Aquadopp© Current Meter

The Aquadopp current meter is designed for any body of water, whether ocean, estuary, lake or river. Current meters measure the water current velocity in a single volume. The Aquadopp current meter is small in size but an extremely powerful sampling system that allows it to be used in a variety of applications.

CURRENT AND WAVE MEASUREMENTS IN THE OCEAN, LAKE AND LABORATORY

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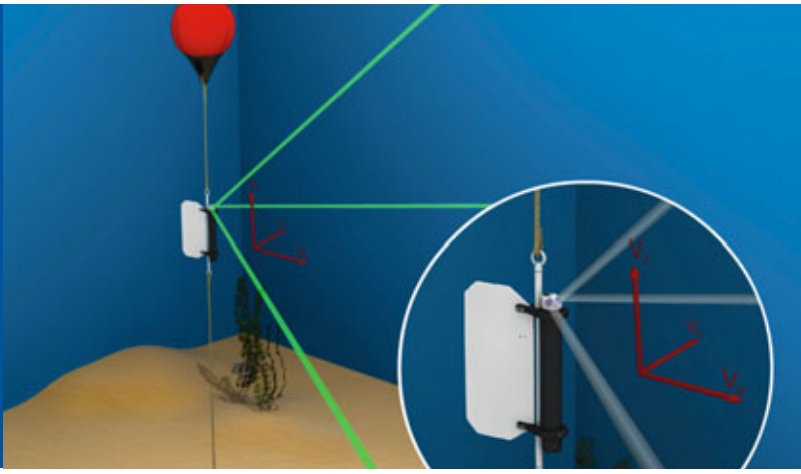
True innovation makes a difference

AQUADOPP CURRENT METER

The most versatile 3D ocean current meter available

The Aquadopp® is probably the most versatile single-point current meter on the market and has become the industry's most trusted model since its introduction in 1999. The Aquadopp® is in use by scientists and engineers all over the world, from the Arctic to the Equatorial Pacific. It is deployed in environments ranging from rivers to deep ocean trenches. The Aquadopp's utility stems from its cost-effective yet robust design requiring low maintenance and no recalibration.



The Aquadopp® advantages

The Aquadopp® has several significant advantages when compared to other open ocean current meters:

- No calibration necessary; no zero-point drift over time
- Low power consumption for long deployments
- All plastic and titanium parts eliminate corrosion
- No moving parts that can be blocked or damaged
- Effective directional wave gauge
- Remote sampling volume away from the mounting structure
- Small and light weight (less than 3kg)

The Aquadopp® Design

The Aquadopp® is comprised of 2 MHz acoustic transducers that transmit short bursts of sound into the water. The sound propagates along narrow acoustic beams and is scattered by small particles or zooplankton suspended in the water.

The echo that reaches the transducers is analyzed for change in frequency (Doppler shift) and water velocity is calculated along each of the acoustic beams. By combining the velocities with the exact beam geometry, either 2D (2 beams) or 3D (3 beams) velocity is calculated and recorded on the internal recorder or reported online.

In addition to velocity measurements, the Aquadopp contains compass and tilt sensors making it possible to measure the orientation of the instrument.

Classical Applications

From the ocean to rivers and the equator to the poles, the Aquadopp® delivers unmatched functionality.

Ocean Moorings
The Aquadopp® with its low maintenace and recalibration needs is ideal for long term deployments. Either clamp it directly to a mooring line or mount it on the Nortek Aquafin or AquaClamp.

Buoys
To measure surface currents, the Aquadopp® can be mounted directly onto surface buoys. The Aquadopp® Surface Current Meter transducer configuration is designed to measure near-surface currents with three acoustic beams directed in a horizontal plane just below the surface.

Fixed Mountings
Whether fixed to an offshore structure, piling, or bottom frame, for every mounting structure there is a corresponding Aquadopp® transducer head configuration that allows high quality measurements to be gathered.

Wave Height
The Aquadopp® can measure wave height, period, and direction using PUV processing. With PUV processing, 2D velocity (U and V) is combined with pressure (P) measurements to provide a full directional spectra solution.

Is your application not listed? Contact Nortek! We look forward to working with you to tailor the most versatile 3D current meter on the market to your unique research.

Rivers
In rivers, channels, and harbors, the Aquadopp® can be side-mounted on a wall to monitor the 2-D flow, avoiding sedimentation on the sensor head.

Deep Water
The deep water Aqudopp® current meters can be used anywhere in the ocean up to 6000 m depth. Both the 6000 m and 3000 m models have demonstrated outstanding performance in low scatter conditions.

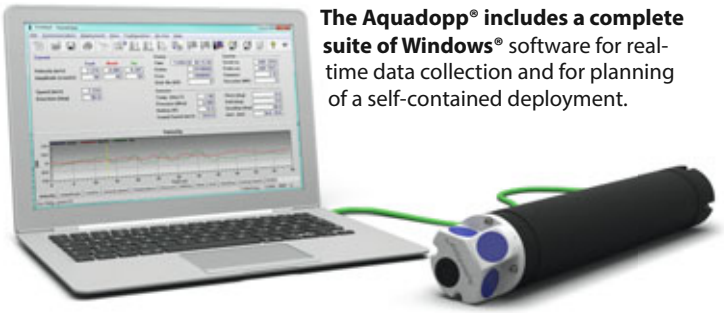
Passing the deep water test
As part of a program aimed at developing long duration subsurface moorings, Wood Hole Oceanographic Institution (WHOI) tested several modern acoustic current meters during the period 2000 to 2005.

The work focused on the fidelity of the speed measurements and showed the challenge of using backscattering acoustic systems in the clear, deep ocean.

Over the course of the test period, Nortek continually improved the Aquadopp construction and with prototype 3, which reflects the design of the current generation deep water Aquadopp current meters, the instrument bias in deep water was reduced to a level that was no longer significant.

"Performance of a new generation of acoustic current meters". Hogg, Nelson G.; Frye, Daniel E., Journal of Physical Oceanography (2007)

Configuration



The Aquadopp® includes a complete suite of Windows® software for real-time data collection and for planning of a self-contained deployment.

It is also designed to be integrated with third party controllers using the RS-232/RS-422 interface (binary or ASCII output).

The Aquadopp® can be used in real-time applications, but also comes standard with an internal recorder, batteries and a highly sophisticated power management network that makes it the system of choice for multi-year self-contained deployments.

The Aquadopp® can be configured to measure more than velocity. The system electronics of the Aquadopp® have integrated temperature and pressure sensors, as well as two analog input channels allowing for integration with 3rd party sensors.

In addition to regular data collection configurations, the Aquadopp® can be set to Diagnostic Mode. Diagnostic mode, a unique feature to the Aquadopp®, collects raw velocity and engineering data at 1Hz for a specified duration and interval. Originally introduced to learn more about mooring motion, it quickly proved popular for wave data as well. Data with such a fine temporal resolution not only provides a useful QA/QC tool, but allows the study of phenomena on very short time scales.

Deep Water Models

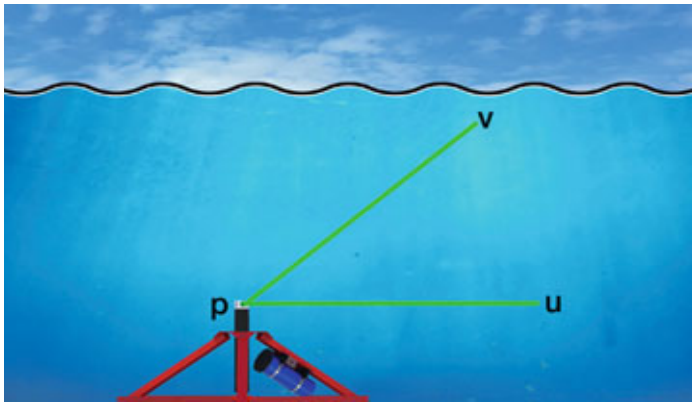
The 3000 m and 6000 m Aquadopps® have all the capabilities of the standard Aquadopp® (300 m) but are designed for deployments in the deep ocean.

The **6000 m Aquadopp®** is the "big brother" in the line of Aquadopp® models. The all-titanium mechanical housing of the 6000 m model with non-corroding materials creates a rugged design built to last at great ocean depths. Though built from grade 2 Titanium, the instrument only weighs ~8kg.

The **3000 m model** is made of Delrin and lined internally with a metal cylinder. The innovative 3000 m design is lighter and more affordable than the 6000 m model; providing a good alternative for intermediate waters.

Measuring currents in the deep ocean is a challenge. In the deep ocean, there are fewer particles than in the upper 500 m of the water column, creating a challenge for instruments that depend on acoustic backscatter. Considerable work has been done with the Aquadopp® to understand the factors that affect acoustic signal strength, improve the sensitivity of the returned echo, and produce high quality data.

PUV waves



The Aquadopp® can be configured to collect directional wave data at the same time as it measures the mean current. Nortek provides postprocessing software, QuickWave, that uses the PUV method to calculate the full directional wave spectra from the raw data.

As a wave sensor, the Aquadopp® requires extra internal memory, but it remains the most cost-effective PUV instrument in the market.

The PUV method is based on linear wave theory. Pressure is used to estimate non-directional parameters(height and period), and the combination of the pressure and the two horizontal velocity components U and V are used to calculate the wave direction.

Transducer Head Congurations

The Aquadopp® current meter is typically constructed with either the "Symmetric" or "Mooring" transducer head configuration. Both geometries provide outstanding 3-component (East,North, Up) observations of velocity.

Symmetric
Symmetric transducer head geometry projects three acoustic beams symmetrically up and away from the instrument. The beams are separated by 120 degrees around the circumference of the instrument and are angled 65 degrees from the vertical.

Mooring
Mooring transducer head geometry projects two acoustic beams in a plane horizontally away from the instrument. These two beams are separated by 90 degrees around the circumference. The third beam projects at an angle 45 degrees from the vertical.

Custom
Nortek offers the ability to craft custom transducer head geometries to meet specific velocity measurement needs. Contact Nortek to learn about what special transducer heads have already been developed and discuss your specific project requirements.

Inline Frames

Aquafin
The Aquafin is designed for connecting an Aquadopp® current meter to a mooring line. It shackles into the mooring line and allows the Aquadopp® to swivel freely so that its beams always look into undisturbed flow. Choose non-magnetic stainless steel or titanium for mooring loads of 1500 kg.

Deep water mounting systems
A variety of mounting systems have been designed for deep water moorings. Some of them clamp directly to the mooring line and some require the line to be cut. The systems have different load bearing strength (generally from 750 to 4500 kg) and are made from different materials (stainless steel or titanium). Most the systems are machined locally and more information is available from your local Nortek representative.

Inductive Modem (IM)

Broadcasting real time data with the Aquadopp inductive modem option

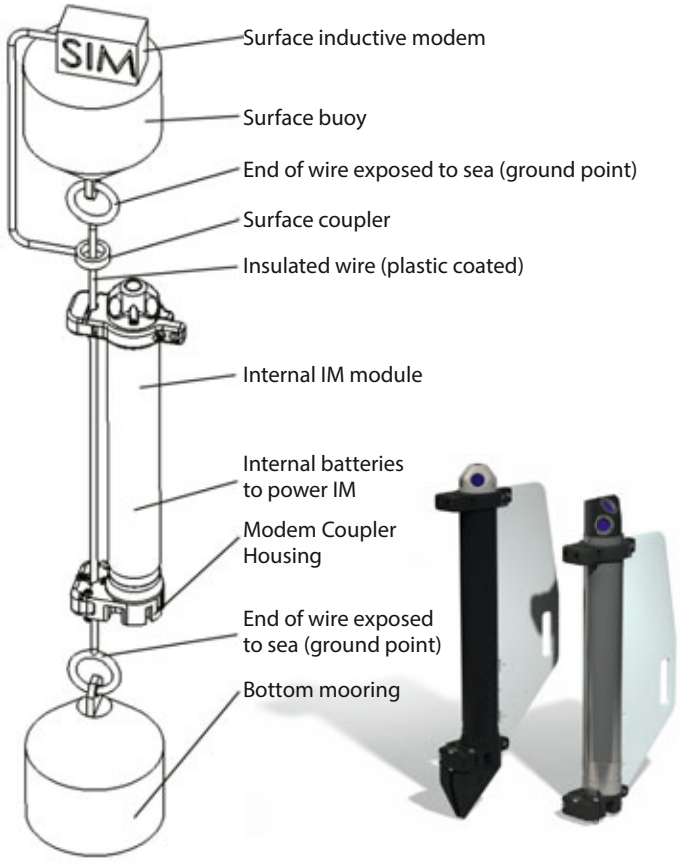
An inductive modem allows real time data to be transmitted through a jacketed, steel cable using sea water as the return ground. This means that real time data can be sent over long distances using robust cables that do not contain individual signal wires.

The mechanical design of the Aquadopp® shallow water (IM400) and deep water current meter (IM6000) have been modified to include a clamping system with electric coils that mounts directly to the unbroken mooring line. The process of sending data includes three steps:

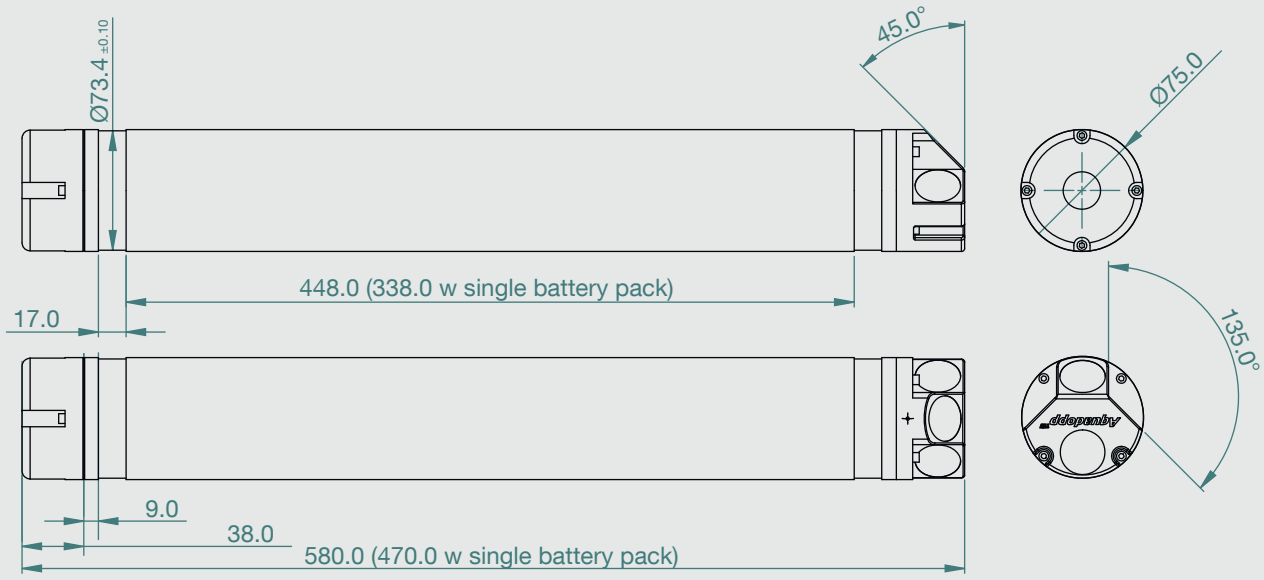
- The Aquadopp stores data both to the internal recorder and to the inductive modem module.
- The Seabird surface modem, usually mounted in a buoy, prompts the Aquadopp to transmit the last data.
- The Seabird Inductive Modem Module mounted in the Aquadopp housing sends the data through the coils clamped around the metal mooring line and up to the surface modem.

The inductive modem is addressable and a single mooring line can include a large number of Aquadopp IM current meters and Seabird IM sensors.

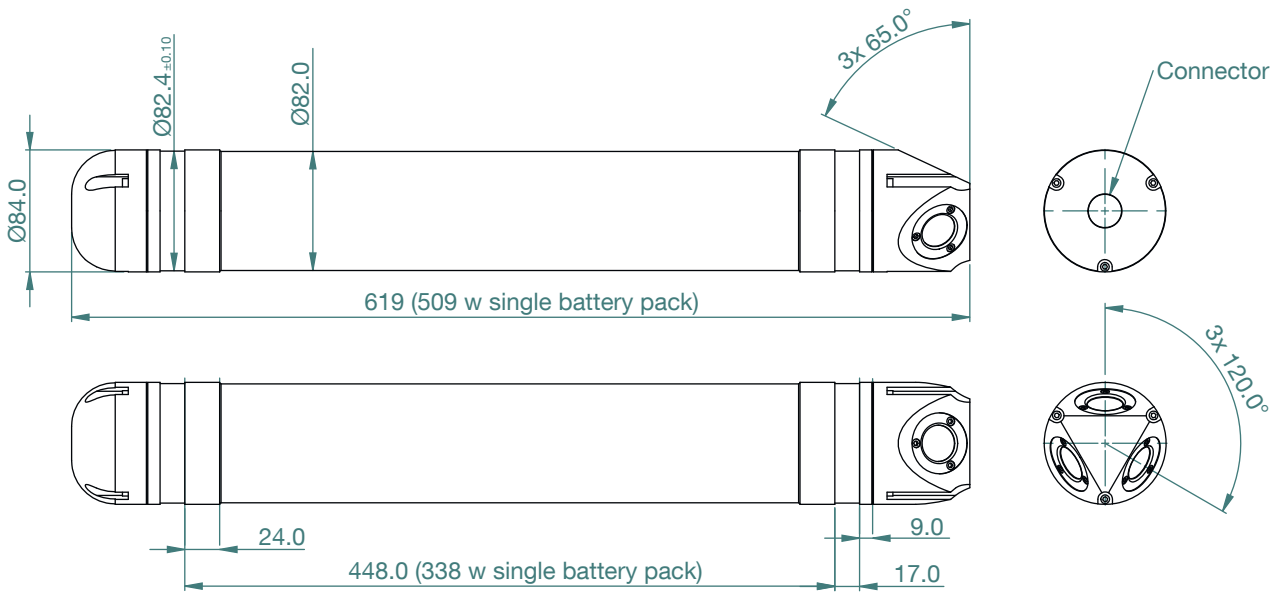
Nortek has also tested communication with the RBR inductive modem, which can be used to transmit data from most other low bandwidth Nortek instruments such as the AWAC and the Aquadopp profiler.



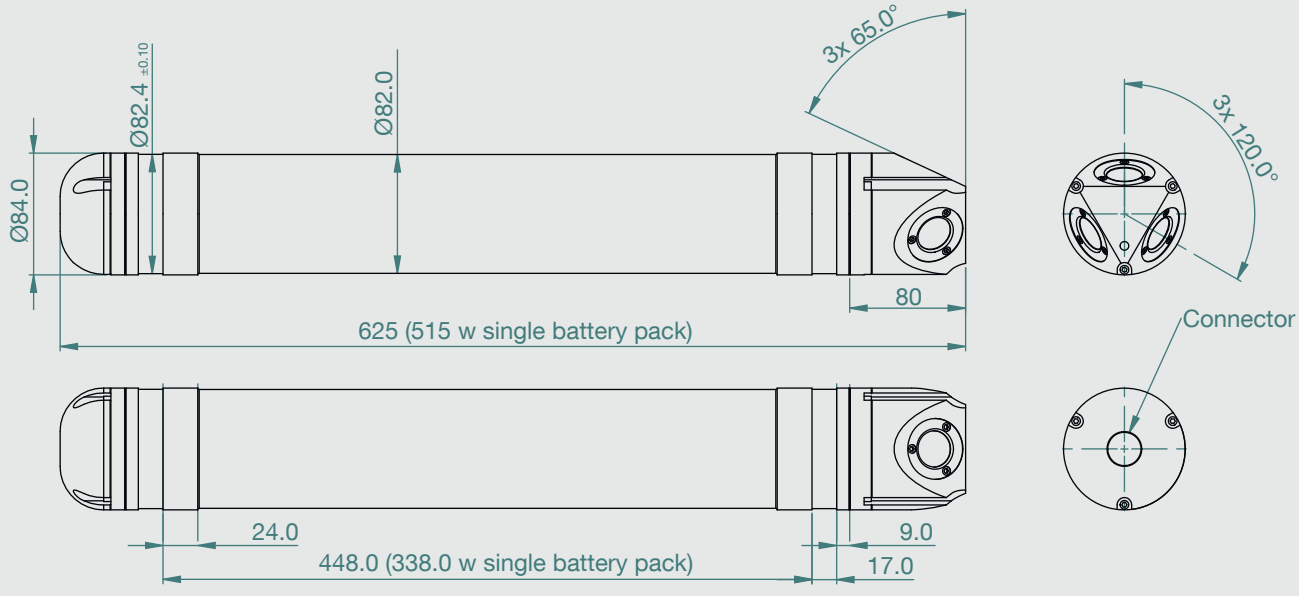
300m



3000m



6000m



Technical Specifications

Water velocity measurement			
	300m	**3000m**	**6000m**
Range:	±5m/s*	±3m/s*	±3m/s*
Accuracy (of measured value ± 0.5m/s):	1%	1%	1%
Maximum sampling rate (output):	1Hz, 4Hz on request	1Hz	1Hz
Internal sampling rate:	23Hz	23Hz	23Hz

*) Inquire for higher ranges

Measurement Area	
Measurement cell size:	0.75m
Measurement cell position:	0.35–5.0m (user selectable)
Default position (along beam):	0.35–1.85m

Doppler Uncertainty (noise)	
Typical uncertainty for default configurations:	0.5–1.0cm/s
Uncertainty in U,V at 1Hz sampling rate:	1.5cm/s

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

Sensors	
Temperature:	Thermistor embedded in head
Range:	-4°C to 40°C
Accuracy/resolution:	0.1°C/0.01°C
Time response:	10 min
Compass:	Magnetometer
Accuracy/resolution:	2°/0.1° for tilt <20°
Tilt:	Liquid level
Accuracy/resolution:	0.2°/0.1°
Maximum tilt:	30°
Up or down:	Automatic detect
Pressure:	Piezoresistive
Range:	300m/3000m/6000m
Accuracy/resolution:	0.5% / 0.005% of full scale

Analog inputs	
Number of channels:	2
Voltage supply:	Three options selectable through firmware commands: •Battery voltage / 500 mA •+5V / 250 mA •+12V / 100 mA
Voltage input:	0–5V
Resolution:	16 bit A/D

Data communication	
I/O:	RS232, RS422. Software supports most commercially available USB–RS232 converters
Communication Baud rate:	300–115200 (baud)
Recorder download baud rate:	600/1200 k.Baud for both RS232 and RS422
User control:	Handled via Win32® software, ActiveX® function calls, or direct commands with binary or ASCII data output

Software («Aquadopp / Aquadopp DW»)	
Operating system:	Windows®XP, Windows®7
Functions:	Deployment planning, start with alarm, data retrieval, ASCII conversion. Online data collection and graphical display. Test modes

Data Recording	
Capacity:	9 MB, can add 32/176/352/MB
Data record:	40 bytes
Diagnostic record:	40 bytes

Power	
DC Input:	9–15VDC
Peak current:	3A at 12VDC (user adjustable)
Max consumption 1Hz:	0.2–1.4 W
Avg. consumption:	0.1W (0.02Hz), 0.01W (0.002Hz)
Sleep consumption:	0.0013 W
Transmitt power:	0.3–20W, 3 adjustable levels
Battery capacity:	50 Wh
New battery voltage:	13.5 Vdc
Data collection (alkaline):	6 months at 10-min, ±1.5cm/s noise
Data collection (lithium):	18 months at 10-min, ±1.5cm/s noise

Real time clock	
Accuracy:	+/- 1min/year
Backup in absence of power:	4 weeks

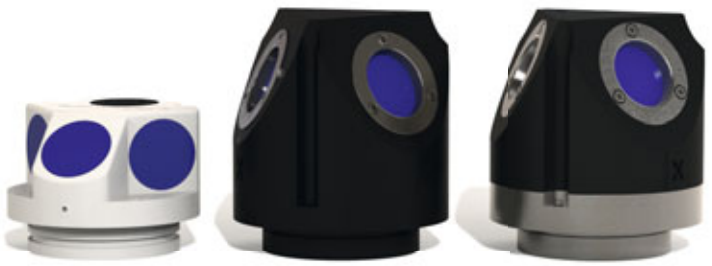
Materials	
Standard:	Delrin and titanium.

Connectors	
Bulkhead (Impulse):	MCBH-8-FS, titanium
Cable:	PMCIL-8-MP on 10-m polyurethane cable

Environmental	
Operating temperature:	-5°C to 40°C
Storage temperature:	-20°C to 60°C
Shock and vibration:	IEC 721–3–2
Pressure rating:	0–300m/0–3000m/0–6000m

Dimensions			
	300m	**3000m**	**6000m**
Weight in air:	2.3kg	3.6kg	7.6kg
Weight in water:	Neutral	1.2kg	4.8kg
Cylinder:	see dimensional drawings		

Options	
Battery:	Lithium or lithium Ion
External batteries:	Alkaline, Lithium or Lithium Ion. (See battery brochure for details)
Head configuration:	Inquire



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TRUE INNOVATION MAKES A DIFFERENCE

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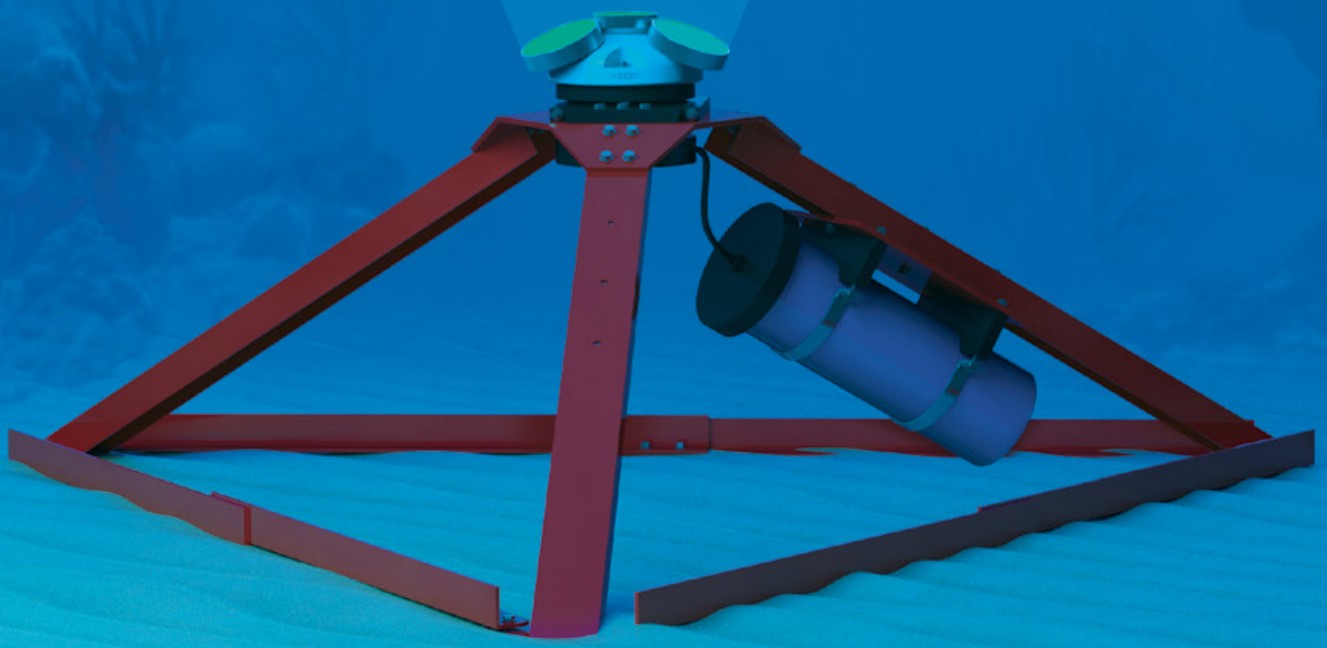
AWAC

Acoustic Wave And Current Profiler



CURRENT AND WAVE MEASUREMENTS IN THE OCEAN, LAKE AND LABORATORY

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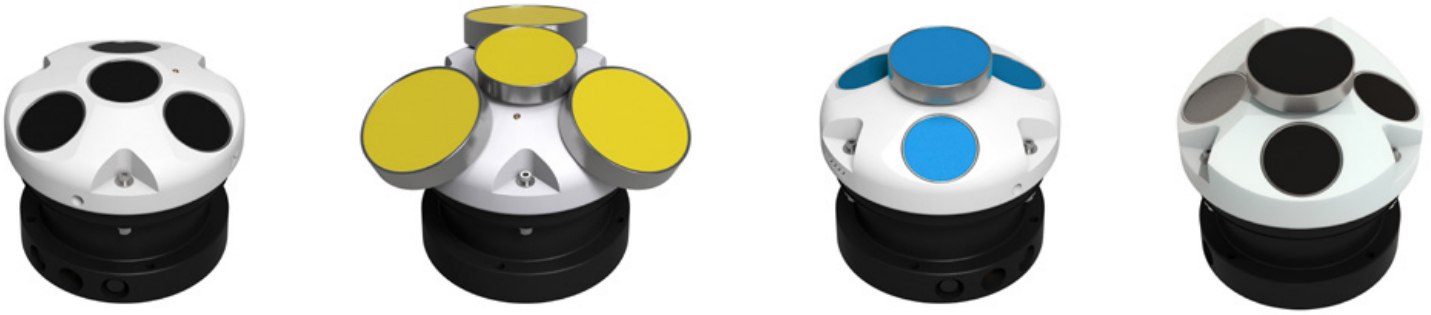
True innovation makes a difference

AWAC

A STANDARD IN OCEAN WAVE MEASUREMENTS

The Nortek Acoustic Waves and Currents (AWAC) sensor is a current profiler and directional wave system in one unit. Nortek has shipped more than 1700 AWACs worldwide since the launch of the first generation unit over a decade ago. The instrument has since revolutionized subsurface wave measurements.

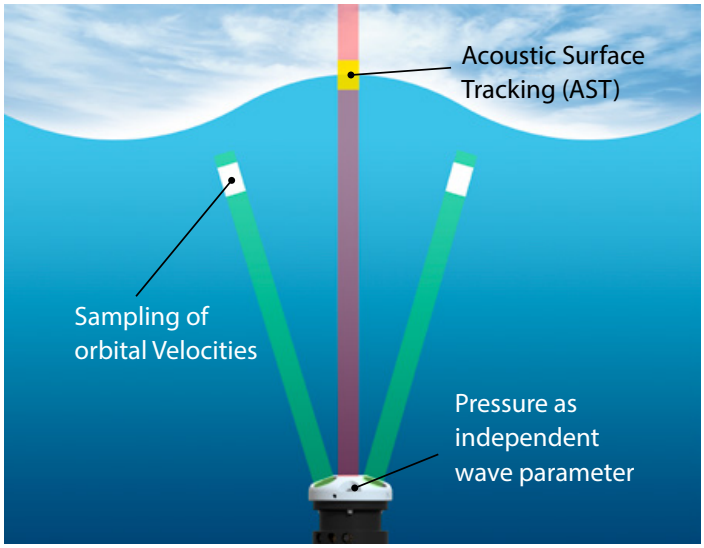


The AWAC is well suited for both autonomous data collection and as part of a real-time data telemetry system. Subsurface deployment means the instrument is always protected from harsh weather, vandalism, and ship traffic. The small, yet rugged instrument is suitable for multi-year operation in tough environments. Plastic and titanium parts avoid corrosion. The AWAC is available in three transmit frequencies for operational ranges spanning 2m to 100m.

Trusted Wave Measurements

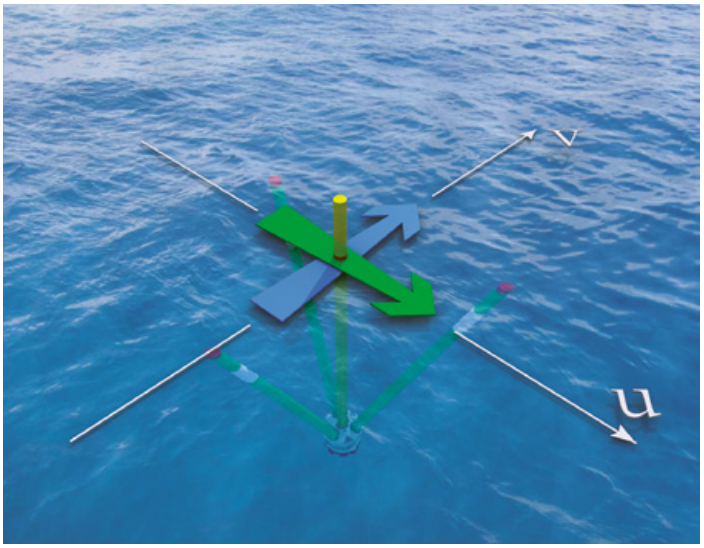
- The AWAC is in use for online and stand-alone applications all over the world. In Europe, researchers have employed dozens of AWACs to evaluate and improve coastal wave models. In Asia, port and harbor authorities trust AWACs to survive and provide excellent data during typhoon conditions. The AWAC has become a reference system for wave measurements after numerous meticulous comparisons with buoys.
- Nortek provides the AWAC as part of a turnkey solution for long-term monitoring. This includes durable connectors and long cables, integrated acoustic modems, a verified internal wave processor, and online processing and data display software.
- The AWAC of today has seen over a decade of development, continually being optimized with enhanced features. These include rapid pinging, narrow acoustic beams to provide the best time and space resolution, adaptive tracking algorithms to accommodate large variations in depth and low power consumption for long endurance deployments.
- The AWAC can be mounted in subsurface buoys to add wave measurements to long moorings or to avoid burial and excessive tilt in soft sediments. Nortek's validated and patented SUV technology (US patent 7,352,651) makes accurate wave measurements and high resolution surface currents attainable in deep water as well as areas with uncertain bottom conditions.

Wave Height



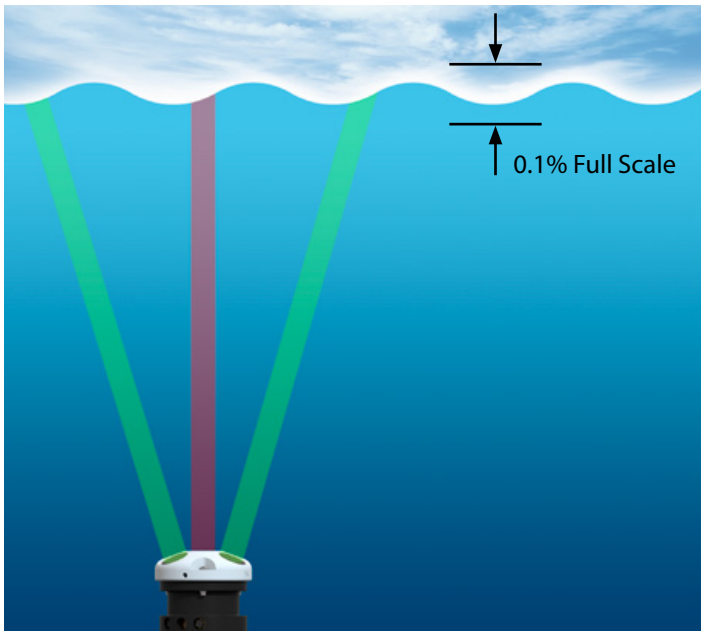
The AWACs extraordinary wave height measurements are a result of the extensively validated and optimized Acoustic Surface Tracking (AST) algorithms. AST estimates the distance to the surface by echo-ranging with the vertically oriented transducer. This method circumvents the depth limitations imposed by bottom mounted pressure and velocity measurements and allows the instrument to capture 1 to 50 second period waves. Moreover, AST gives you the ability to derive wave parameters based on times series analyses such as Hmax, H1/10, and Tmean. Time series analysis is included in the Nortek wave processing software.

Wave Direction



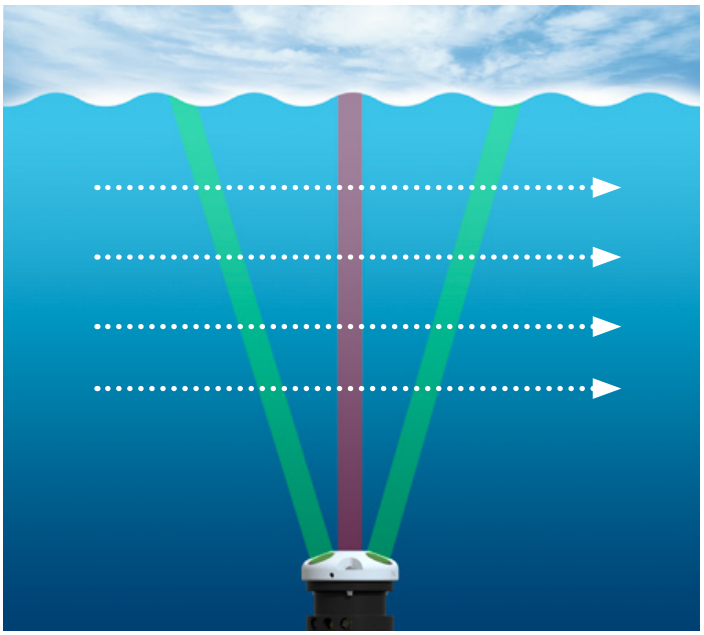
Wave direction is calculated by combining AST with orbital velocity measurements that have adaptively been sampled in a large cell located near the surface. If the AWAC is mounted in a non-moving frame or structure, Nortek uses the maximum likelihood method applied to the three velocities and the surface position to estimate all directional wave parameters and spectra. and spread. Nortek's patented SUV processing can be used to calculate all the same directional estimates from an AWAC on a subsurface buoy.

Tidal Elevation



The AWAC pressure data are suitable for measuring the tidal elevation from a fixed bottom mounted structure. Nortek recently extended the option to upgrade the AWAC pressure sensor to an absolute accuracy of 0.1% of full scale, or 5 cm for a 50 m sensor. This pressure sensor is temperature compensated and the tidal changes only span a small portion of the full-scale range. Therefore, accuracy of the change in tidal elevation is normally twice that of the absolute accuracy, or around 2.5 cm for a 50 sensor.

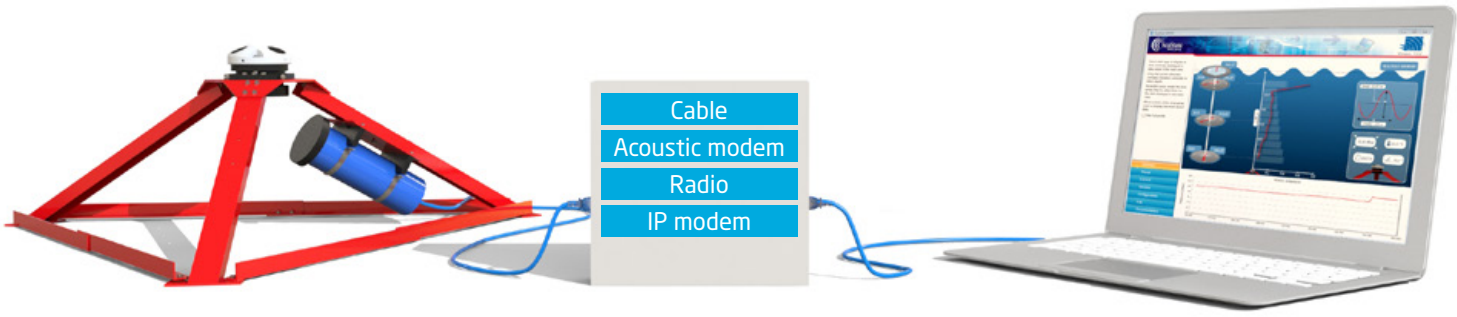
Current Profile



The AWAC uses the three slanted beams to measure the current profile over a range determined by the acoustic frequency. Large transducers transmit narrow acoustic beams and provide accurate data. The AWAC will alternate between wave data collection and current profiling. If the wave data collection is longer than the interval between current profiles, the AWAC will skip a current profile to ensure continuous wave data. Please contact Nortek if concurrent wave and current information is required.

Real-Time Data Collection

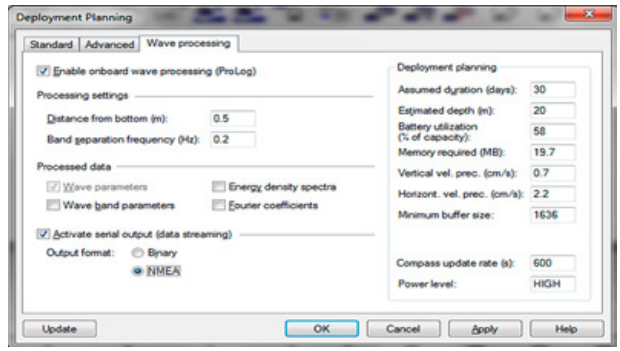
Most Nortek products can be used either in stand-alone or online mode. In stand-alone mode, data is collected to the internal recorder, and the power comes from external batteries. In an online system, data are transferred to a shore station using one or more communication links.



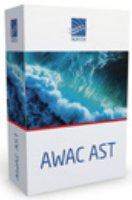
- **Cables:** Nortek provides rugged polyurethane cables with optional titanium connectors. Data may be transferred over cables of up to 5000m. An interface box installed on shore protects the AWAC from surges and converts the supply voltage to 48V. A DCDC converter in the instrument reduces the voltage back to 15V.
- **Acoustic modems:** In combination with the ProLog internal processor, it is possible to transfer wave and current data over short distances underwater using acoustic modems provided by Nortek.
- **Radio and IP modems:** Radio communication relies on line-of-sight and can be used to transfer AWAC data from an offshore buoy to shore or from a point along the coast further inland. In areas with adequate cellular communication, IP modems may be used to transfer data.
- **AOS:** It is possible to integrate the AWAC with the Nortek Autonomous Online System and view the resulting data in a hosted web environment.

ProLog

The ProLog consists of a powerful processor and a 4 GB SD-card recorder laid out on a separate circuit board that fits inside the AWAC. The processor takes the raw data from the AWAC, runs the directional wave processing algorithms and outputs the processed data in ASCII (NMEA) or binary format. This makes the ProLog ideally suited for online applications where data transfer rates are limited, as when using acoustic modems or satellites. The NMEA format also facilitates the integration of the AWAC with 3rd party external controllers.



Nortek offers a full suite of software with the AWAC



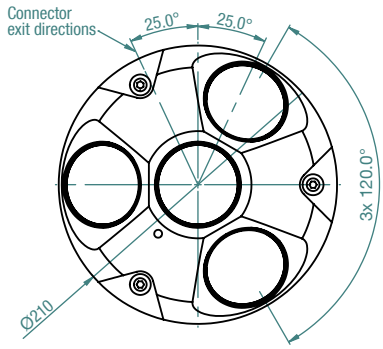
AWAC-AST is included with all AWAC deliveries. It features a simple interface used to configure the instrument for deployment, retrieve the data, and convert the raw data to ASCII.

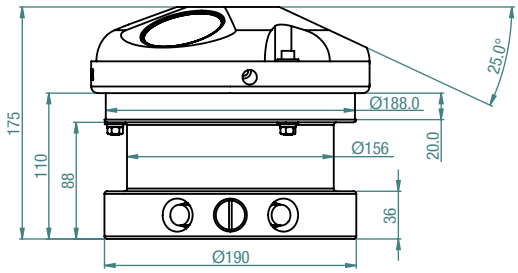
Quickwave provides the functionality of Storm in a non-graphical environment. A wave processing module embedded in a DLL is available for those who wish to write their own real time software.»

Storm provides a full graphical interface to view the raw wave data and current profiles, perform QA/QC, and plot the directional and non-directional wave parameters.

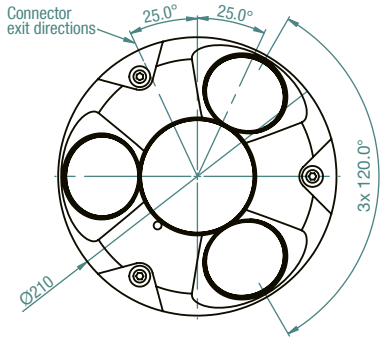
SeaState is designed for configurations where there is direct communication. It collects, processes, records and displays data in real-time as a series of graphical images, which are suitable both for engineering and scientific applications. SeaState accepts both raw data and processed wave data from a ProLog internal processor.

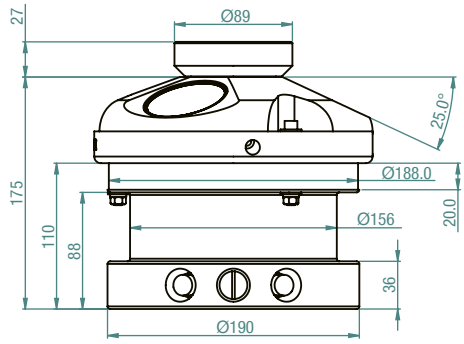
1MHz



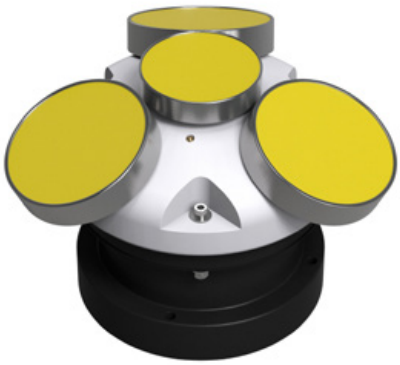


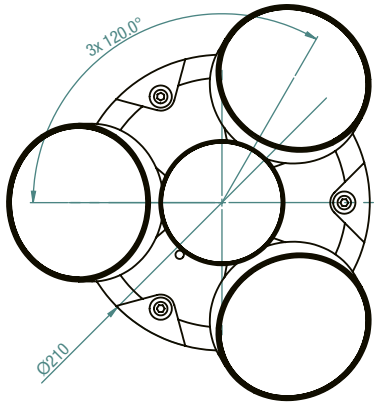
600kHz

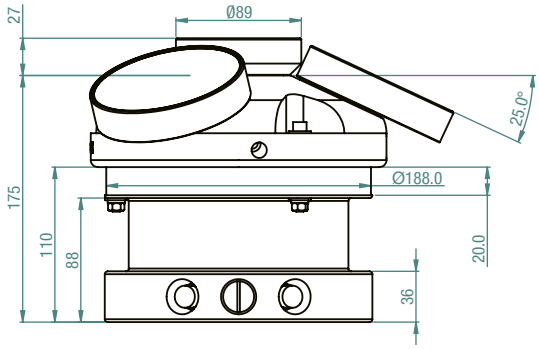




400kHz

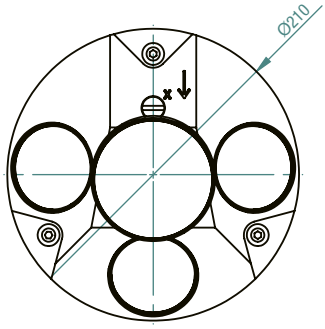


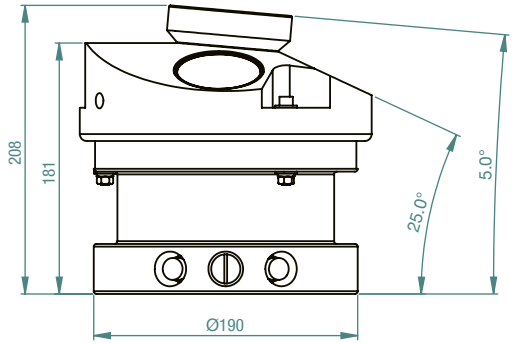




Platform Mount (1MHz and 600kHz)

Contact Nortek for additional transducer configuration options designed to mount on coastal, offshore, or marine renewable energy structures.





All dimensions in mm.

Technical Specifications

System	
Acoustic frequency:	1MHz, 600kHz or 400kHz
Acoustic beams:	4 beams, one vertical, three slanted at 25°
Vertical beam opening angle:	1.7°
Operational modes:	Stand-alone or online monitoring
Current Profile	
Maximum range:	30m (1MHz), 50m (600 kHz), 100m (400kHz)*
Depth cell size:	0.25 – 4.0m (1MHz) 0.5 – 8.0m (600kHz) 1.0 – 8.0m (400kHz)
Number of cells:	Typical 20–40, max. 128
Maximum output rate:	1Hz
*)depends on local conditions	
Velocity measurements	
Velocity range:	±10 m/s horizontal, ±5 m/s along beam
Accuracy:	1% of measured value ±0.5 cm/s
Doppler uncertainty	
Current profile:	1cm/s (typical)
Wave measurements	
Maximum depth:	35m (1MHz), 60m (600 kHz), 100m (400kHz)
Data types:	Pressure, one velocity along each beam, AST*
Sampling rate (output):	2 Hz velocity, 4 Hz AST* (1MHz), 1 Hz velocity, 2Hz AST* (600kHz), 0.75 Hz velocity, 1.5Hz AST* (400kHz)
No. of samples per burst:	512, 1024, or 2048. Inquire for options
Wave estimates	
Range:	-15 to +15m
Accuracy/resolution (Hs):	<1% of measured value/1cm
Accuracy/resolution (Dir):	2° / 0.1°
Period range:	0.5 - 50s (1MHz), 1 - 50s (0.6MHz), 1.5 - 50s (0.4MHz)

Depth(m)	cut-off period (Hs)	cut-off period (dir)
5	0.5 sec	1.5 sec
20	0.9 sec	3.1 sec
60	1.5 sec	4.2 sec
100	2 sec	5.0 sec

Sensors	
Temperature:	Thermistor embedded in housing
Range:	–4°C to 40°C
Accuracy/ Resolution:	0.1°C/0.01°C
Time constant:	<5 min
Compass	Magnetoresistive
Accuracy/Resolution:	2°/0.1° for tilt <15°
Tilt:	Liquid level
Maximum tilt:	30°, AST* requires <10° instrument tilt
Up or down:	Automatic detect
Pressure:	Piezoresistive
Standard range:	0–50 m (1MHz) / 0-100m (0.6MHz) / 0-100m (0,4MHz)
Accuracy:	0.5% of full scale. Optional 0.1% of full scale.
Resolution:	0.005% of full scale
Transducer configurations	
Standard:	3 beams 120° apart, one vertical
Platform mount:	3 beams 90° apart, one at 5°
Materials	
Standard:	Delrin and polyurethane plastics with titanium screws
Connectors:	
Bulkhead (Impulse):	MCBH-2-FS, MCBH-8-FS, optional Birns 3K-7-OR-CA
Cable:	PMCIL-8-MP, Optional Birns

Environmental	
Operating temperature:	–4°C to 40°C
Storage temperature:	–20°C to 60°C
Shock and vibration:	IEC 721–3–2
Depth rating:	300m
Dimensions:	
	See drawing
Weight in air:	7.3 kg (0.4MHz), 6.2 kg (0.6MHz), 6.1 kg (1MHz)
Weight in water:	3.6 kg (0.4MHz), 2.9 kg (0.6MHz & 1MHz)
Canister for 2*36D pack with Alkaline batteries:	In air 17,2kg, in water 7,8kg
Canister for 2*36D pack with Lithium batteries:	In air 14,4kg, in water 5kg
Canister for 1*36D pack with Alkaline batteries:	In air 10,5kg, in water 4,3kg
Canister for 1*36D pack with Lithium batteries:	In air 9,1kg, in water 2,9kg
Analog Inputs	
Number of channels:	2
Supply voltage to analog output devices:	Three options selectable through firmware commands: • Battery voltage/500mA • +5V/250mA (default) • +12V/100mA
Voltage Input:	0-5V
Resolution:	16 bit A/D
Data Recording	
Capacity(standard):	9MB (standard), 4GB upgrade option
Profile record:	Ncells×9 + 120
Wave record:	Nsamples×24 + 1KB
Data Communication	
I/O:	RS 232 or RS 422
Communication baud rate:	300–115200
Recorder download baud rate:	600/1200 kBaud for both RS232 and RS422
User control:	Handled via «AWAC» software, or ActiveX® controls. «SeaState» for online systems.
Output formats:	Output formats: NMEA, Binary. Prolog provides same types also for processed wave and current data.
Power	
DC input:	9-18 VDC
Peak current:	3A
Power consumption:	Transmit power: 1–30W, 3 adjustable levels
Sleep consumption:	1 mW (RS232) 5 mW (RS422)
Real time clock	
Accuracy:	± 1min/year
Backup in absence of power:	1 year
Online Cable	
Polyurethane jacket, Shore D hardness, 13mm in diameter. Maximum RS422 communication distance 5km when used with interface box.	
Online Projects	
Nortek can provide long cables, radio/telephone communication equipment, acoustic modems, etc., that can meet the requirements of your specific project.	

*) AST = Acoustic Surface Tracking

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