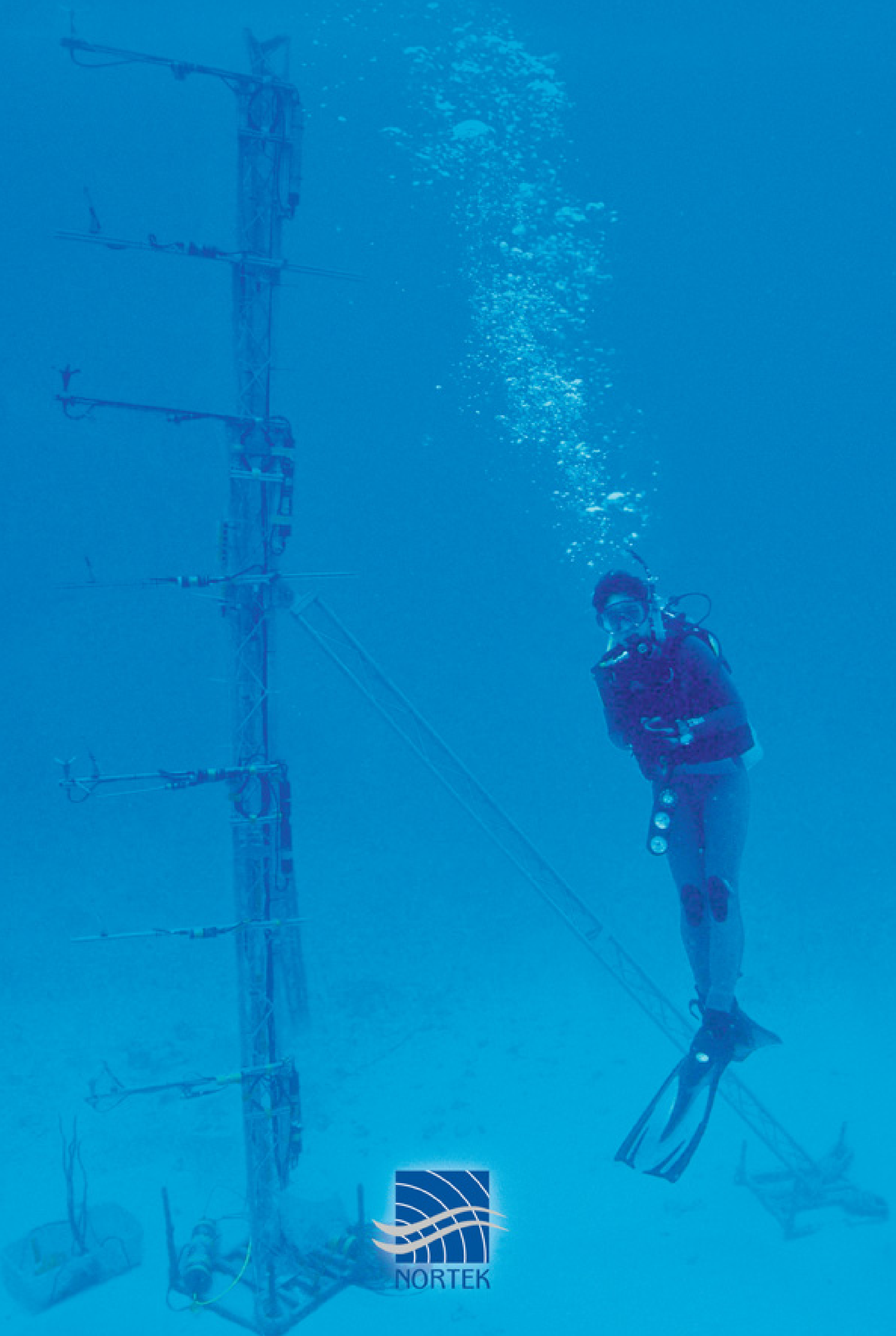
VECTOR

3D Acoustic Velocimeter



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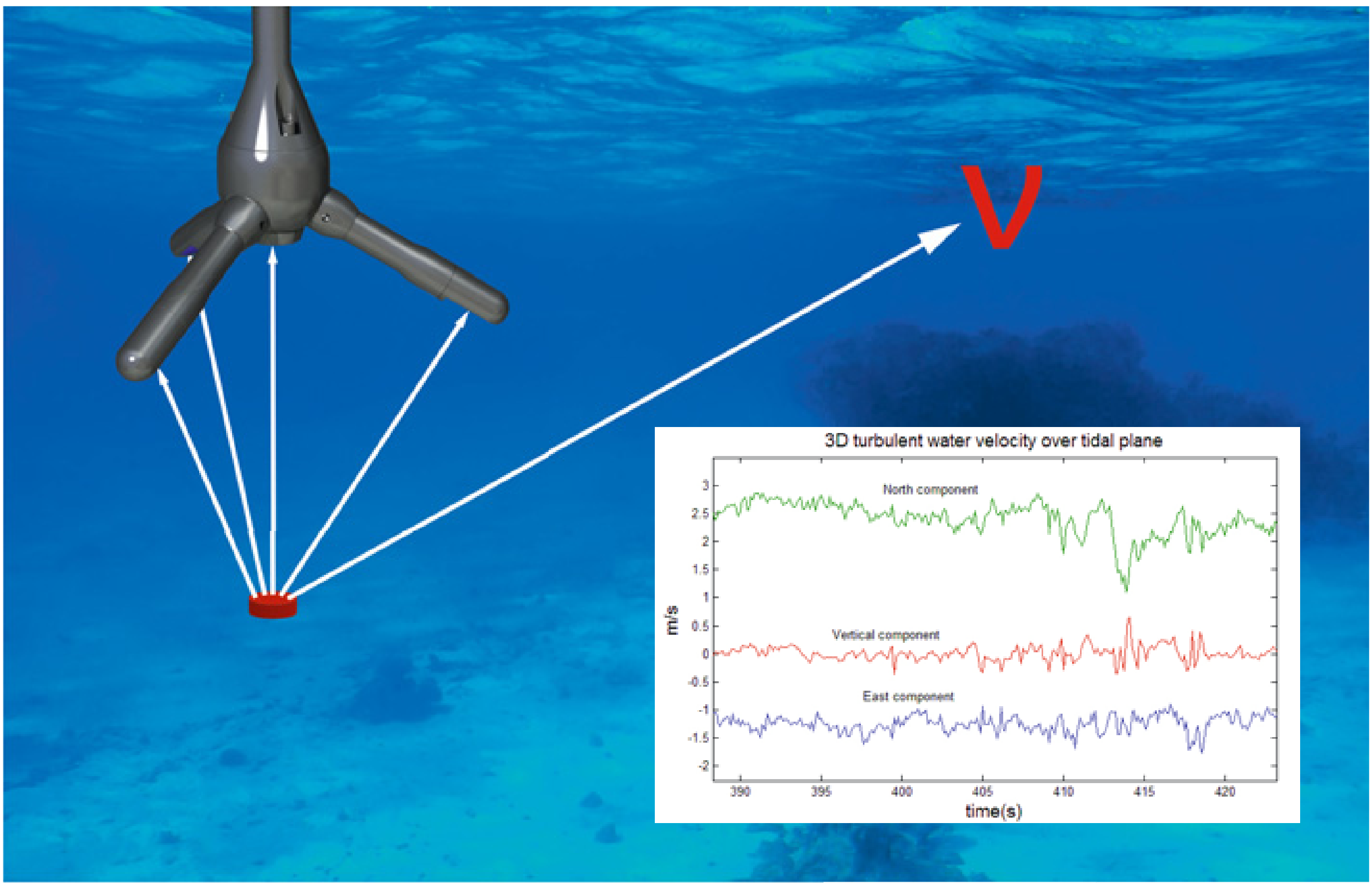
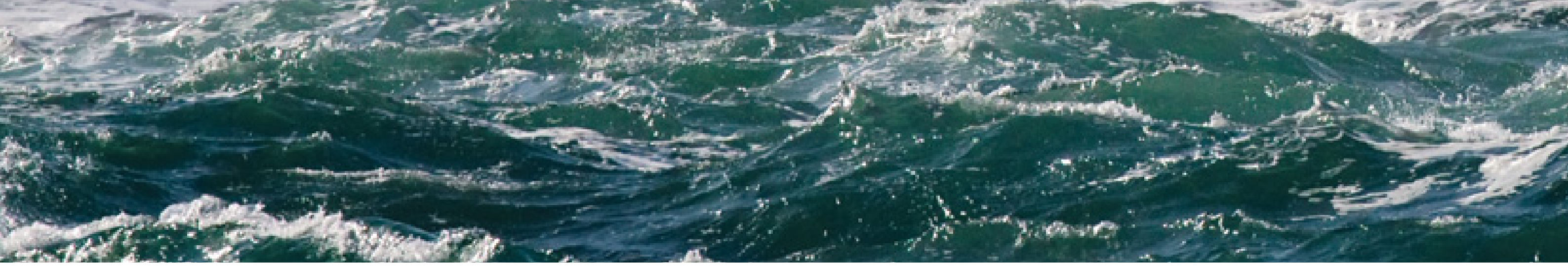
VECTOR
3D Acoustic Velocimeter

The Vector 3D current meter collects high-resolution velocity and pressure data in rapidly changing environments. Based on processing schemes originally developed for the Nortek Acoustic Doppler Velocimeter, the system integrates low-noise Doppler velocity measurements with standard sensors such as temperature, pressure, tilt, and compass.

State-of-the-art power management and miniaturized electronics combine in a compact single-canister design that is suitable for real time operation or self-contained deployments. In addition to continuous sampling the Vector also supports burst sampling, where data are sampled for a short period of time before it "sleeps" to preserve battery power and recorder memory.

Pressure is measured at the same rate as velocity. All other sensors are sampled at 1 Hz. The Vector comes with a complete suite of Windows® software for deployment planning, real time data collection and data retrieval. As an option, the post processing program ExploreV is available to review, process and interpret your Vector data. The processing includes spectral analysis and calculation of turbulence parameters.

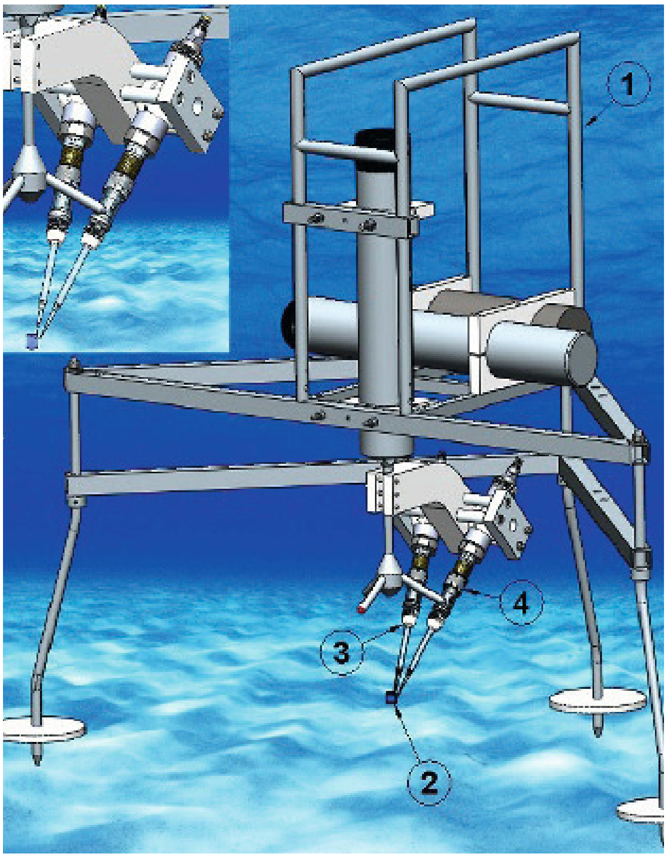




Eddy Correlation

The Vector can be used to estimate the vertical flux of scalar quantities. Using the Eddy Correlation technique this is achieved by combining the Vector vertical velocity with rapid measurements of the scalar quantity of interest (c) and then estimating the expected value <c'w'>. Because the vertical velocity component is low noise and uncorrelated with the scalar measurements, the expected value of the flux can be estimated quite precisely.

Originally, the flux most studied was vertical momentum flux (<u'w'> and <v'w'>), where u' and v' are also estimated from the Vector data. Later, temperature flux measurement have become common (<T'w'>) and for this purpose researchers have used fast temperature and/or conductivity sensors from Precision Measurement Engineering. Another popular combination is dissolved oxygen, where an electrochemical DO sensor is combined with a low-noise amplifier to study biological activity in the benthic boundary layers.

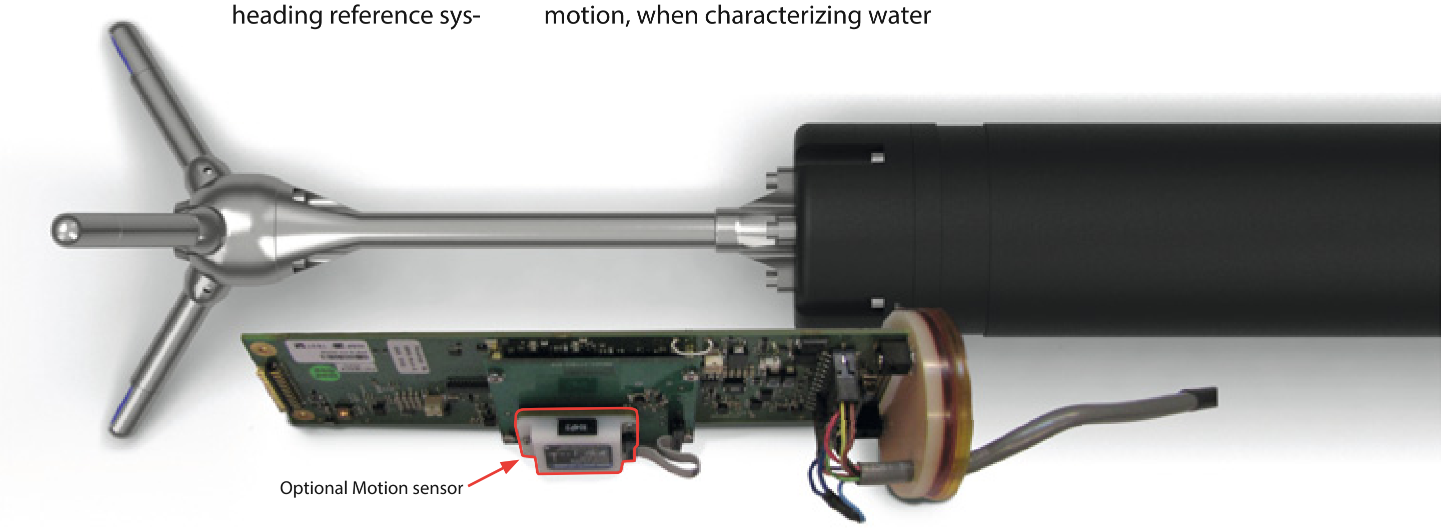


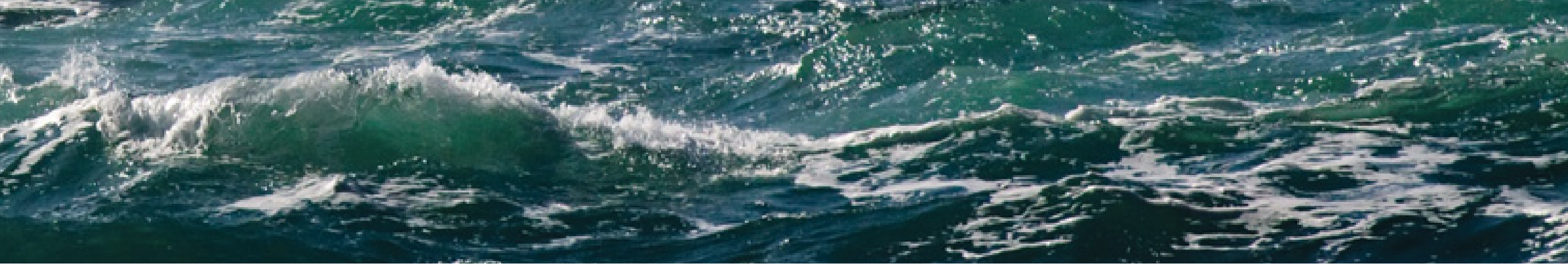
Example of DO Eddy correlation system

1) ROV deployable frame, 2) measurement volume, 3) sensor holder, 4) connecter to amplifier. From McGinnis et al. 2011. Figure by R. Schwarz, Geomar

Optional Motion Sensor

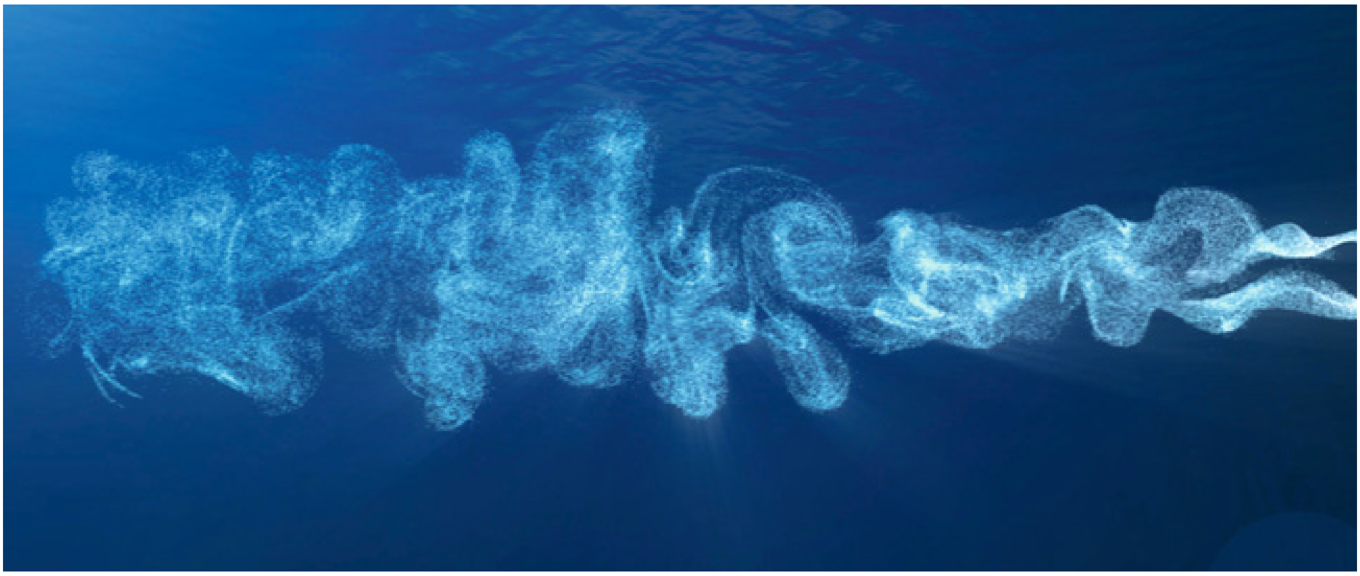
The Nortek Vector comes standard with heading and 2D tilt sensors that has a response time of about 1Hz. To measure the motion of the Vector itself when the mounting can be expected to move, the standard magnetometer can be replaced with a small and low power motion sensor that has a much faster response time. This attitude and heading reference system (AHRS) measures nine different sensors using an internal 3D magnetometer, 3D linear accelerometer and a triaxial gyro. The Vector stores this data to the internal recorder at the same rate as the velocity sampling rate set by the user in the deployment planning software. The AHRS data can be of particular interest when studying mooring motion, when characterizing water turbulence for tidal power plants, or when it is uncertain whether the deployment frame moves during data collection. In all cases, the AHRS makes it possible to identify how the Vector moves. This again makes it possible to separate the Vector motion from the Vector velocity data, either by analyzing the time series or by looking at the Spectra.





Turbulence

The Vector is designed with turbulence and wave measurements in mind. Typical applications include bottom boundary layer measurements, ocean engineering, coastal studies and river turbulence. In addition, the Vector is used whenever a distinct and small sampling volume is required. Water quality is of little importance - the Vector works equally well in typical ocean surface conditions or in the high sediment suspensions found near the coast or in rivers.
The system response when submerged is near instantaneous, making wave crest measurement possible as the probe moves in and out of the water. Nortek shipped the first Vectors in 1999. Today, it is being used by scientists and engineers at renowned institutions worldwide.



Surface Waves

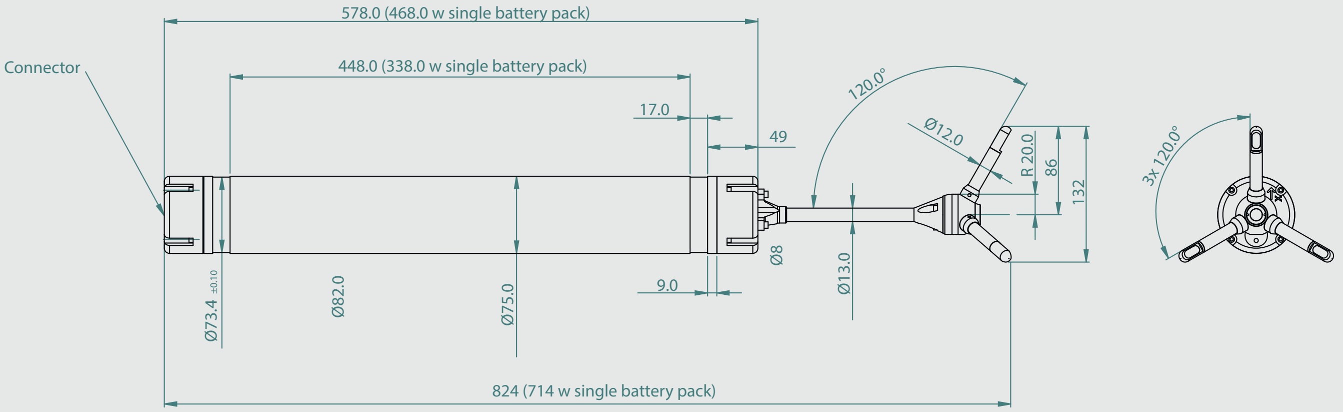
Measurements with the Vector can be processed using the PUV method to extract information on the wave field. The name PUV is a description of the method, and is an abbreviation of the three quantities measured: Pressure and the two horizontal components of the wave's orbital velocity, U and V.

The pressure measurement provides estimates of the non-directional wave parameters (height, period, etc.) and the combined P, U, and V measurements are used to estimate the directional wave parameters.

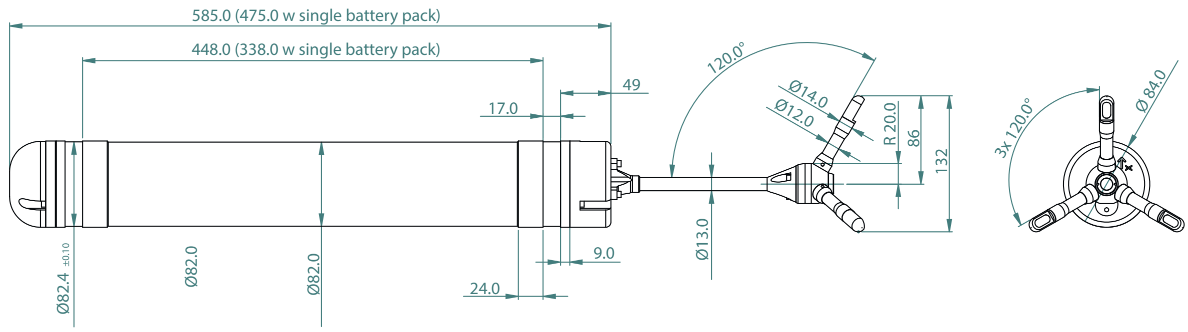
Agate Beach Experiment, photograph by Dennis Darnell, SiO

Technical Drawings

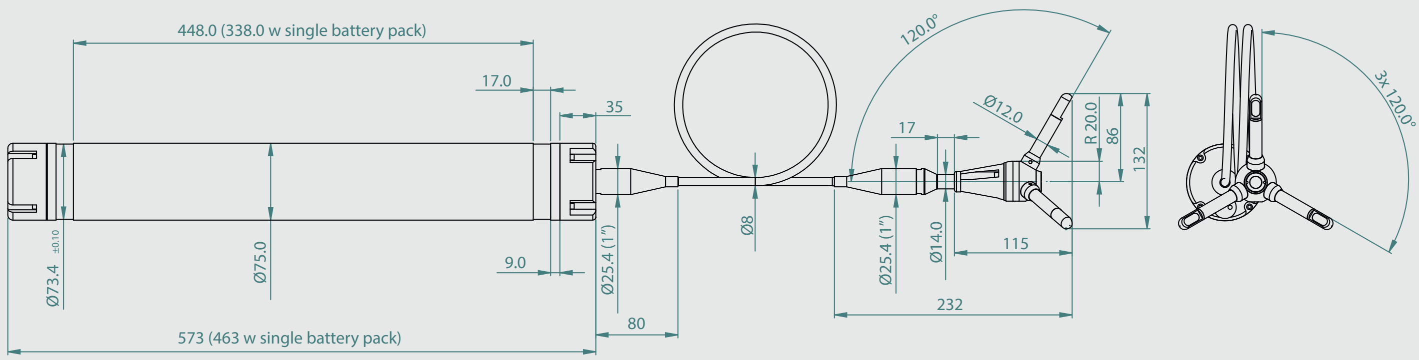
Fixed Stem Standard



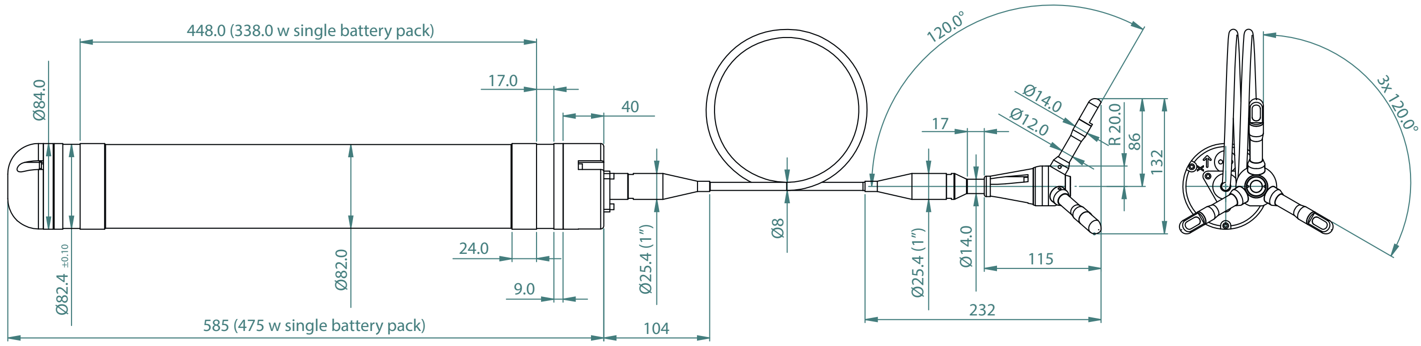
Fixed Stem 4000 m



Cable Probe Standard



Cable Probe 4000 m



All dimensions in mm.

Technical Specifications

Water Velocity Measurement	
Velocity Range:	±0.01, 0.1, 0.3, 2, 4, 7 m/s (software selectable)
Accuracy:	±0.5% of measured value ±1 mm/s
Sampling rate (output):	1–64 Hz
Internal sampling rate:	100–250 Hz
Sampling Volume	
Distance from probe:	0.15 m
Diameter:	15 mm
Height (user selectable):	5–20 mm
Doppler Uncertainty (noise)	
Typ. uncertainty at 16 Hz:	1% of velocity range
Echo Intensity	
Acoustic frequency:	6 MHz
Resolution:	0.45 dB
Dynamic range:	90 dB
Sensors	
Temperature:	Thermistor embedded in end bell
Range:	–4 ºC to 40ºC
Accuracy/Resolution:	0.1 ºC / 0.01ºC
Time response:	10 min
Compass:	Magnetometer
Accuracy/Resolution:	2º/0.1º for tilt < 20°
Tilt:	Liquid level
Accuracy/Resolution:	0.2º/0.1º
Up or down:	Automatic detect
Maximum tilt:	30°
Pressure:	Piezoresistive
Standard Range:	0–20 m, inquire for options
Accuracy/Resolution:	0.5% / Better than 0.005% of full scale
Data Communication	
I/O:	RS 232 or RS 422. Software supports most commercially available USB– RS 232 converters.
Communication Baud rate:	300–115200
Recorder download baud rate:	600/1200 kBaud for both RS232 and RS422
User control:	Handled via Vector Win32® software, ActiveX® function calls, or direct commands.
Analog outputs:	3 channels standard, one for each velocity component or two velocities and pressure. Output range is 0–5 V, scaling is user selectable.
Analog Inputs	
No. of channels:	2
Supply voltage to analog output devices:	Three options selectable through firmware commands: • Battery voltage/500 mA • +5V/250 mA • +12V/100 mA
Software ("Vector")	
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 (standard):	9 MB, can add 32/176/352MB or 4GB (Prolog)
Data record:	24 bytes at sampling rate + 28 bytes/second

Power	
DC Input:	9–15 VDC
Peak current:	3A
Max consumption:	64 Hz 1.5 W
Typ. consumption, 4Hz:	0.6–1.0 W
Sleep consumption:	0.0003 mW (RS232), 0.005 mW (RS422)
Transmit power:	2 adjustable levels
Battery capacity:	100 Wh
New battery voltage:	13.5 VDC
Data collection capacity:	Refer to planning section in software
Real time clock	
Accuracy:	± 1min/year
Backup in absence of power:	4 weeks
Connectors	
Bulkhead (Impulse):	MCBH-8-FS
Cable:	PMCIL-8-MP on 10-m polyurethane cable
Materials	
Standard model:	Delrin® housing. Titanium probe and screws
Environmental	
Operating temperature:	–4ºC to +40ºC
Storage temperature:	–20ºC to +60ºC
Shock and vibration:	IEC 721-3-2
Pressure rating:	300 m for canister.
Dimensions	
	see drawings on page 5
Weight in air:	5.0 kg (standard), 8.3 kg (4000m)
Weight in water:	1.5 kg (standard), 5.1 kg (4000m)
Options	
Acoustic beams:	Probe mounted on fixed stem or on 2-m cable (see drawing)
Batteries:	Lithium or Lithium Ion
External batteries:	Alkaline, Lithium or Lithium Ion (see battery brochure for details)
Pressure sensor:	Specify range.

In most cases, the Vector is deployed as a self contained instrument with internal recorder, or connected to an on-line PC. It can also be operated from any third-party controller using RS 232 or RS 422 communication.

ISO 9001 CERTIFIED COMPANY

CURRENT AND WAVE MEASUREMENTS IN THE OCEAN, LAKE AND LABORATORY

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