NORTEK AS

AWAC

ACOUSTIC WAVE AND CURRENT METER

USER GUIDE

SEPTEMBER 2005

AWAC

ACOUSTIC WAVE AND CURRENT METER

FOR FIRMWARE VERSION 1.10 ONWARDS

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NORTEK AS

Software updates and technical support

Find us on the world wide web:

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Your Feedback is appreciated

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

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

Nortek Forum Support

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

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

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

Communicating with us

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

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OVERVIEW

What's in this Manual?

Chapter 1 – Introduction

Here we introduce you to the AWAC documentation, suggesting which chapters are a must-read.

Chapter 2 – Main Data

This chapter provides the technical specifications.

Chapter 3 – Technical Description

In this chapter you will find a description of the AWAC's technical principles and practical aspects such as the cable pin-outs.

Chapter 4 – Functional Description

This chapter presents important terminology and provides some of the theory behind the Doppler and AST principles.

Chapter 5 – Preparation

An important part of the manual dealing with receiving control, installation of the accompanying software, and how to calibrate and verify the instrument-sensors' performance. In addition you will find hints and tips to make you sure that everything works as intended *before* you deploy your AWAC.

Chapter 6 – Setting up for Operation

This chapter presents our recommended procedure for data collection including deployment planning and mounting guidelines.

Chapter 7 – Getting the Data Out of the AWAC

In this chapter you'll find a description of how to get the acquired data transferred to your computer and how to convert the data to ASCII format for further processing in programs like MATLAB® or Microsoft® Excel.

Chapter 8 – Analysing the Acquired Data

The deployment setup software supplied with your AWAC can also be used to view the acquired data. This chapter outlines the features of the program.

Chapter 9 – Operational Concerns

If things don't work as expected, what then? This chapter provides basic troubleshooting, including tips on avoiding grounding problems and what to do when the AWAC seems to refuse to communicate with the PC.

Chapter 10 – Use with Other Instruments

You can connect up to two analogue sensors to the AWAC, typically CT and turbidity sensors. These can be controlled and even powered from the AWAC and their data will be stored in the AWAC's internal memory.

Chapter 11 – Maintenance

To keep the instrument in good shape, regular maintenance is required.

Appendix 1 – Spare Parts and Drawings

Drawings to enable you to make frames that fit and a spare parts list.

Appendix 2 – Returning AWAC for Repair

In the unlikely event of the need for a return for repair – the procedure to follow is given here.

DETAILS

The Table of Contents

CHAPTER 1
Introduction

Thank you for choosing Nortek! The AWAC has been designed to provide you with many years of safe, reliable service.

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

Note that the manual describes a fully equipped unit including the optional Acoustic Surface Tracking (AST) extension, but all optional features are clearly marked as optional.

Before you start to use the system we do recommend that you look through this user manual and read the chapters recommended below.

Getting Started

Tip: In order to take account of new developments you may have to upgrade the AWAC firmware – see ***Upgrading the Firmware*** in ***Chapter 5*** for details.

To get you up and running:

1. Read through the chapters 2 and 3.
2. Run the AWAC tests outlined in chapter 5.
3. Start using the AWAC as described in chapter 6.
4. Perform regular maintenance as described in chapter 11.

Warranty

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

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

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

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

Please make sure you receive a Return Merchandise Authorization (RMA) *before* any product or module is returned. An RMA can be obtained using our e-mail address: inquiry@nortek.no or our Fax No.: +47 6713 6770. See also *Appendix 2*.

CHAPTER 2
Main Data

Tip: Mechanical drawings showing the AWAC's physical dimensions can be found in ***Appendix 1***

This chapter provides the technical specifications of your AWAC.

Weight and Outline Dimensions

Transport weight: 40kg (transport box, all inclusive)
Transport box dimensions: 0.70 × 0.38 × 0.11 [m] (w×l×h)
Weight in air: 5.6kg
Weight in water: 2.5kg
Height: 0.17m
Diameter: 0.21m

Power

DC Input: 9–16 VDC.
Battery DC-input: Nominal voltage: 13.5–18V
Absolute maximum DC input voltage: 18.6V
Peak current: 2A
Operating power consumption: 1W (typical)

Environmental

Operating temperature: –5 °C to +35 °C
Storage temperature: –20 °C to 45 °C
Shock and vibration: IEC 721–3–2

Sensors

Temperature (thermistor embedded in head)

Range: –4 °C to +30 °C
Accuracy/Resolution: –0.1 °C/0.01 °C
Time response: Approximately 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: 0–50 m (standard)
Accuracy/Resolution: 0.25% / Better than 0.005% of F.S. per sample

Data Communication

I/0: RS232 or RS422
Baud rate: 300–115200 (user setting)
User control: Handled via “AWAC” or “AWAC AST” software

Water Velocity Measurements

Velocity range: ± 10m/s horizontal, ± 5m/s along beam
(inquire for higher ranges)
Accuracy: 1% of measured value ± 0.5cm/s

Doppler uncertainty

Waves: 2.7cm/s at 1Hz for 1m cells
Current profile: 0.5–1 cm/s (typical)

Software (“AWAC/AWAC AST”)

Operating systems: Windows® 95/98, Windows® 2000, Windows® NT®, Windows® XP

Stand-alone operation: Deployment planning, start with alarm, logging to internal recorder.

Data download for intermittent connections: Intelligent dial-up scheduler with download of latest data is optional and can be ordered separately at any time.

Long cables: RS422 over cables up to 5 km

GSM phone link: Direct communication over GSM-modem (optional – can be ordered separately at any time)

Radio link: Transparent, requires compatible radio modems.

Displays: Display of data for current profile and wave measurements as well as internal and external sensors.

Data Recording

Capacity (standard): 2 MB, expandable to 26 MB, 82 MB, or 152 MB
Profile record (memory in bytes): $9 \times N_{cells} + 120$
Wave record (memory in bytes): 24×No. of samples + 46

System

Acoustic frequency: 1 MHz, 600kHz
Acoustic beams: 4 beams, one vertical, three slanted at 25º
Operational modes: Stand-alone or long term monitoring

Current Profile (1 MHz)

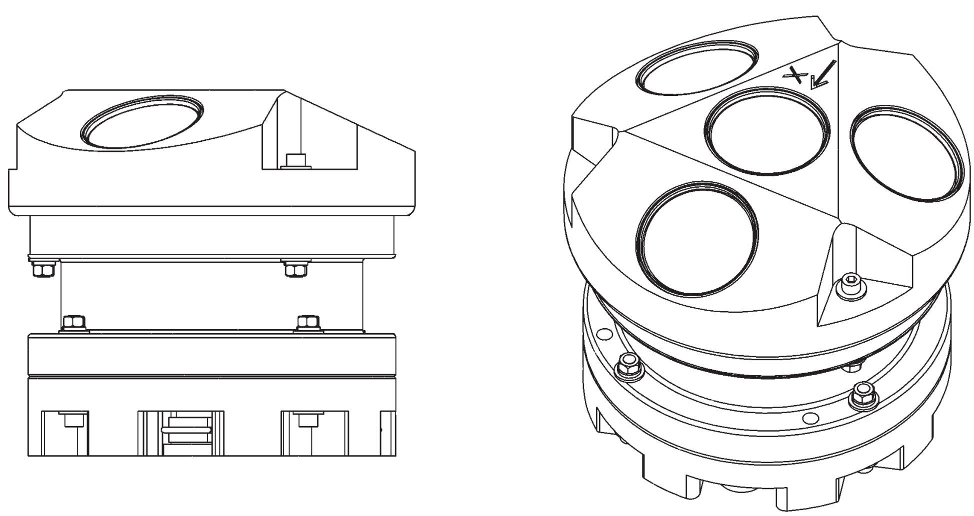
Maximum range: 20–30m (depends on local conditions)
Depth cell size: 0.4–2.0m
Number of cells: Typical 20–40, maximum 128
Maximum output rate: 1s
Internal sampling rate: 6Hz

Wave Data (1 MHz)

Maximum depth: 40 m
Data types: Pressure and velocity cell along each beam,
Acoustic Surface Tracking – AST, (optional)
Depth cell size: 0.4–2.0 m
Maximum sampling rate (output): 2Hz, AST 4 Hz (optional)
Internal sampling rate: 6Hz
Number of samples per burst: 512, 1024, or 2048

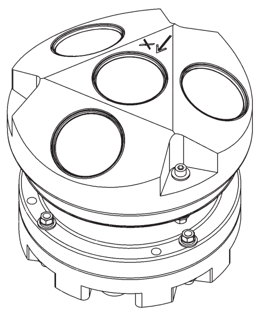
CHAPTER 3
Technical Description

The below Fig. shows a standard 1 MHz AWAC. Note that optional designs are available and these may look different.



AWAC Components

The Sensor Head



The sensor head contains four acoustic transducers and a pressure sensor, all visible from the outside.

The sensor head also holds the following sensors:

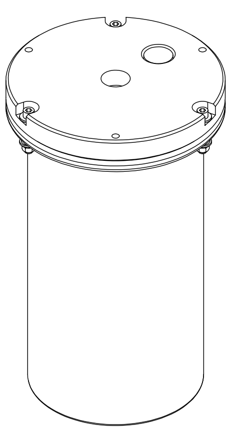
- **Tilt sensor.** The tilt sensor is located on the analogue board attached to the head, inside the case. The tilt sensor orientation is set in accordance with the system orientation during normal operation. The standard AWAC is designed for vertical orientation. The instrument can be inverted 180° – you can use it pointing up or down.
- **Temperature sensor.** The temperature sensor, standard on all AWACs, is mounted inside the sensor head and has a conductive (titanium) contact to the water.
- **Pressure sensor.** The pressure sensor is mounted in the AWAC sensor head, near the middle transducer. To avoid mud assembling on the sensor, the pressure sensor connects to the outside through a narrow hole in the side of the canister.

Electronics Module

The electronics consist of two boards that hold the power transmitter, analogue and digital signal processing, power conditioning, and a 2MB data recorder.

Compass

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



External Battery Pack

You supply power to the AWAC from an external battery pack via the 2-pin connector or from an external power supply using cable with an 8-pin connector. NORTEK alkaline battery packs start life at a voltage of 13.5VDC 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 13.5VDC battery pack will spend the largest part of its life somewhere in a voltage range of 10.5–12.5VDC.

If you remove power to an instrument that is collecting data, it will resume collecting data again as soon as power is restored. When this happens, the instrument's setup will be the same as it was before power was turned off. However, the time may be lost if the power failure lasts more than about 12 hours. Be careful not to exceed the instrument's maximum voltage (18 VDC). If you apply power with the wrong polarity, a diode protects the instrument from damage.

Power Requirements Using RS 422

Caution! Be sure to use *silicone spray* and not *silicone grease* on the dummy plugs and the cables. The use of silicone grease on these may cause permanent damage to the system! Silicone grease should be applied to the O-rings only.

RS 422 power requirements are higher than those of RS 232, and harder to predict. RS 422 increases sleep power consumption to at least 60 mW and it increases operational power consumption by 60–250 mW, depending on how the RS 232/RS 422 converter is terminated. Since RS 422 is normally used in real time operations, you may supply the additional required power from an external power source.

Power & Communication Cable

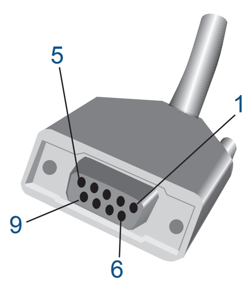
The power connector pin-out.

The power and communication cable is mounted to the external connector. The cable supplies external DC power (9–16 V) and connects an external computer to the AWAC for 2-way serial communication.

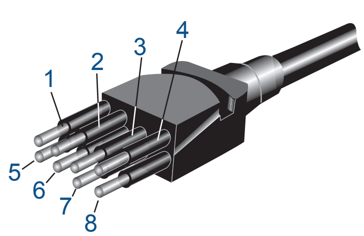
Cable Wiring

The AWAC comes standard with an 8-conductor connector and cable. The signals that are available in the AWAC depend on the internal harness that has been installed. Any one of the harnesses described in the tables below can be used.

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



The 9-pin D-sub connector pin-out.

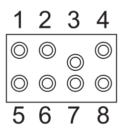
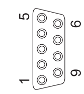
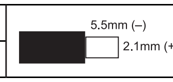


The 8-pin underwater connector pin-out.

RS 232 cable with analogue inputs

	Underwater connector		Purpose		Termination		
	Pin number	Wire color			Pins	Description	
	3	Black	RS232 Tx	twisted pair	2	9-pin Dsub, female	5 9 1 6 Facing sockets
	4	White	RS232 Rx		3		
1 2 3 4 5 6 7 8 Pin numbers, looking at the pins	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		5.5mm (–) 2.1mm (+)
	2	White	power positive		Red wire		
	Screen	Bare	ground	3 bare wires for grounds, connected internally to power ground			

8-conductor cable wiring – RS 422 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 wire5	
	6	White/purple	Synch in		Green wire	
	1	Black	Power ground	twisted pair	Black wire	
	2	White	Power positive		Red wire	
	Screen	Bare	Power greound	three ground lines through shield		

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

CHAPTER 4
Functional Description

This chapter outlines some of the underlying principles that control the operation and application of the AWAC Current meter.

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 AWAC 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. This is expressed by the following equation:

$$V = \frac{F_{Doppler}}{F_{source}} \cdot \frac{C}{2}$$

where:

$F_{Doppler}$ is the change in received frequency, known as the Doppler shift

F_{source} is the frequency of transmitted sound

V is the current velocity

C is the speed of sound

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

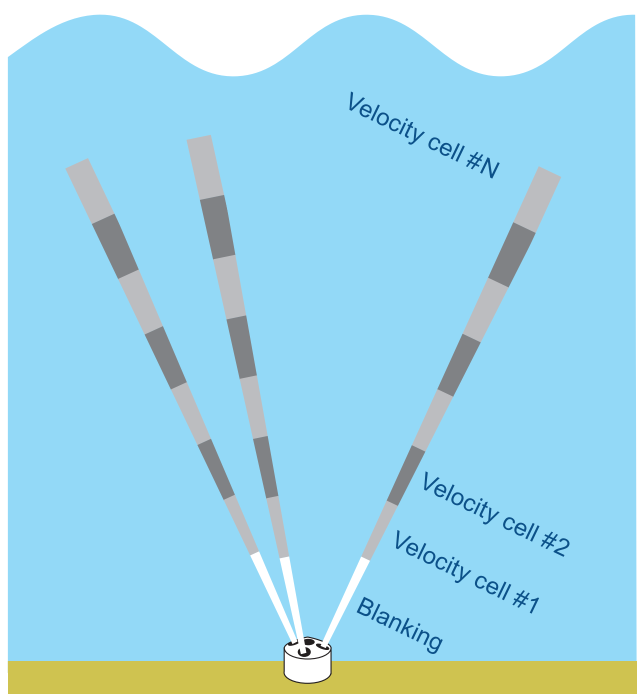
Sound does not reflect from the water itself, but rather from particles suspended in the water. These particles are typically zooplankton or suspended sediment. Long experience with Doppler current sensors tells us that the small particles the AWAC sees move on average at the same speed as the water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

Measurement Area, Blanking, Wave Measurement Area

The AWAC transducers generate sound such that the majority of the energy is concentrated in a narrow beam. The Doppler shift measured by each transducer is proportional to the velocity of the particles along its acoustic beam. Any particle motion perpendicular to the beam will not affect the Doppler shift. By combining the velocities from several transducers, and knowing the relative orientation of those transducers, the three dimensional velocity can be calculated. Velocity is assumed homogeneous at a given layer.

The figure overleaf illustrates the orientation of the three slanted transducers used by the AWAC. Each transducer generates a beam oriented 25° off the vertical axis. The three beams are equally spaced at 120° azimuth angles.

The AWAC measures the velocity at different distances from the transducer by measuring the Doppler shift of the returning signal at different times following the transmit pulse. No measurements are made immediately in front of the transducer in what is referred to as the blanking region. This allows time for the transducers and electronics to recover from the transmit pulse. Following the blanking distance, the AWAC averages the return signal over a period of time corresponding to the depth cell size selected by the user.



The orientation of the three slanted transducers used by the AWAC. Each transducer generates a beam oriented 25° off the vertical axis. The three beams are equally spaced at 120° azimuth angles.

The profiling range of the instrument is determined by the acoustic frequency and the strength of the scattering return from the water. The strength of the return signal will decay as the pulse moves further away from the transducer due to the geometric spreading of the sound waves and the absorption of acoustic energy by the water. The maximum profiling range is determined when the return signal amplitude is not sufficiently greater than the noise level of the system; most directly, this is monitored by the signal amplitude. The maximum profiling range can also be seen by the point at which the standard deviation of velocity estimates starts to increase significantly.

It is important to remember that the return signals used by the AWAC are very weak. Ambient electronic noise and obstructions in the water can have a significant affect on AWAC operation. Deployments in areas with large obstructions (piers, docks, etc.) should be carefully planned to avoid interference with AWAC data collection.

Position of Depth Cells

When measuring the Doppler shift, the AWAC starts out by transmitting a pulse. The pulse propagates along the acoustic beam and generates an echo as it moves away from the AWAC. The echo is received and amplified before it is sectioned up in smaller segments, where each segment corresponds to a depth cell.

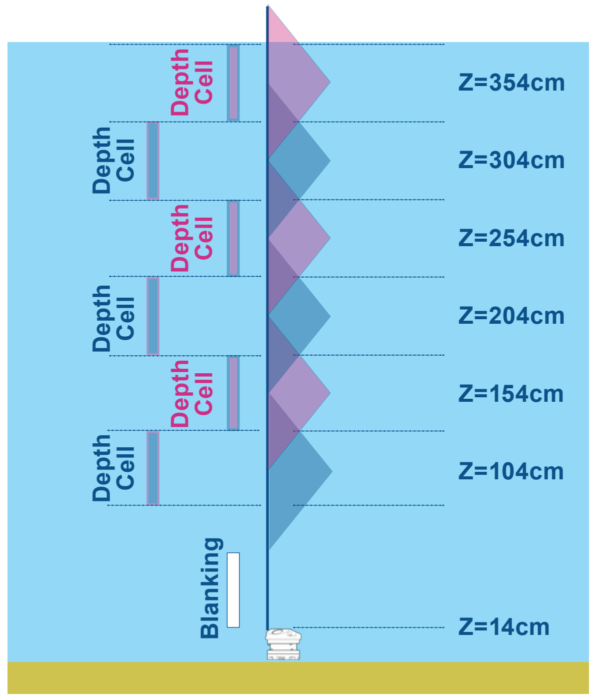
When trying to determine the exact position of the depth cells, consider the following:

- The size and location of the depth cell are determined both by the transmit pulse length and the size of the received echo segment ("The receive windows").
- Mathematically, the depth cell is the convolution of the transmit pulse length and the receive window.
- The depth cell does not give equal weight to all points within the cell but is weighted toward the middle. When the transmit pulse and the receive pulse are matched as they are in the AWAC, the weighting function has a triangular shape.
- Because the velocity of a depth cell is weighted toward the middle of the cell, it has become customary to speak of the depth cell size as being half the size of the baseline.

This last issue sometimes leads to confusion because it implies that the mid-point of the first depth cell (Z_1) is located further away from the AWAC than what you maybe would immediately think:

$$Z_i = \text{Blanking} + i \times \text{Depth cell size}$$

Depth cell positions for an AWAC with 0.5 m depth cells showing mid-point and the triangular weighting around the mid-point. Note that since we use the middle part of the received signal as the depth cell, the distance to mid-point of the first cell will be one full cell size.

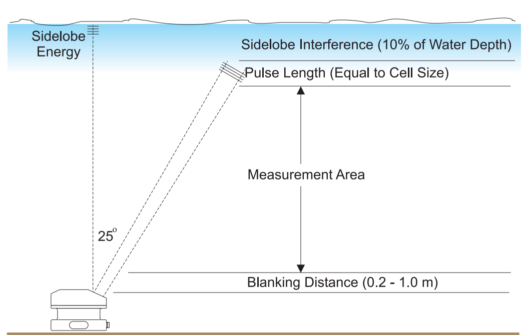


Data Collection Near Boundaries

When operating near a boundary (surface or bottom), special consideration must be taken when analysing data collected near that boundary. This section briefly explains data collection concerns for near boundary operations, and outlines steps for near boundary data analysis.

The figure below shows the AWAC profiling range broken down into several regions.

The AWAC profiling range broken down into several regions – see text for details.



The first portion of the profile is lost while the system recovers from acoustic transmission. This region is referred to as the blanking distance, and its size varies with acoustic frequency. No data is collected for a period following the end of the transmit pulse to eliminate any possible interference.

After the blanking distance, the instrument will make velocity measurements in multiple depth cells where the size is determined by the user.

Although most of the acoustic energy is concentrated in a narrow beam, some energy is transmitted in all directions. As pictured in the figure above, this side-lobe energy will reflect from the boundary while the main beam is still in the region near the boundary. This is called side-lobe interference and may affect the last 10% of the velocity profile for the AWAC. The extent to which the sidelobe reflection will contaminate the velocity measurements is a function of the boundary conditions, the scattering return strength from the water, and the acoustic properties of the transducers.

Nortek AS has invested considerable research into transducer design in reducing the level of sidelobe energy, and hence the possibility of sidelobe interference. Our experience has shown that in many conditions, the AWAC is able to make accurate velocity measurements all the way to a boundary. However, you should be aware that there always is a potential for interference, and any near boundary data should be analysed carefully. To be on the safe side, we recommend that the last 10% of the range is excluded from the profile.

Measuring Waves

It is important to remember that the AWAC collects raw wave data. Therefore the data, by inspection, may not be entirely meaningful (except for perhaps the AST record). This raw data must go through a processing step before it can be used to interpret the waves on the surface. The processing will lead to classic wave estimates for height, period, and direction. Unlike the current profile estimates the wave processing is quite complex and is done in “post processing”.

The AWAC measures three independent quantities that can be used to estimate waves parameters. These quantities are pressure, orbital velocities, and AST. Since each of these measurements is independent of one another, there is a means to check the data quality by comparing these estimators to one another. Again, this is done in post processing.

The data record of the raw signal will not provide a clear view of the wave environment on the surface. For instance, the pressure record is an attenuated version of the free surface. The attenuation is dependent upon both the AWAC’s deployment depth and the surface wave frequencies. Therefore this data record is not going to be particularly useful until processing is performed. This is similarly true of the orbital velocity measurements. In fact, the orbital velocities will often appear noisy, and a sinusoidal wave pattern can sometimes be difficult to observe when waves are short in period.

Tip: The AWAC software has a replay mode that allows you to inspect the raw wave data retrieved from the AWAC.

The exception may be the AST record, which is direct measure of the free surface. This record gives the user the possibility to see exactly the wave profile. This represents the best way to get a quick inspection of the wave conditions. Of course, there exists the possibility for bad detections and this would have to be accounted for in processing as well.

Directional Estimates

You will notice that the wave velocity cells (seen from above) are located in such a way that they construct an equilateral triangle just below the surface (looking from the surface downward). This "projected array" is designed so that a special type of processing known as the *Maximum Likelihood Method* (MLM) may be used after data collection. In addition to the wave velocity cells, the AST measurement in the centre of the array is included to add a fourth measurement point in the middle of the array. The AST is included in the MLM solution to improve upon the accuracy of the directional estimates.

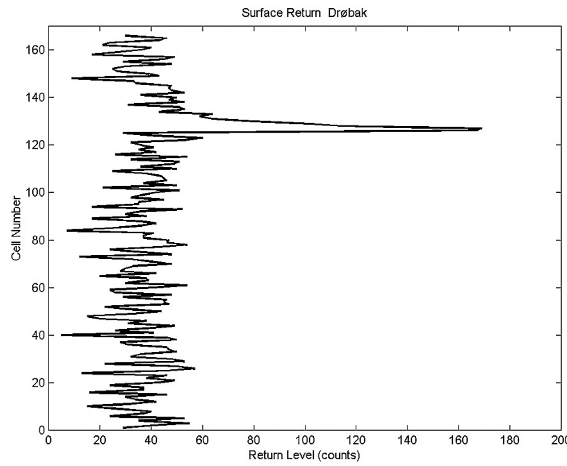
It is important to note that the directional estimates of short waves will be limited by the size of the projected array. The size of this array or the horizontal separation distance between cells is dependent upon the deployment depth. As the deployment depth increases, so does the cell separation. The implication of increased separation distance for the array is that the larger the minimum wavelength that can be resolved for directional estimates. The rule of thumb is that directional estimates for waves that have a wavelength that is two times the separation distance or greater can be resolved unambiguously.

AST – Acoustic Surface Tracking (optional)

The optional *Acoustic Surface Tracking* (AST) feature of the AWAC operates much like a standard acoustic range detector. The centre beam is used to transmit a very short pulse (relative to the Doppler velocity measurements). The travel time from the AWAC to the surface and back allows us to estimate the distance to the surface for each ping. Fortunately, the strong impedance mismatch at the water-air interface provides near perfect reflection, and thus provides a strong return. An example of the return pulse is presented in the Fig. below, as you can see the surface is not very difficult to locate the surface return.

Although the transmit pulse is rather short we have large receive window so that we ensure a surface detection. High resolution of the surface is ensured by finely discretising the receive window into smaller bins. Each one of the return bins is 2.4cm. Even greater resolution of the exact surface is achieved through quadratic interpolation of the peak point and its neighbours. The final resolution of the distance to the surface is 1mm.

The surface provides a strong return pulse, so the surface is not difficult to locate.

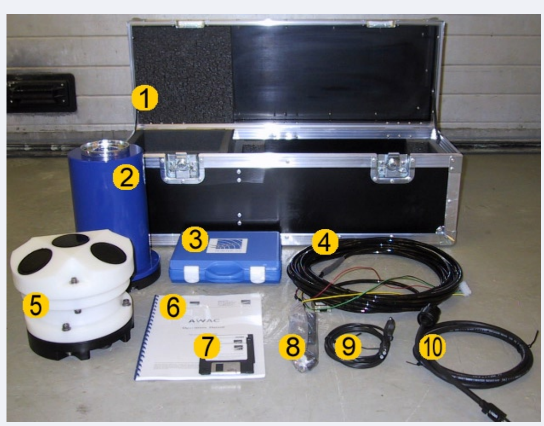


CHAPTER 5
Preparation

We recommend the following procedure to prepare your new AWAC for future successful operation:

1. Make a reception control, as described in *Inspect the Received System*.
2. Install the AWAC Software on a PC, as described in *Install the AWAC software on a PC*.
3. Run a functional test of your new AWAC, as described in *Run a Functional Test*.
4. When you are ready to deploy the AWAC for data acquisition, mount the AWAC in accordance with the guidelines provided in *Mounting Guidelines*.

Inspecting the Received System



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

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

1. Transportation box
2. Battery canister
3. Tool kit
4. External power/signal cable
5. AWAC current meter
6. AWAC user manual
7. AWAC software
8. AC Adaptor (110–230VAC to 9–16VDC)
9. Power cable
10. AWAC battery cable

Do not hesitate to contact NORTEK if you find parts of the delivery to be missing.

Installing the AWAC Software on a PC

To install the AWAC software, do as follows:

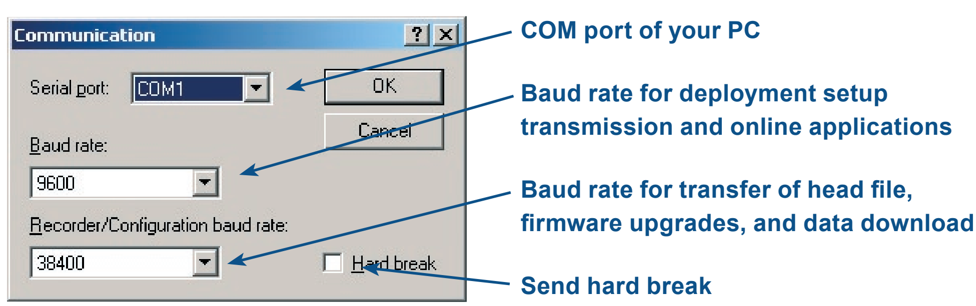
1. Insert the CD and run the **Setup.exe** file
2. Follow the on-screen instructions. Accept default settings.
3. Restart your PC to finalize the installation process, if prompted to.

Running a Functionality Test

To run a functionality test, do as follows:

1. Plug in the AC adaptor and connect the AWAC to the PC serial port.
2. Start the AWAC software.
3. Select **Communication** > **Serial Port** to specify the port number to use. The dialogue box will look like this:

Press **Communication > Serial port** to produce this menu. When running a functional test accept the default baud rate.



4. Accept the default baud rate settings (9600 baud), which is also the default instrument baud rate.

Recorder/Configuration baud rate. The baud rate for transfer of head file and firmware upgrades as well as data downloads may differ from the other baud rate setting (which is used for the transmission of deployment setups and for online applications). The reason why is that the former assumes that the batteries are in good condition and that the cable between the PC and the instrument is short, so that high transmission rates can be used without problems. You may change this setting if you upgrade *in-situ* using long cables. As a safety precaution, the AWAC verifies the received head file and firmware upgrade files before they are allowed to replace the existing head- and firmware files. Hence, using the wrong transmission speed will not cause trouble. To make a permanent change of the baud rate – see *Changing the Baud Rate* in *Chapter 6*.

Sending Hard Break. The *break* is used to interrupt the AWAC regardless of what mode it is in and is frequently used in the communication with the AWAC. Sending a break used to be done by holding the transmit line high on the serial line for a period of 500 ms. This is what we refer to as **hard break**. This works fine if you have a direct connection between your PC and the instrument. But once you use something else, for example a modem, you may get into trouble. The problem is that different types of modems handle hard breaks in their own way. Certain GSM modems will, for example, accept a 500ms hard break on the input, but they will only output a 100ms hard break, which may not be accepted as a break in the instrument.

To cope with problems like these we have introduced a different type of break, called **soft break**. The soft break consists entirely of characters, so it can be used with any devices capable of RS232 or RS422 communication.

Tip! With two types of break and one version of the communication software you may get into communication problems if the software is set up with the wrong type of break. The easiest way to circumvent this problem is to use the *auto detection feature* in the software.

Make sure you have set up the correct serial port and press the **Stop Data Collection** button on the toolbar. The software will then find the correct communication baud rate and break type for you.

You can use to terminal emulator to test the communication yourself. If you have a modem version of the software the auto detection feature is disabled. In this case, set the correct baud rate in the serial communications setup and try the two different break types using the terminal emulator. Check or uncheck the hard break box, go to the terminal emulator and send two breaks.

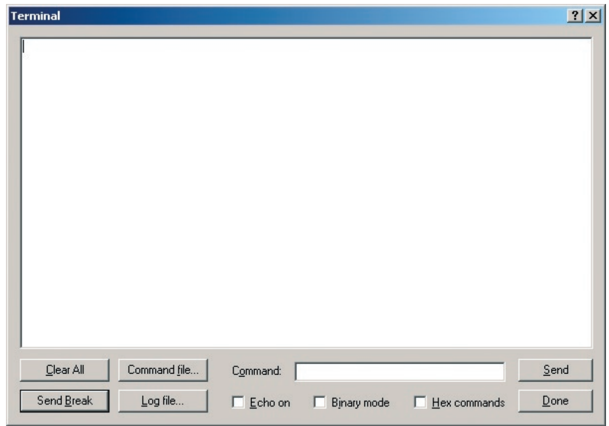
If you get a response to both breaks you have the correct setting.

There are a couple of things to be aware of:

- If the instrument is in sleep mode it will respond to both hard break and soft break. This is why you should send two breaks with the terminal emulator to make sure you have the correct setting.
- If an instrument equipped with soft break is in sleep mode, it will wake up regardless of what baud rate setting you send the soft break with. When the instrument *is not* in sleep mode it will respond to soft break only, and only when the soft break is sent with the same baud rate that the instrument is configured with. Again, you should send two breaks with the terminal emulator to make sure the break setting works.

5 Check the instrument communication and verify that the instrument is alive by activating the Terminal Emulator window (select **Communication** > **Terminal Emulator** and click the **Send Break** button to send a BREAK signal over the serial port. A break causes the instrument to report an identification string.

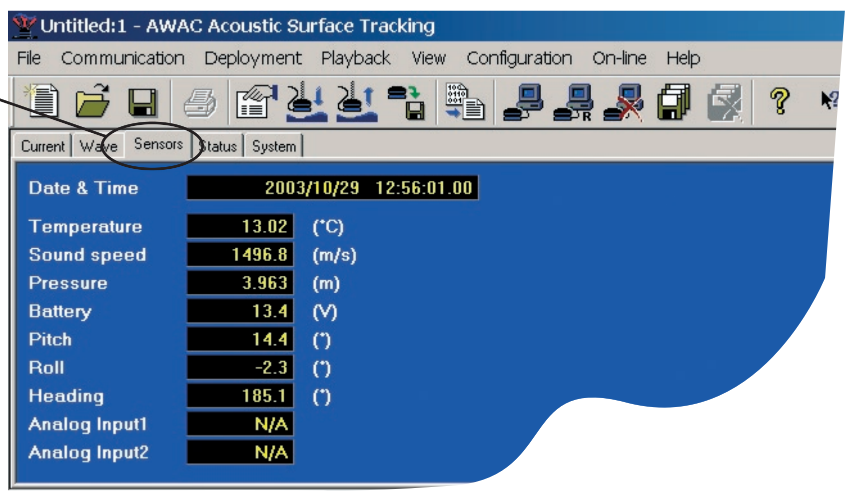
Press **Communication > Terminal Emulator** to produce this menu. When running a functional test Click the SEND BREAK button.



6 First check the noise level of the instrument. Pinging in air should produce a signal strength (amplitude) of 15–30 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 water and observe the signal strength and the velocity. The signal strength should rise noticeably for the first range cells and the velocity data should appear less noisy.

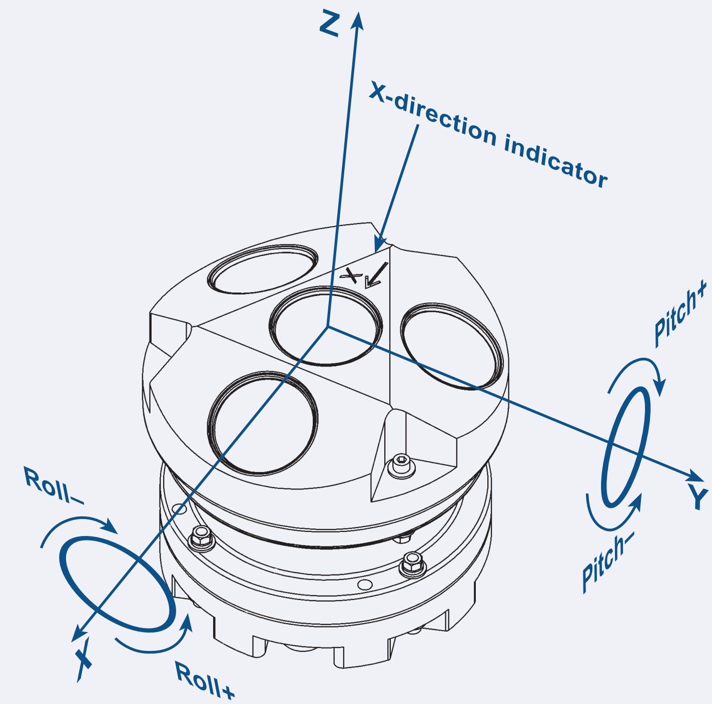
7 Check sensor readings. Click the **Sensors** tab just below the icon bar to produce the following:

Press the **Sensors** tab to produce this screen and check that the readings make sense – see text for details. This screenshot is taken during a test deployment at a little less than a depth of 4 m.



Note: Whenever the X-axis points towards north, the heading will be 0°

Defining pitch and roll:



- Tilt and rotate the AWAC to verify that the readings are sensible.
- Temperature should be close to the ambient temperature, assuming that the AWAC has been exposed to a constant temperature for at least an hour. The temperature sensor is located inside the sensor head.
- Pressure should be near zero. Check the pressure sensor in 50 cm deep water.
- Battery voltage shall be greater than 13 VDC (new battery).

Test the recorder function

Note: If you leave the AWAC 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 AWAC into command mode and it will then enter into a sleep state (the lowest possible power consumption) after 5 minutes of inactivity.

You can test the recorder with the same setup as the above. Do as follows:

1. Test the data collection by first clicking **On-line** >**Start With Recorder**.
2. Write a name to use for the file you will record internally (in the AWAC).
3. After a few minutes acquiring data, stop the data collection.
4. Retrieve the data by clicking **Deployment** > **Recorder Data Retrieval**.
5. Convert it to ASCII by clicking **Deployment** > **Data Conversion**.
6. Review the data acquired with an ASCII text editor (i.e. Notepad)

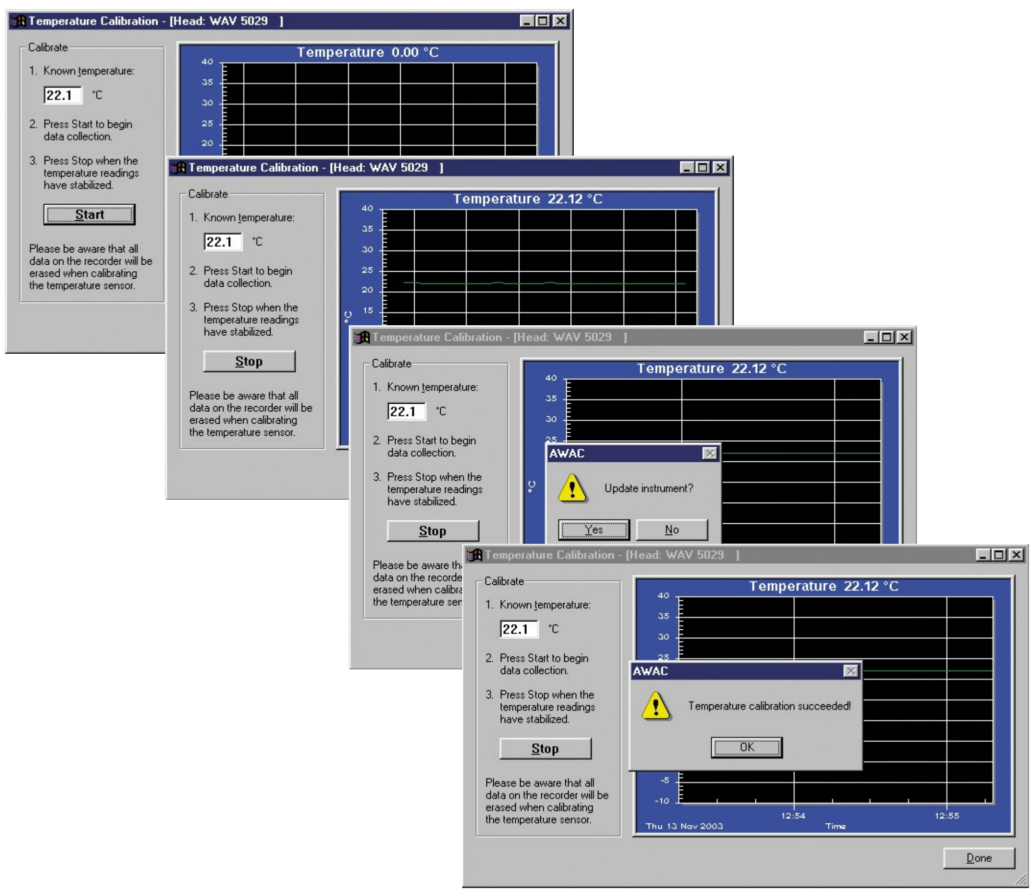
Starting with an Empty Memory

To erase the AWACs contents of data:

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

Verifying the Internal Sensors

The AWAC has four sensors that should be checked regularly to verify their performance. These are the tilt sensor, the temperature sensor, the pressure sensor, and the compass. It is of great importance to check and calibrate the compass sensor. The compass is sensitive to all magnetic fields, not only the earth's. Hence magnetic material used in the mooring may bias the compass readings significantly.



Temperature calibration. Click **On-line** > **Temperature** calibration to produce this display and enter the ambient temperature. Make sure the AWAC temperature readings have stabilized – see text for details.

Calibrating the Temperature Sensor

To calibrate the temperature sensor:

1 Connect the AWAC to the computer and let the AWAC be exposed to a constant temperature for more than 15 minutes to stabilize the temperature readings from the AWAC.

2 Click **Online** > **Temperature Calibration**

3 Use a thermometer with sufficient precision for your task to read the ambient temperature and key in this temperature in the AWAC dialogue box.

4 Follow the online instructions.

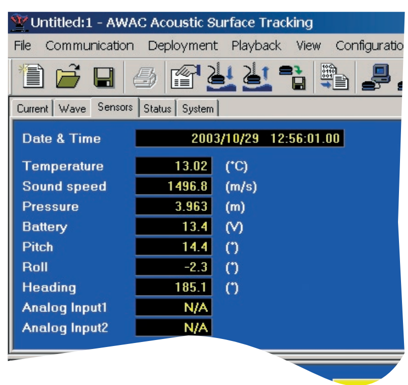
Verifying the Tilt Sensor

To verify the tilt sensor:

1 While the AWAC is connected to the computer, place it level on a flat surface.

2 In the main screen inspect the heading, pitch, and roll readings.

Tilt sensor verification. Click the **Sensors** tab in the numerical tab part of the main screen and verify that the tilt readings make sense. In case of significant deviations, contact the factory.



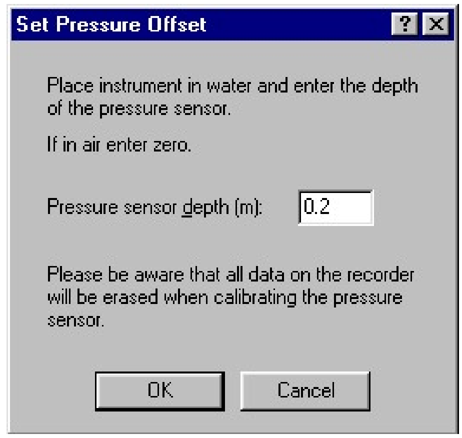
Setting the Pressure Sensor offset

To calibrate the pressure sensor:

1 Have the AWAC connected to the computer and submerge the AWAC in water.

2 Click **On-line** > **Set Pressure Offset** and key in the depth in m. The pressure sensor is located inside the AWAC body, but if you decide to use the top of the AWAC as pressure reference, that should work fine and contribute to good agreement between depth readings based on pressure and depth readings based on AST (given that the atmospheric pressure doesn't change too much).

The dialogue box for setting the pressure offset – see text for more.



Tip: Atmospheric changes can vary the depth reading as much as 0.3 m!

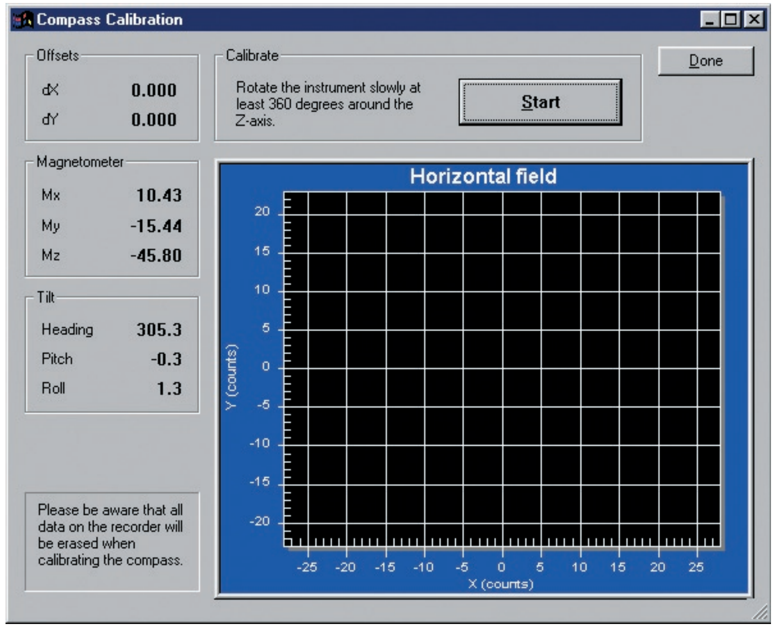
Calibrating the Compass

The compass calibration is designed to adjust for magnetic materials that may be present in your deployment frame. As a consequence, calibration of the compass should take place after the AWAC has been mounted in its frame. Be sure to mount the battery canister and all other materials that is to be attached to the frame and conduct the procedure outside, away from other possible magnetic elements.

To calibrate the compass, do as follows:

1. Assemble the frame with AWAC, battery canister, and the extra ballast needed to create a stable frame and connect the system to the computer as usual.
2. Make sure it is possible to rotate the entire system (AWAC + frame, including battery canister and extra ballast) 360° horizontally.
3. Click **On-line** > **Compass Calibration**. This will produce the following dialogue box:

The Compass Calibration dialogue box.



Make sure the frame is level when calibrating the compass and rotate the entire system to be deployed around the z-axis of the AWAC.

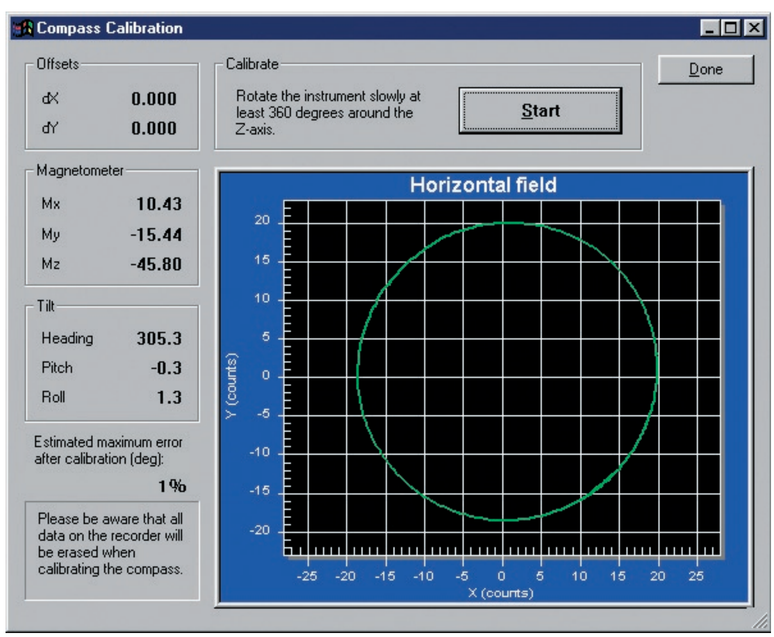
Note: Whenever the X-axis points towards north, the heading will be 0°

4 Click **Start** and rotate the entire system slowly 360° around the z-axis of the AWAC. An example of successful rotation is shown below.

5 To utilize the obtained values, click **Done**. You will be prompted to confirm that the new values shall be transferred to the AWAC to serve as the new compass setting.

The Compass Calibration dialogue box after a succesful calibration has been made.

When doing this in-situ with the AWAC mounted in a heavy frame, you cannot expect to end up with a circle as perfect as this one. However, we recommend you to do this slowly in an attempt to come as close to the ideal circle as possible.



Upgrading the Firmware

By the term *firmware* we are referring to the internal software of the AWAC, as opposed to the AWAC software running on a PC and described in this manual.

When you purchase a brand new AWAC from the factory, the AWAC has a firmware version matching the PC software. Hence no firmware upgrade will be needed before you start using the AWAC.

However, new functionality (and in rare cases bugfixes) is likely to be offered in the future, requiring that the firmware is upgraded. New firmware is posted on our web site at http://www.nortek-as.com/support.php. You will need to register to get access, but access is otherwise free of charge.

To do a firmware upgrade:

1 Go to http://www.nortek-as.com/support.php, register if this is the first time, otherwise log into the **User Room**, click on **Software&Firmware** and download the new firmware file to your computer.

2 Click on **Configuration** > **Firmware Upgrade** in the AWAC software, browse to the downloaded firmware file and select it.

3 You will now be prompted to key in a license key:

The License Key dialogue box will appear when attempting to upgrade the firmware.

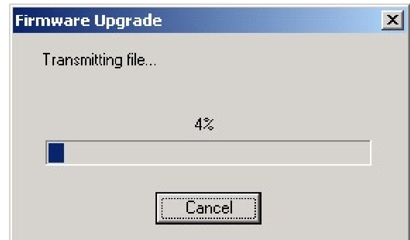
Note! The license key is based on a specific AWAC serial number. Hence it applies to one specific AWAC only. It cannot be used to upgrade the firmware of an AWAC with a different serial number.

The license key can be found on the software CD that accompanied your AWAC. If you cannot locate it, contact Nortek AS for a new license key.

Bugfix-releases are free of charge and can be installed using the accompanying license key. However, upgrades including new functionality are, in general, not free of charge. The license key that accompanied your AWAC will therefore not work with such new versions. Contact Nortek AS if you would like to upgrade to new functionality when available.

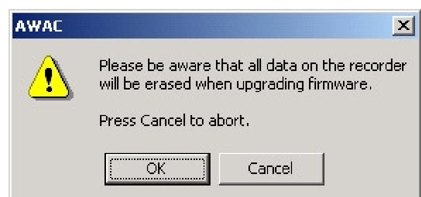
4 Enter the license key and press OK to start downloading the file into the instrument.

This will produce the following box:



To ensure that the AWAC firmware does not become corrupted because the download transmission failed during the download process, the AWAC runs a check on the received file before it is allowed to replace the existing firmware.

Once verified as valid, the following dialogue box will appear …



… just to warn you that any data acquired in the AWAC will be erased to avoid inconsistencies. In other words, transfer data that you would like to retain to your PC before you upgrade the firmware.

CHAPTER 6
Setting up for Operation

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

The AWAC has three different modes of operation:

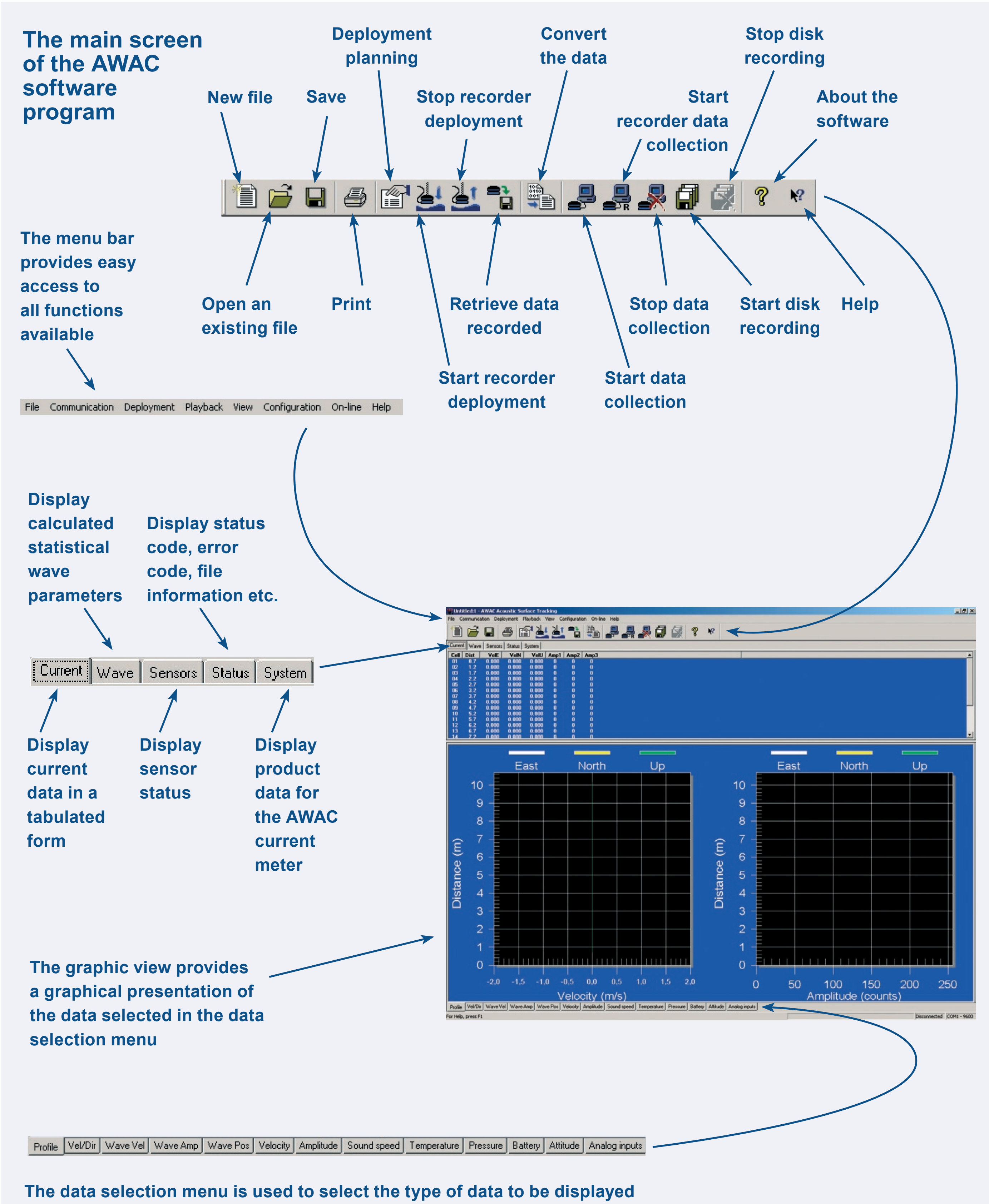
- **Command mode.** An AWAC in command mode is powered up and ready to accept your instructions. If it gets commands is received for about five minutes, it automatically goes into power down mode.
- **Data Acquisition Mode** (continuous and burst). The AWAC enters data acquisition mode when you click any of the **Start** commands (i.e. **Start Recorder Deployment**) in the AWAC software.
- **Power Down Mode.** This mode saves power during deployments and prevents your battery from dissipating between deployments. The AWAC automatically powers down from command mode after about five minutes of inactivity.

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

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

Autonomous Deployment vs. Online Monitoring

Although designed primarily for autonomous deployments, the AWAC may just as well be used in monitoring applications with online connection to a remote computer. For back-up you may then set up the AWAC to record a copy of all


The main screen of the AWAC software program
Deployment planning
Convert the data
Stop disk recording
New file
Save
Stop recorder deployment
Start recorder data collection
About the software
The menu bar provides easy access to all functions available
Open an existing file
Print
Retrieve data recorded
Stop data collection
Start disk recording
Help
Start recorder deployment
Start data collection
File Communication Deployment Playback View Configuration On-line Help
Display calculated statistical wave parameters
Display status code, error code, file information etc.
Current Wave Sensors Status System
Display current data in a tabulated form
Display sensor status
Display product data for the AWAC current meter
East North Up
Distance (m)
Velocity (m/s)
Amplitude (counts)
The graphic view provides a graphical presentation of the data selected in the data selection menu
Profile Vel/Dir Wave Vel Wave Amp Wave Pos Velocity Amplitude Sound speed Temperature Pressure Battery Attitude Analog inputs
The data selection menu is used to select the type of data to be displayed

data acquired to the internal recorder, in addition to have the data transferred to the remote computer.

This is called **Recorder Data Collection**, as opposed to just **Data Collection**.

The AWAC may also be used together with up to two analogue sensors or with a controller.

When used with a controller, the controller may serve as an external storage device and it may provide power and sampling control, thus creating a very sophisticated system. All this is treated in more detail in *Chapter 10 – Use with Other Instruments*.

Installation of the AWAC software is described in the previous chapter.

The AWAC Software Main Menu

Tip! Verify performance before you deploy. You probably want to verify that your configuration works well and that you are going to record meaningful data *before* you deploy the AWAC and leave it on its own – see also *Chapter 5*.

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

Operation of the AWAC Current Meter is controlled from the main menu – see side bar.

The main menu is divided into 9 areas:

1. The top menu gives easy access to all functions included in the AWAC software.
2. The second row – the icon bar – contains shortcuts to main functions. Click on the preferred icon to access the preferred function.
3. The wave window contains configuration parameters for wave mode.
4. The current window contains numerical current data for all measurement cells.
5. The sensor data window displays sensor status.
6. The status window displays data, such as error code, status code and file information.
7. The system window contains product data for the AWAC Current Meter.
8. The graphic view gives a graphical presentation of data selected in the data selection menu.
9. The data selection menu is used for selecting the types of data to be viewed.

Data collection – a Recommended Procedure

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

1. Connect the battery pack.

Caution! Be sure to use *silicone spray* and not *silicone grease* on the dummy plugs and the cables. The use of silicone grease on these may cause permanent damage to the system! Silicone grease should be applied to the o-rings only.

2 Install new desiccant, if necessary. See *Replacing Desiccant* in *Chapter 11*

3 Run a Compass calibration. See *Calibrating the Compass* in *Chapter 5*

4 Test AWAC according to the procedure outlined in *Run a Functionality Test* in *Chapter 5*.

5 Set the real time clock in your PC (the correct time of day).

6 Use AWAC software to plan deployment. Click **Deployment** > **Planning**.

7 Erase recorder. Click **Deployment** > **Erase Recorder**.

8 Start deployment. Click **Deployment** > **Start Recorder Deployment**.

9 Enter a 6-character deployment name.

10 Set AWAC time to PC time. Click **On-line** > **Set Clock**.

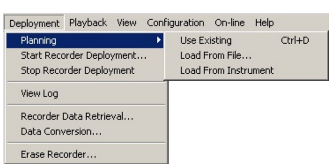
11 If appropriate, set a delayed start-up time.

12 Disconnect cable and install dummy plug. Insert plug pins with silicone spray.

13 Verify pinging with an AM radio just prior to deployment.

14 Install on site. Make sure the acoustic beams point where you want and that they are not obstructed. For AST mode vertical orientation is crucial. See *Mounting Guidelines* for tips and hints.

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 dialogue 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 dialogue contains all parameters required to specify the operation of the instrument. The **Deployment** planning pane on the right hand of the dialogue displays performance parameters that are automatically updated as you change the parameter settings. When finished, press **OK** to put the changes into effect. 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 dialogue 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 parameter settings that correspond with the current standard settings press the **Update from Standard** button (Advanced tab).

A few Words on AST Wave Measurements

As outlined in *Chapter 4 – Functional Description,* the Acoustic Surface Tracking (AST) feature of the AWAC operates much like a standard acoustic range detector. The centre beam is used to transmit a very short pulse (relative to the Doppler velocity measurements). The travel time from the AWAC to the surface and back allows us to estimate the distance to the surface for each ping.

Basically there are two AST measurement modes – *Standard* and *Static*.

Standard Mode. In the *Standard* mode everything is adaptively configured based on the water depth to achieve the best quality data. Aside from setting the sampling scheme (number of samples, rate, interval), there is nothing else you need to configure. You may enter the *estimated depth,* but this is only used for estimating the power and memory consumption.

In *Standard* mode the positioning of the receive window is a calculated automatically in firmware during the current profile mode. Therefore prior knowledge of wave heights and tidal variation is not required.

The *Standard* mode is set up from the Standard tab.

Static Mode. This setup mode provides more flexibility for establishing the detection window. The beginning of the detection window is defined by the user. You must then specify the size of the detection window. Clearly this requires that you are familiar with the expected maximum water level (wave environment) in order to properly detect all waves using the specified window size.

Under the *Static* mode you have the option of choosing the method through which the peak associated with the surface is identified. The default (automatic) method is to identify the maximum peak as the surface return. Alternatively, you may chose to identify the surface return as the first peak above a defined threshold. The standard value for this approach is 100.

The measurement cells and AST window are adaptively determined during the profile mode for the *Standard Setup*. This is not true if you set up for AST by ticking off the **Static mode** box in the *Advanced Settings* in the **Deployment setup** menu. Doing so requires a clear understanding of the expected wave height as well as minimal tidal variation for the deployment area. In general, the *Standard mode* should be preferred since it uses an adaptive approach to locating the velocity cells and AST receive window. The *Static mode* is reserved for special cases, typically such as shallow lakes.

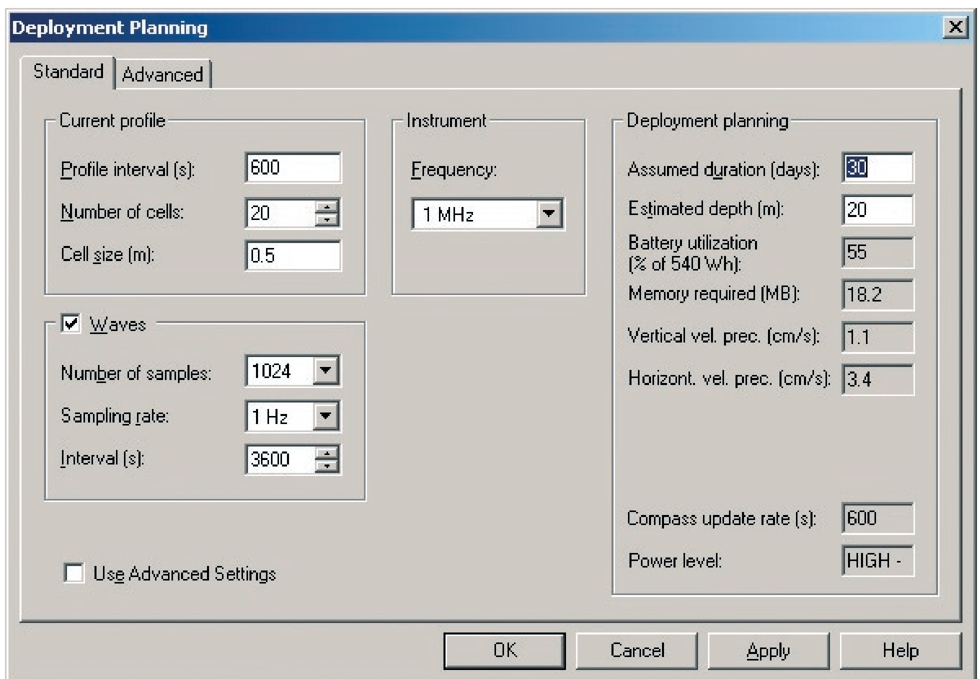
Deployment Details – the Standard Tab

Modes of operation. The AWAC has two modes of operation, current profiling and wave measurements. The two modes are sequential, i.e. the system first averages the full current profile over the prescribed *averaging interval* and then collects wave data for a period of time determined by the number of samples and the sampling rate. The whole sequence will start over again each *measurement interval*. In case of conflict, preference is given to wave measurements as shown in the Fig. on the next page. To save recorder space, the AWAC collects wave velocity data at one level only (no profiling).

Current profile interval. The time between each current profile measurement.

Number of cells and cell size. The number of cells, in combination with cell size determines how far away from the sensor measurements will be made. Whether meaningful measurements really can be made all the way out to the most distant cells depends on the amount of scatterers in the water.

The deployment dialogue box has two levels – Standard and Advanced. The two are accessed by clicking the corresponding tab. This screenshot shows the contents of the **Standard** tab panes. See text for details on the dialogue box contents.

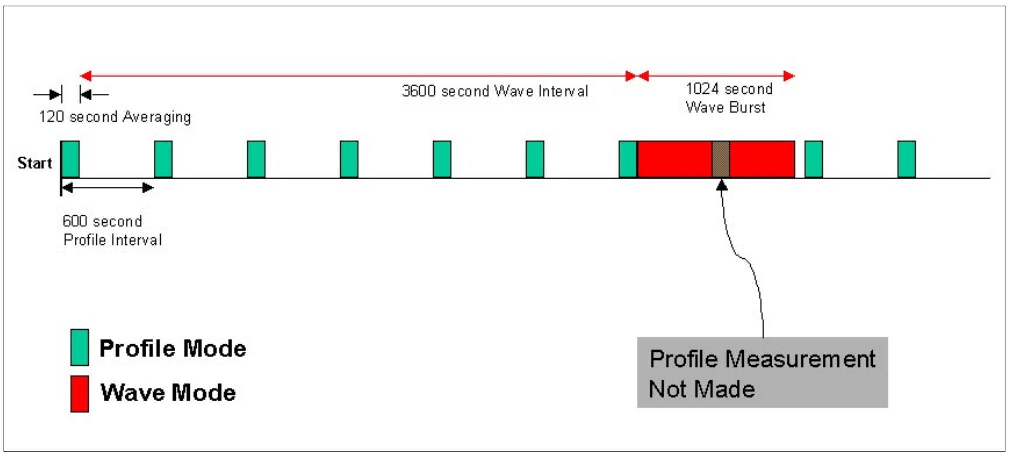


Waves. Check this box if you want the AWAC to measure waves. If your AWAC is equipped with AST, this algorithm will be used. Otherwise the traditional method is applied – See *Measuring Waves* in *Chapter 4* for more on this.

Number of samples. The wave spectra are calculated from the time series using FFT algorithms. This is why the number of samples is either 512, 1024 or 2048. The highest number gives better accuracy, but requires more computational power. Please note that the number of samples refer to velocity and pressure. If you have the AST option, the AST rate is twice the static sampling rate. In other words, if you set the sampling to 1024 samples at 1Hz, you will have 2048 measurements of the surface position collected at 2Hz.

Sampling rate. Configuring the AWAC for AST measurements essentially involves choosing a sampling rate that is logical for the deployment depth, the target waves, and the memory consumption. As the AWAC is deployed in greater and greater depths the benefit of sampling at the higher rate diminishes. This is due to the fact that the *footprint* of the centre beam on the surface starts to approach the size of the waves as the AWAC is moved into deeper waters. As a general rule of thumb, the sampling should be set to 1Hz for depths greater than 20 metres and 2Hz for depths less than 20 metres.

The AWAC measures profile and waves sequentially. In case of conflict, wave measurements have priority over profile measurements. However, an interpolation is made when you view this in the AWAC software, so that the suppressed profile measurement seems to have been made. The interpolation follows the data when they are converted to ASCII. Observe that the raw file will not contain this interpolation.



Interval. The time between each wave measurement (time series).

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

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.

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! The basis for the battery utilization calculations is an unused 540Wh alkaline battery. If you are using a partly depleted battery, the calculated percentage will be incorrect. If you are using lithium batteries, the capacity will increase by a factor of 2.5.

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

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 of the current profile data along the vertical axis and in the horizontal plane.

Compass update rate and power level. Information about how often the compass will be read and how much energy the AWAC will send into the water. These values can be altered in *Advanced* planning.

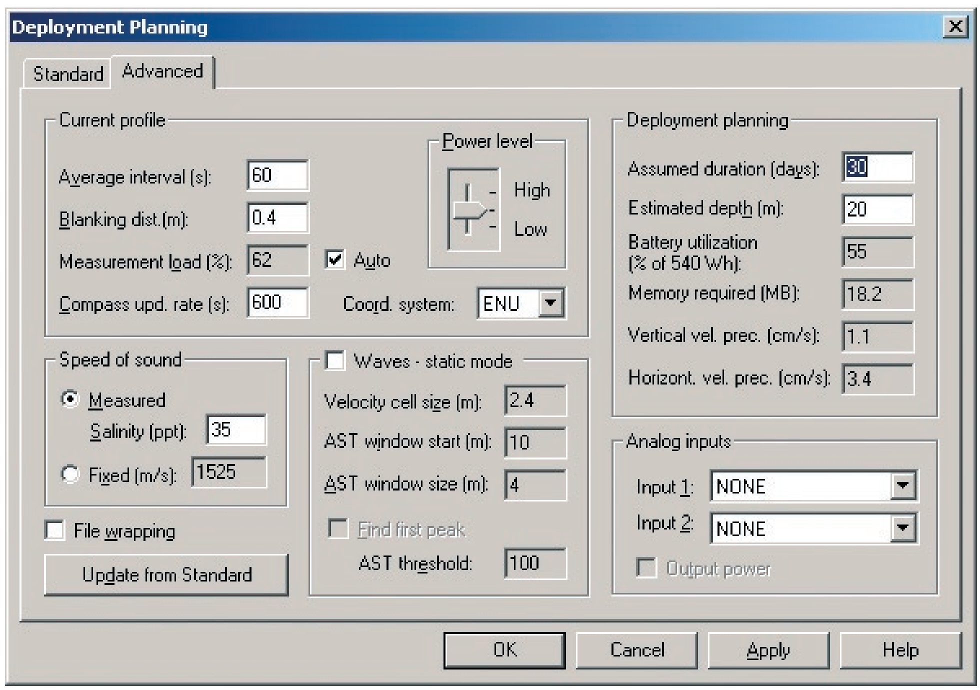
The Advanced Tab

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

Blanking distance. The distance from the sensor to the start of the measurement area. See *Measurement Area, Blanking, Wave Measurement Area* in *Chapter 4* for an illustration of this.

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). The measurement load can be increased to improve the velocity precision at the expense of increased power consumption.

The deployment dialogue box has two levels – Standard and Advanced. The two are accessed by clicking the corresponding tab. This screenshot shows the contents of the **Advanced** tab panes. See text for details on the dialogue box contents.



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 12dB. Unless you know your environment has high backscatter, you should generally use the power level calculated in Standard mode.

Note! Wave mode raw velocity data are always collected in beam coordinates.

Coordinate system. You may specify the coordinate system to be used:

- **Beam** means that the recorded velocity will be in the coordinate system of the acoustic beams, about 25° with respect to the vertical.

- **XYZ** means that the measurements are transformed to a fixed orthogonal XYZ coordinate system
- **ENU** means that the data are converted to geographic coordinates for every measurement. This is the standard mode for current profiling.

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.

Waves – static mode. Check this box to access the AST setup parameters:

- **Velocity cell size.** The wave-induced velocities are sampled in a cell with user-selectable vertical size. This is normally as close to the surface as possible without touching. Unless having reasons for using something other than 2–4 metres, we suggest that the default value is used.
- **AST window start.** This is a fixed distance from the instrument (normally the seabed). Make sure the window starts below the sea surface.
- **AST window size.** This value should be set so that the sea surface always is contained within the AST window. Sea states and tidal variations should be taken into consideration.
- **Find first peak.** Typically, in shallow water your AST window may be large compared to the deployment depth. In such cases you may experience multiple reflections from the surface and the seabed. To find the true surface position use the **Find first peak**, which allow you to specify a threshold. Peaks lower than this threshold will then not be taken into consideration when looking for the surface. Threshold is in internal units of counts.

Note! The use of analogue inputs requires a special internal harness. Some systems are equipped with this at the time of purchase. However, you may also purchase the harness separately and upgrade the AWAC.

Analogue inputs. The instrument can read two analogue inputs at the same time. The input range is 0–5V, where 0V equals 0 counts, 5V equals 65 535 counts and 2.5V equals 32 768 counts.

Profile, Wave, or **Profile & Wave** specifies whether to sample data at the start of a profile sampling, of a wave sampling, or both. Only one analogue input can be used in the wave cycle.

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

File wrapping. If checked, data is logged to the internal instrument recorder in ring-buffer mode. This ensures that the recorder always holds the latest data. If not checked data logging will stop when the recorder is full. File wrapping off is normally only used in on-line systems.

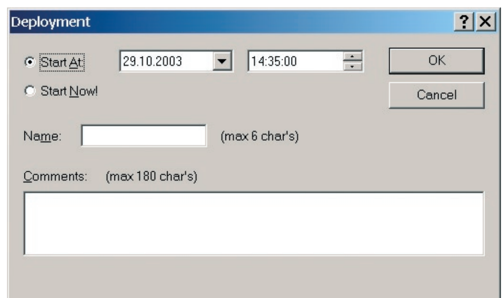
The **Deployment planning** is described under the previous section (the *Standard tab*).

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

Setting the Time and using Delayed Start-up. The software allows you to set the AWAC time and a delayed start-up time when you start the deployment. The easiest way to set the AWAC 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 AWACs with one another or with other sensors.

The time setting menu lets you specify a start time, a name for the deployment and even add notes about the task.



Tip! Remember to keep the unit powered at all time after the deployment has been started! Otherwise the correct time may be lost.

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

A frame in need of more weight, but otherwise OK.

Mounting Guidelines

The AWAC is often used in areas with large waves. Large waves generate strong orbital currents, which again means that the mounting frame will be subject to strong forces. To survive the wave forces the mounting frame should be compact at the same time as it should be heavy. Contact NORTEK if you need ideas on what the mounting frame should look like.

Things to Consider when Mounting

Tip! The best way to hold an AWAC (and the external battery pack) onto a fixed structure is to clamp it around its circumference.

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

- When mounting the AWAC near large obstructions (bridges, piers, walls, etc.), ensure that the acoustic beams do not "see" any obstructions. Objects interfering with the beams may violate your data.

- Keep the AWAC away from magnetic materials. Consider the frame or cable holding the AWAC, and the structure it is mounted on. Nearby magnetic materials could cause the directional readings to be in error.
- 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 AWAC's beams.
- 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 twice its maximum reading. For example, the standard 50m pressure sensor can safely withstand 100m depth, but it will not record meaningful data beyond 50m.

Use of Long Cables

RS232 data communication at 9600 baud will normally work fine for cables up to 20–30m 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 AWAC between the end cap and the circuit board. Keep in mind that RS422 uses more power in sleep mode.

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 16VDC, and never falls below 9VDC.

Changing the Baud Rate

You may specify two separate baud rates for the AWAC (see also *Running a Functionality Test* in *Chapter 5* for more on this). 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.

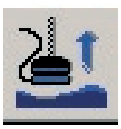
Tip! If data download is interrupted, the AWAC could be left with a baud rate setting other than the one used for normal communication. Then, when the software tries to connect to the AWAC, it may spend a few moments searching for the current baud rate.

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

1. Set up the AWAC and connect it to your computer.
2. Set the baud rate in **Communication** >**Serial Port** 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 AWAC will reawake with the new baud rate.

Stop Recorder Deployment



The Stop Recorder Deployment icon

Before you tell the AWAC to stop collecting data, verify that the computer time is accurate. The software will compare the computer time with the AWAC time, and you can use this information to quantify clock drifts. After you connect the AWAC to your computer, click **Deployment** > **Stop Recorder Deployment** or click the corresponding icon.

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

Recording Data Internally as a Backup

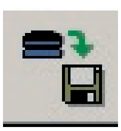
The Start with Recorder icon

You can set the instrument to record data internally along with sending data out the serial port. To do this, use **Online** > **Start with recorder** or click the corresponding icon.

The AWAC has two modes of internal recording. The standard mode is to stop recording when the recorder is full. The AWAC 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 have deployed the AWAC with batteries and want to collect data even if the external power supply fails.

CHAPTER 7
Getting Data Out of the AWAC

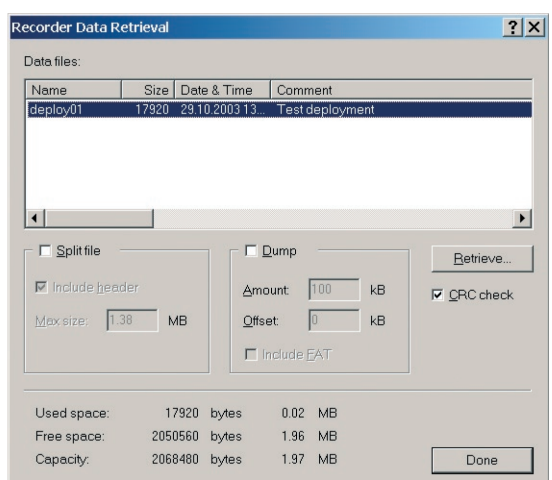
This chapter explains how to get the data out of the AWAC by means of the AWAC software. If you are going to do post processing in programs like Microsoft® Excel and MATLAB® the data must be converted to ASCII format first. This chapter shows you how.



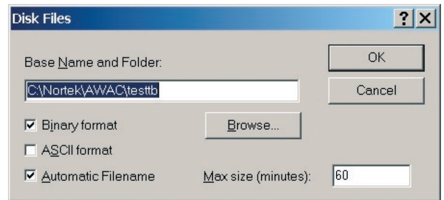
The Recorder Data Retrieval icon

To retrieve data from the instrument:

1 Click **Deployment** > **Recorder Data retrieval** or click the corresponding icon. Within a moment, you will see a list of the recorded data files – in the case of more than one file, the most recent file will be the last one listed:



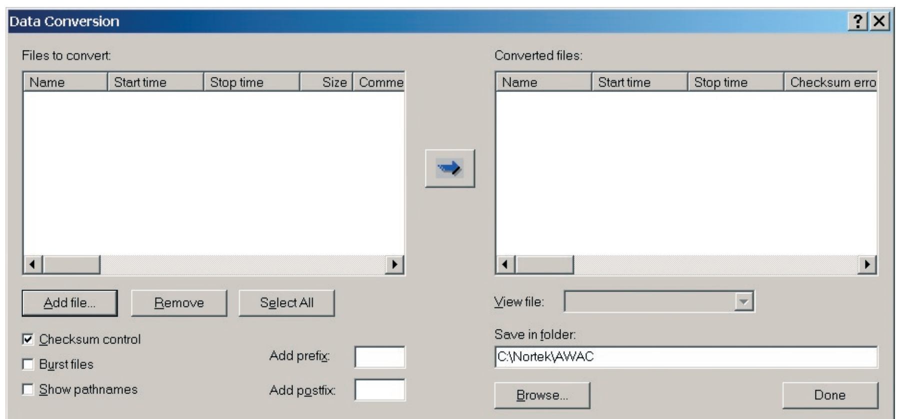
2 Highlight the file(s) you want, click **Retrieve** and select the location for the file:



3 The selected files will now be retrieved and put on your hard drive.

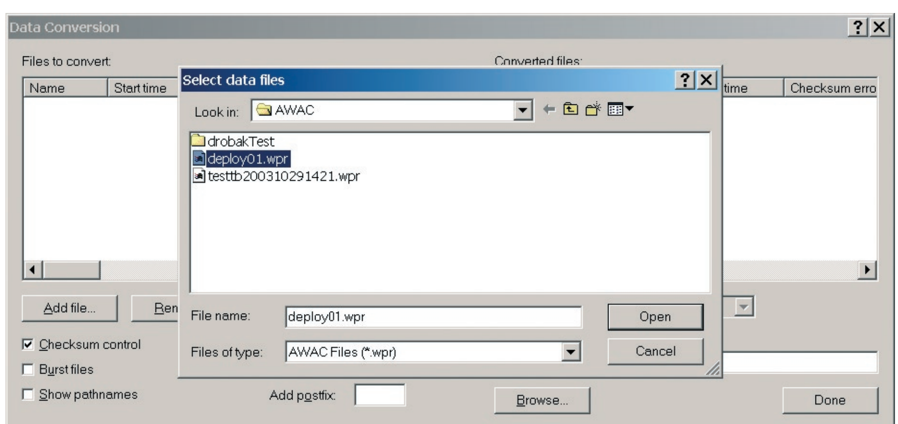
To convert the retrieved data into ASCII format:

1 Click **Deployment** > **Data Conversion** or click the corresponding icon.



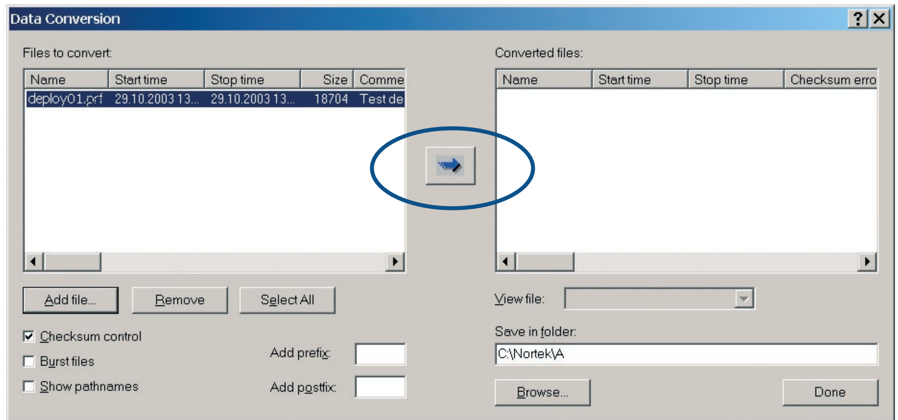
2 Define where to put the converted files (**Save in folder**).

3 Click **Add file...** to insert files for conversion. Select files (use the **SHIFT** key and/or the **CTRL** key to select more than one file) and click **Open**.

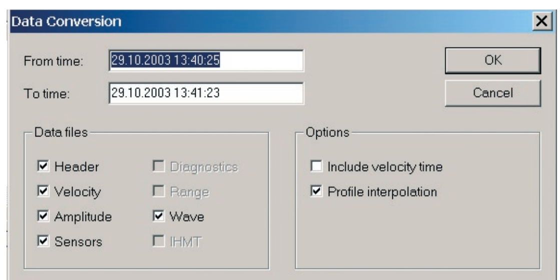


4 Files selected will now be inserted in the left column. Repeat **3** if you want to convert files from other folders.

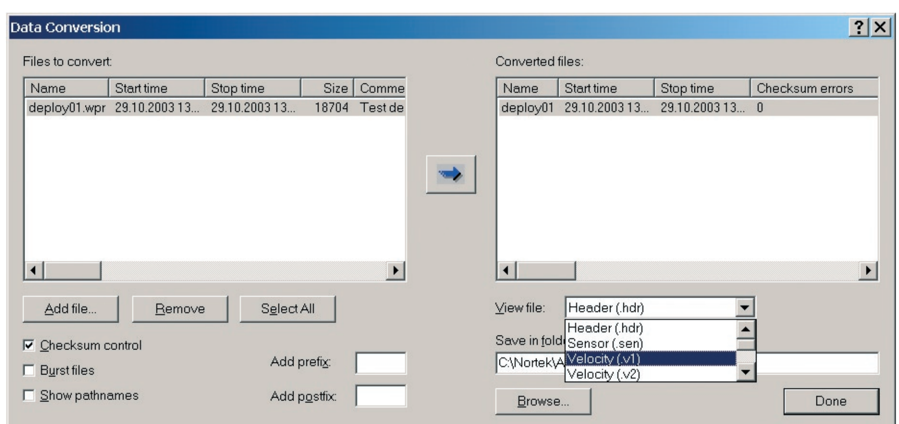
5 Once you have entered all the files required, highlight (by selecting) the files to be converted and click the arrow between the two columns:



6 You will now be prompted to specify what part of the files you want to convert:

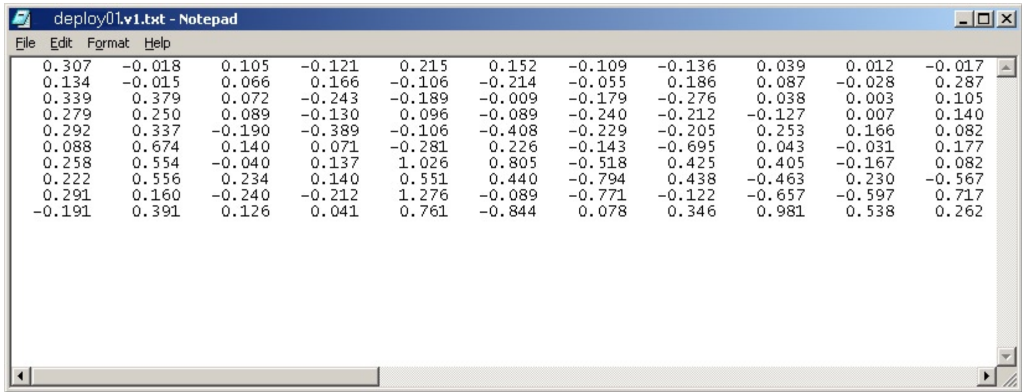


7 To view the contents of a converted file, select what part or type you would like to inspect:



This will start Notepad (unless your PC is configured otherwise) and show the contents of the selected file:

The contents of the converted file is shown in Notepad, see the previous page for more on this.



0.307	-0.018	0.105	-0.121	0.215	0.152	-0.109	-0.136	0.039	0.012	-0.017
0.134	-0.015	0.066	0.166	-0.106	-0.214	-0.055	0.186	0.087	-0.028	0.287
0.339	0.379	0.072	-0.243	-0.189	-0.009	-0.179	-0.276	0.038	0.003	0.105
0.279	0.250	0.089	-0.130	0.096	-0.089	-0.240	-0.212	-0.127	0.007	0.140
0.292	0.337	-0.190	-0.389	-0.106	-0.408	-0.229	-0.205	0.253	0.166	0.082
0.088	0.674	0.140	0.071	-0.281	0.226	-0.143	-0.695	0.043	-0.031	0.177
0.258	0.554	-0.040	0.137	1.026	0.805	-0.518	0.425	0.405	-0.167	0.082
0.222	0.556	0.234	0.140	0.551	0.440	-0.794	0.438	-0.463	0.230	-0.567
0.291	0.160	-0.240	-0.212	1.276	-0.089	-0.771	-0.122	-0.657	-0.597	0.717
-0.191	0.391	0.126	0.041	0.761	-0.844	0.078	0.346	0.981	0.538	0.262

Finish Operations

Note! To conserve your battery when the AWAC is not being used for a period of time, be sure it is not in data acquisition mode.

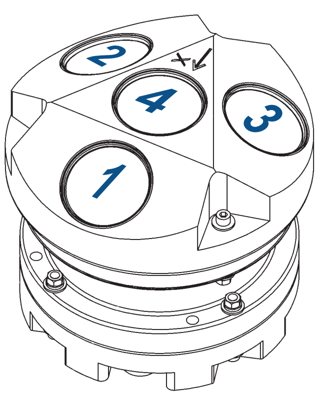
Be sure to stop data recording using one of the **Stop** buttons before you store an AWAC.

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.

Raw Data

The wave processing is based on the raw wave surface track, pressure and wave velocities. The raw time series are constructed from 512/1024/2048 samples collected at a rate of 1 or 2Hz. The AST time series is always sampled at twice the rate of the pressure and velocity (2 or 4Hz). The data is displayed in the software under the tabs **Wave Vel** or **Wave Press**. There are three along-beam velocities, one from each slanted beam, where beam 1 is pointing in the compass direction and beam 4 is the vertical AST beam. The velocity data is collected in a sampling volume located along the beams at some distance below the surface. The position and size of the sampling volume will change with the mean water level and the wave height.



The beam numbering system

Things to consider when looking at the raw data, include the following:

- **The pressure signal** should be smooth and clean. The resolution of the pressure sensor is usually a fraction of a cm (about 14-bit resolution at 1Hz), and there should be no sudden jumps or discontinues in the time series. The raw pressure signals gives an immediate indication about the wave condition; long waves (T>8 s) gives a strong pressure signal at the bottom and a variation of 1 m in the pressure signal mean that the wave height is at least the same. On the other hand, a very weak signal in the pressure sensor (variations of only a few cm) usually means that the waves are small.

- **The raw wave velocities** will appear noisy even at moderate sea states. Only at times with large waves can you expect a smooth signal. Even so, the noise should not be excessive and it should be possible to see the wave signal when there are significant wave action on the surface. Watch out for large jumps or discontinuities; this could mean that part of the sampling volume has touched the surface, which would render the velocity data invalid.
- **The raw AST signal.** Here you should look for appearance, i.e. that the data look reasonable and that you have no data loss, and above all, that the data is similar to the pressure measurements

Binary Data Files

Tip! Use our web site (http://www.nortek-as.com) to get access to the latest tech-notes and user experiences regarding i.a. data analysis.

Binary files created by the AWAC program all use the same format, whether internally recorded or recorded using the real-time **Record to Disk** option. Binary data files include a header (50–100 bytes long), and each data record (whether normal or diagnostic) adds 40 bytes. The binary file format is not documented here, since it is all shown in the header file – see example in side bar overleaf.

An example of parts of the header file showing that the data format is well documented in the header file itself. This will ensure that no matter how many firmware upgrades you do, you will always have access to the format used when the acquired data was downloaded.

Sample.hdr.txt - Notepad

File Edit Format Help

```
System40                             0
System41                             5
System42                             16384
System43                             0
System44                             0
System45                             0

Data file format
----------------------------------------------------------------------
[D:\Proj\ParaDopp\Deploy\Data\Wavepro\IHMT\Apr2000\22201.v1]
 1    Velocity Cell 1 (Beam1|X|East)   (m/s)
 2    Velocity Cell 2 (Beam1|X|East)   (m/s)
      .
      .
 n    Velocity Cell n (Beam1|X|East)   (m/s)
----------------------------------------------------------------------
[D:\Proj\ParaDopp\Deploy\Data\Wavepro\IHMT\Apr2000\22201.v2]
 1    Velocity Cell 1 (Beam2|Y|North)  (m/s)
 2    Velocity Cell 2 (Beam2|Y|North)  (m/s)
      .
      .
 n    Velocity Cell n (Beam2|Y|North)  (m/s)
----------------------------------------------------------------------
[D:\Proj\ParaDopp\Deploy\Data\Wavepro\IHMT\Apr2000\22201.v3]
 1    Velocity Cell 1 (Beam3|Z|Up)     (m/s)
 2    Velocity Cell 2 (Beam3|Z|Up)     (m/s)
      .
      .
 n    Velocity Cell n (Beam3|Z|Up)     (m/s)
----------------------------------------------------------------------
[D:\Proj\ParaDopp\Deploy\Data\Wavepro\IHMT\Apr2000\22201.a1]
 1    Amplitude Cell 1 (Beam1)         (counts)
 2    Amplitude Cell 2 (Beam1)         (counts)
      .
      .
 n    Amplitude Cell n (Beam1)         (counts)
----------------------------------------------------------------------
[D:\Proj\ParaDopp\Deploy\Data\Wavepro\IHMT\Apr2000\22201.a2]
 1    Amplitude Cell 1 (Beam2)         (counts)
 2    Amplitude Cell 2 (Beam2)         (counts)
      .
      .
 n    Amplitude Cell n (Beam2)         (counts)
----------------------------------------------------------------------
[D:\Proj\ParaDopp\Deploy\Data\Wavepro\IHMT\Apr2000\22201.a3]
 1    Amplitude Cell 1 (Beam3)         (counts)
 2    Amplitude Cell 2 (Beam3)         (counts)
      .
      .
 n    Amplitude Cell n (Beam3)         (counts)
----------------------------------------------------------------------
[D:\Proj\ParaDopp\Deploy\Data\Wavepro\IHMT\Apr2000\22201.sen]
 1    Month                            (1-12)
 2    Day                              (1-31)
 3    Year
 4    Hour                             (0-23)
 5    Minute                           (0-59)
 6    Second                           (0-59)
 7    Error code
 8    Status code
 9    Battery voltage                  (V)
10    Soundspeed                       (m/s)
11    Heading                          (degrees)
12    Pitch                            (degrees)
13    Roll                             (degrees)
14    Pressure                         (m)
15    Temperature                      (degrees C)
16    Analog input 1
17    Analog input 2
```

CHAPTER 8
Analysing the Acquired Data

The software supplied with your AWAC has been designed to provide you with the ability to set up the AWAC for deployment, upgrade the firmware, download acquired data, do a quality assurance of the downloaded data, and convert the acquired data to ASCII format to take advantage of general post processing software programs like Microsoft® Excel and MATLAB®.

For an in-depth analysis of the current profiling and the wave data, we recommend the **Nortek ExploreWave** software program, which is available separately. The wave processing made in ExploreWave is purely post processing not affecting the raw data itself. This means that the wave parameters can be calculated and recalculated repeatedly with no risk of destroying the raw data.

This chapter deals with the capabilities of the AWAC software program.

Correcting Data for Sound Speed Errors

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

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

Data already acquired cannot be corrected from within the AWAC software, so you will have to do this for yourself or add a correction term to all applicable values when importing ASCII converted data to Excel or MATLAB®.

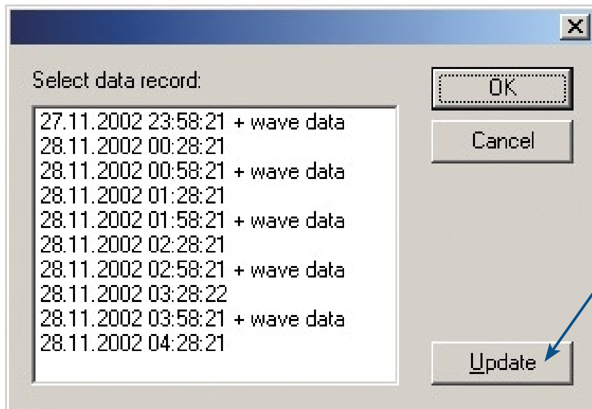
Viewing a File Downloaded from the AWAC

To view a file already downloaded from the AWAC:

1 Select **Playback** > **Open File** to locate the file to be viewed. This will open the familiar Windows® Open file dialogue box.

2 When you have selected the file to open the following box appears:

The file which you have have downloaded from the AWAC is organised as a series of events, sinply because in-between the events, the instrument is in sleep mode and no data acquisition takes place. Click on the event you would like to view.



When looking a several events, one after the other, you may want to keep this box floating on top of the AWAC software screen. Click **Update** to update the display with the new event without closing this box

This dialogue box shows that an AWAC measurement file consists of several events (in between the events the instrument goes to sleep to conserve power).

The numbers are the date and time of day for the start of each event. The text **+ wave data** will appear for the events that included wave measurements only.

3 Select an event to view, click **OK** (or double-click) to show the selected event, closing the dialogue box or click **Update** to show the selected event keeping the dialogue box floating on top of the AWAC software main screen.

The selected event will now be displayed.

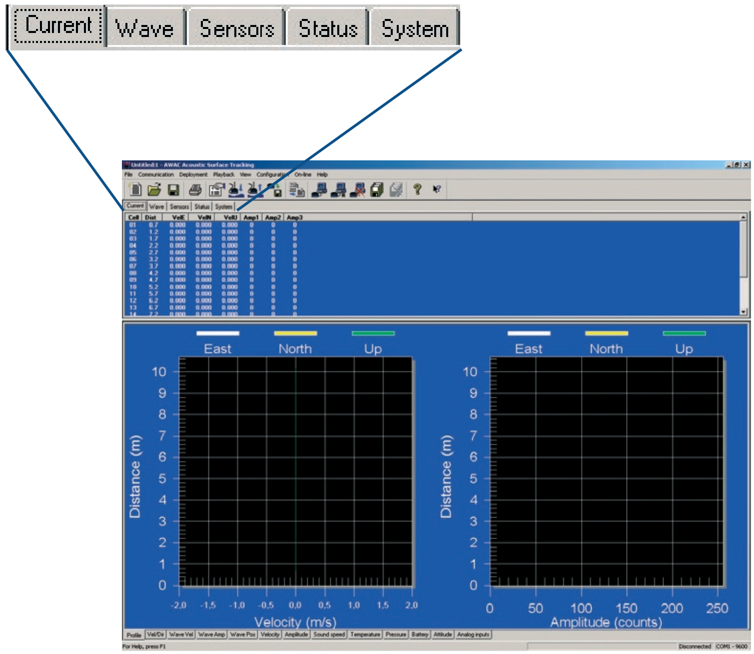
To get the Select data record dialogue box back on the screen if you closed it by clicking OK:

- Select **Playback** > **Data Record...**

The display options are treated in detail in the following.

The Numerical Tabs

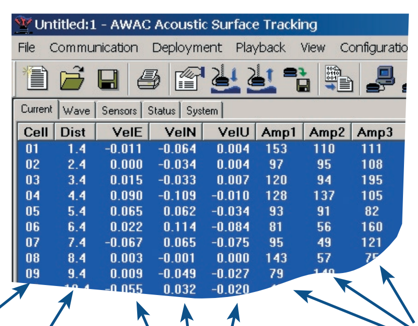
The numerical tabs of the main screen let you inspect the acquired data in a variety of ways.



The Current Tab

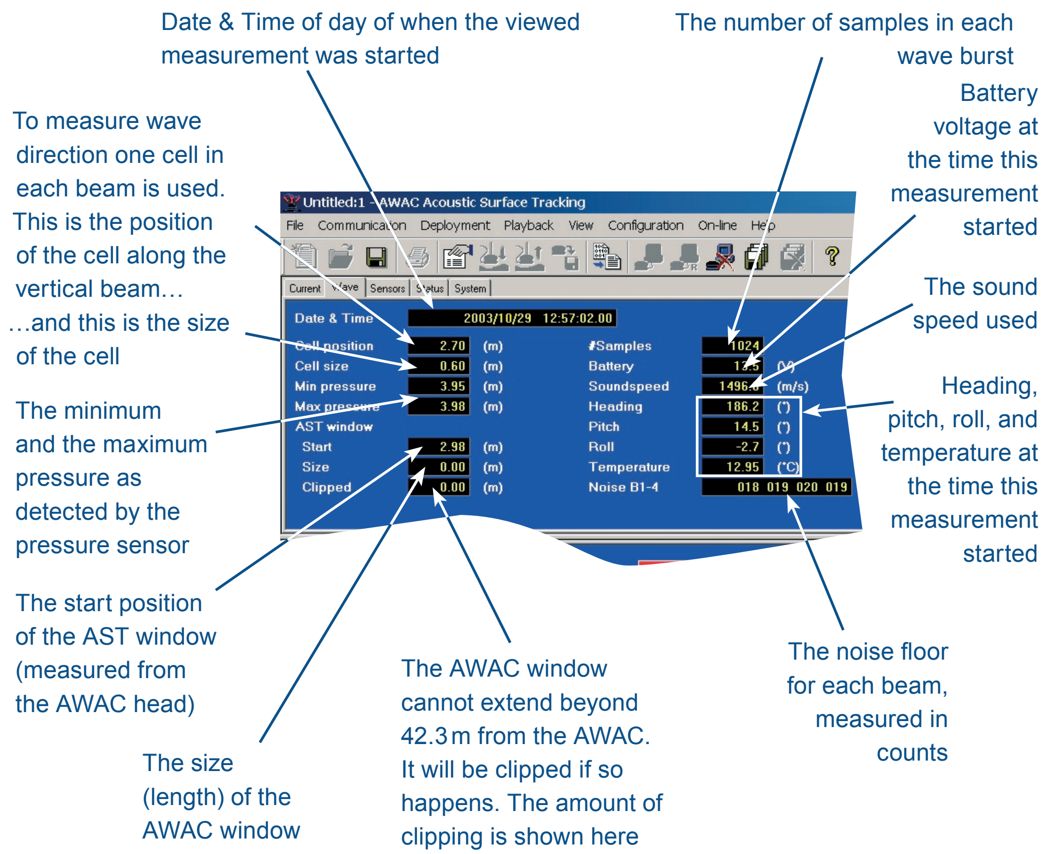
The Current Tab provides a tabulation of the measured current profiles per cell, including the measured amplitudes to indicate the received signal strength.

The Current Tab provides a tabulated list of the measured current profiles.



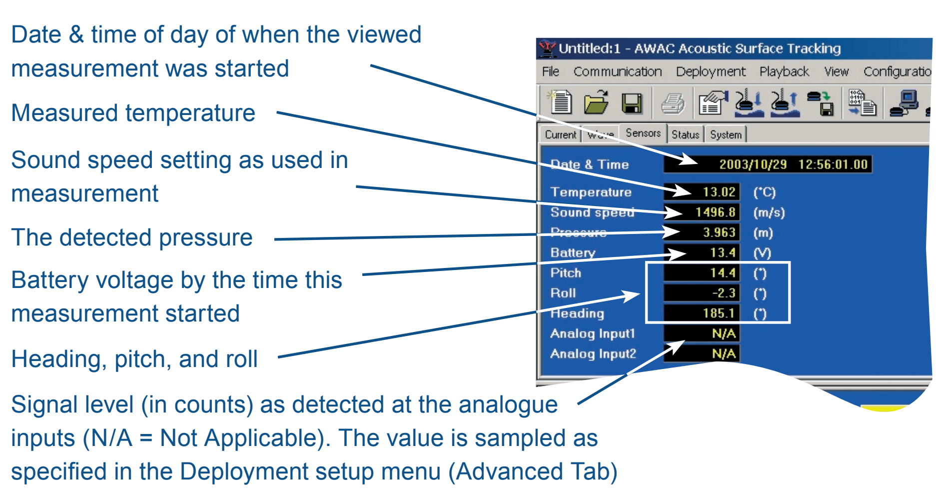
The Wave Tab

The Wave Tab shows the position of the cells the AST uses to calculate the waves and their direction.



The Sensors Tab

The Sensors Tab provides information about the sensor and the reading of the analogue inputs.



The Status Tab

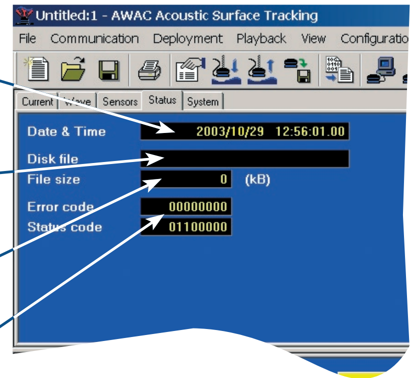
The Status Tab provides information on the path to the disk file and its size as well as if any errors have occurred.

Date & time of day of when the viewed measurement was started

Disk file shows the name of the disk file in use for data recording. The field displays OFF if no data are stored to the computer disk

File size is the size of the file being recorded to disk

Error codes and Status codes – see below for an interpretation



Error codes

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Not used	Not used	Not used	Flash	Tag bit	Sensor data	Measurement data	Compass
			0=OK 1= Error	0=OK 1= Error	0=OK 1= Error	0=OK 1= Error	0=OK 1= Error

Status codes

Bit 7&6	Bit 5&4	Bit 3	Bit 2	Bit 1	Bit 0
Power level 00 = 0 (high) 01 = 1 10 = 2 11 = 3 (low)	Wakeup state 00 = bad power 01 = power applied 10 = break 11 = RTC alarm	Roll 0 = OK 1 = out of range	Pitch 0 = OK 1 = out of range	Scaling 0 = mm/s 1 = 0.1mm/s	Orientation 0 = up 1 = down

The System Tab

The System Tab provides information on the system itself.

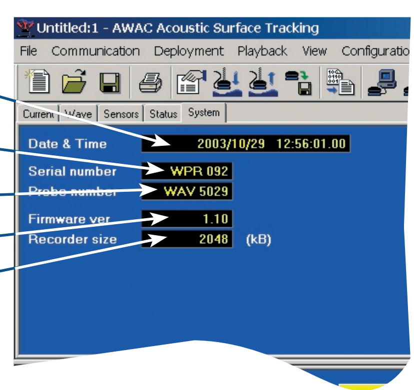
Date & time of day of when the viewed measurement was started

Serial No. of the PCB inside the AWAC

Serial No. of the AWAC head

AWAC firmware version

Recorder (memory) size



The Graphical Tabs

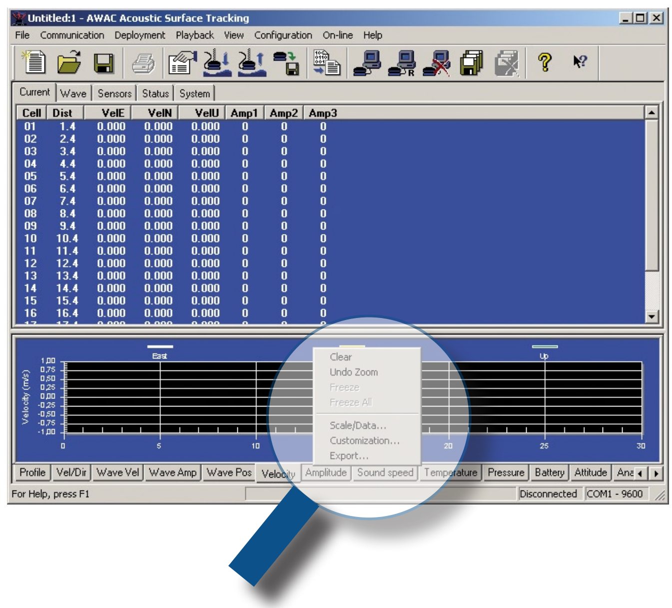
The graphical tabs determine what to display in the lower part of the AWAC software main screen. By right-clicking the mouse whilst positioned in the graph area, you may customize the display.

Customizing the Display

To be able to customize the graphical display:

- Whilst positioned in the graph area, right-click the mouse. A context-sensitive menu will now appear.

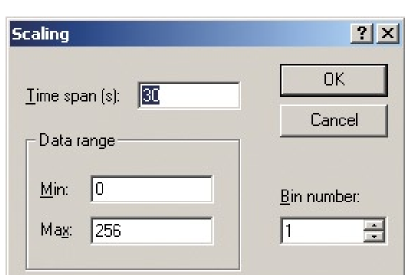
If you right-click the mouse whilst in the graph area, a context-sensitive menu will appear.

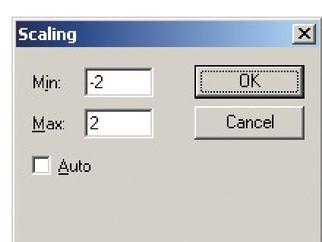


To change the time scale:

- In the context-sensitive menu, click the **Scaling...** or **Scale/Data...** The exact name and appearance of this submenu depends on the function displayed at the moment you right-clicked. If **Scaling** appears ghosted, there is nothing to set for the function currently displayed.

The Scaling submenu comes in two flavours; with and without bin (cell) number specification. This choice appears only when meaningful. In addition, the scaling submenu lets you define the time span in seconds for level vs. time displays, and the data range (vertical axis setting). For profiles, the scaling refers to the levels and not to the distance span shown. You may also select autoscaling in some cases.

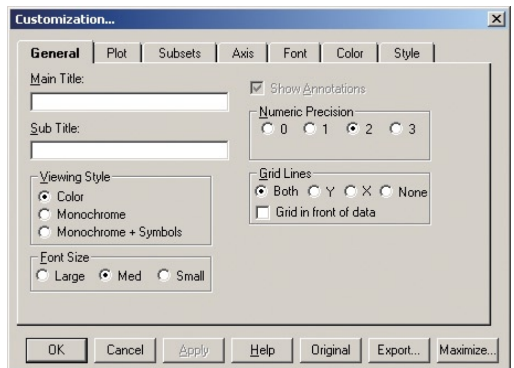




To change the look of the graphs:

1. In the context-sensitive menu, click the **Customization...** This will produce a tabbed dialogue box.
2. Set the parameters as required for your application. Parameters are explained in the following.

The General Tab



Main Title & Sub Title. These two edit-boxes allow adding, editing, and deletion of main and sub titles. If no title is present, entering one will add one. If you remove all the characters from a title, the title will be deleted from the image.

Viewing Style. The graph supports three viewing styles:

- Color
- Monochrome
- Monochrome with Symbols

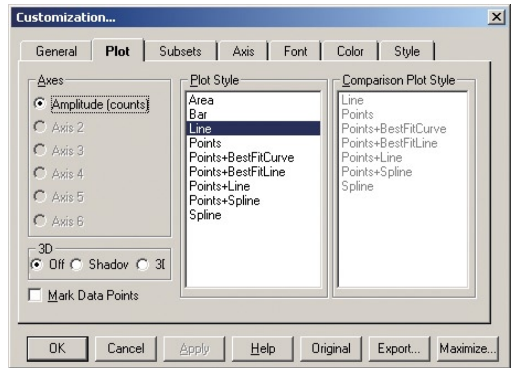
This customization allows you to quickly adjust the image to best suite printing on a monochrome printer. If fewer than four subsets are to be included in a graph, then the Monochrome setting will probably be the best choice. If four or more subsets are to be included in the graph, then Monochrome with Symbols will help distinguish the different subsets.

Font Size. The graph supports three font sizes, Large, Medium, and Small. This gives you the option of selecting the font size that is most readable. When printing the graph, a font size of Medium or Small is suggested.

Numeric precision. Defines the number decimals to be used when placing data labels onto the graph, and when exporting Text/Data via the Export Dialogue box.

Grid Lines. The graph can contain vertical grid lines, horizontal grid lines, both vertical and horizontal grid lines, or no grid lines. Grid lines can be made to appear in front of the graph.

The Plot Tab



Axes: Lists the axes available for customization (context-sensitive – depends on function viewed when this menu was entered).

Plot Style. The AWAC software supports a multitude of plotting methods. Depending on the implementation, some plotting methods may not be available. Also, many but not all of these plotting styles can be set for a secondary comparison plotting style.

If the graph has multiple y-axes, you can control plotting styles for each individual axis by selecting the axis in the axis-button group.

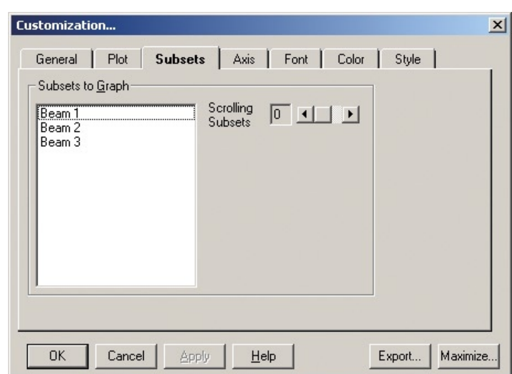
3D. This feature allows you to add three-dimensional effects to the plots:

- **Off:** No 3D effect is added.
- **Shadow:** Draw shadows behind bars, points, and the area of an area graph.
- **3D:** Bars and area charts are drawn in a 3D fashion.

Mark Data Points. Adds small circular marks at data point locations.

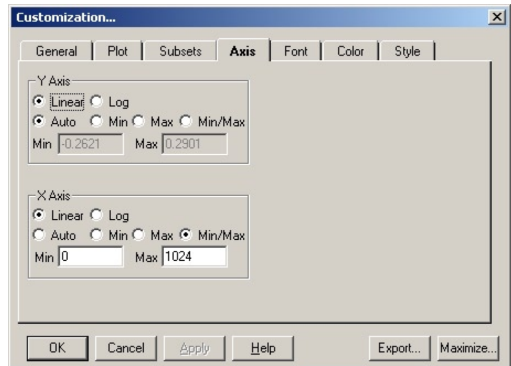
Comparison Plot Style. Not used.

The Subset Tab



Subsets. The subsets tab is used to add annotation to the graphs, typically East, North, Up or Beam 1, Beam 2, Beam 3.

The Axis Tab



Axis. This tab lets you specify axis type and range. Select between linear or logarithmic axes and the following range settings:

- **Auto:** Graph automatically determines min and max based on data.
- **Min:** Manually set Min and automatically set Max.
- **Max:** Manually set Max and automatically set Min.
- **Min/Max:** Manually set both the Min and Max.

Additional parameter fields are available when meaningful, otherwise they appear ghosted.

The Font Tab

The font tab (not shown) lets you specify font size and appearance for the titles and annotations used in the graphs.

The Colour Tab

The colour tab (not shown) lets you specify the colours used in the graphs for the curves and the backgrounds.

The Style Tab

The Style tab (not shown) lets you specify the look of each of the curves appearing in a graph.

Exporting a Graph

Graphs can be exported to the Windows® clipboard as text, Windows® Metafile and to a printer, and as files for use in other applications, such as reports and presentations. Normally we will recommend that you save the graph as a file.

The following formats are available:

- **Metafile** to be used for *Clipboard, File,* and *Printer*
- **Bitmap** to be used for *Clipboard*, and *File*
- **Text/Data** to be used for *Clipboard*, and *File*
- **JPEG** to be used for *File*

To export a graph:

1. Press **X** when displaying the required graph or click the **Export** key in the Customization Dialogue box.
2. Select the type of export desired.
3. Select the destination of the export.
4. If available, select the size of the image to export.
5. Press the Export/Print button.

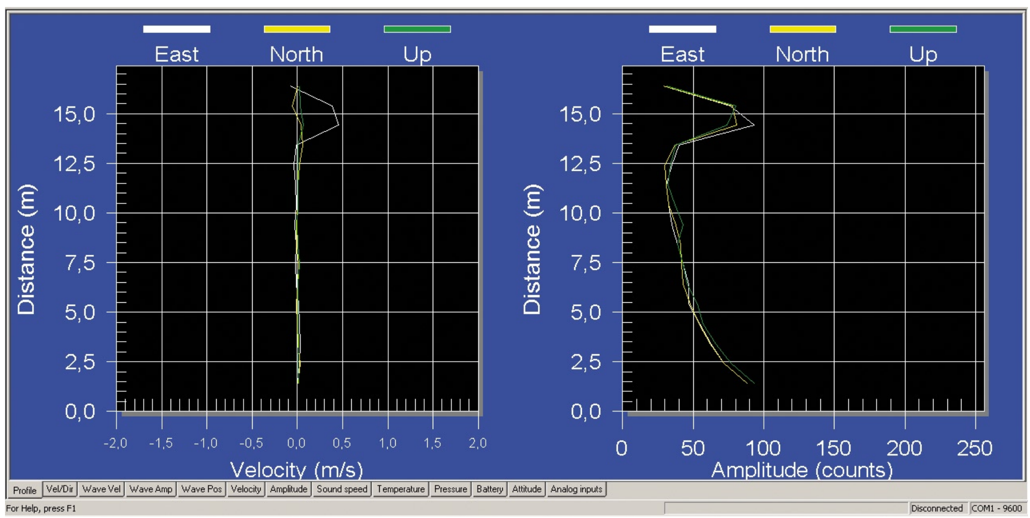
Tip! In general, we recommend that you convert the file to ASCII rather than exporting it as text from here.

Printer as destination. If your exporting a metafile to the printer, pressing the **Print** button will produce the Windows® Print dialogue box, which lets you print as usual.

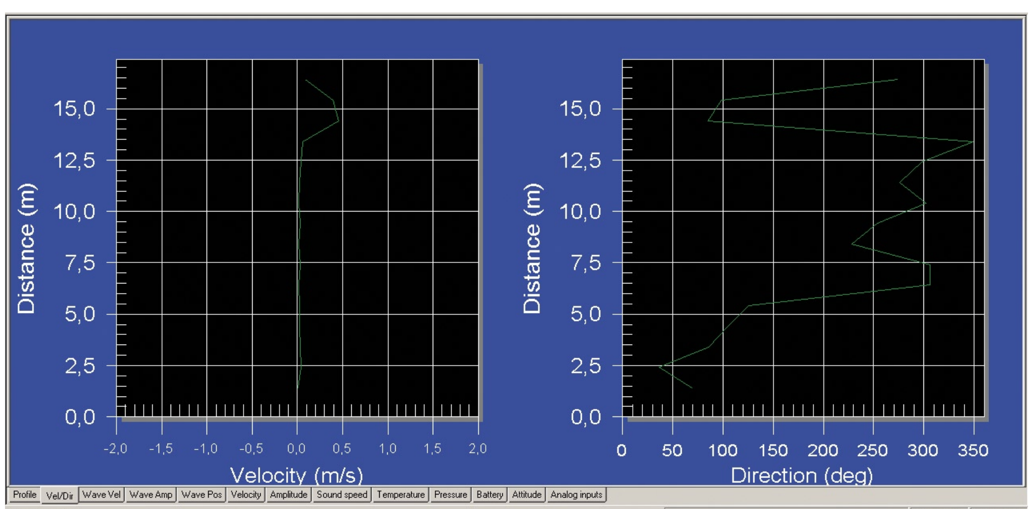
The Different Graphs Available

On the following pages you will find screenshot examples of the available graphs. They are all shown in their standard look – no change of colours or other "tweaking" (as discussed in the above set of menus) has been applied.

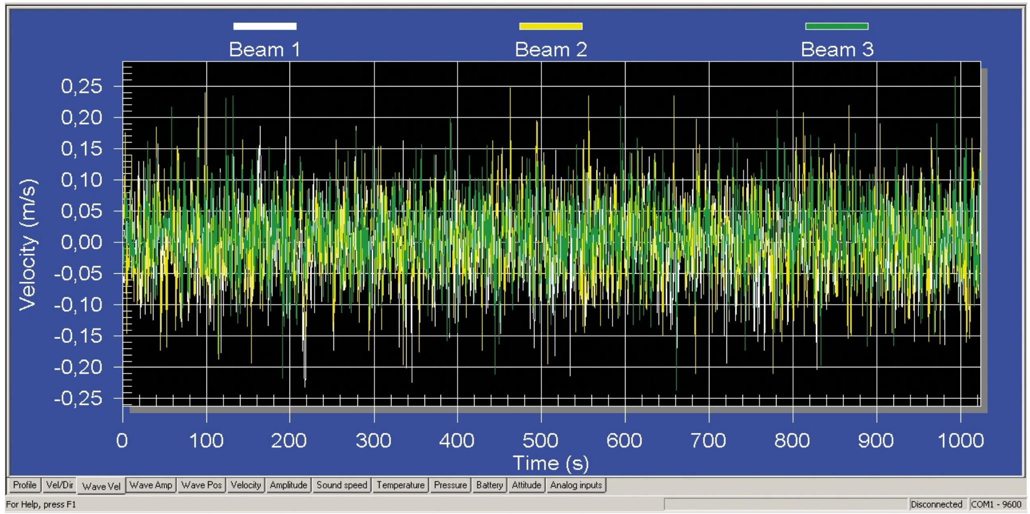
The **Profile** tab shows the velocity profile in m/s and as amplitude in counts. The latter is an indicator of the strength of the received signal. For amplitude measurements, the counts-scale spans from 0 to 255. Typical noise level is around 20–30 counts. To give you an idea of how much a count is, suffice it to say that one count corresponds to approximately 0.4 dB. Hence, counts are logarithmic by nature.



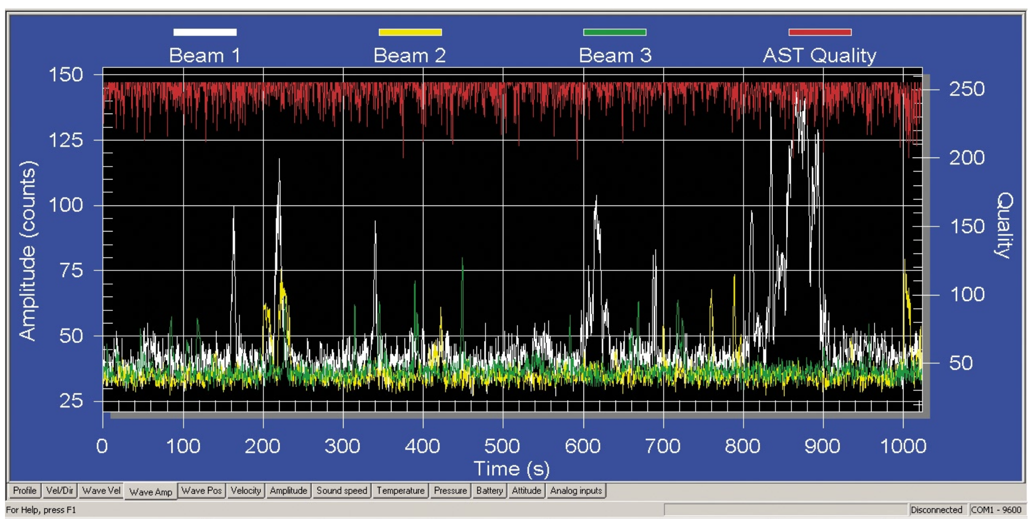
The **Vel/Dir** tab shows the combined velocity profile in **East/North** direction (**Up** is ignored). The corresponding direction is in degrees relative to North following traditional compass conventions so that positive (increasing) angles are clockwise (towards East). If you used XYZ, the direction angle will be relative to the X direction, but it will not follow the usual trigonometric conventions as compass conventions are preferred.



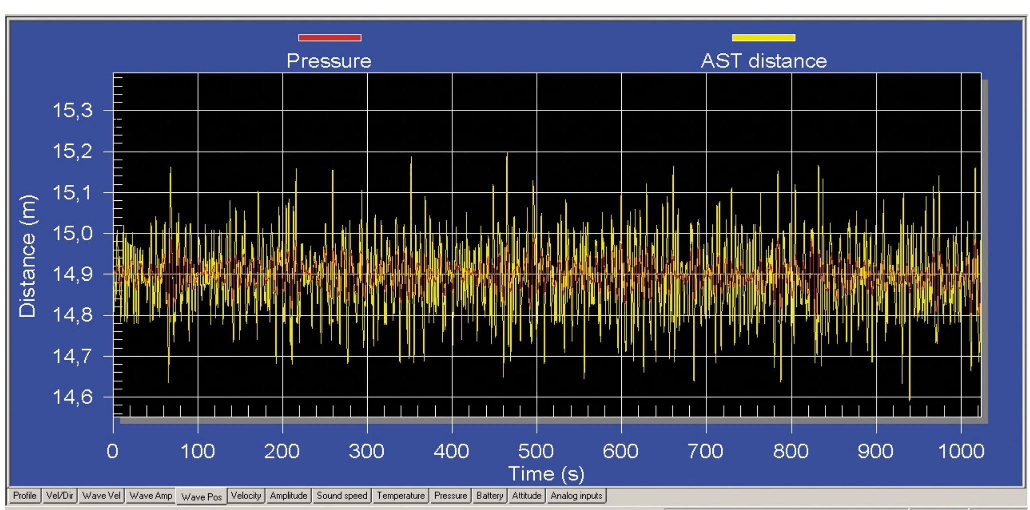
The **Wave/Vel** tab shows the wave velocity for each of the three slanted beams (1, 2, and 3). The time span shown is autoscaled to show the entire event interval.
To zoom in on a part of the graph, just position the mouse where you want the zoom to start and keep the left mouse button depressed while you draw a rectangle. This will be now be the zoomed part. To undo the zoom press the **Z** key or right-click whilst in the graph.



The **Wave/Amp** tab shows the amplitude for each of the three slanted beams (1, 2, and 3) and the AST quality in counts. The latter is an indication of the AST returned signal strength and thus a signal- to-noise ratio indicator. The time span shown is autoscaled to show the entire event interval.
To zoom, see the Wave/Vel tab for details.



The **Wave/Pos** tab shows a comparison between the pressure sensor's estimate of the distance to the surface and the AST's estimate of the same.



The above screenshots were taken from a deployment downloaded to the computer and then retrieved through the **Playback** command.

In addition, there are a number of displays available which will contain no graph unless the AWAC is connected to a computer and run in real time mode:

Velocity tab. The Velocity screen (not shown) displays the velocity in accordance with the coordinates you specified in the deployment setup.

Amplitude tab. This screen (not shown) displays the velocity vs time in counts (to indicate received signal strength) and in accordance with the coordinates you specified in the deployment setup.

Soundspeed tab. This screen (not shown) displays the sound speed vs. time. If your deployment setup uses fixed sound speed, this will be a flat line. If your deployment setup uses a keyed-in salinity and temperature, the sound speed will be calculated as the temperature changes. Note that any external CT sensors connected will be logged only. The information they provide will not be used in the AWAC's own measurement.

Temperature tab. This screen (not shown) displays the temperature vs. time based on the AWAC's internal thermometer.

Pressure tab. This screen (not shown) displays the pressure vs. time based on the AWAC's internal pressure sensor.

Battery tab. This screen (not shown) displays the battery voltage vs. time based on the AWAC's internal voltage measurement.

Attitude tab. This screen (not shown) shows the head, pitch, and roll of the AWAC vs. time.

Analogue tab. This screen (not shown) shows the signals received from analogue sensors connected to the Analogue inputs of the AWAC.

CHAPTER 9
Operational Concerns

My Data Doesn't Look Right

The AWAC 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.

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 submerged in 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.

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, and are not normally a problem in the field.

Mooring tilt

Sometimes mounting frames can tilt excessively or even fall over. If the AWAC's tilt reading is 30º or less, your current profile data can still be okay, but it is recommended that you try to mount the system such that the tilt is less than 5º. For systems operating in wave mode, and in particular with the AST option, we recommend that you deploy the instrument with less than 5° tilt.

Troubleshooting

Initial Problems? Did You Check This?

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

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

No Detection of the AWAC on the Serial Port

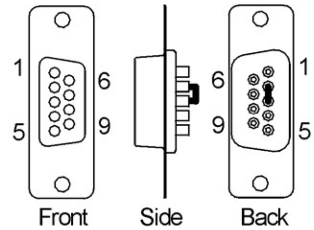
If you cannot connect to the instrument, first try sending a break to the AWAC. Send a break by clicking **Communication** > **Terminal emulator**, and then clicking the **Send Break** button. If the AWAC is powered and properly connected, and if the terminal is set to use the correct serial port, you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

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

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

To run a serial loop-back test:

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



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

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

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

To test your interface cable:

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

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

Data transfer problems

The members of the Windows® family of operating systems are not identical when it comes to transferring data to the serial port at high speeds (115kB is the highest a PC can do). Nor are computers; some have serial ports with buffers, while others have not. In general, newer computers have fewer problems than older ones, Windows NT® , Windows® 2000, and Windows® XP clearly have fewer problems than Windows® 95/98, and desktops seem to have less problems than laptops. If you encounter any disruptions when transferring the data file from the AWAC to the computer, simply reduce the Recorder/configuration baudrate until everything works fine. If problems persist, try to find another computer.

CHAPTER 10
Use with Other Instruments

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

The following should be observed:

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

  To activate powering of the external sensor from the AWAC:

  1. In the AWAC software click **Deployment** > **Planning** > **Use existing** or use **Load from Instrument**.
  2. Click **Use Advanced** and go to the **Advanced** tab.
  3. Define which analogue input (1, 2 or both) to use. **PROFILE** is used to sample data at the same rate as profile measurements are started, while **WAVE** samples every time an AST wave measurement is started. The **PROFILE & WAVE** is used to sample data every time a profile or an AST wave measurement is started. Only one of the inputs can be set to sample while wave measurements are made. A warning will appear if you attempt to set them both to wave related sampling.
  4. Check the **Output power** box.

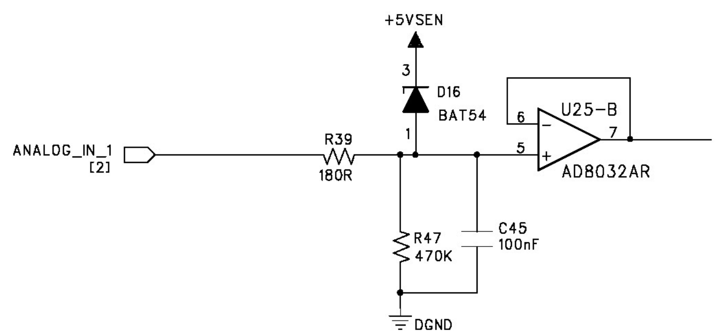
- The data from the external sensor will not be affected by the AWAC data quality. For example, the external sensor's data will be totally unaffected even if the AWAC is out of water and thus measuring noise only.

- No powering of the external sensor will take place when the AWAC is in sleep mode. This helps reducing the system's power consumption significantly.

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

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

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



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

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

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

CHAPTER 11
Maintenance

Before you assemble a system that involves custom cables, power supplies or the like, first assemble and test the AWAC 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.

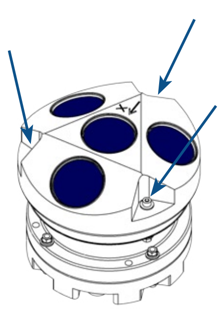
Preventive Maintenance

Cleaning

Clean the AWAC Current Meter regularly. Use a mild detergent to clean the AWAC. Pay special attention to the transducers.

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

Replacing Desiccant



Unscrew the three screws as shown to gain access to the AWAC interior and replace the desiccant at least once a year.

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 inside the AWAC housing as shown.

Painting with Anti-fouling Paints

Painting the transducers with anti-fouling agents will reduce fouling of the transducers, in particular for the first 36 months. Laws regulating the use of paints mixed with (poisonous) anti-fouling agents are different in different countries. As a general guide we have good experience with TBT agents, but recommend that you avoid copper-based paints.

Installing and Replacing Batteries

The AWAC is shipped with a separate battery pack. The following procedure outlines how to connect the battery pack or to install a new one.

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

Tip! Be sure to always include desiccant in the pressure case. Humid air can condense enough water to damage the electrical circuitry.

Caution! Users of lithium batteries, should take extreme care when replacing such batteries Legislation regarding disposal of batteries – lithium batteries, in particular – vary from country to country.

1. Remove the three 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 three screws and washers. Tighten the screws only until the end-cap touches the pressure case. Keep in mind that the 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.
5. Test communication with the AWAC's built-in terminal emulator program by sending a 'break' command to the instrument. If it is wired correctly then you should see the AWAC'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.
6. 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 file**). 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.
7. 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.
8. Check and/or reset the clock if necessary.
9. Because the battery pack uses standard alkaline batteries, you do not normally need to observe any special precautions when you dispose of old batteries.

Corrective Maintenance

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

APPENDIX 1
Spare Parts and Drawings

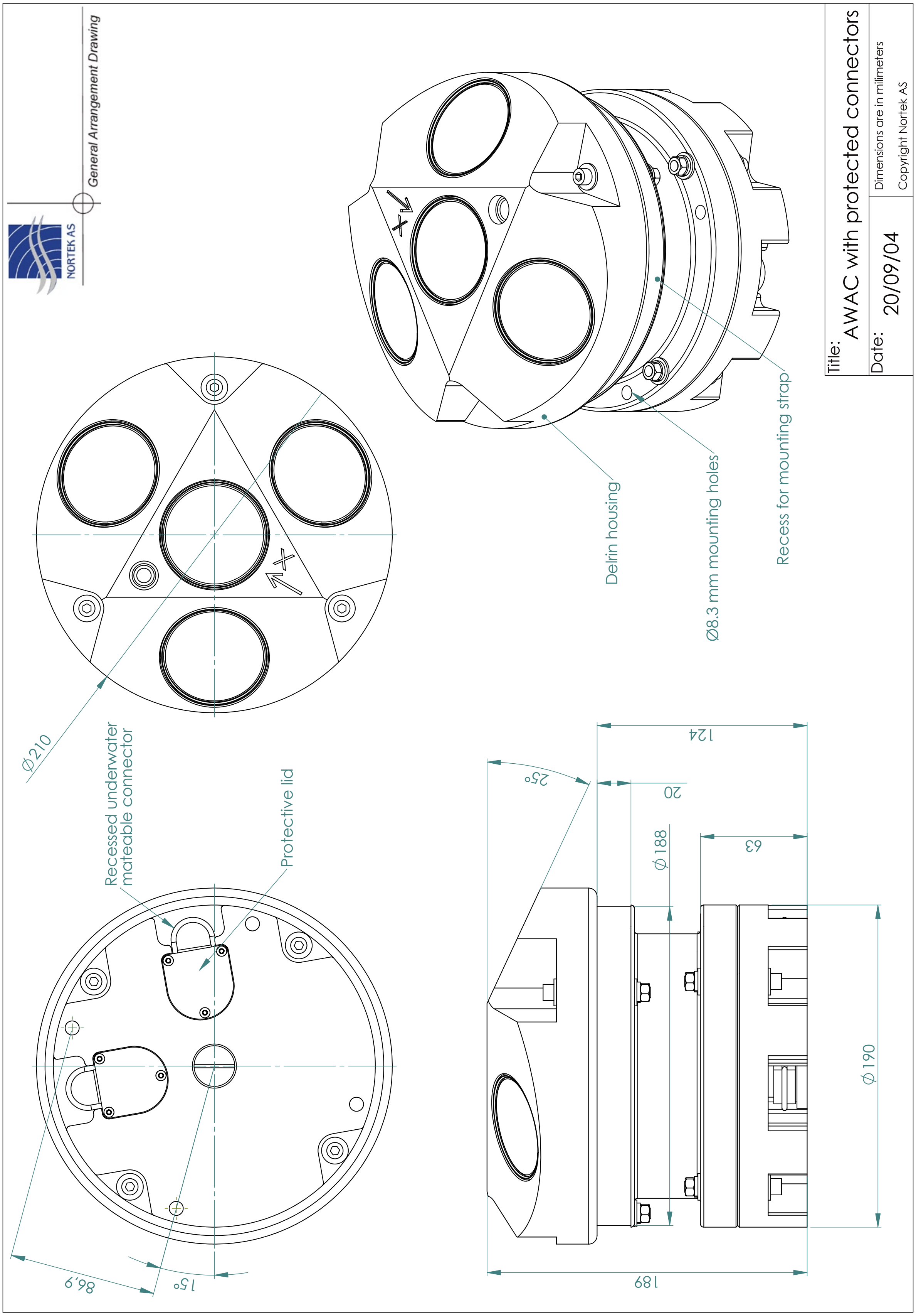
Caution! The increased base height is available as retrofit for existing short-base models. Compare your unit with the drawing before you make any frame arrangements to avoid that the AWAC won't fit your system.

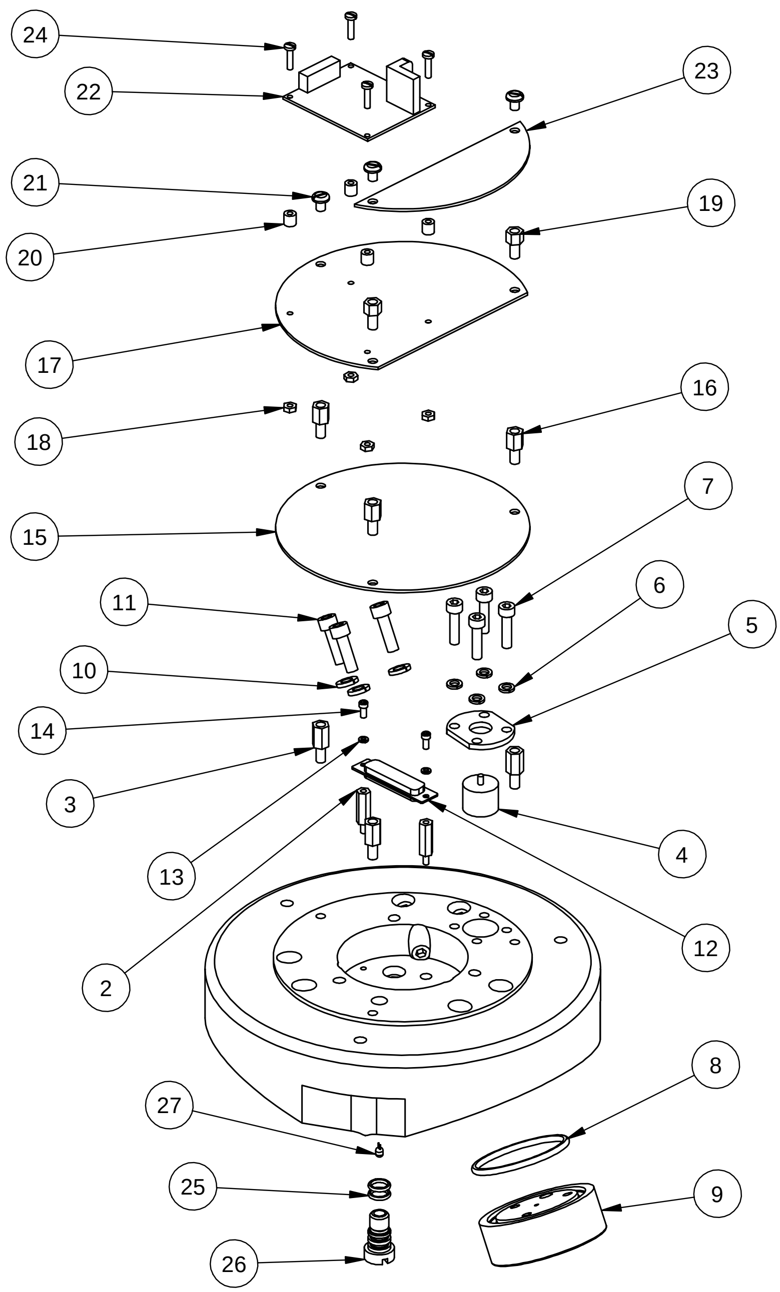
This chapter provides mechanical drawings and spare parts lists applying to AWAC. Always refer to the spare part numbers (whenever applicable) when ordering spare parts from NORTEK.

AWAC units with serial number **N-5074** (engraved in the white top) or higher are fitted with a base height of 63 mm, while the old had a base height of 57 mm. The new version incorporates lids to protect the connectors.

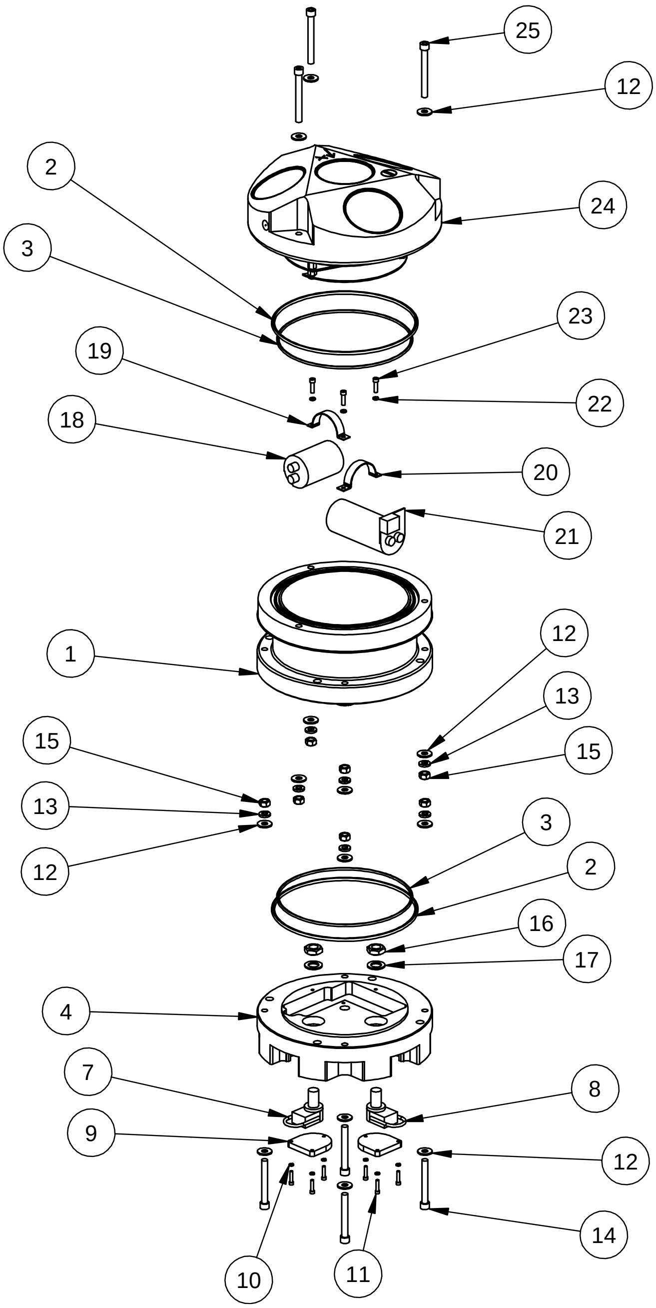
Mechanical drawings of the new version can be found overleaf.

Mechanical dimensions of AWAC – new version, with serial number higher than N-5074. Note that the new base is available as retrofit for old models. This means that even old models may have been fitted with new base.





ITEM NO.	PART NUMBER	Title
1	N2009-011	AWAC Transducer Head
2	4538 4-40 SS 0	4-40x3/4 " Standoff
3	4575 1032 SS 0	10-32x1/2" standoff
4	PA-10/xxxx/yy	PA-10 pressure sensor
5	N2009-010	Pressure sensor retainer
6	92146A550	#10 Lock Washer
7	91292A128	M5x20 soc. cap screw
8	-	O-ring 47,22 x 3,53
9	N2009-008	AWAC Transducer Cup
10	92153A426	M6 Spring Washer
11	91292A137	M6x20 soc. cap srew
12	44-115-26	DB25 Male Connector
13	92146A005	#4 spring washer
14	92196A106	4-40 Socket Cap Screw
15	N2015-005	Prodopp Analog
16	4573 1032 0 0	10-32x3/8" Standoff
17	N2015-002	Prodopp Digital
18	94812A112	4-40 Nut
19	4571 1032 O 0	10-32x1/4" Standoff
20	94639A103 #4	#4x1/4" Spacer
21	95000A825	10-32x1/2" Screw
22	TCM 2-20	Compass
23	N2016-002	Prodopp Recorder
24	95000A110 Binding	4-40 Screw, Binding Hd.
25	-	O-ring 8,0 x 2,0
26	N2009-043	Temp sensor plug
27	DC95F103V	Temperature Sensor



ITEM NO.	PART NUMBER	Title
1	N2009-013	AWAC Canister
2	-	O-ring 151,99 x 3,53
3	-	O-ring 142,5x2,62
4	N2009-007	AWAC Bottom Lid
5	N2009-037	AWAC center sealing plug
6	-	O-ring 16,31x2,21
7	LPMBH-FS-2	2 Pin Mini Connector
8	LPMBH-FS-8	8 Pin Mini Connector
9	N2011-130	Connector Cover Plate
10	-	#4 spring washer
11	-	4-40x3/8" soc. cap screw
12	-	1/4" Flat Washer
13	-	1/4" Spring Washer
14	-	1/4"-20 UNC x 2" Soc. Cap Srew
15	-	1/4"-20 UNC Hex Nut
16	91847A515	7/16" Nut
17	98019A502	7/16" Flat Washer
18	PEH200 MA 4470M	Capasitor (48V system only)
19	N2022-006 sheet2	Capasitor Clamp AWAC (48V system only)
20	N2022-006 sheet 1	Capasitor Clamp AWAC (48V system only)
21	PEH200 HC 5220M	Capasitor (48V system only)
22	92146A007	#6 Spring Washer
23	92196A148	6-32 UNC Soc. Cap Screw
24	N2009-013	AWAC Transducer Head Assembly
25	-	1/4"-20 UNC x 2 1/4" Soc. Cap Screw

APPENDIX 2
Returning AWAC for Repair

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

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

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

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

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

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

Proforma Invoice

NORTEK AS

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

RECEIVER	
Name:	Nortek AS
Address:	Vangkroken 2
City:	NO-1351 Rud
Country:	Norway
Tel.:	+47 67 17 45 00
Fax:	+47 67 13 67 70
E-mail:	inquiry@nortek.no
Contact:	Jonas Røstad

About the Goods

Date:

No. of Units: **Weight:**

Delivery Terms:

Customs Account No.: 28605-56

Description of Goods:

Origin: NO **Value:**

Total Value:

Nortek RMA No:

Reason for Export:

Date:

Exporter's signature

NORTEK AS

Nortek AS, Vangkroken 2, NO-1351 Rud, Norway. Tel +47 6717 4500. Fax +47 6713 6770. inquiry@nortek.no. www.nortek-as.com