



AANDERAA INSTRUMENTS

DATA COLLECTING INSTRUMENTS FOR LAND SEA AND AIR



The RCM 9

*A unique
Recording Current Meter
for use in the sea
and in freshwater
featuring the Mark II
DOPPLER CURRENT
SENSOR DCS 3920*

Measuring:

- **Current Speed**
- **Current Direction**
- **Temperature**

- **Conductivity (optional)**
- **Instrument Depth (optional)**
- **Turbidity (optional)**
- **Oxygen (optional)**

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

Features:

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

Specially well suited for:

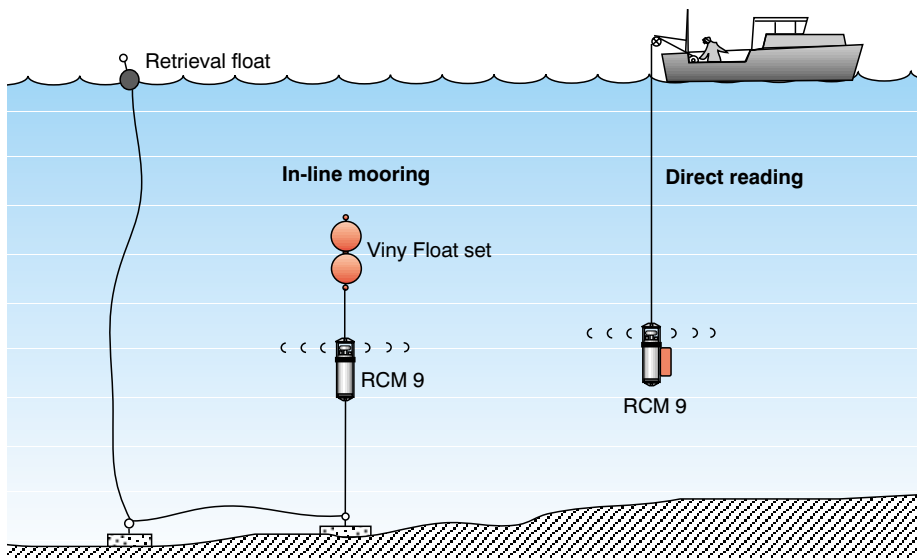
- **Operation in the Wave Zone**
- **Monitoring Low Current Speeds**

FIELDS OF APPLICATIONS

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 operation in the wave zone. An arctic temperature range ensures proper operation in the Polar Regions.

In-line Mooring

The most common way to use the RCM 9 is in an in-line mooring configuration as shown below. 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 the so-called u-anchoring where retrieval of the instrument is done simply by pulling it on board the vessel by means of the retrieval float and mooring line.



Direct Reading

The illustration to the left also shows how the instrument can be used for direct reading of current, temperature, and parameters such as conductivity, turbidity, oxygen and instrument depth. This is conveniently done due to its compact design, low drag force and easy handling. The instrument can be lowered into the sea from a small boat using a simple winch. In this application a small vane plate should be fastened to the instrument to avoid spin during operation. Data can be stored internally and read after retrieval or be read in real time on deck by use of the profiling cable. See also page 6.



Mooring Frame

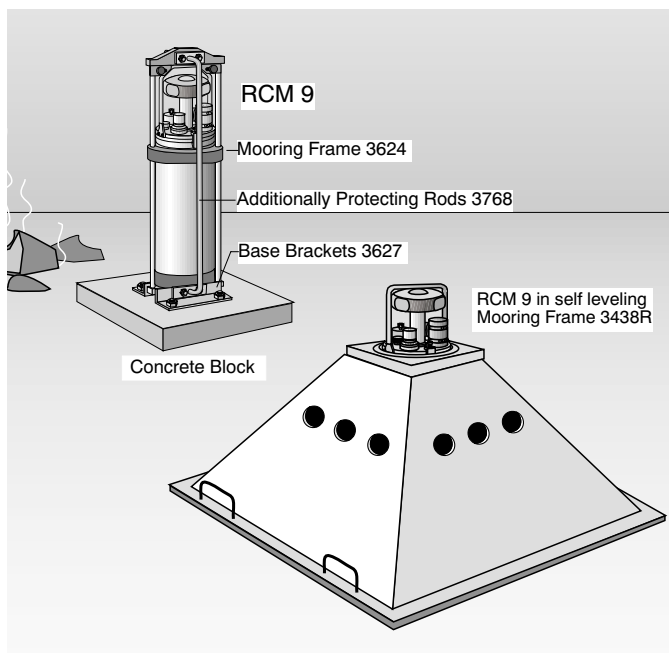
A special mooring frame for the RCM 9 is made to facilitate easy installation and removal of the instrument by use of two knobs. A diver can accomplish deployment and retrieval. The mooring frame is made of stain-less steel and has a breaking load of 8000 Kg. The frame is equipped with a Sensor Protecting Ring.

Measurements on the Seabed

The illustration to the right shows an RCM 9 placed on the seabed. For the upper application, the frame must be furnished with two base brackets and placed on a concrete block or similar.

The RCM 9 can also be mounted in a self-leveling Frame 3438R, which makes the installation on the seabed very easy.

One of these arrangements is often required for studying the transportation of sediments and falling particles from sea farm mares.



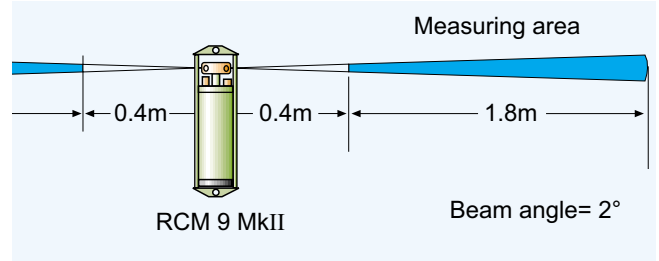
GENERAL DESCRIPTION OF THE INSTRUMENT

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 9, 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 are conductivity, turbidity of the water, dissolved oxygen as well as instrument depth.

The RCM 9 utilizes the well-known Doppler shift principle as the basis for its measurements. The system transmits an acoustic sinusoidal pulse at 2MHz. As the sound propagates through the water, minute parts of its energy is reflected or scattered by small particles in the water. This back-scattered energy is received by the system and analyzed to find any change in frequency. An upward shift in frequency means that the particles are moving towards the transducer and a downward shift that the particles are moving away from the transducer. The degree of shift signifies the rate of movement.

Assuming that the particles follow the currents in the water, this system is used to monitor and determine the current speed and direction of the water. The direction is found by the use of measurements along two orthogonal axis and linking them to true north by use of an internal compass reading.

The scattering particles are normally plankton, organisms and particles stemming from man-made activity. Near the surface, gas bubbles are important scatterers. Thus the energy back-scattered and the usefulness of the instrument depends on the presence of sufficient scatterers. These conditions will vary from place to place and significant seasonal variations are normally found in less polluted waters.



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 1000 meters. The current speed and direction are averaged over the measuring interval.

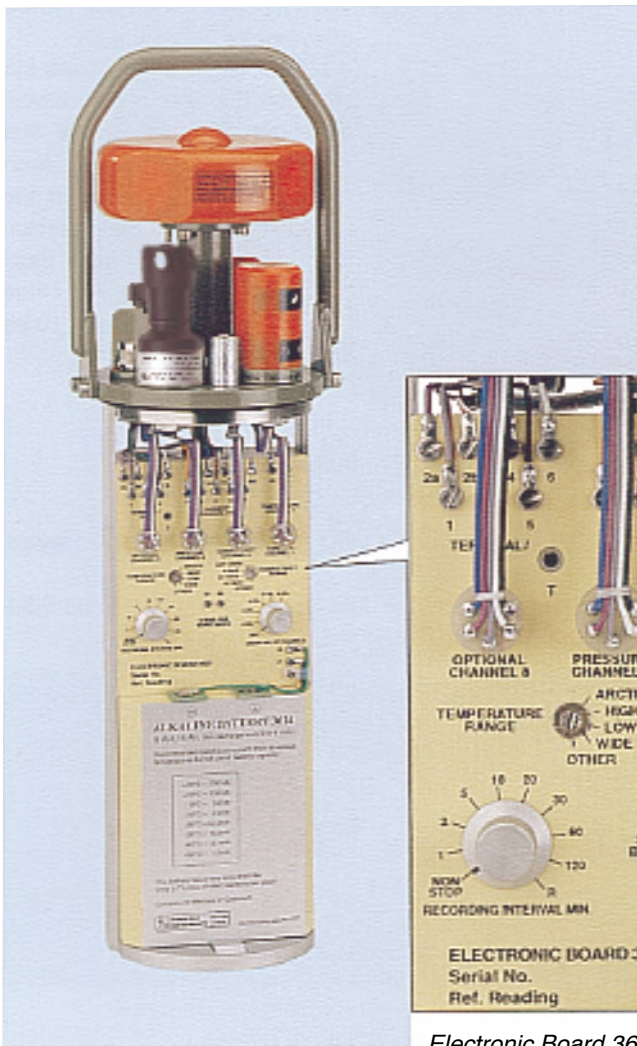
The RCM Doppler Current Sensor on the instrument sends out 600 pings during each recording interval. The pings are normally distributed equally in time over the whole measuring interval but it is also possible to select a Burst Mode.

When the instrument is moored near the sea surface, the Burst Mode will reduce the influence of waves. In this mode the 600 pings are executed in the last minute of the measuring interval.

Among the advantages of the RCM 9 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 error this will have on the current measurement, a «Forward Pinging Algorithm» has been introduced.

When the DCS samples a positive Doppler shift from one of the transducers for the measurement in the X-axis, it will continue to use this transducer for the measurement along the X-axis. When the Doppler shift becomes negative, it will then change to the opposite transducer, and so on. The same algorithm is also applied for the Y-axis and the DCS toggles between sampling in the two axis.



Electronic Board 3623, Control switches

The instrument is equipped with a watertight receptacle that enables external triggering and powering of the instrument as well as real-time data acquisition via cable. The RCM 9 belongs to a family of well proven oceanographic instruments that share a set of common features. They are all of simple and sturdy design, they have low power consumption, they employ potted electronic circuits, and they have the same well proven pressure case and same data storage units. The number of sensors to be scanned can be set by a selector switch inside the instrument. One can choose

between 4, 5, 6, 7, or 8 channels. The fewer channels selected increases available DSU memory for long deployments.

The standard sensors for this instrument are:

- Current Speed and Direction Sensor
- Water Temperature Sensor

Optional sensors are:

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



Doppler Current Sensor 3920



Turbidity Sensor 3612

Conductivity Sensor 3619



Pressure Sensor 3815

Oxygen Sensor 3675

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 Sensor 3675

measures the dissolved oxygen in the water. The sensor is based upon an oxygen probe from Oxyquard, which is adapted to the instrument by a special converter. The sensor is specially designed for the RCM 9. The upper part is the probe and the lower part is the converter with the installation stud molded on to the probe. The range is 0-20mg/l with accuracy ± 0.8 mg/l. The output from the sensor is an SR 10 signal.

Doppler Current Sensor 3920

This disk-shaped sensor has an OD of 120 mm, is 45 mm thick and has a 10-pin receptacle at its lower end. The sensor is fastened to the instrument by an 86mm high sensor foot. Four piezoceramic acoustic transducers are placed 90° apart around the circumference of the sensor that is molded in a polyurethane material.

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 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. A low frequency acoustic transducer for data transmission is molded into the top of the sensor.


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.

SPECIFICATIONS FOR RECORDING CURRENT METER RCM9, MK II

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: ( signifies Mk II changes)

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 3920
 Range: 0 to 300cm/s
 Resolution: 0.3cm/s 
 *Accuracy: 
 Absolute: ± 0.15 cm/s
 Relative: $\pm 1\%$ of reading
 Statistic precision: 0.5 cm/s (standard deviation)
 Direction Sensor : Magnetic compass, Hall effect type
 Resolution: 0.35°
 Accuracy: $\pm 5^\circ$ for 0-15° tilt and
 $\pm 7.5^\circ$ for 15-35° tilt
 Acoustic Frequency: 2 MHz
 Power: 25 Watt in 1 ms pulses
 Beam Angle: $\pm 1^\circ$ (Main Lobe)
 Installation distance: Minimum 0.5m from the bottom
 Minimum 0.75m from the surface

Ch.4 Temperature: Temperature Sensor 3621

Sensor type: Thermistor (Fenwall GB32JM19)
 Resolution: 0.1% of selected range
 Accuracy: $\pm 0.05^\circ\text{C}$
 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
 24 – 38 mS/cm
 Accuracy: $\pm 0.2\%$ of range
 0 – 2 mS/cm (**Cond. Sensor 3619N**)
 Accuracy: $\pm 0.8\%$ of range
 Resolution: 0.1% of range

Ch.6 Pressure (Optional): Pressure Sensor 3815

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

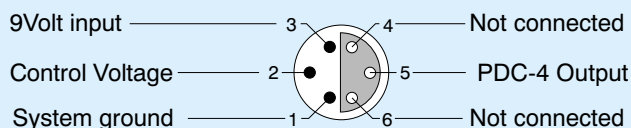
Ch.8: Oxygen (Optional): Oxygen Sensor 3675

Sensor Type: Oxyguard
 Range: 0-20mg/l
 Resolution: 0.025mg/l
 Accuracy: ± 0.8 mg/l
 Response time: 1 minute (63%)

Watertight Receptacle:

PIN CONFIGURATION

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



Number of Channels: Selectable from 4 to 8 channels


External Triggering: A positive 5volt pulse to the electrical terminal, 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, 9V 15Ah (nominal 12.5Ah 220Ω down to 6V at 4°C) or Lithium Battery 3677, 7.2V 30Ah for 1 year, respectively 2 years and 6 months operation at one hour interval, or 92, respectively 220 days at 10 minute interval

Average Current Consumption (mA): 
 $0.50 + (50 \text{ divided by the recording interval in minutes})$

Depth Capability: 1000 meters

Dimensions: 513mm High
 128mm OD

Weight (kg): in air in water

Net (with frame): 22.5 14.5

Gross (with frame): 32.5

Packing: Plywood case: 190x 250x 650 mm

External Materials: Stainless acid proof steel,
 OSNISIL, Titanium,
 Durotong DT 322 polyurethane

Accessories:
 (Included) Mooring Frame 3624 with Sensor
 Protecting Ring 966278
 (Optional) Base Brackets 3627(2) for Frame
 Additional Protecting Rods 3768
 Vane Plate 3681
 DCS Test Unit 3731

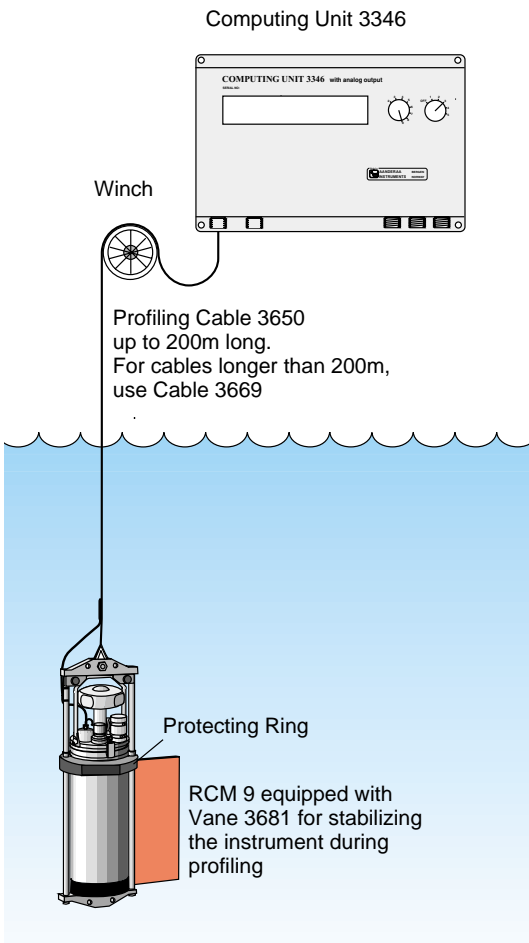
Spares: A set of recommended spares is delivered free of charge with each instrument (o-rings, sealing plugs, tools, cotter pins etc)

Warranty: Two years against faulty materials and workmanship. For subsurface cables contact factory

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

Direct Reading Current Meter, RCM 9

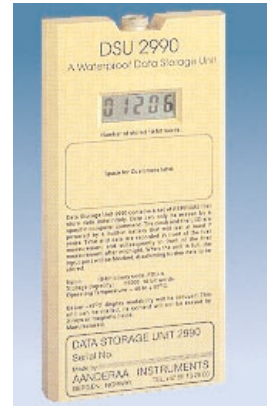
The compact RCM 9 is well suited as a direct reading current meter. The instrument can be lowered with Profiling Cable 3650 using a small winch. The cable may be up to 200m long. On board, Computing Unit 3346 provides the output in engineering units on a display and as RS232 output for a PC. To stabilize the RCM9 during profiling, the mooring frame is equipped with Vane 3681. The response time (63%) is 12 seconds for the temperature sensor and one minute for the oxygen sensor. Data can be stored internally and read after retrieval if an ordinary mooring line is used.



Data Storage Units DSU 2990 and 2990E

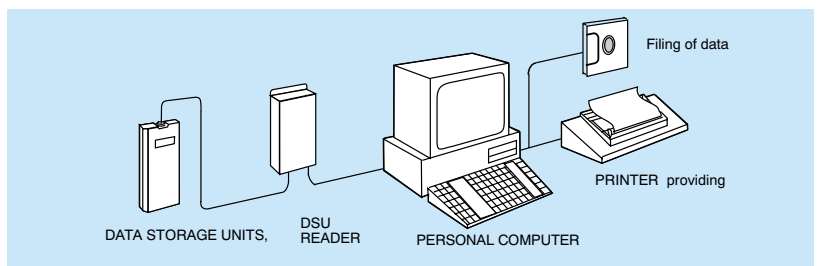
are standard data storage devices for Aanderaa data collecting instruments. They are rugged, waterproof and have an LCD that shows the total number of data word stored. The 2990 version can store 65 000 10-bit data words and the 2990 E version can store 262000 data words.

A built-in quartz clock allows the time of the first measurement to be recorded in the DSU. Time is also recorded for the first measurement after midnight.



Reading of Stored Data

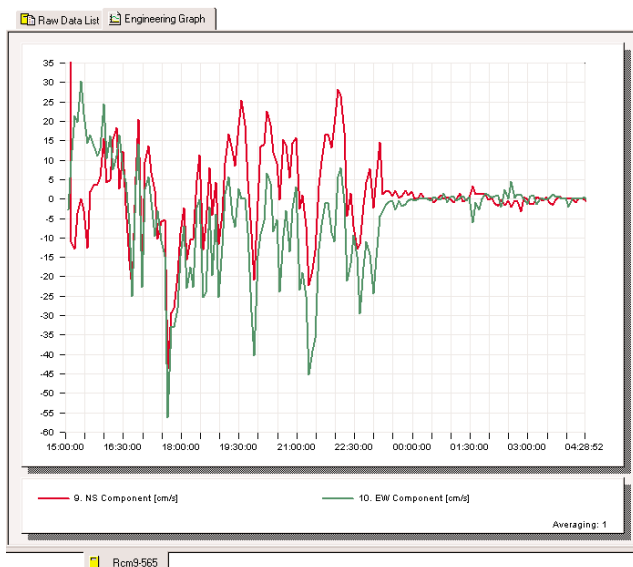
The data can be transferred from the DSU to a PC using the DSU Reader 2995 and a suitable communication program. The reader is an RS 232 interface between the PC and the DSU.



Data Reading Program 5059

is a new software program that may be 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 and 2000.

In addition to enable downloading and exporting of DSU data, it may 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 instruments. A limited version 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.



Engineering data graph from Data Reading program 5059

Representative's Stamp

Latest version is on the Internet

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