AANDERAA

Doppler Current Meter RCM 11

A state-of-the-art Recording Current Meter designed for deep sea operation down to 6000 meters

Measuring:
- *Current Speed*
- *Current Direction*
- *Temperature*

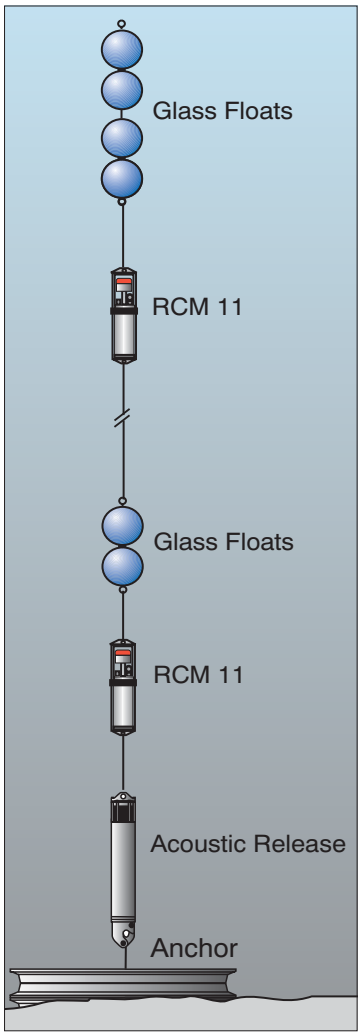
Optional:
- *Conductivity*
- *Instrument Depth*
- *Turbidity and Oxygen*

Features:
- *No offset*
- *Low noise*
- *Forward pinging algorithm improves accuracy*
- *Insensitive to fouling*
- *No moving parts*
- *Easy installation and handling*
- *Easy functional verification using an external Test Unit*

Stores data internally in the standard Data Storage Unit DSU 2990 or transmits data in real-time via cable.

Specially well suited for:
- *Operation down to 6000 m depth*
- *Monitoring Low Current Speeds in very clear water*

The instrument can be used in the sea, in oceans, in lakes and in rivers and its special technical features, such as the narrow beam, compact design and type of integration makes it especially well suited for deep sea operation in very clear waters. An arctic temperature range ensures proper operation in the Polar Regions.



In-line Mooring

The most common way to use the RCM 11 is in an in-line mooring configuration as shown to the left. As it operates under a tilt up to 35° from vertical, it has a variety of in-line mooring applications by use of surface buoy or sub surface buoy. The instrument is installed in a mooring frame that allows easy installation and removal of the instrument without disassembly of the mooring line. The illustration shows an anchoring where retrieval of the instrument is done simply by activating the acoustic release. The glass float will bring the mooring line and the instrument package to the surface.

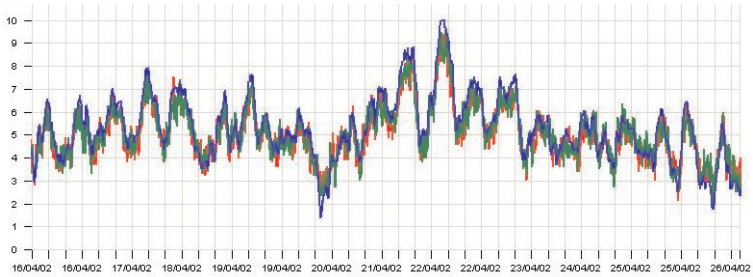
Comparing the RCM 11 with a WMCM in a short mooring

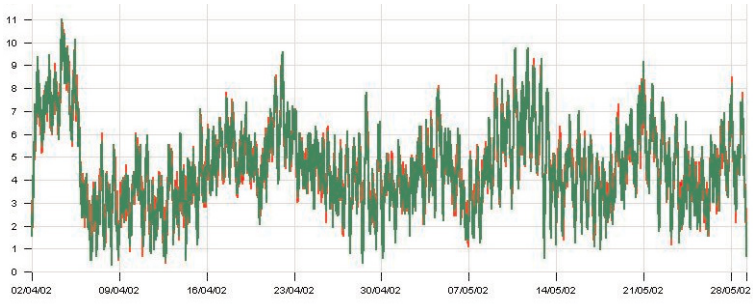
Measurements are often performed repetitively to track changes in the sea current situation at the same location. For these applications, it is important that new measurements may be compared to older measurements.

The two graphs below show measurement results from a deployment south of Bermuda. The deployment time was 2 month (april - may 2002), at a depth of 4000m with a short mooring of 300m with the instruments located at the top of the mooring to prevent increased scatter level from the bottom sediments. The test arrangement is shown to the right.

Two separate tests were performed with this single deployment. The first was to compare measurement made by the RCM 11 and the WMCM. The second test was performed to compare burst and normal sampling schemes when the mooring movements were expected to be low.

The upper graph shows the comparison of the current speed [m/s] measured with two RCM 11s and one WMCM (blue line). It is clearly seen that the current speeds measured by the instruments are very similar. For illustration purposes only a short time interval has been included, and we have included a period of the deployment where the VMCM was not stalling due to speeds below impeller threshold. One of the RCM 11 was configured to Burst mode (red line), while the other to normal mode (green line). It is seen that the current speed [m/s] measured with two RCM 11s are very similar, hence the short mooring has not moved significantly during the deployment time. This is best illustrated in the lower graph, were the WMCM results have been removed, and the graph covers the entire deployment time. The results also show that two RCM11 obtains the same results, even if they have not been specifically calibrated. As such it is a proof of that the intrinsic "calibrated by design" approach used is correct.

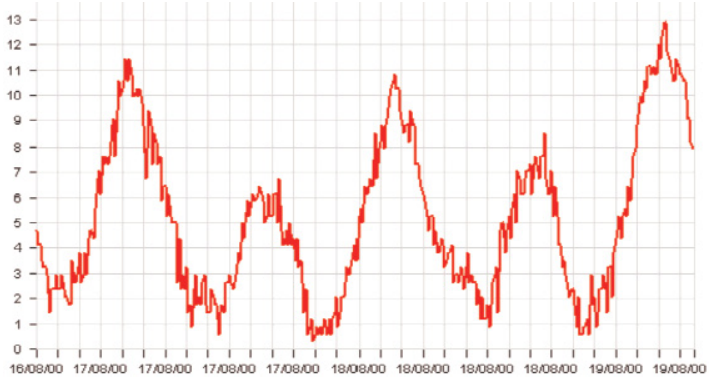


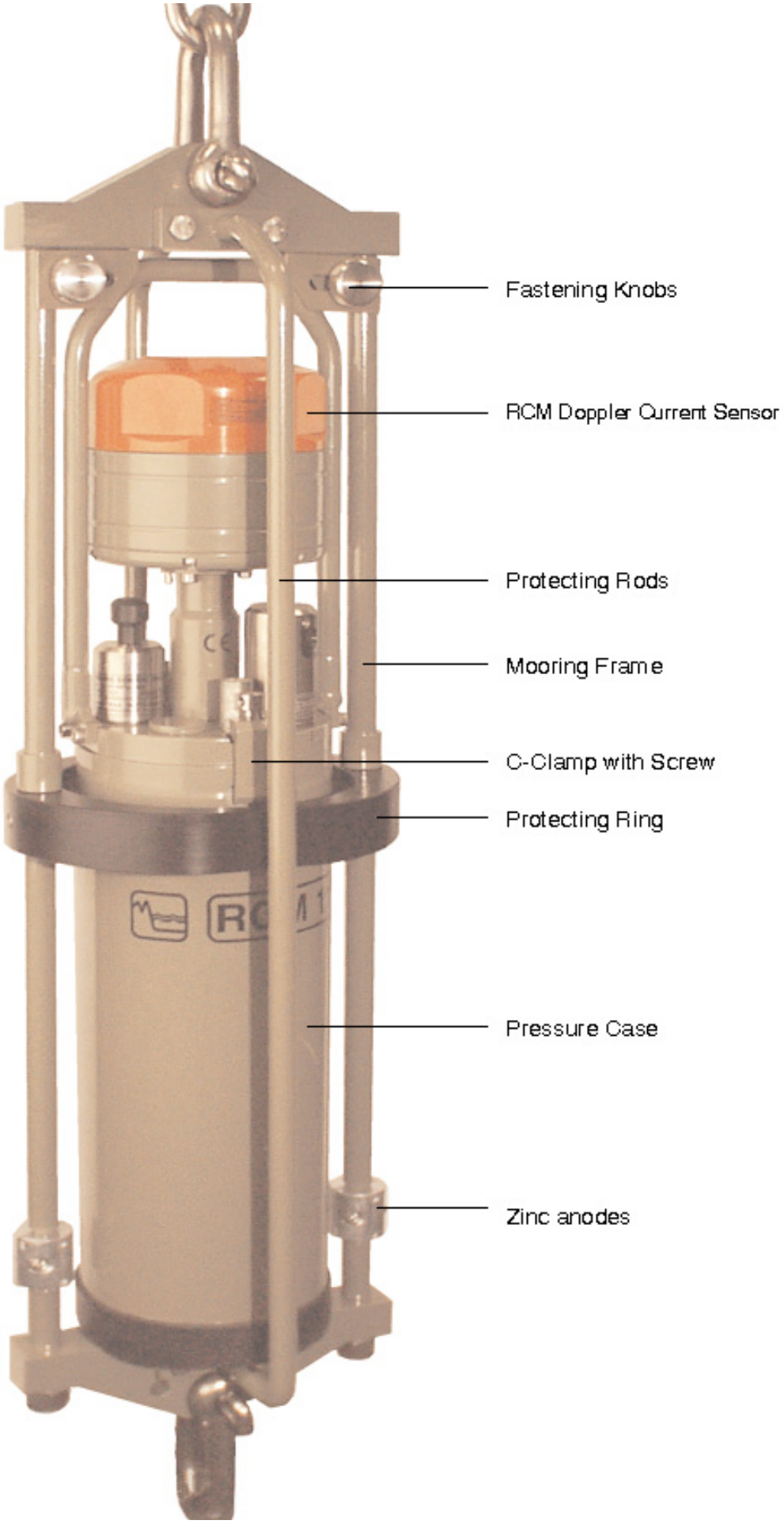


A series of measurements were taken by one of our customers in august 2000.

The graph to the right shows the current speed measured with an RCM 11 over a 3 day period at 1400 meters depth.

The measured values, between 0,5 and 12cm/s, are almost without any noise even though the current speed was only a fraction of RCM 11's capability. Notice also the tidal influence on the measurements even at 1400 meters depth.




Fastening Knobs
RCM Doppler Current Sensor
Protecting Rods
Mooring Frame
C-Clamp with Screw
Protecting Ring
Pressure Case
Zinc anodes

The development of a small, low power doppler current sensors that has taken place in recent years, opens for many interesting applications. One of these is the RCM 11, a unique new self-contained instrument that can be moored in the sea for long periods of time. In standard version it measures the horizontal current speed and direction, as well as temperature. Optional sensors for measuring conductivity, turbidity of the water, dissolved oxygen as well as instrument depth are also available. Optional Output from the Doppler Current sensor is Instrument Tilt and Signal Strength.

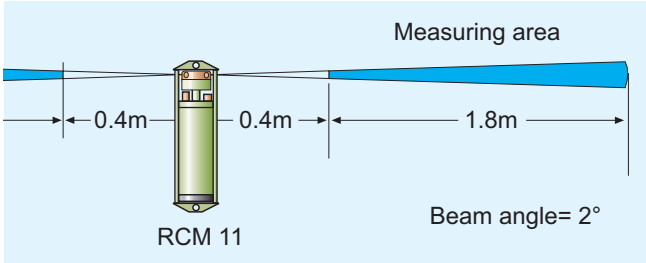
The instrument can operate continuously or in eight intervals from 1 to 120 minutes. At 60-minute recording interval the operating time is more than two years.

The RCM Doppler Current Sensor is furnished with a new Hall effect compass and a two-axis tilt sensor that compensates for the effect of inclination. This feature allows the instrument to be used in a mooring line with an inclination up to 35° from vertical. The instrument has a depth capacity of 6000 meters. The current speed and direction are averaged over the measuring interval.

The RCM Doppler Current Sensor on the instrument sends out 150, 300 or 600 pings during each recording interval. The pings are normally distributed equally in time over the whole measuring interval but it is also possible to select a Burst Mode.

When the instrument is moored near the sea surface, the Burst Mode will reduce the influence of waves. In this mode all pings are executed in the last minute of the measuring interval.

Among the advantages of the RCM 11 are its ease of deployment and that it has no moving parts. Even though the measuring window of the DCS is between 0.4 to 2.2 meters from the sensor itself, which minimizes the effect of marine fouling and local turbulence, the current in the wake of the sensor will be lower than the actual current. To avoid



the impact this will have on the current measurement, a so-called «Forward Pinging Algorithm» has been introduced.

The RCM 11 belongs to a family of well proven oceanographic instruments that share a set of common features;

- **Simple and Sturdy Design**
- **Low Power Consumption**
- **Potted Electronic Circuits**
- **Well proven Pressure Case and Data Storage Units.**

The number of sensors to be scanned can be set by a selector switch inside the instrument. One can choose between 2 to 10 channels. The fewer channels selected increases available DSU memory for long deployments.

The standard sensors for this instrument are:

- Current Speed/Direction Sensor
- Water Temperature Sensor

Optional sensors are:

- Depth Sensor
- Oxygen Sensor
- Conductivity Sensor
- Turbidity Sensor

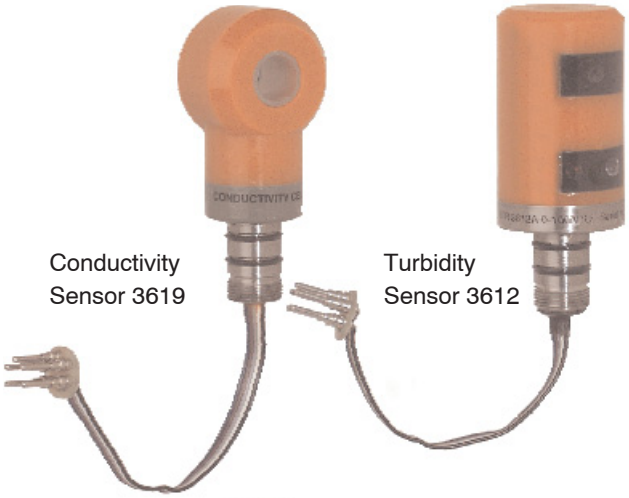
The latter two sensors can only be used in depth down to 2000 meters.

Mooring Frame

A special mooring frame is made to facilitate easy installation and removal of the instrument by use of 2 knobs. The mooring frame is made of stain-less steel and has a breaking load of 8000 Kg. The frame is equipped with a Sensor Protecting Ring.

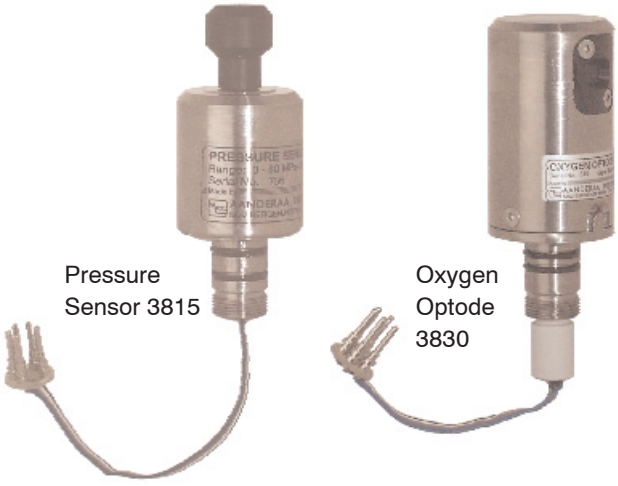
Additional protecting rods can be installed if required.

Doppler Current Sensor 3280



Conductivity Sensor 3619

Turbidity Sensor 3612



Pressure Sensor 3815

Oxygen Optode 3830

Doppler Current Sensor 3820

The sensor utilizes the well-known Doppler Shift principle as the basis for its measurements. The sensor transmits acoustic pulses of 2MHz into the water in sequence. As the sound propagates, small particles or air bubbles in the water reflect a portion of the energy. The back-scattered energy from the area between 0.4 to 2,2 meters from the sensor is picked up by the transducers and analyzed to find any change in frequency. The DCS 3820 employs state-of-the-art signal-processing and computer tuned electronics. The unit achieves low static noise even in waters with scarcely any backscatters. As such the DCS 3820 is well suited for deep sea measurements when the sea current is expected to be low.

The current direction is found by taking the measurements along two orthogonal axes, x and y. These measurements are compensated for tilt by use of an electrolytic tilt sensor and referred to magnetic North by means of an internal Hall-effect compass. A microprocessor computes vector averaged current speed and direction over the last sampling interval. The sensor output is the Aanderaa standard SR10.

The sensor has an OD of 120 mm, is 100mm thick and has a 10-pin receptacle at its lower end. The sensor is fastened to the instrument by an 86 mm high sensor foot. Four piezoceramic acoustic transducers are placed 90° apart around the circumference of the sensor that is molded in a polyurethane material.

Conductivity Sensor 3619

This sensor measures the conductivity in the water by use of an inductive cell made of two toroids. The primary toroid induces a loop current through the bore of the cell. This again induces a voltage over the secondary toroid. A compensating current through a compensating winding creates a loop current in the opposite direction. This current is balanced until the resultant loop current and the voltage over the secondary winding equals zero. The current in the compensating winding is a measure of the conductivity of the water. The Conductivity Cell and the electronics are molded in a polyurethane material.

Turbidity Sensor 3612

This sensor measures the turbidity of the water by use of back-scattered infrared light. This measurement is known to have good correlation to the amount of suspended matters and can be used to monitor sediments, algae, or particle pollution. Three light emitting diodes and a photo diode are pointing to a common center at an angle of 15°. Once every measuring cycle the light emitting diodes send out light and the reflected light from particles in the water is picked up by the photodiode. The sensor is shaped as a small cylinder molded in polyurethane material. Depth capacity: 2000m.

Pressure Sensor 3815

The sensor is shaped as a small cylinder molded in Durotong polyurethane. It measures the absolute pressure by means of a piezoresistive bridge. One measurement is taken for every measurement cycle. This is an analog sensor, and the output is the Aanderaa standard VR22 signal.

Oxygen Optode 3830

This Oxygen Optode measures dissolved oxygen in fresh and sea water by using the latest technology. The principle of measuremens is bades on the effect of dynamic luminecence quenching (lifetime based) by molecular oxygen.The range is 0-16mg/l with accuracy ±0.3mg/l or 5 % whichever is greater. The output from the sensor is an SR 10 signal.

SPECIFICATIONS FOR RECORDING CURRENT METER RCM 11 AANDERAA INSTRUMENTS

Measuring system: A self balancing bridge with sequential measurement of 8 channels and solid state memory. 10-bit binary word for each channel. The channels are:

Ch.1 Reference is a fixed reading to check the RCM's performance and to identify individual instruments

Ch.2 and Ch.3, Current Speed and Direction:

Speed Sensor Type:	**Doppler Current Sensor 3820**
Range:	0 to 300 cm/s
Resolution:	0.3 cm/s
*Accuracy:	
Absolute:	±0.15 cm/s
Relative:	±1% of reading
Statistic precision:	< 0.45 cm/s (standard deviation)
Direction Sensor :	Magnetic compass, Hall effect type
Resolution:	0.35°
Accuracy:	±5° for 0-15° tilt and ±7.5° for 15-35° tilt
Acoustic Frequency:	2 MHz
Power:	25 Watt in 1 ms pulses
Beam Angle:	±1° (Main Lobe)
Installation distance:	Minimum 0.5 m from the bottom
(to the DCS head)	Minimum 0.75 m from the surface

Ch.4 Temperature:	**Temperature Sensor 3621**
Sensor type:	Thermistor (Fenwall GB32JM19)
Resolution:	0.1% of selected range
Accuracy:	±0.05°C
Response time:	12 seconds (63%)
Selectable Ranges:	
Wide range:	−0.64 to 32.87°C
Low range:	−2.70 to 21.77°C
High range:	+9.81 to 36.66°C
Arctic range:	−3.01 to 5.92°C

Ch.5 Conductivity (Optional): Conductivity Sensor 3619

Sensor Type:	Inductive Cell
Selectable ranges:	0 – 74 mS/cm or 24 – 38 mS/cm
Accuracy:	±0.2% of range
Resolution:	0.1% of range
Depth capacity:	2000 meters

Ch.6 Pressure (Optional): Pressure Sensor 3815

Sensor Type:	Silicon piezoresistive bridge
Available ranges:	0 - 700 kPa, 0 - 3500 kPa 0 - 7000 kPa, 0 - 20 MPa. 0 - 60 MPa
Resolution:	0.1% of range
Accuracy:	±0.25% of range

Ch.7 Turbidity [Optional):Turbidity Sensor 3612

Sensor type:	Optical Back-scatter Sensor
Available ranges:	0-20, 0-100, 0-500 NTU
Resolution:	0.1 % of full scale
Accuracy:	2% of full scale
Depth capacity:	2000 meters

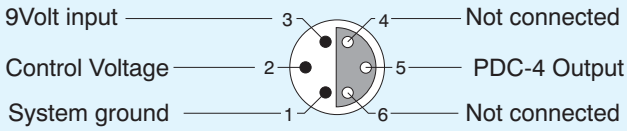
Ch.8: Oxygen (Optional): Oxygen Optode 3830

Sensor Type:	Oxygen Optode
Range:	0 - 500μM
Resolution:	<1μM
Accuracy:	<8μM or 5% whichever is greater
Response time:	Setting (63%): <25 seconds
Depth capacity:	6000 meters

Watertight Receptacle:

PIN CONFIGURATION

Receptacle, exterior view; pin =● ; bushing =○



Number of Channels:	Selectable from 4 to 8 channels
External Triggering:	A positive 5 volt pulse to the Watertight Receptacle, PDC-4 output pin, will trigger one measurement cycle
Recording Intervals:	1, 2, 5, 10, 20, 30, 60 and 120 minutes Continuous.(4 s x no.of ch. + 2s) and Remote Start only
Recording System:	Data Storage Unit 2990 or 2990E Data storage in EEPROM
Storage Capacity:	DSU 2990: 9000 records (7 ch.) (2 months at 10 minute interval) DSU 2990E: 36100 records (7 ch.) (8 months at 10 minute interval)
Battery:	Alkaline Battery 3614, 9 V 15 Ah or Lithium Battery 3677, 7.2 V 30 Ah for 1year, respectively 2 years and 4 months operation at one hour interval, or 92, respectively 220 days at 10 minute interval
Average Current Consumption (mA):	0.50 + (50 divided by the recording interval in minutes)
Depth Capability:	6000 meters
Dimensions:	595 mm High 128 mm OD

Weight (kg):	in air	in water
Net (with frame):	26.5	18.0
Gross (with frame):	37.5	

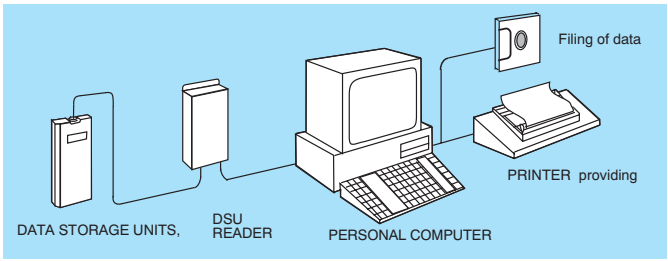
Packing:	Plywood case: 190x 250x 650 mm
External Materials:	Stainless acid proof steel, OSNISIL, Titanium, Durotong DT 322 polyurethane
Accessories:	
(Included)	Mooring Frame 3824 with Sensor Protecting Ring 966278
(Optional)	Base Brackets 3627(2) for Frame Additional Protecting Rods 3783 Vane Plate 3681 DCS Test Unit 3731
Spares:	A set of recommended spares is delivered free of charge with each instrument (o-rings, sealing plugs, tools, cotter pins etc)
Warranty:	Two years against faulty materials and workmanship. For subsurface cables contact factory

*Assumes speed of sound is 1500 m/s. Actual speed of sound can be corrected for using the 5059 program.

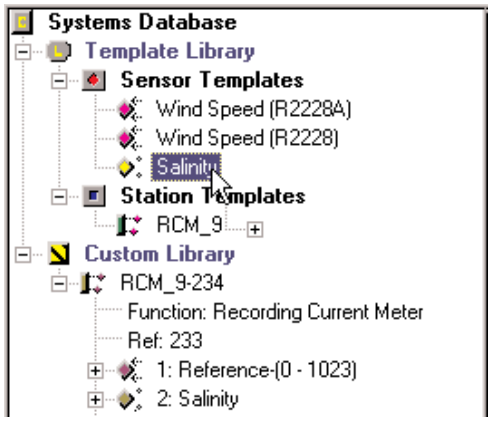
RCM11 Top end plate with a selection of sensors and wireing to the Electronic Board

Data Storage Units DSU 2990 and 2990E
are standard data storage devices for Aanderaa data collecting instruments. They are rugged, waterproof and have an LCD that shows the total number of data word stored. The 2990 version can store 65 000 10-bit data words and the 2990 E version can store 262000 data words.
A built-in quartz clock allows the time of the first measurement to be recorded in the DSU as well as every first measurement after midnight.

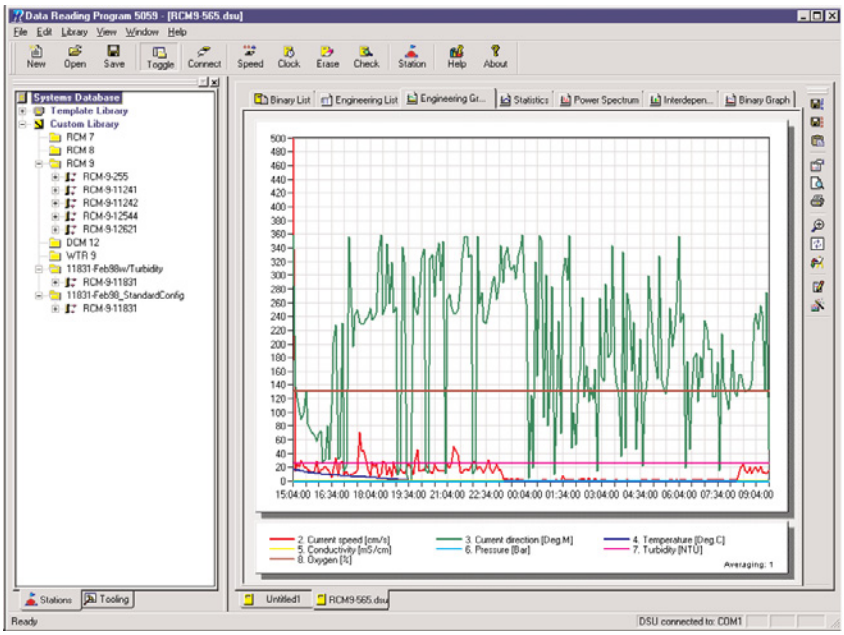
Reading of Stored Data
Data can be transferred from the DSU to a PC using the DSU Reader 2995 and a suitable communication program. The reader is an RS 232 interface between the PC and the DSU.



Data Reading Program 5059
is a new software program from Aanderaa used to download DSU 2990 data to a Personal Computer. The program is based on the latest software technology and is designed for use with Windows 95, Windows 98 and Windows NT.
In addition to downloading and exporting of DSU data, it can also be used for data analysis. The 5059 includes extensive charting and analysis facilities, and the resulting analysis graphs may be exported to programs such as Microsoft Word and Excel. The modern user interface, including drag & drop facilities, and an extensive built-in Help system makes the 5059 easy to use.
A sensor, station and instrument library allows you to build up a library holding configuration and calibration sets for all your Aanderaa instruments. A limited version of this program is supplied free of charge. The full version is available at a moderate cost. Please contact the factory or visit our web site to obtain a 30 day fully functional trial version. The program is delivered on a CD with a comprehensive operating manual.



Virtual sensor handling, Salinity



Engineering Data graph from RCM 9 serial. no. 565

Representative's Stamp

Latest version is on the Internet

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