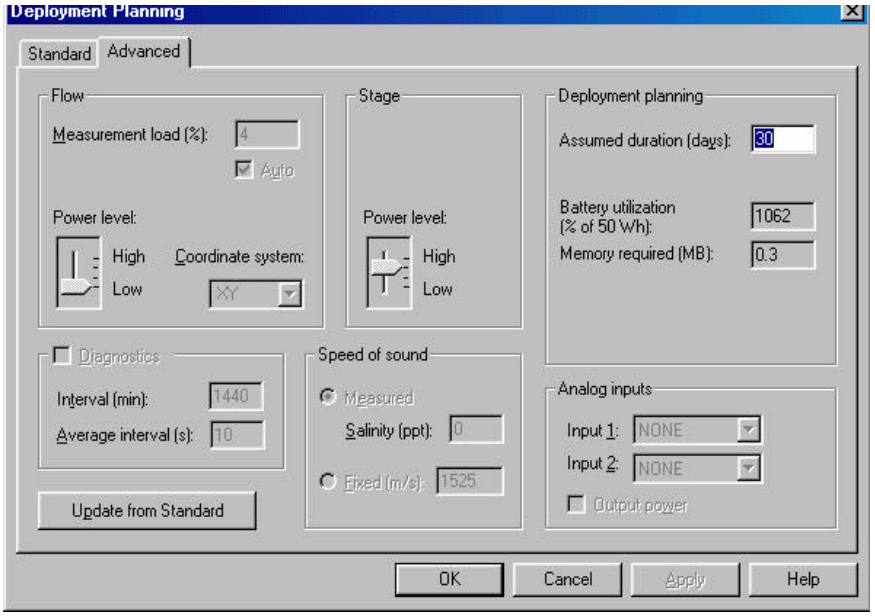
Advanced tab

Measurement load (%)

The EasyQ can reduce power usage by resting for a fraction of each second. The measurement load gives you the fraction of time that the EasyQ is on for each second. The software determines the smallest measurement load necessary to obtain an instrumental uncertainty over the duration of the measurement interval, which is smaller than 1 cm/s. Its objective is to minimize energy usage, and it produces good results in most cases because the uncertainty of measured velocity in typical rivers is the result of flow fluctuation rather than instrumental uncertainty. In cases where you are not limited by power, you should uncheck the "Auto" box and enter 100 to get as many pings as possible.

Power level

You can manually adjust the EasyQ's power levels in four steps, for both velocity and stage, independently. Each step represents roughly 6 dB, or a factor of 4 in power. If you are not limited by power, set the Flow Power to High, but be careful to adjust the Stage Power according to the maximum depth you expect:



Maximum depth is less than:	Recommended stage power level:
5 m	Low
8 m	Low+
10 m	High-
> 10 m	High

Diagnostics
Check the box to enable Diagnostics. Diagnostics are only available when data are recorded internally or when they are recorded externally using serial communication. Diagnostic measurements consist of a series of Range Check profiles on all four of the EasyQ's beams. Diagnostics are not available in SDI-12 mode.

Interval (min) Diagnostics
The time in minutes between diagnostics measurements.

Average Interval (s) Diagnostics
The time is seconds during which diagnostic data are collected. A single average echo intensity profile is recorded for each beam.

Speed of Sound
In normal circumstances, check the "Measured" box and enter the appropriate salinity (0 for freshwater rivers) so that the EasyQ can compute the sound speed. You can select the other box to enter a fixed sound speed as well.

5.2.2. Binary Data

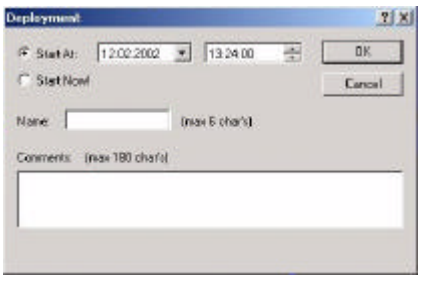
Binary files created by the EasyQ program all use the same format, whether internally recorded or recorded using the real-time "Record to Disk" option. The binary file format is not documented, but the EasyQ software makes it easy to convert the data to an ASCII format.

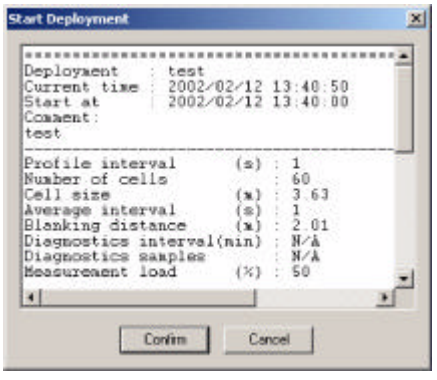
5.2.3. ASCII Data

The EasyQ software creates a variety of different ASCII files from its binary files. The ASCII files always have the same name as the binary file (unless you choose to change the name when you convert the files), and the file type indicates what kind of file it is. It always creates a header file (*.hdr), which gives you information about how the instrument was set up. The header file also contains a description of the formats used to create the other associated ASCII files.

5.2.4. Start recorder deployment

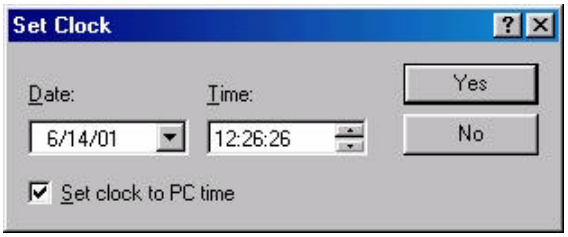
Before you start a deployment, either define a new deployment configuration or load a saved configuration from memory. Then click "Deployment", "Start Deployment", and enter a short deployment name (used for the internal data file). The program allows you to set the EasyQ's internal clock (see below), 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.





Setting the Time and using Delayed Start-up

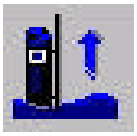
The software allows you to set the EasyQ time and a delayed start-up time when you start the deployment. The easiest way to set the EasyQ time is to make sure the PC time is set correctly before you start the deployment. An important reason to set the correct time may be to synchronize a group of EasyQs 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 EasyQ starts data collection on the hour or to conserve batteries for a deployment that starts some time in the future. You can start an EasyQ deployment well in advance of when you plan to install it on site, and use a delayed start-up to conserve the EasyQ's battery and recording resources for the actual deployment.

5.2.5. Stop recorder Deployment

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



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

5.2.6. 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 EasyQ has two modes of internal recording. The standard mode is to stop recording when the recorder is full. The EasyQ 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.

5.2.7. Getting Data out of the EasyQ

Use the EasyQ 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:

A variety of different ASCII files can be created, depending on what is recorded. The ASCII files all use the same name as the original file, but each gets a different file type. Some data formats will use multiple files, for example range-check/diagnostic data uses a different file for each beam.

ASCII data file formats are documented at the end of Header Files (.hdr). The Header Files also contain useful information about how the instrument was setup for data collection.

5.2.8. Finish operations

Stop data collection using one of the "Stop" buttons before you store a EasyQ.

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

5.2.9. 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 i.e. data analysis.

5.4. Operational concerns

If the EasyQ works but there is a lot of noise in the velocity, chances are that one of the following has happened:

- There are not enough particles in the water
- The velocity range is set too high
- One or more of the beams are 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.

5.4.1. My data don't look right

The EasyQ 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).

5.4.2. Boundaries.

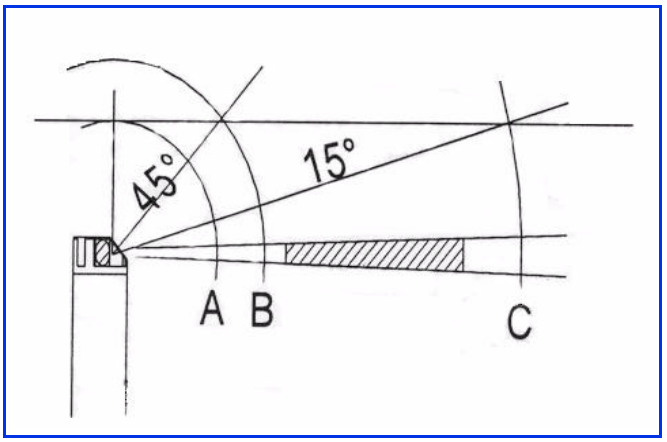
In open waters, boundaries are not a concern, but if you want to use the EasyQ near the bottom or surface, you should think about the boundaries as you design your experiment.

CAUTION: If one of your beams crosses a hard boundary, whether surface, bottom or wall, data from that beam will be bad.

5.4.3. Sidelobes.

Transducer sidelobes are rays of acoustic energy that go in directions other than the main beam. Because the EasyQ'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.

If you are concerned about sidelobes, The 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 EasyQ 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.

5.5. 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 EasyQ’s 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.

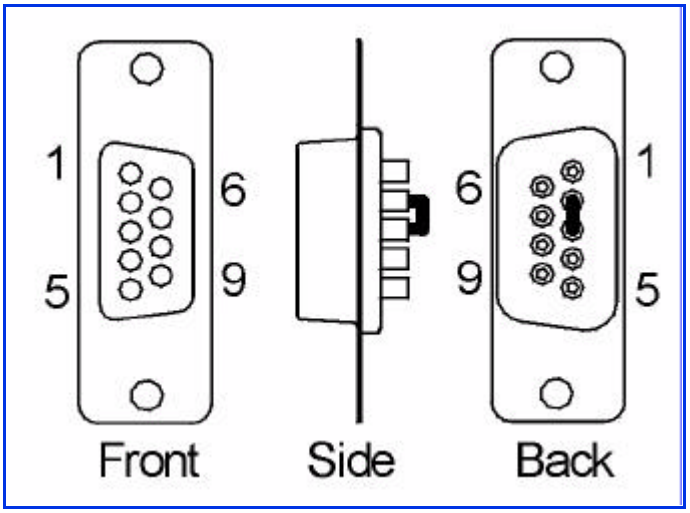
5.5.2. Problems detecting the instrument on the Serial Port

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

If you see a response consisting of garbled text or strange characters, then the EasyQ 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 EasyQ'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 EasyQ 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 EasyQ River Flow Monitor. Use a mild detergent to clean the EasyQ. Pay special attention to the transducers.

Check the pressure sensor and remove any dirt behind the protecting cover.

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 EasyQ 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 water 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.

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

5. Test communication with the EasyQ's built-in terminal emulator program by sending a 'break' command to the instrument. If it is wired correctly then you should see the EasyQ's wakeup 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.

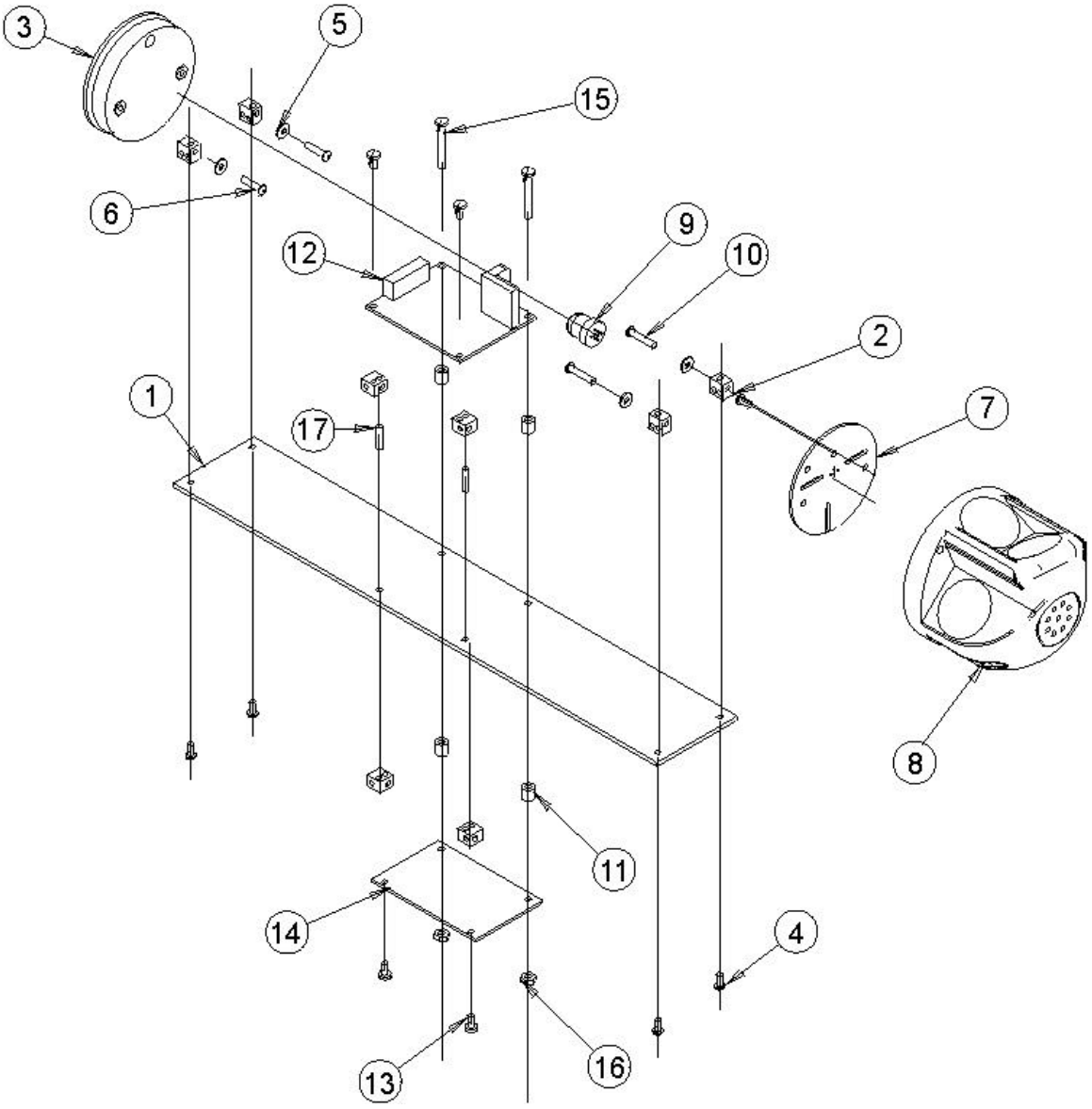
CAUTION: If you have lithium batteries, keep in mind that you must be very careful and that disposal requires special precautions and/or procedures. Rules for disposal of batteries, especially lithium batteries, vary from country to country.

6.2. Corrective Maintenance

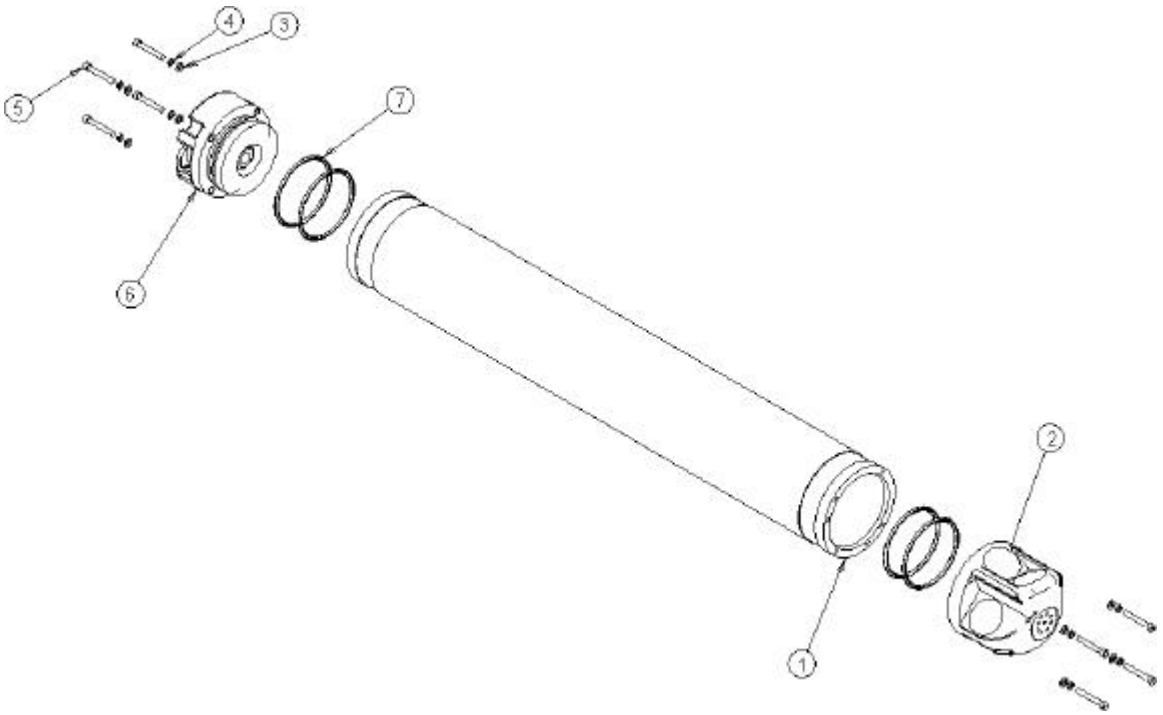
Only qualified personnel are allowed to perform corrective maintenance activities. Please refer to the separate service manual or contact NORTEK for further assistance.

7. SPARE PARTS

Always use the spare part number 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/Vector 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	Easy-Q Std. Head assy.	N2011-023		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/Vector Housing	N2011-007	Delrin (POM) Black	1
2	Easy-Q Head Assy.	N2011-023		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 EasyQ, 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 EasyQ and its data structures, and simplify your software development job.

Please contact NORTEK for further information.

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:**