Technical Description No.211
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OPERATING MANUAL

RCM 9 Mk II
RCM 11

Recording Current Meter
RCM9, Mk II and RCM 11

AANDERAA INSTRUMENTS
DATA COLLECTING INSTRUMENTS FOR LAND SEA AND AIR

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PO BOX 160, NESTTUN FANAVEIEN 13B TEL. +47 55 109900 E-MAIL: info@aanderaa.no
5852 BERGEN, NORWAY 5221 NESTTUN, NORWAY FAX.+47 55 109910 WEB: http://www.aanderaa.com

INTRODUCTION

This manual describes the Recording Current Meter, RCM 9 Mk II and RCM 11. Both instruments combining well proven components, items and parts with up to date technology. The instruments features new improved ***RCM Doppler Current Sensors*** as well as sensors for Temperature, Conductivity, Pressure, Turbidity and Oxygen measurements. The two latter with depth capacity 2000 meters. The instruments can be used in the sea, in oceans, in lakes and in rivers. A special Arctic temp range makes it well suited for use in Polar Regions.

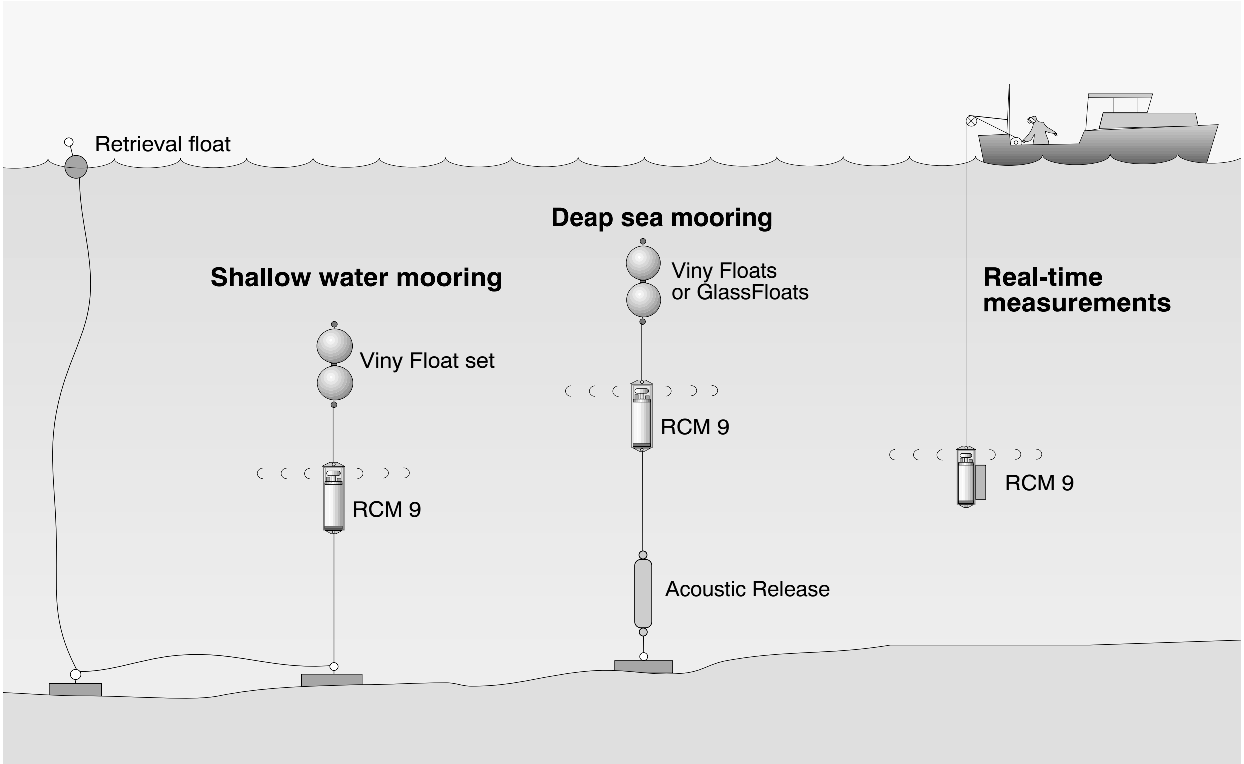
The use of the instruments requires practical insight in several fields such as mooring, deployment and recovery of instruments, operation and maintenance, sensor calibration, data processing and interpretation. It is our intention by this manual to give sufficient background information and documentation for the user to ensure successful operation of the instruments.

Among the advantages of the RCM 9 Mk II and RCM 11 are their ease of deployment and that they have no moving parts. The current is measured in the area from 0.4 to 2.2 meters from the instrument which minimizes the effect of marine fouling and local turbulence. The instrument is equipped with a watertight receptacle that enables external triggering and testing of a fully assembled instrument as well as real-time data acquisition via cable.

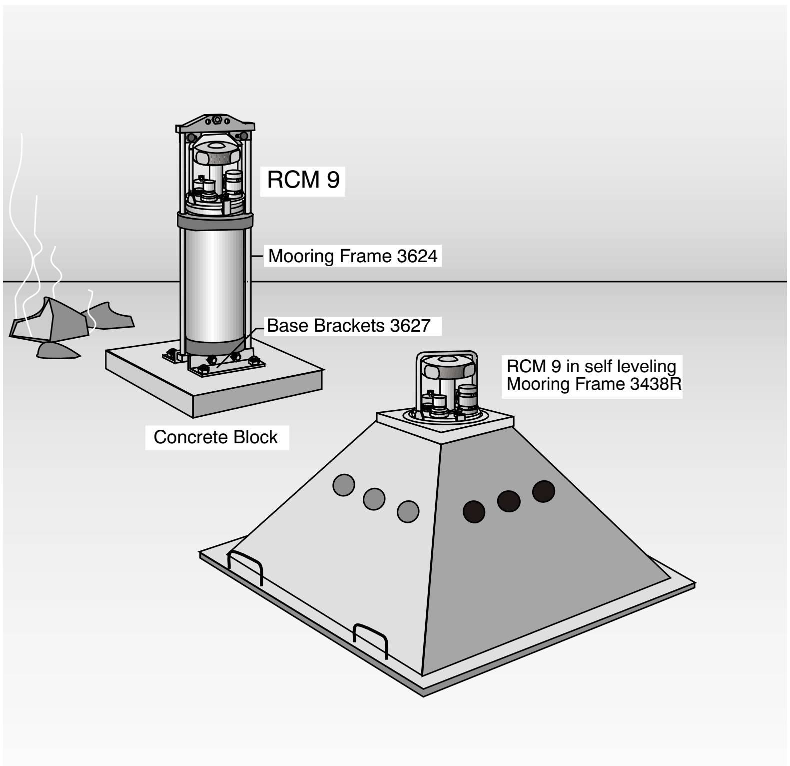
The illustrations in chapter 7 include some 4 and 6 digit stock identification numbers which should always be quoted when ordering spare parts.

Chapters 1 to 7 describes the RCM 9 Mk II. These chapters are also valid for the RCM 11except for the physical dimentions and pressure capability for the instrument and sensors. Chapter 8 describes the additional items and spesifications for the RCM 11.

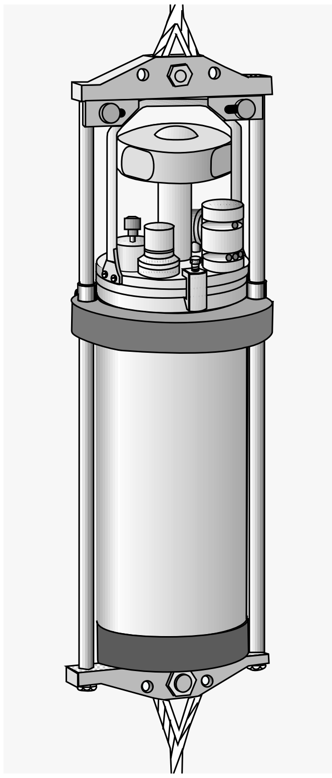
APPLICATIONS
Different types of anchoring and usage.



U-Anchoring *I-Anchoring* *Direct reading*



Bottom mounted RCM 9 Mk II



RCM 9 Mk II in Frame

CHAPTER ONE

SHORT DESCRIPTION, SPECIFICATIONS.

Recording Current Meter Model 9, Mk II is a self-recording current meter intended to be moored to measure and record the vector averaged speed, direction, the temperature, conductivity, turbidity and oxygen of ocean currents as well as the instrument´s deployment depth. A special feature of the Conductivity Cell, part no. 3619N, is the optional range 0-2mS which enables conductivity measurements of fresh water.

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 Mk II are its ease of deployment and that it has no moving parts. The current is measured in the area from 0.4 to 2.2 meters from the instrument which minimizes the effect of marine fouling and local turbulence.

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 illustrations on page 0-04 shows 2 typical ways of mooring the instrument. "U-anchoring" is suitable for shallow waters, while "I-anchoring" can be used for all depths, provided that the depth capability of the release device or current meter is not exceeded. For "U-anchoring" a piece of heavy chain can be used as an anchoring weight rather than a solid weight because it is easier to hoist off the bottom. The instrument can also be used for profiling 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. Data can be stored internally and read after retrieval or be read in real-time on deck by use of a wire cable. Another illustration on the same page shows how the RCM 9 Mk II can be used for measurements close to the seabed. The instrument with mooring frame is then fastened with two base brackets to a concrete block or similar. The brackets are shown in figure 7.13 on page 7-11.

The instrument records data internally in a removable and reusable solid-state Data Storage Unit (DSU) 2990, the standard data storage device for all Aanderaa recording instruments.

A built-in quartz clock triggers the measuring cycle at regular, programmable intervals. A basic sensor configuration is:

Ch.1. Reference (a control and identification reading)
" 2. Current speed
" 3. Current direction
" 4. Temperature

Optional sensors from Aanderaa are:

” 5. Conductivity
” 6. Pressure
” 7. Turbidity
” 8. Oxygen

The reference is a fixed reading that serves as a control on the performance of the instrument and to identify data series from individual instruments.

Temperature is measured by a thermistor fitted into a stud on the top end-plate which extends into the water. Conductivity is measured by an electrodeless induction type conductivity sensor and turbidity is measured by use of back-scattered infra-red light. The instrument depth is calculated from pressure measurements taken by a piezoresistive bridge.

The current speed and direction are measured by the new RCM Doppler Current Sensor (DCS) specially developed for the RCM 9 Mk II. The sensor measures the horizontal current in an area from 0.4 to 2.2 meters from the instrument. The measurements are compensated for tilt, and referred to magnetic North by means of an internal Hall-effect compass. A microprocessor computes vector averaged speed and direction over the last sampling interval.

Figure 7.01 shows the complete recording current meter, RCM 9 Mk II. It consists of the instrument with the mooring frame. The recording unit is always installed in the frame when deployed. The frame allows for easy installation and removal of the instrument without disassembly of the mooring line. The frame is furnished with a Protecting Ring to shield the sensors on the top end-plate. The frame can also be equipped with additional protecting rods installed 90° on the frame rods. See drawing on page 7-10 figure 7.12. As the instrument operates under a tilt of up to 35° from vertical, it has a variety of in-line mooring applications in combination with surface or sub-surface floats.

The instrument is held to the frame by two handles which facilitates easy installation and removal of the recording unit.

Figure 7.02 shows the assembled RCM 9 Mk II. All external and internal parts are fastened to the top end plate, and the instrument can be lifted out of the pressure case in one piece after removing the two C-clamps.

All external parts are protected from corrosion by a durable olive green epoxy coating. Further corrosion protection is ensured by the use of a sacrificial zinc anode, fitted to the top end plate. The top end plate is furnished with a handle for carrying the unit. The top end plate also has an electrical terminal. This terminal can be used for real-time data reading, checking the performance of the instrument, as well as remote triggering. A digital display unit e.g. Deck Unit 3127 or Computing Unit 3015, can be connected to display data. By use of the PDC-4/RS232C Deck Unit 3127, the output signal can also be read by a personal computer via the same terminal.

Burst Mode - The instruments can either be run in Normal mode, with no connection between Bl and B2, or in Burst mode by using the strap between terminal Bl and B2. In Normal mode 600 ping (150 ping set) is equally distributed through the whole sampling interval. This gives a ping frequency of:

600pings divided by sampling interval in seconds

In Burst mode all 600 ping (150 ping set) is distributed through the last minute of the sampling interval, which gives a ping frequency of:

600pings divided by 60seconds = 10 Hz.

If a movement other than the sea current influences the instruments it is recommended to use a ping frequency at least 4 times the frequency of the movement. This movement can either be caused by waves or movement in the mooring (strumming).

- In Normal mode the measurement is an average of the whole sampling interval1
- In Burst mode the measurement is an average of the last minute of the sampling interval.
- For Non-stop and one minute interval the Burst mode strap has no influence.

Figure 7.03 shows the interior of the recording unit seen from the electronic board side. The electronics is hermetically encapsulated in a board of low density polyurethane. The control switches for the instrument is embedded in the board, and comprises the recording interval switch, the ON/OFF channel selector switch and the range selectors for temperature and conductivity. The 9 volts,15Ah (nominal capacity 12.5Ah, 220Ω down to 6.0V at 4.0°C) alkaline battery, located at the lower end of the unit, has sufficient capacity for more than 9000 records (equivalent to 1 year and 3 month operation at one hour recording interval). By using the Lithium Battery 3677, 7.2V 30Ah the capacity will increase to 22000 records (equivalent to 2 years and 6 months operation at 1 hour sampling interval).

When the ON/OFF Channel selector switch is turned to channel 7, the unit is powered, the clock is reset and one measuring cycle of 7 channels is immediately executed. The instrument then comes to rest awaiting the next triggering pulse from the clock to arrive after which another measuring cycle is carried out. The data in the PDC-4 code are stored in the DSU 2990 when they are measured and simultaneously telemetered into the water acoustically.

Figure 7.04 shows the interior of the instrument seen from the Data Storage Unit (DSU) side. The DSU is held by means of its electrical connector at the top and 2 snap-on locks at the lower end.

A new RCM 9 Mk II, when delivered from the factory, is equipped with Data Storage Unit and battery installed, ready for use. The only preparation needed prior to use, is to select temperature and conductivity range, to open the oxygen sensor for measurements by moving the o-ring to a ”parking slot”, to set the desired sampling interval and to select the correct number of channels to be read.

When shipped, the instrument with mooring frame is packed in a plywood box as shown on figure 7.06. The plywood box also contains a set of recommended spares and accessories.

Specifications for the Recording Current Meter, RCM 9 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: (Mk 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:	±1% of reading
Statistic precision:	0.5 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 0.5m from the bottom
(to the DCS head)	Minimum 0.75m 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
	24 – 38 mS/cm
Accuracy:	±0.2% of range
	0 – 2 mS/cm **(Cond. Sensor 3619N)**
Accuracy:	±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:	±0.25% of range

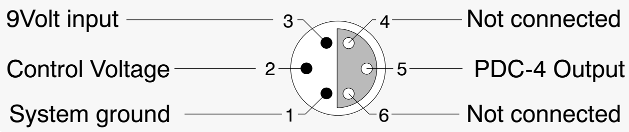
Ch.7 Turbidity [Optional):Turbidity Sensor 3612

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:	± 0.8mg/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 1year, 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 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.

CHAPTER TWO

THEORY OF OPERATION

The measuring system used in this instrument is a self-balancing bridge system that processes its 8 sensor channels sequentially. The sensor forms one half of the bridge and the other half is a 10-step approximation network. The system carries out the same process for all sensors. The bridge and sensors act together as described below. All power and signals are referred to positive ground to maintained compatibility with former Aanderaa equipment.

The output code is the PDC-4 code (see fig. 2-02). This code is chosen because it is simple, compact and well suited for telemetering. Data are stored in the Data Storage Unit (DSU) 2990. Computer compatibility is taken care of when reading the DSU via the DSU Reader 2995. The PDC-4 coded information is then converted to ASCII coded RS-232C signals.

The VR22 and SR10 sensor signals.

The RCM-9 uses sensors with analog output signal of type VR22 and digital output signal of type SR10.[1)] These signal forms allow simple sensor design, offers high accuracy over a wide temperature range at low power consumption, and permits analog and digital sensors to be interchanged.

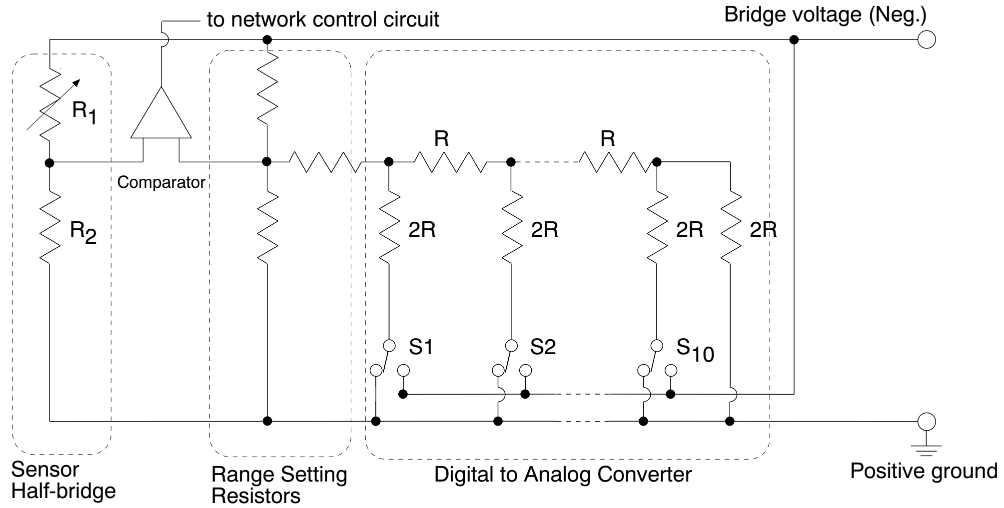


Fig. 2. 01 VR22/SR10 Measuring Circuit

When reading an analog VR22 signal, the sensor acts as the left half of a Wheatstone measuring bridge, and an R-2R network inside the electronic board as the other half of the bridge (see figure 2.01). The bridge is balanced successively in 10 binary steps by setting the switches $S_1, S_2 ... S_{10}$.

[1)] Except for the temperature sensor and the conductivity cell where the ranges are selectable.

This cycle forms a 10 bit binary word that represents the ratio between the resistors in the half bridge of the sensor.

By equipping the sensor bridge with one resistor that varies with the parameter that needs to be measured i.e temperature, a simple sensor is made. Since such sensing resistors usually has a relatively small change of resistance in the measuring range, the output range of VR22 sensors are set to be 1/22'nd of the applied Bridge Voltage varying ±1/44'th around the middle.

The Bridge Voltage is applied as a pulse for each step in the approximation cycle. By using these pulses to clock out the content of a ten bit shift register, a ten bit digital word can be read on the same input as for the VR22 signal. This means that a sensor with the digital output called SR10 and sensors with analog VR22 output can be connected to the same input channel without any reconfiguration of the electronic board.

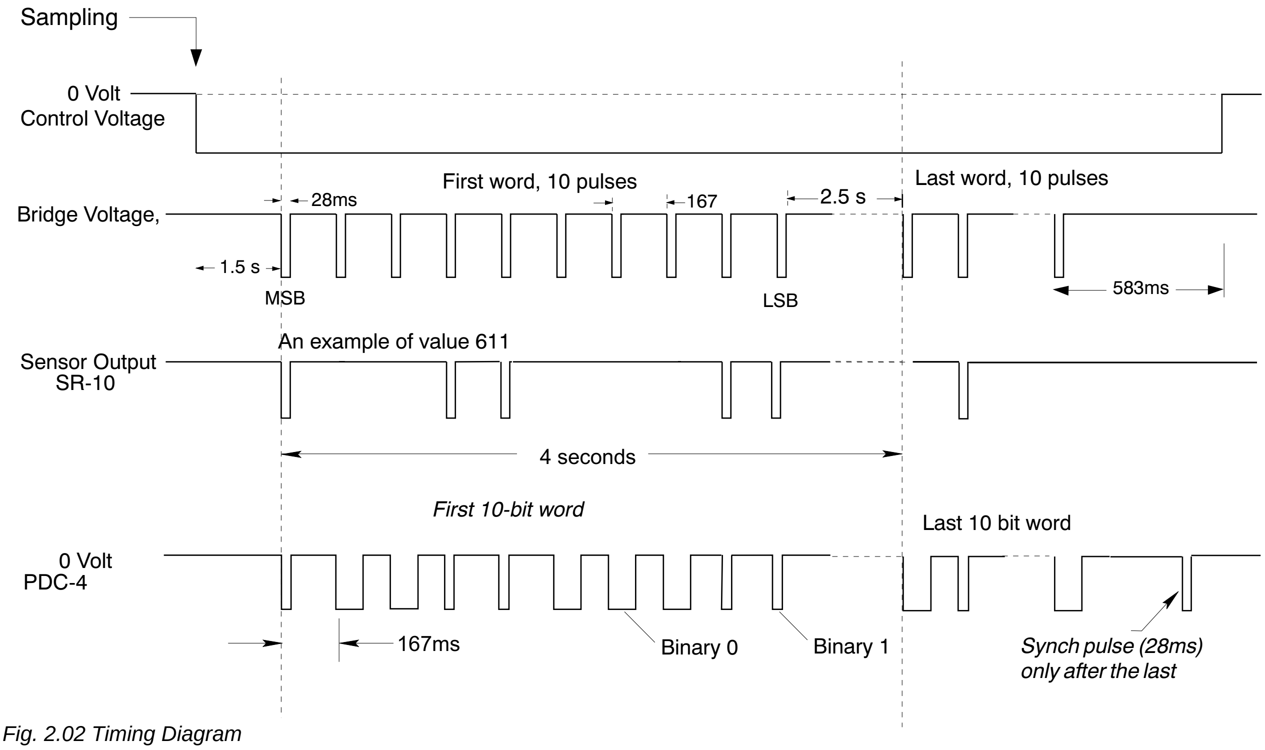


Fig. 2.02 Timing Diagram

By reading all input channels sequentially the sensor signals can be multiplexed and read by the same input circuit, see figure (functional diagram). The Bridge Voltage is applied to all sensors in a sequence of ten pulses. This sequence takes 4 seconds and is repeated for each input channel to be read. The reading cycle is initiated by a Control Voltage, which is used for activation of the output of digital sensors and is on during the whole reading cycle, see fig.2.02.

Electronic board.

The Electronic Board 3623 shown in figure 7.07 contains the main electronic circuitry of the instrument. It comprises a printed circuit board with screw terminals, 4 receptacles for sensor connection, temperature and conductivity range selectors and two control switches all embedded in a polyurethane casting. This design makes the component a solid board which will not be affected by a harsh environment. The electrical functions of the board can be divided into seven main functions or circuits:

1. Voltage regulator and bridge voltage generator.
2. Multiplexer and sensor input circuits.
3. Comparator and bridge balancing circuits.
4. Control circuits and micro-processor.
5. Circuits for output pulses and remote start.
6. Acoustic Oscillator.
7. Quartz Clock.

The voltage regulators and bridge voltage generator provide all required operating voltages. Ten –5 volt pulses of 28 milliseconds duration are generated for each of the sensor channels and supplied to all channels simultaneously.

The multiplexer switches each of the sensor channels to the comparator and bridge balancing circuit. The micro-processor and control circuit initiate and control the various operations of the board.

The output signal circuit generates the PDC-4 coded output pulses as described on page 2-12. It also initiates triggering of the instrument when a positive pulse of 5 to 8 volts is applied to the output terminal. The pulse should be 50 milliseconds or more.

The modulator circuit for the acoustic transducer converts the PDC-4 code to a frequency shift signal. The short PDC-4 pulses (ones) are converted to 83ms pulses of 16.384 KHz and the long pulses to 15.7 KHz.

The quartz clock triggers the instrument at preset intervals. The intervals can be set to 1, 2, 5, 10, 20, 30, 60 or 120 minutes by a rotary switch embedded in the board. The switch also has a position for “Non Stop” (Continuous) operation and a position for “R” (Remote start only). The remote start feature is useful during calibration or checking of the instrument as it will respond only to the remote start signal.

For other time intervals remote triggering will only be executed if there is enough time to perform a measuring cycle before the instrument is triggered by the clock. A complete measurement cycle of 8 channels takes 4X8 seconds plus 2s = 34 seconds.

When either the internal interval clock or the external signal have triggered the instrument, the Electronic Board will initiate the sensor reading by turning on the Control voltage to all sensors. After a 1.5 seconds the first 10 Bridge Voltage pulses is send out and the first sensor channel is read (Reference reading). The reading is converted to PDC4 and stored in the Data Storing Unit. The Electronic Board then continues in the same manner until the selected number of channel is read.

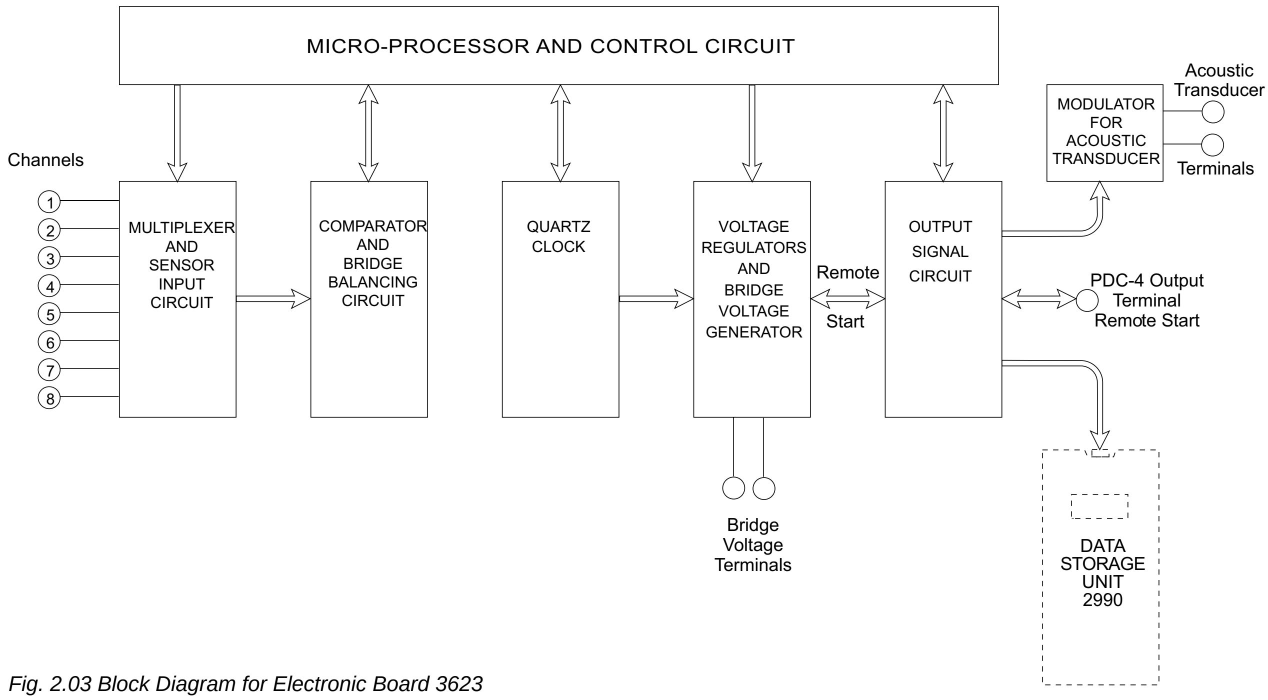


Fig. 2.03 Block Diagram for Electronic Board 3623

After finishing the reading cycle the Control Voltage and most off the Electronic Board is turned off, awaiting for a new triggering.

The Electronic Board controls the ping rate of the Doppler Current Sensor. The instrument can either operate with distributed pinging, i,e, with 600 pings (150 pings/transducer) distributed over the entire measuring interval.

A small temperature range selector switch is embedded in the board. Four ranges can be selected; Arctic, Low, High, or Wide range. See specifications on page 1-04 for actual ranges in degrees Centigrade.

A similar switch for selecting the conductivity ranges is also embedded in the board. Two standard ranges are available, 0-74 mS, 24-38 mS, and an optional 0-2 mS plus a fourth position for a customer specified range.

The instruments ON/OFF switch is a part of the channel selector switch. In addition to the Off position one can select between 4, 5, 6, 7 and 8 channels. The instrument operates normally with 7 channels (reference and 6 parameters). but has an additional channel for an optional sensor.

Data Storage Unit.

The Data Storage Unit (DSU), figure 7.08 is in the form of a solid board molded in low density polyurethane. It contains a set of EEPROMs for storage of data. On its top there is a 6-pin receptacle for the input/output of data. A 5-digit liquid crystal display indicates the total number of data words stored. When reading the data, the display number is counted down, and the display will therefore always show the number of words left to be read.

The DSU is furnished with a built-in, presetable, real-time quartz clock enabling time information to be recorded. Within a temperature range of –10 to + 45° the accuracy of the clock is ± 2 s/day. A time record consists of six 10-bit words. The first is a fixed binary reading equal to 7, followed by 5 words indicating year, month, day, hour and minute. Time information is recorded for the first measurement taken, and subsequently every day (24 hours) at the time of the first measurement after midnight. The clock features automatic leap year compensation.

The DSU exists as two models, the model DSU 2990 storing 65500 ten bit data words and the DSU 2990E model storing 262000 data words. The input port will be blocked when full, disallowing further storage of data.

When the instrument is turned ON the DSU is powered by the instrument's battery. When disconnected a built-in battery (Lithium AA cell, 3.4 volts, 1.9 Ah)will provide power for the display and the clock. The power consumption is 30µA, and the battery lasts at least 7 years. For reading of stored data, setting the real-time clock and erasing data from the DSU, refer to page 4.01.

The RCM Doppler Current Sensor 3920

This disk-shaped sensor with 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 86 mm high sensor outlet. Four piezoceramic acoustic transducers are placed 90° apart around the circumference of the sensor body which is molded in a polyurethane material.

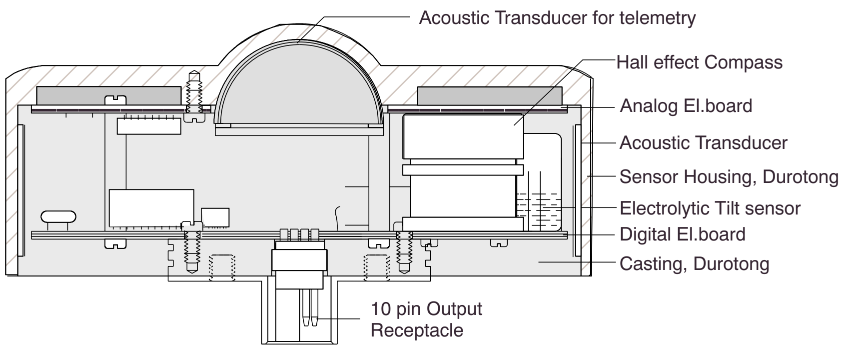


Fig. 2.04 RCM Doppler Current Sensor 3920

The sensor utilizes the well known Doppler Shift principle as the basis for its measurements. The sensor transmits 600 acoustic pulses (pings) of 2MHz into the water in sequence in every measurement interval. As the sound propagates, a portion of the energy is reflected by small particles or air bubbles in the water. The back-scattered energy from the area 0.4 to 2.2 meters from the sensor is picked up by the transducers and analyzed to find any change in frequency. Even though the measuring window of the DCS is at a distance from the sensor itself, the current in

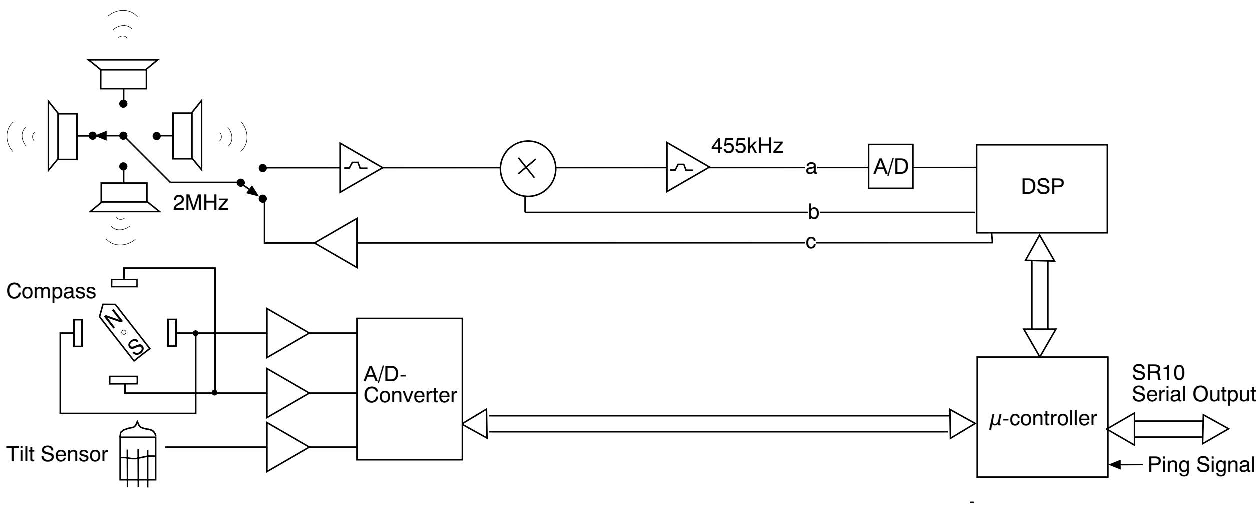


Fig.2.05 Functional Diagram, RCM Doppler Current Sensor 3920

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.

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 micro-processor 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. **A Test Unit 3731 is available for testing the function of the Doppler Current Sensor 3920.**

Temperature sensor 3621.

The temperature sensing thermistor is housed in a stainless steel stud, figure 7.09, fitted to the top end plate by a 16mm stem and extends into the water. The thermistor, Fenwall GB 32JM19, is molded into the stud with polyurethane. The time constant for the temperature to reach 63% of a step change in temperature is about 12 seconds. Together with a set of resistors the thermistor forms a half-bridge. The output voltage does not cover full range, therefore range reducing resistors are used. The values of these resistors vary with the temperature range chosen by the temperature range selector switch located on the main electronic board.

Four ranges are available; High, Low, Wide and Arctic temp. range.

The instrument raw data reading N is a function of the thermistor resistance R_T as well as the range reducing resistors R_1 and R_2.

Temp. Range	R_T Ω at given temp.	R_1 Ω	R_2 Ω
Wide	5788(-0.34°C), 1523(32.17°C)	5050	2180
Low	6090(-1.46°C), 2298(21.48°C)	11400	3350
High	3668(10.08°C), 1320(36.04°C)	11700	2500
Arctic	6140(-1.64°C), 4443(5.62°C)	7320	3380

For Low, High and Wide temperature range:

$$\text{Raw Data (N)} = \left[\frac{R_1 R_2 (R_T + 953 + 40K) + 20K (R_T + 953)(R_1 + 2R_2)}{2R_1 R_2 (R_T + 953 + 30K) + 60K (R_T + 953)(R_1 + R_2)} - \frac{1}{2} \right] \cdot 2 2 \cdot 1024 + 512$$

For Arctic Temperature range:

$$\text{Raw Data (N)} = \left[\frac{R_2 (R_1 + R_T + 953)}{R_1 (R_T + 953) + R_2 (R_1 + R_T + 953)} - \frac{1}{2} \right] \cdot 2 2 \cdot 1024 + 512$$

When Fenwal's data over nominal thermistor resistance versus temperature is inserted in the above formulas, the following tables can be calculated:

HIGH RANGE 9.81 to + 36.66°C.

Temp.°C	9.81	10	11	12	13	14	15	16	17	18	19	20	21	22
Calculated Reading N	0	8	50	92	134	176	217	259	300	341	381	422	462	501

Temp.°C	23	24	25	26	27	28	29	30	31	32	33	34	35	36.66
Calculated Reading N	540	579	617	655	692	729	765	800	835	870	904	937	970	1023

LOW RANGE - 2.70 to + 21.77°C.

Temp.°C	–2.7	–2	–1	0	1	2	3	4	5	6	7	8	9
Calculated Reading N	0	29	71	114	156	199	241	284	327	370	413	456	499

Temp.°C	10	11	12	13	14	15	16	17	18	19	20	21	21.77
Calculated Reading N	542	584	627	669	711	752	793	834	875	915	954	993	1023

WIDE RANGE -0.64 to + 32.87°C.

Temp.°C	-0.64	0	1	2	3	4	5	6	7	8	9	10	11	12
Calculated Reading N	0	19	48	78	108	139	170	201	232	263	294	326	358	390

Temp.°C	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Calculated Reading N	421	453	485	517	548	580	611	643	674	705	735	766	796	826

Temp.°C	27	28	29	30	31	32	32.87
Calculated Reading N	856	885	914	943	971	999	1023

As readings will be integer numbers, the actual reading will be the nearest integer. For special application in arctic cold water a high resolution temperature range, –3.01°C to + 5.92°C gives a resolution of 0.008°C.

ARCTIC RANGE –3.01 to + 5.92°C

Temp.°C	–3	–2.5	–2.0	–1.5	–1.0	–0.5	0.0	0.5	1.0	1.5	2.0	2.5	3.0
Calculated Reading N	1	57	113	169	226	282	339	396	454	511	568	626	684

Temp.°C	3.5	4.0	4.5	5.0	5.5	5.9
Calculated Reading N	742	800	858	916	974	1020

The Isocurve thermistors are equal to within ± 0.1°C and the following nominal formulas for the different ranges are calculated and are accurate to ± 0.15°C:

High: $T = 9.811 + 2.390E\text{-}2 \times N - 5.941E\text{-}7 \times N^2 + 2.820E\text{-}9 \times N^3$

Low: $T = -2.705 + 2.406E\text{-}2 \times N - 2.238E\text{-}6 \times N^2 + 2.056E\text{-}9 \times N^3$

Wide: $T = -6.386E\text{-}1 + 3.417E\text{-}2 \times N - 6.292E\text{-}6 \times N^2 + 4.800E\text{-}9 \times N^3$

Arctic: $T = -3.007 + 8.969E\text{-}3 \times N - 3.476E\text{-}7 \times N^2 + 1.134E\text{-}10 \times N^3$

A formula derived from the calibration of the instrument prior to shipment will accompany the instrument. The accuracy of the calibration formula is 0.05°C.

Conductivity Cell 3619.

This sensor measures the conductivity in the water by use of an inductive cell made of two toroids, see figure 2.06 and 7.09. 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 required in the compensating winding is a measure of the conductivity of the water. The pick-up winding is used to set a reference voltage for the Digital to Analog Converter (DAC), see figure 2.07.

The conductivity cell and the electronics are molded in a polyurethane material. In order to obtain a stable volume of the sea water loop, a glass tube is installed in the bore hole of the cell.

The conductivity cell is balanced by successive approximation in 10 binary steps. The microprocessor turns on a bridge voltage supply to all parts for each step. The output is zero when the transmission through the compensating loop is equal to the sea-loop transmission. The output is positive when the sea-loop transmission is higher and negative when the sea-loop is lower than the transmission in the compensating loop.

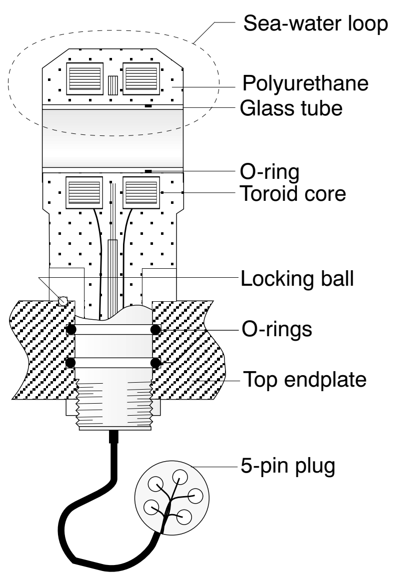


Fig.2.06 Conductivity Cell 3619

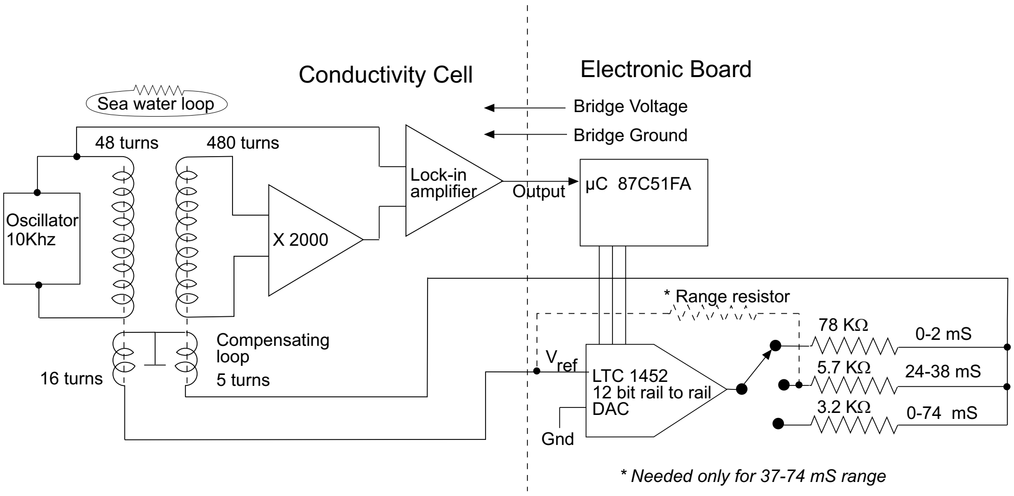


Fig. 2.07 Conductivity Cell, Block diagram

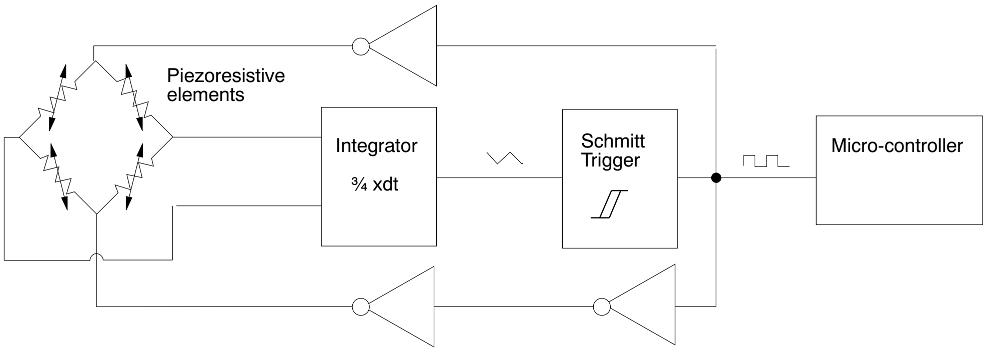
The calibration of the cell may be affected by the geometry of the cell's surroundings, and must therefore be done with the cell installed on an instrument. Small scars in the epoxy coating of parts near the cell may also affect the calibration. Therefore, such scars should be repaired by using a repair lacquer. A tin can with 50 grams of repair lacquer, part no 2579 is available. When the cell is removed, seal the installation bore by Sealing Plug 3625.

The RCM 9 Mk II has three conductivity ranges which can be set by a rotary switch. The ranges are; 0-74 mS/cm, 24-38 mS/cm. The range 0-2 mS/cm and a customer specified range are optional.

For correct installation, the flange of the cell is furnished with a cavity and a nylon ball that must fit in a corresponding cavity in the top end-plate.

Pressure sensor 3815.

The sensing element in the Pressure Sensor 3815 is the STS Sensor Technik Sirnach, Type TD15 sensor. The sensor is shaped as a small cylinder, moulded in polyurethane and fastened to the RCM 9 Mk II top end plate by a 16mm stud penetrating the top end-plate. The sensor is connected to the electronic board by a 5 pin plug. To prevent internal corrosion, the sensor tube is



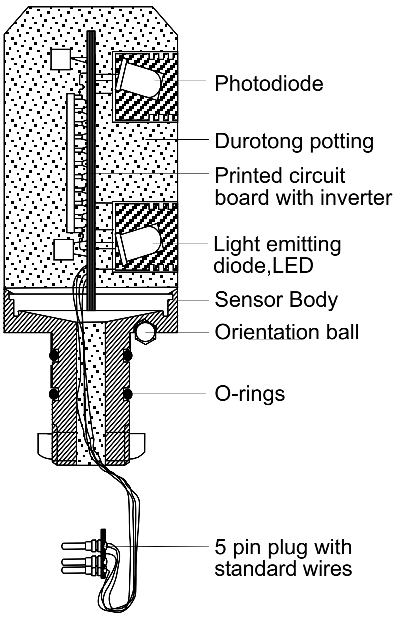
filled with silicone oil. Available ranges are 0-700 kPa, 0-3500 kPa, 0-7000kPa and 0-20 MPa.

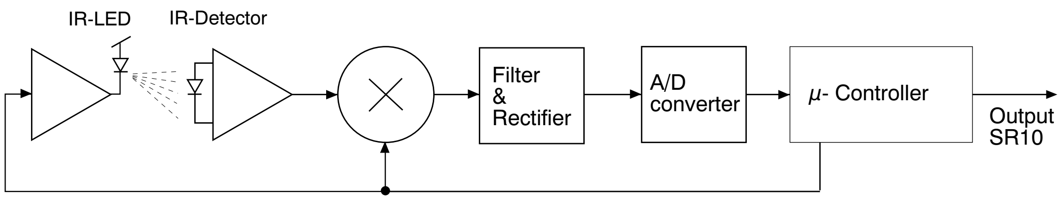
The sensor measures the absolute pressure by means of the piezoresistive bridge. The output voltage from the bridge is amplified to give a VR 22 output signal.

During calibration, different pressures are applied to the sensor at different temperatures. Coefficients for linearization and temperature compensation are calculated from these measurements and stored inside the sensor in an EEPROM circuit. The sensor measures pressure and temperature and uses the coefficients to give linearized and temperature compensated output.
If the sensor is removed, a 16mm sealing plug, part no. 3625 must be installed.

Turbidity Sensor 3612 (Depth Capacity: 2000m)

This sensor measures the turbidity of the water by use of back-scattered infra-red 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. Two light emitting diodes and one photo diode are pointing towards 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. A micro-controller generates 2kHz pulses which are amplified and fed to infra-red diodes sending light into the water. Scattered light from particles in the water are picked up by the IR detector. Signals from the detector are amplified and compared with a reference signal. Signals which have the same frequency are fed into a filter and rectifier. The DC signal from the rectifier is further converted to a digital signal which are connected to a micro-controller that gives an SR10 output signal. The sensor is shaped as a small cylinder molded in polyurethane material.It is also furnished with a 16mm stud for fastening the sensor to the top end-plate. The sensor plugs directly to the electronic board inside the instrument by a 5 pin plug. See also fig.7.09.
If the sensor is removed, a 16mm sealing plug, part no. 3625 must be installed.





Oxygen Sensor 3675 (Depth capacity: 2000m)

The oxygen sensor measures the dissolved oxygen in the water. The sensor is based upon a specially made oxygen probe from Oxyquard and it is adapted to the instrument by an RS 232 converter. 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 ±0.8mg/l. The output from the sensor is an SR 10 signal.

The oxygen probe has a pressure equalizing port between the electrolyte chamber and the outside of the probe. The port is located in an o-ring groove between the sensor base and the probe. To avoid leakage of the electrolyte during transportation an o-ring is placed in the groove to seal the port. Before use the o-ring must be removed to a ”parking slot” just above the groove.

The probe is compensated for changes in the oxygen permeability at different temperatures in such way that the output is correct for the oxygen partial pressure within the range of the probe.

Figure 2.08 shows the above mentioned o-ring groove and the ”parking slot” for the o-ring. The normal operating time for the probe between service is one to five years.

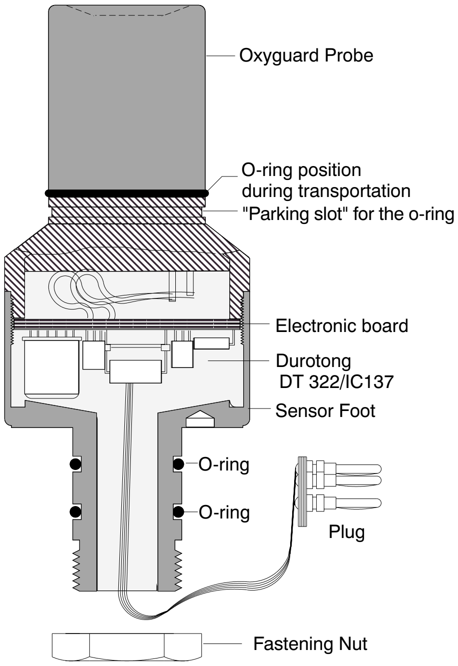


Fig. 2.08 Oxygen Sensor

Typically signs that will call for service are:

- The output is unstable, i.e. caused by punctured membrane in the probe.
- Corroded anode, also caused by puncture membrane.

If this occur, the sensor should be sent to factory for service.

If the sensor is removed, a 16mm sealing plug, part no. 3625 must be installed.

Pressure case.

The pressure case shown in figure 7.10 consists of an OSNISIL copper alloy tube (95% Cu, 3.5% Ni and 0.9% Si). The lower end plate, made of non-magnetic acid proof stainless steel (57.2% Fe, 17.5% Cr, 12.5% Ni, 2.7% Mo and maximum 0.06% C) is furnished with an O-ring and press fitted to the pressure tube. The lower end of the pressure case is fitted with a rubber base. At the top end of the pressure tube there is machined a circular groove into which the clamps grip, thus holding the top-end plate seated in the pressure case.

The pressure case and all external metal parts of this instrument are furnished with an olive green epoxy coating applied by an electrostatic powder process. This coating performs well in sea-water and will protect the covered parts from corrosion. However, the O-ring seats are not epoxy coated but nickel-plated. The corrosion of these surfaces is inhibited by the use of a sacrificial zinc anode fitted to the top end plate.

Top end plate.

The top end plate, made of the same non-magnetic acid proof steel alloy as the bottom end plate, is seen in figure 7.05. All external and internal parts of the instrument are fastened to the top end plate, so that the instrument can be removed from the pressure case as one unit. The sealing between the top end-plate and the pressure tube is obtained by an O-ring as seen in figure 7.10. All top end plates are bored to accommodate an optional sensor. When a sensor is not installed, the 16 mm sealing plug 3625 must be installed instead. The electrical terminal, part number 3622 is fitted to the top end plate and mates with plug 2828Ti.

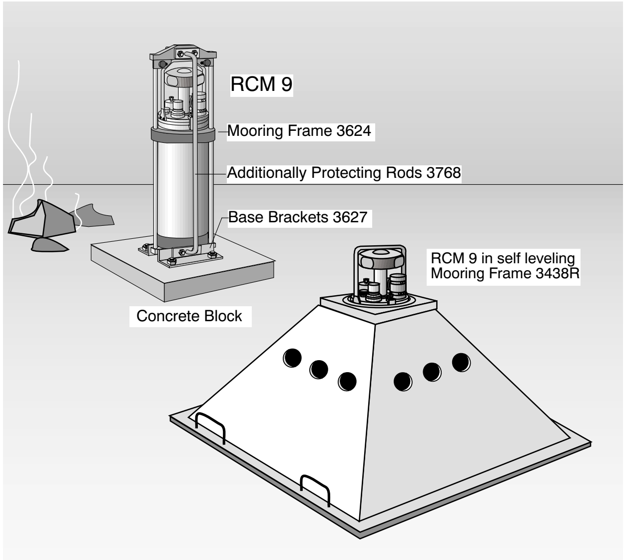


Fig.2.09 Seabed Installation of the RCM 9 Mk II

Mooring Frame

The Mooring Frame 3624, shown in figure 7.12, facilitates easy installation and removal of the instrument without disassembly of the mooring line. The mooring frame is fastened to the mooring line by means of two shackles. The instrument is hold in place by two knobs which are easily removed, even under water. The frame is made of stainless steel and has a breaking load of more than 8000 kilograms. Two additional protecting rods, to protect the instrument further, are also available. These rods are installed 90° on the frame after the instrument has been fastened to the frame.

The mooring frame is also conveniently used when measurements on the seabed is required. For this application, the frame is furnished with two base brackets and placed on a concrete block or similar. A self-leveling Mooring Frame 3438R is also available. See illustration figure 2.09.

Alkaline Battery

The RCM 9 Mk II uses a special Alkaline Battery, part number 3614, which is designed and assembled by Aanderaa Instruments. It consists of 6 ea 1.5V D-cell alkaline batteries molded into a block of polyurethane foam. It measures 37x106x130mm and it is equipped with standard PP9 battery type button connectors on the top. The capacity is 15Ah and the voltage is 9V. (nominal capacity 12.5Ah, 220Ω down to 6.0V at 4.0°C)

The use of alkaline battery is chosen because of it´s low self discharge (less than 0.7% a year).

For shorter measurement series an ordinary 9v battery, such as the one used in RCM 7, TR 7 or WLR 7 can also be used. For more information see chapter 3, page 3-03.

Lithium Battery

A heavy duty 7V lithium battery is now available for long deployment applications. The battry consist of 6ea D-cells with a total capacity of 30Ah. The Part number is 3677.

CHAPTER THREE

OPERATING INSTRUCTIONS

Receiving a new instrument and taking it into use.

The instrument is shipped in a plywood box, see figures 7.06. also containing the Mooring frame. The RCM 9 Mk II is equipped with battery when shipped and the DSU clock is set to GMT. The only preparation needed is to check that the recording interval switch is set to the desired interval. Before doing so, check the unit for possible shipping damage.

If everything looks OK, prepared the instrument for deployment as follows:

1) Remove the two C-clamps at the top end-plate and lift the unit out of the pressure case.

2) Set the recording interval switch as required.

3) Check that the temperature and conductivity range selector switches are set to the required ranges.

4) Place the ON/OFF Channel Selector Switch to the number of the highest channel which is connected to a sensor.
   The instrument starts immediately, and the DSU records time information and one mea surement cycle of the selected channels. At the end of the cycle, the DSU display will show 6 words for the time information plus the number for the selected sensor channels).
   The clock in the DSU is set to GMT at the factory.

5) Slide the instrument down into the pressure case. Ensure that the O-ring is correctly seated in its groove in the top end- plate. Tighten the C-clamps until the top end-plate rests against the edge of the pressure case. Do not overtight as this will damage the clamps.

6) Ensure that a protective cap is fitted to the electrical terminal.
   The instrument can now be fastened to the mooring frame.
   If used, fit additional protecting rods and deploy the instrument.

7) When the instrument is used for direct reading or profiling, the stabilizing Frame Vane Plate 3681 should be installed. The Vane is fastened to the Mooring frame 3624.

Retrieval of the instrument and removing the DSU.

When an instrument is retrieved after a period of recording, it should first be rinsed in fresh water and dried. The unit can then be opened. After opening, the following procedure is recommended (read the whole procedure before stopping the instrument):

1) Wait until the instrument starts again and finishes the recording cycle (observe the DSU display).

2) Set the channel selector switch to OFF.

3) Write down the time for the last recording

4) Remove the DSU from the recording unit by releasing the 2 snap-on locks at the lower end of the instrument. Pull the DSU out and press down to release it from the connector on the top. Refer to chapter 4 for reading of the DSU.

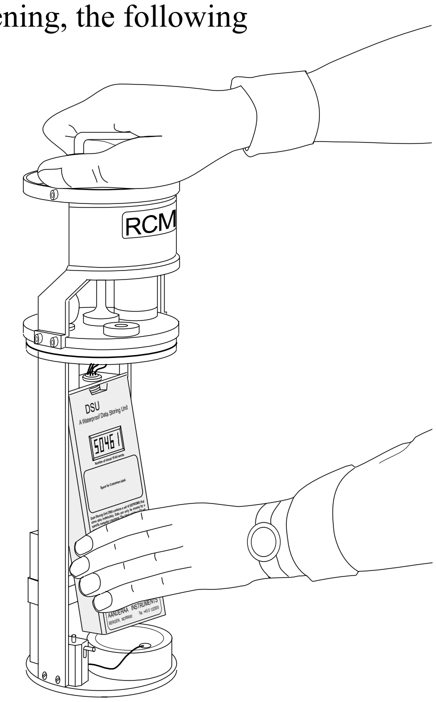


Fig. 3.01 Installation/Removal of DSU

Conductivity Cell test.

Can best be done with the Resistor Set 3742 as a sea-water loop. This set is supplied with the instrument and contains, embedded in a casting, one 50 ohm, one 80 ohm, one 110 ohm and one 2000 ohm resistor which are used for the various ranges. The correct readings of the cell with these 3 loops are shown in the calibration sheet accompany the instrument. For the range 0-74 mS/cm use 50 ohms and 2000 ohms. For the range 24-38 mS/cm use 80 ohms and 110 ohms and for the range 0 – 2 mS/cm, use open loop and 2000 ohms.

Fresh battery.

The correct battery for the RCM 9 Mk II is Alkaline Battery 3614 from Aanderaa. The capacity is 15Ah (nominal capacity 12.5Ah, 220Ω down to 6.0V at 4.0°C) at 9 volts sufficient for 1 year operation at one hour interval or 92 days at ten minutes interval.

The table below will show how many days the RCM 9 Mk II can operate on the 3614 battery and how many records can be stored.

RCM 9 Mk II (7 channels)

Samling	3614 Alkaline Battery (12.5-15Ah)				3677 Battery(30Ah)	
interval	DSU 2990		DSU 2990E		DSU 2990E	
in minutes	Days	Words	Days	Words	Days	Words
1	7	65.500	10	100.866	24	242.070
2	13	65.500	20	100.926	47	237.168
5	33	65.500	48	97.062	115	232.536
10	65	65.500	92	93.294	220	223.086
20	129	65.500	170	86.706	395	201.456
30	192	65.500	235	80.376	540	184.686
60	370	64.386	370	64.386	850	147.906
120	530	47.706	530	47.706	1200	108.006

The half minute measuring interval is continuous operation of 7 channels.

The Data Storage Unit DSU model 2990 can store 65000 words and the 2990E model can store 262000 words. To get full credit for the battery capacity we recommend the 2990E model for use in the RCM 9 Mk II.

For extra long deployment periode we recommend our new Lithium Battery part no. 3677 which has 30Ah capacity.

When installing a battery always check that battery terminals are well seated and give good contact.

CHAPTER FOUR

READING OF DSU AND DATA PROCESSING

Stored data is read by connecting the Data Storage Unit (DSU) 2990 via a DSU Reader 2995, to the RS-232C port of a computer, see figure 4.01. A suitable program must control the read-out process. The operating manual for the DSU Reader, Technical Description No. 145, provides the user with sufficient information to write his own read-out program.

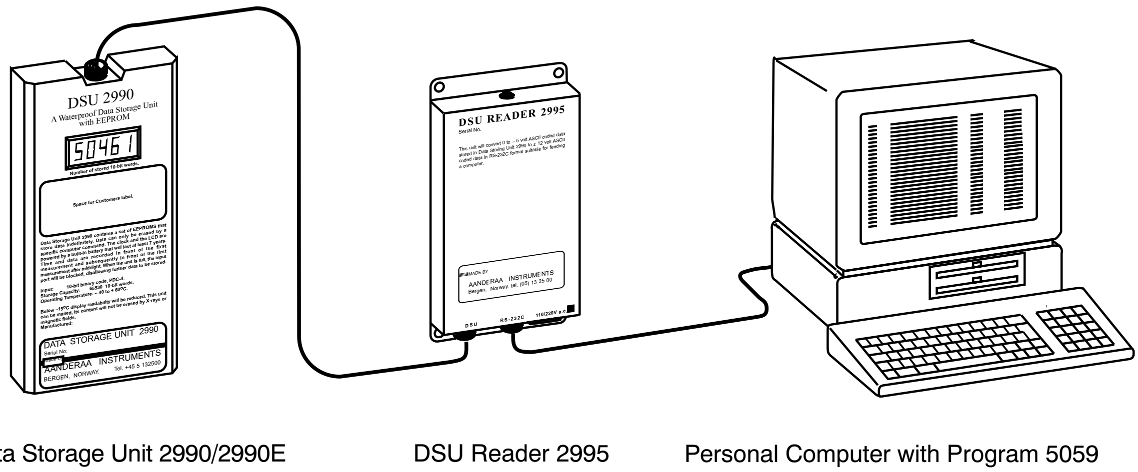


Fig. 4.01 Data Reading

The DSU Reader 2995 converts the 0 to -5V serial signals associated with the DSU to dual-polarity signals in accordance with the RS-232C standard. In addition it supplies the -6V control voltage for powering the DSU during the read-out process. The DSU is connected to the DSU Reader 2995 by a standard Connecting Cable 2842C. A computer interfacing cable, 3016C, with a 6-pin 2828 Plug at one end and a 9-pin D-connector at the other, connects the DSU Reader to the PC’s serial input port.

The DSU will examine bytes received from the computer and execute the command routines. In case of an invalid command, it will return to the stand-by mode. Altogether eleven command codes are valid for communication with the DSU. Beside the commands for controlling the data read-out, which will not erase the stored data, commands are also given for display and setting the real-time clock and for erasing the content of the DSU. With the exception of the ‘ERASE’ commands, all commands are single characters.

Data Reading Program 5059

The Data Reading Program DRP 5059 is a totally new Win32 based program, designed using the most modern software technology presently available. Emphasized has been put on ease of use together with versatile, graphical user interface and system flexibility.

Minimum requirements are:

Pentium 166 Processor (recommended), 16MB RAM for Windows 95 and 98, 32MB RAM for Windows NT, 10MB Hard Disk. It can be used with Windows ©95, build 1111, Windows ©98 and Windows NT™ Sp3. The program replaces the Data Reading Program 4059. The program will not work with Windows 3.1 or 3.11, and customers working in these environments should still use the 4059 program.

It is a component based program, built using a large set of independent binary components that become a part of your operating system instead of building the application into one huge executable file.

As such, each component becomes available to any application that can make use of it.

The advantage of using this technique is that only one copy of the component resides on your

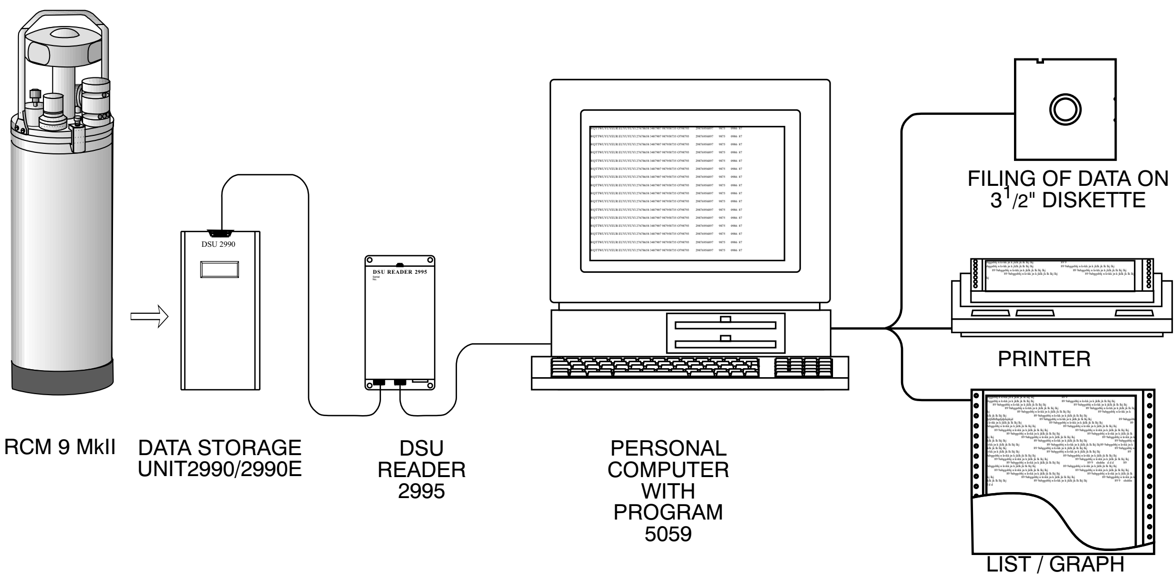


Fig. 4.02 Data Reading System

disk although several applications may use it. This yields less chance for bugs or errors and it improves productivity through reuse of programming effort. An example of such a component is the AAICOMServer used to set up the serial (COM) ports and download the DSU. Used in the Display Program 3710, it has proven its reliability. Perhaps the most important feature is the possibility to design your own custom analysis tool components. The DRP 5059 incorporates a special hook-in mechanism for ActiveX components. The hook-in interface provides your ActiveX component with access to the database and to a window in which you can show the analysis result.

In most cases, you will probably be satisfied with the tools shipped with the program from the factory. These tools comprise graphing features, statistical analysis and signal analysis. Analyze the exported ASCII files from the database in other products such as Microsoft Excel.
The Data Reading Program 5059 is a multi-document application. A document always links to a measurement session. A measurement session usually consists of the data that is stored in a single Data Storage Unit (DSU).
A DSU connects to a document via a COM port. Several documents can open at the same time. Each document uses a separate COM port, so to work with two DSUs at the same time, two COM ports must be available.
The COM port is, however only needed during the actual DSU download (reading) session and not while working with a previously downloaded DSU file or an imported ASCII file.
The Data Reading Program 5059 is a new, multifunction handling and data processing program. It contains:
A Template Library of standard instruments, stations and sensors from Aanderaa Instruments, a Custom Library to store customers' own product specifications and a Tooling section for different data handling functions as well as a faster data transfer mode. Two sample *.dsu files, located in the samples directory, allows for experimenting with the program without having to download a DSU item.
To download a complete version of the Data Reading Program 5059, see our web pages on the internet. The program grants a 30 day trial period during which time all functionality is available.
After the trial period the program reverts into a non- licensed, limited capability version. By purchasing a license key from the manufacturer, or one of our representatives, the full functionality will be retained. The size of this file is 3253KB

CHAPTER FIVE

CALIBRATION

General.

Each RCM 9 Mk II is calibrated at the factory prior to shipment. Normally it does not have to be recalibrated for several years unless changes have been made to the instrument, i.e. replacement of defective sensors or change of sensor range. However, to ensure maximum accuracy, the calibration should be checked once a year.

The calibration procedures described in this chapter are those in use by the manufacturer. During calibration, instruments are connected to a printer through the electrical terminal on the top end plate for direct read-out of the measured parameters.

The relationship between sensor raw data readings (N) and the various quantities in physical units, is given as a power series of third degree. For some users and some applications, a simpler, linear relation would be preferable. The coefficients A, B, C and D of the power series is therefore given in a form that also covers the best linear fit to the sensor characteristic.

$$A + B\,N + C\,N^2 + D\,N^3$$

Current Speed and Direction

The RCM Doppler Current Sensor has no individual calibration. The currents in the two orthogonal directions are given by the doppler shift of the transmitted sound. Since both the transmitted frequency and the measurement of the back-scattered frequency are based on a common crystal oscillator, the correlation between the actual current and the measurements are fixed. According to the formula for the Doppler effect.

$$f_s = 2\,\frac{C_{sea}}{C_{sound}}\,f_T$$

where f_S is reflected sound, f_T is the transmitted sound, C_{sea} is the current speed of the water and C_{sound} is the speed of sound in the water.

During calculation in the RCM Doppler Current Sensor, the speed of sound is set to 1500 m/s. This is correct within ± 2% when the temperature is between + 5 to + 22°C, salinity between 34 to 37 ppt and depth is less than 100 m.

To obtain greater accuracy for wider operating conditions, the current speed can be corrected for variations of the speed of sound by the following formula:

$$C_c = \frac{C_u \cdot C_{sound}}{1500}$$

where C_u is the uncorrected reading, and C_{sound} is the actual speed of sound which is:*

$$C_{sound} = 1449.05+4.57\cdot t-5.21\cdot 10^{-2}.t^2+2.3\cdot 10^{-4}\cdot t^3$$
$$+(1.333-1.26\cdot 10^{-2}\cdot t+9\cdot 10^{-5}\cdot t^2)(S-35)+1.63\cdot 10^{-2}.D+1.8\cdot 10^{-7}\cdot D^2$$

where t = water temperature in Degrees Celsius
S = Salinity in ppt
D = Depth in meters
* Coppen,Journal of the Acoustic Society of America.69,862(1981)

Temperature.

The ISO-curve type thermistor used in this sensor has well defined characteristics where the coefficients C and D in the formula on page 5-01 make no significant difference to the individual sensor. Thus factory calibration of individual sensors is restricted to measurements at two different temperatures from which the values of A and B are calculated.

These measurements are performed with the instruments immersed in a temperature stabilized bath which is stirred to avoid temperature gradients. The temperature is measured by a platinum thermometer (Automatic Systems Laboratories, model F25) which is frequently checked against an Equiphase Cell(Trademark of Trans-sonic, Inc., Burlington, Massachusetts.) establishing the triple point of water (0.0098 °C).

During calibration, the instrument must be allowed sufficient time for proper temperature stabilization. This is indicated by a steady temperature reading for about four or five samples
(2 minute sampling interval).

Conductivity.

The conductivity cell is best calibrated using a sea-water bath of known conductivity.

Calibration at the factory is performed by the use of a reference conductivity cell, which has a measuring range of 15 mS/cm. The reading of this cell is used to calculate the conductivity of the bath (the reference cell is checked once a year against water samples.

A quick check of the cell performance can be done by using a "sea-water loop" through the bore of the cell. "Sea-water loops" of 50 ohms, 80 ohms, 110ohms and 2000 ohms are supplied with the instrument and the readings with these loops in the bore of the cell are given in the calibration sheet accompanying the instrument.

CALCULATING OF SALINITY

The 5059 DSU reader software will calculate the salinity in a seperate virtual channel. The salinity calculations will appear in the engineering units file as a seperate column. The formula used is presented below :

Input parameters

*	CND :	Conductivity	: [mS/cm].	
*	T :	Temperature	: [°C]. (ref. IPTS-68).	
*	P :	Presssure	: [dbar].	

Output parameters

*	Sal :	Salinity	: [PPT]	(ref PSS-78)

Functions

RT35(T)= ((((1.0031E-9)· T-6.9698E-7)· T+1.104259E-4)·T+2.00564E-2)·T+0.6766097

C(P) = (((3.989E-15)·P-6.370E-10)·P+2.070E-5)·P

B(T) = ((4.464E-4)·T+3.426E-2)·T+1

A(T) = – (3.107E-3)·T+0.4215

Formulas

D T = T - 15

$$R = \frac{CND}{42.914mS/cm}$$

R=1 when T=15°C, P=0, Sal=35PPT

(Conversion from conductivity in mS/cm to relative conductivity R)

$$RT = \sqrt{\frac{R}{R_{T35}\cdot\left(1+\frac{C}{A\cdot R+B}\right)}}$$

$$Sal = ((((2.7081\cdot R_T - 7.0261)\cdot R_T+14.0941)\cdot R_T+25.3851)\cdot R_T-0.1692)\cdot R_T+0.0080+$$

$$\left(\frac{\Delta T}{1+0.0162\cdot\Delta T}\right)\cdot(((((0.0636-0.0144\cdot R_T)\cdot R_T- 0.0375)\cdot R_T- 0.0066)\cdot R_T-0.0056)\cdot(R_T+0.0005)$$

REFERENCES :

Also located in Unesco report No. 37 1981 practical salinity scale 1978 : E.L. Lewis IEEE Ocean eng. Jan 1980.

Pressure.

The pressure sensor is a linear sensor. Calibration is performed using deadweight testers covering the range from 0 to 200 kg/cm2. Several readings are taken throughout the range (5-6 points). Two of these are used for the calculation of the coefficients A, B, and C. The other readings serve as check points. The sensor is only accepted if all the readings are within the accuracy limits as compared to the linear characteristics.

Turbidity

Each sensor is calibrated prior to delivery and a calibration sheet Form 501 is enclosed. This calibration is valid for years provided the acrylic material covering the LEDs are kept clean and transparent. If recalibration should be necessary, this must be done at the factory.

During calibration the sensor is submerged in six different formazine solutions with known turbidity and connected to a Sensor Scanning Unit SSU 3010 or a Datalogger. These units gives a raw data reading for each of the six solutions and based on the readings a set of calibration coefficients are calculated. See Calibration Sheet, Form 501 following each sensor.

Oxygen

Each sensor is calibrated prior to delivery and is valid for years unless the membrane in the oxygen probe is punctured or severely fouled. *See page 5-05 for a membrane replacement procedure*. Recalibration should be carried out if the reading in air does not show 100% ±4% (or equivalent raw data reading as given in the sensors Calibration Sheet,Form 533 supplied with the sensor) or when the membrane and electrolyte have been replaced due to damage of the original membrane.

Calibration.

The calibration is done by taking a 100% and a 0% oxygen reading and then calculating the new coefficients.

During calibration, leave the sensor on the instrument, remove the DSU and set the Recording Interval Selector switch to R (Remote start).

1) Connect Deck Unit 3127 to the Electrical Terminal on the top end plate and apply power to the unit. A measurement in the air gives a 100% oxygen reading.
2) Trigger the instrument by turning the selector switch on the Deck Unit to Remote Start and then back to ON.
3) Check the reading on the Deck Unit for the Oxygen Channel(6 or 8) This reading is called N1.

To get a reading with 0% oxygen, turn the instrument up side down and submerge the sensor in a water bath which is saturated with Natrium Sulphite. Use 2 table spoon Anhydrited Natrium Sulphite in each liter of distilled water.

4) Trigger the instrument once more and check the 0% reading, N0

The A and B calibration coefficients are obtained from the following formulas:

$$A = \frac{-N0}{N1 - N0} \qquad B = \frac{1}{N1 - N0}$$

Replace the A and B coefficients on the sensor's Calibration Sheet and in software used to convert raw data to data in engineering units according to formula:

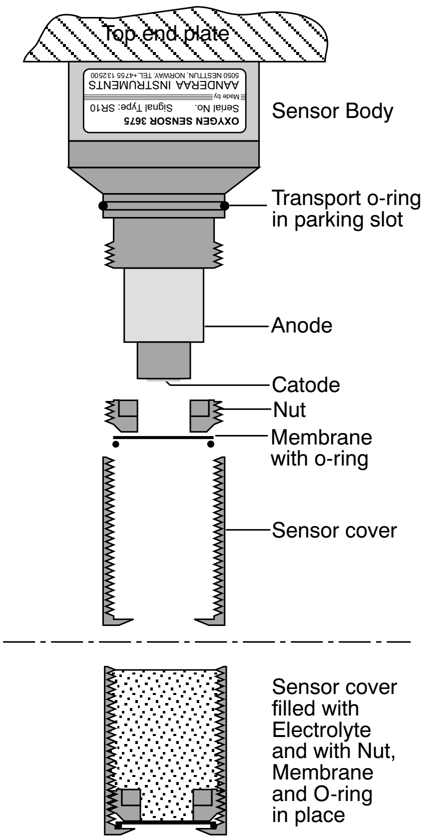
$$\text{Oxygen(mg/l)}=(A + BN + CN^2 + DN^3)\bullet C_{sat}\,(1-1.25E\text{-}04\cdot \text{Depth})$$

where N is the raw data reading, C_{sat} is saturation in the table on page 5-06 and on the Calibration Sheet and Depth is the instrument depth in meters. The coefficients C and D are zero.

°C	0 ppt	10 ppt	20 ppt	30 ppt	40 ppt	°C	0 ppt	10 ppt	20 ppt	30 ppt	40 ppt	°C	0 ppt	10 ppt	20 ppt	30 ppt	40 ppt
0	14.6	13.8	13.0	12.1	11.3	11	11.1	10.5	9.9	9.4	8.8	22	8.8	8.4	8.0	7.6	7.1
1	14.2	13.4	12.6	11.8	11.0	12	10.8	10.3	9.7	9.2	8.6	23	8.7	8.3	7.9	7.4	7.0
2	13.6	13.1	12.3	11.5	10.8	13	10.6	10.1	9.5	9.0	8.5	24	8.5	8.1	7.7	7.3	6.9
3	13.5	12.7	12.0	11.2	10.5	14	10.4	9.9	9.3	8.8	8.3	25	8.4	8.0	7.6	7.2	6.7
4	13.1	12.4	11.7	11.0	10.3	15	10.2	9.7	9.1	8.6	8.1	26	8.2	7.8	7.4	7.0	6.6
5	12.8	12.1	11.4	10.7	10.0	16	10.0	9.5	9.0	8.5	8.0	27	8.1	7.7	7.3	6.9	6.5
6	12.5	11.8	11.1	10.5	9.8	17	9.7	9.3	8.8	8.3	7.8	28	7.9	7.6	7.1	6.8	6.4
7	12.2	11.5	10.9	10.2	9.6	18	9.5	9.1	8.6	8.2	7.7	29	7.8	7.4	7.0	6.6	6.3
8	11.8	11.2	10.6	10.0	9.4	19	9.4	8.8	8.5	8.0	7.6	30	7.6	7.3	6.9	6.5	6.1
9	11.6	11.0	10.4	9.8	9.2	20	9.2	8.7	8.3	7.8	7.4						
10	11.1	10.7	10.1	9.6	9.0	21	9.0	8.6	8.1	7.7	7.3						

Dissolved oxygen (C_{sat}) values (mg/l) in water saturated with air in function of temperature (C°) and salinity (PPT)

To replace the Membrane and electrolyte proceed as follows:



1) With the instrument upside down, check that the trans port o-ring on the oxygen sensor is in its parking slot.
2) Unscrew the top of the sensor, the sensor cover, and throw away the electrolyte.
3) Use a toothbrush or similar and remove loose oxide from the anode.
Warning!
Never use steel or metal brush as this will harm the anode.

4) Use the enclosed special tool to remove the nut holding the membrane and o ring in place. Remove the old o-ring and membrane. Clean and dry the cover and threads thoroughly.
5) Install a new membrane and o-ring and fill the sensor cover with new electrolyte and screw the cover slowly on to the sensor. This will allow air bubbles to escape together with excessive eletrolyte.
6) Recalibrate the sensor as described on page 5-04.

A set of spares, part no. 918017B is deliverd with each sensor. It contains one bottle of Electrolyte, 40ml, five to six membranes, five O-rings and a tool for changing the membrane.

CHAPTER SIX

MAINTENANCE

General.

The RCM 9 Mk II requires a minimum of maintenance. Apart from keeping the outside of the instrument clean, changing pressure case o-ring, zinc anode and corroded parts, only the following yearly maintenance is required:

Yearly maintenance.

1) Refill silicone oil in the pressure sensor by use of a hypodermic syringe. Use silicone oil of 60000 centistoke e.g. Dow Corning Silicone Oil DC200, Aanderaa part no 260017. Take care not to puncture the membrane inside the sensor.

3) Corroded parts should be replaced by new when necessary. Always fill crevices between metal surfaces and threaded screw holes with Tectyl 506 to avoid crevice corrosion.

4) Check or recalibrate according to the recommendations given in chapter five of this manual.

Spare Parts

The manufacturer always keeps a stock of spare parts, accessories and consumable parts for quick delivery. Orders may be placed by telex, telefax, telephone or by mail. See page 7-09 for RCM 9 Mk II spare part list

Replacement of parts.

All parts of the instrument are uniformly made, a feature that allows change of parts without influencing the calibration or performance, e.g. if a failure should occur in the electronic board, a new board can be ordered and installed without any adjustments or re-calibration of the sensors. In the same way, calibration for a sensor is valid regardless of which RCM 9 Mk II it is installed in. This allows for factory supply of calibrated sensors for in-stallation by the customer.

Factory service.

Factory service is offered for maintenance, repair or calibration of instruments or parts. When returning instruments or parts for service, use the "Instrument Service Order" form no 135. Normal turn-around time is three to

four weeks, but on request the service department will make every possible effort to meet customers´ requirements.

Recommended Spare Parts and Accessories.

The following set, part no. 3645 is included with the RCM 9 Mk II when delivered.
The set is packed in a cardboard box and it consists of:

1 ea	2577	Tectyl,506, 5cl
1 ea	2579	Repair lacquer,5cl
1 ea	865000	O-ring, SOR 72
4 ea	862006	O-ring, for 16mm stud.
1 ea	913003	Wrench for C-clamp
1 e	913018	Wrench, 19mm
1 ea	963352	Zinc Anode
4 ea	963024	Zinc Anode, half for Frame
4 ea	642103	Umbraco screw, M5x16
2 ea	660003	Cotter pin
4ea	680037	Panduit locking strap
1 ea	963346	Sealing plug, 16mm
1 ea	642122	Umbraco screw, M4x25mm
1 ea	913022	Allen key for 4mm Umbraco screw
4 ea	750015	Steel ball, positioning tenon for sensors
1 ea	863013	O-ring, RM 0216-24
1 ea	912002A	Allen key, for 5mm Umbraco Screw
1 ea	963360	Nut, M16 x 1

The Oxygen Sensor 3675 is optional and when delivered: 1 ea Spare Part Set 918017B

Maintenance Kit for RCM9/11

This kit, part no. 3813, can be ordered from the factory and consists of the following parts:

1 ea	1141021	Jiffy envelope Type D, Self sealing
0.4kg	1260087	Kluber,Syntheso Grease.
4 ea	1642103	Unbraco screw, M5 x 16
1 ea	1642122	Unbraco screw, M4 x 25mm
2 ea	1660003	Cotter pin Ø5 x 32mm
4 ea	1680037	Panduit locking strap
1 ea	1865000	O-Ring, SOR 72
1 ea	1865001	O-Ring,SOR 71
4 ea	1963024	Zinc Anode(Half) for Frame
1 ea	3963352	Zinc Anode,Mod-9/11.
1 ea	3963384	Pressure Inlet.

CHAPTER SEVEN

Pictures

Illustrations

PICTURES

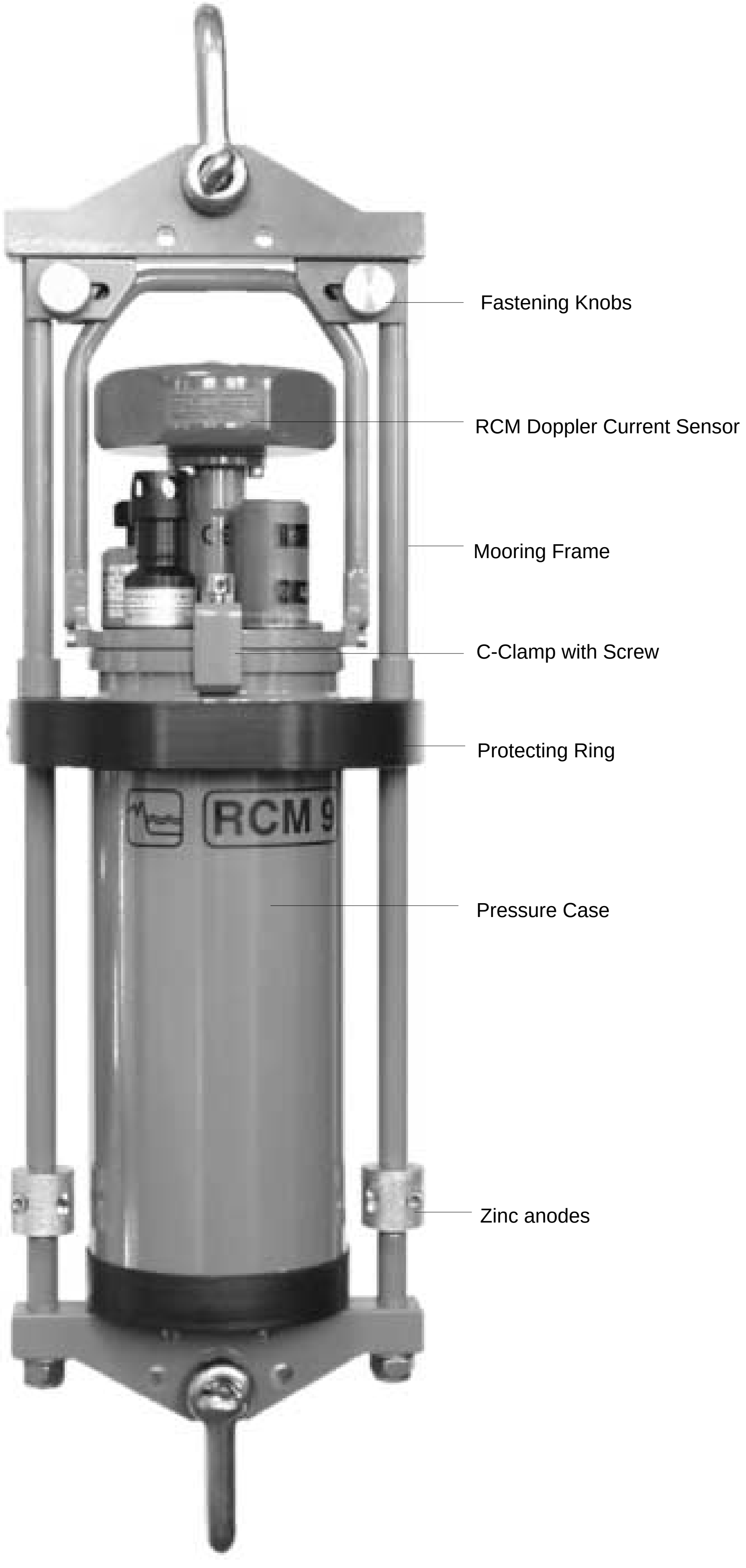


Fig.7.01 Recording Current Meter RCM 9 Mk II, in Mooring frame

Fig. 7.02   The RCM 9 Mk II

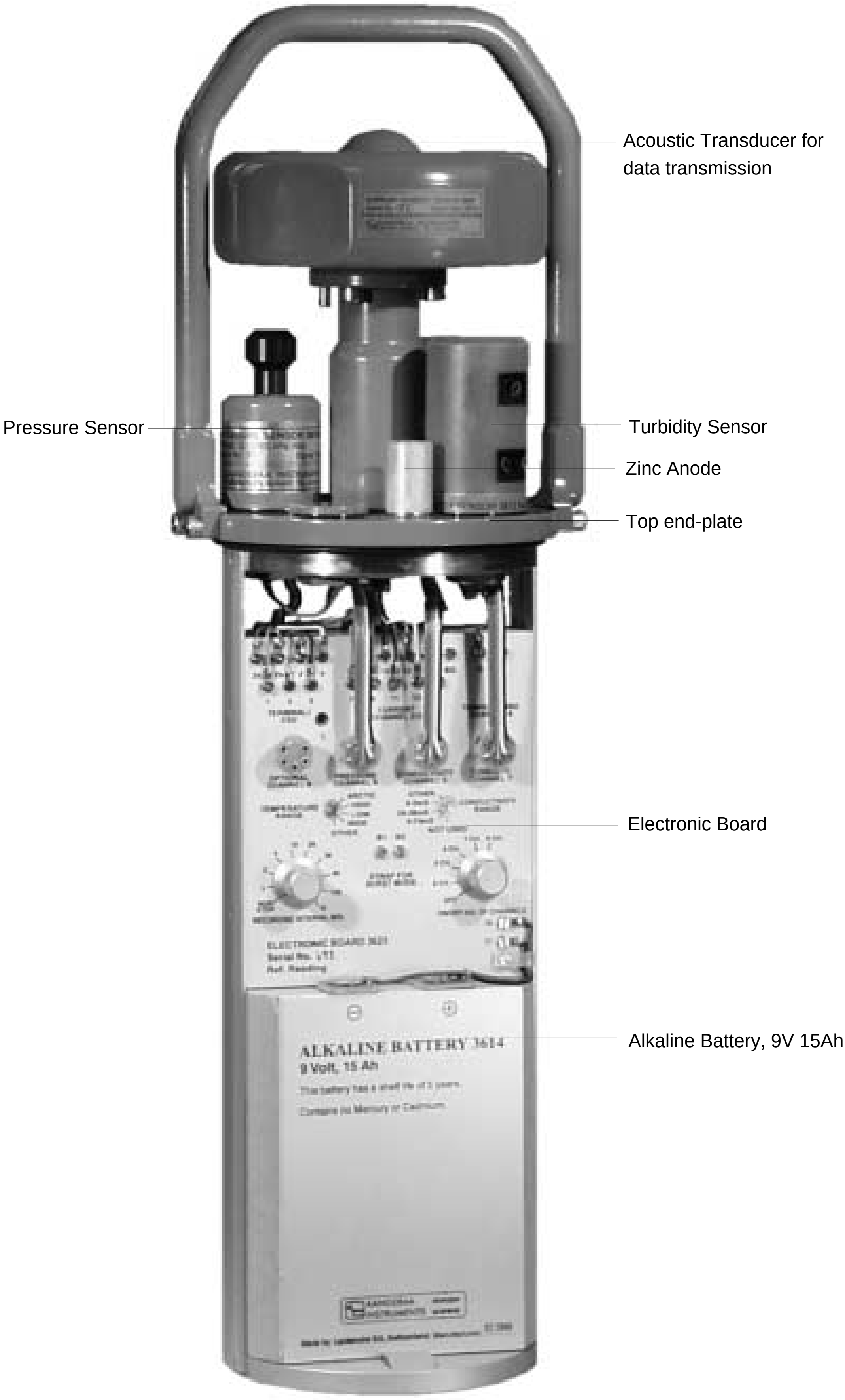


Fig. 7.03 Internal view, Electronic Board Side

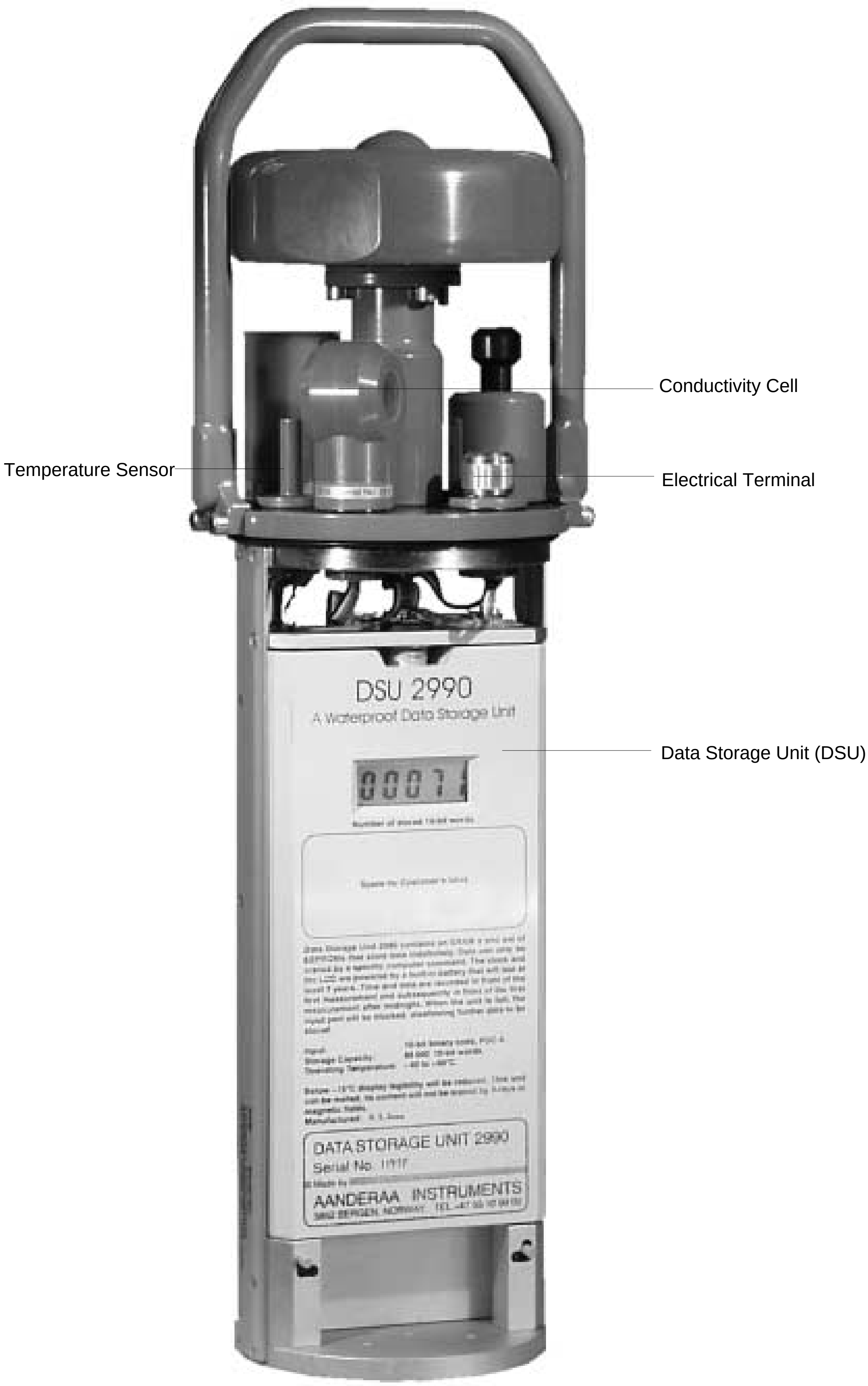


Fig. 7.04 Internal view, Data Storage Unit (DSU) side

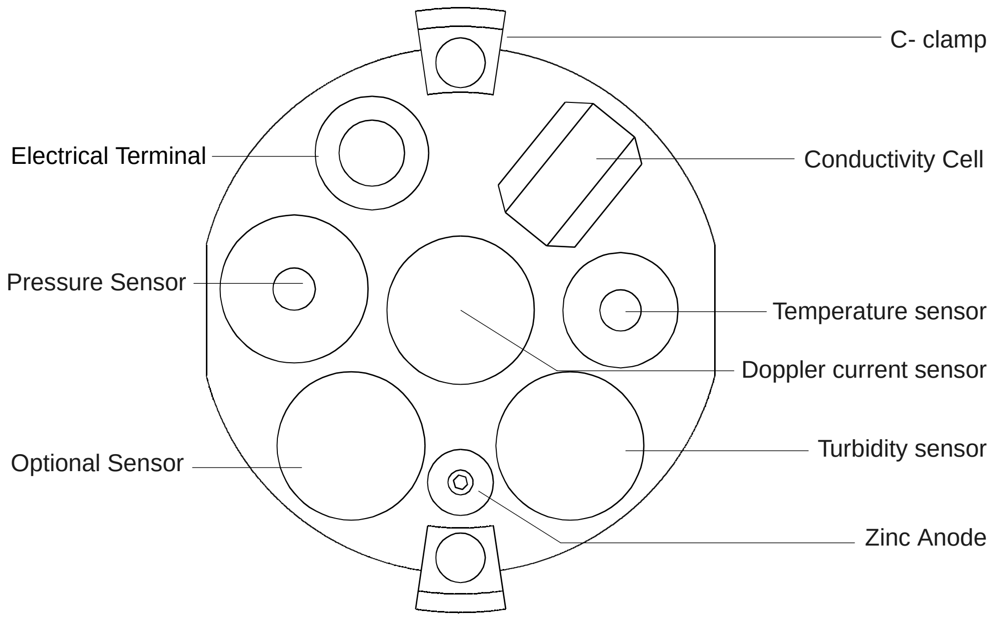


Fig. 7.05 Top End-plate, seen from above. Location of sensors, etc.

Fig. 7.06 RCM 9 Mk II as shipped

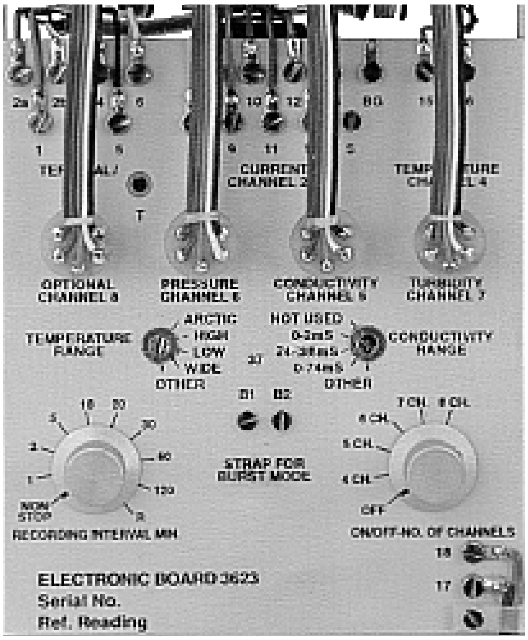


FIG. 7.07Electronic Board 3623

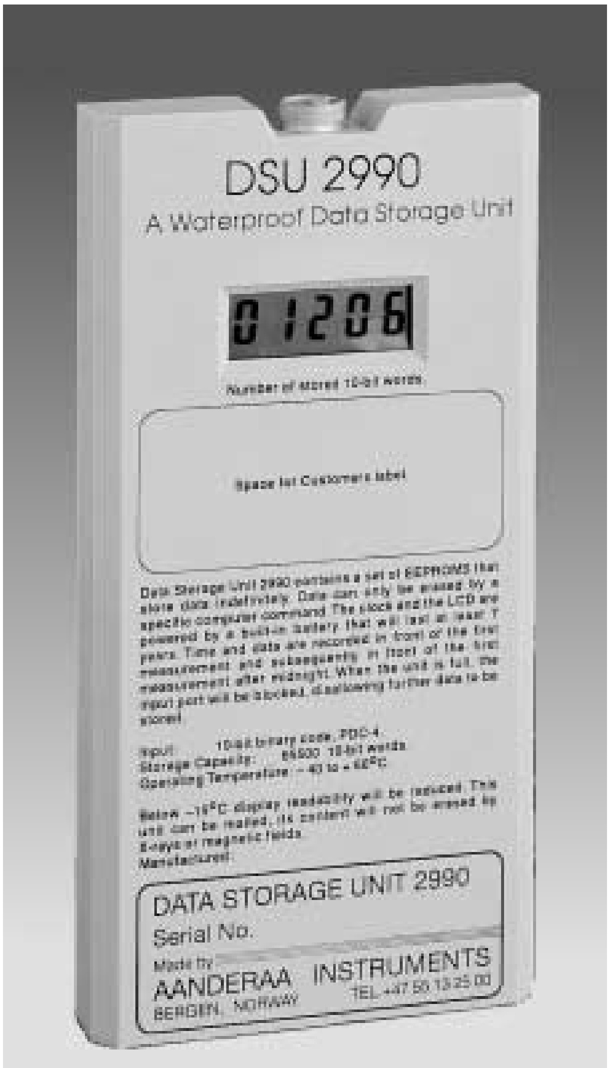


FIG. 7.08 Data Storage Unit (DSU) 2990

RCM Doppler Current Sensor 3920

Pressure Sensor 3815

Conductivity Cell 3619

Turbidity Sensor 3612

Temperature Sensor 3621

Oxygen Sensor 3675

Fig. 7.09 Sensors

ILLUSTRATIONS

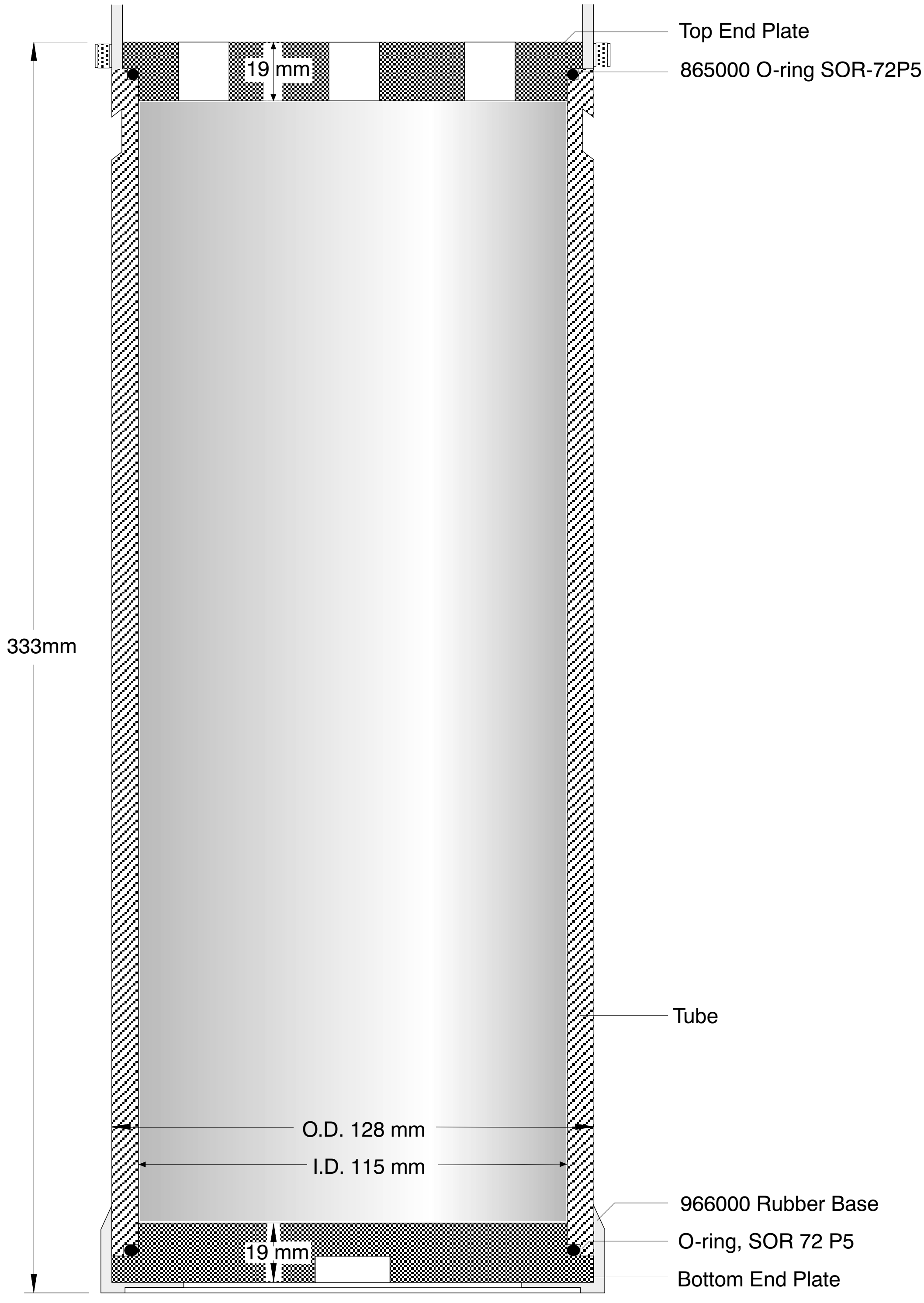
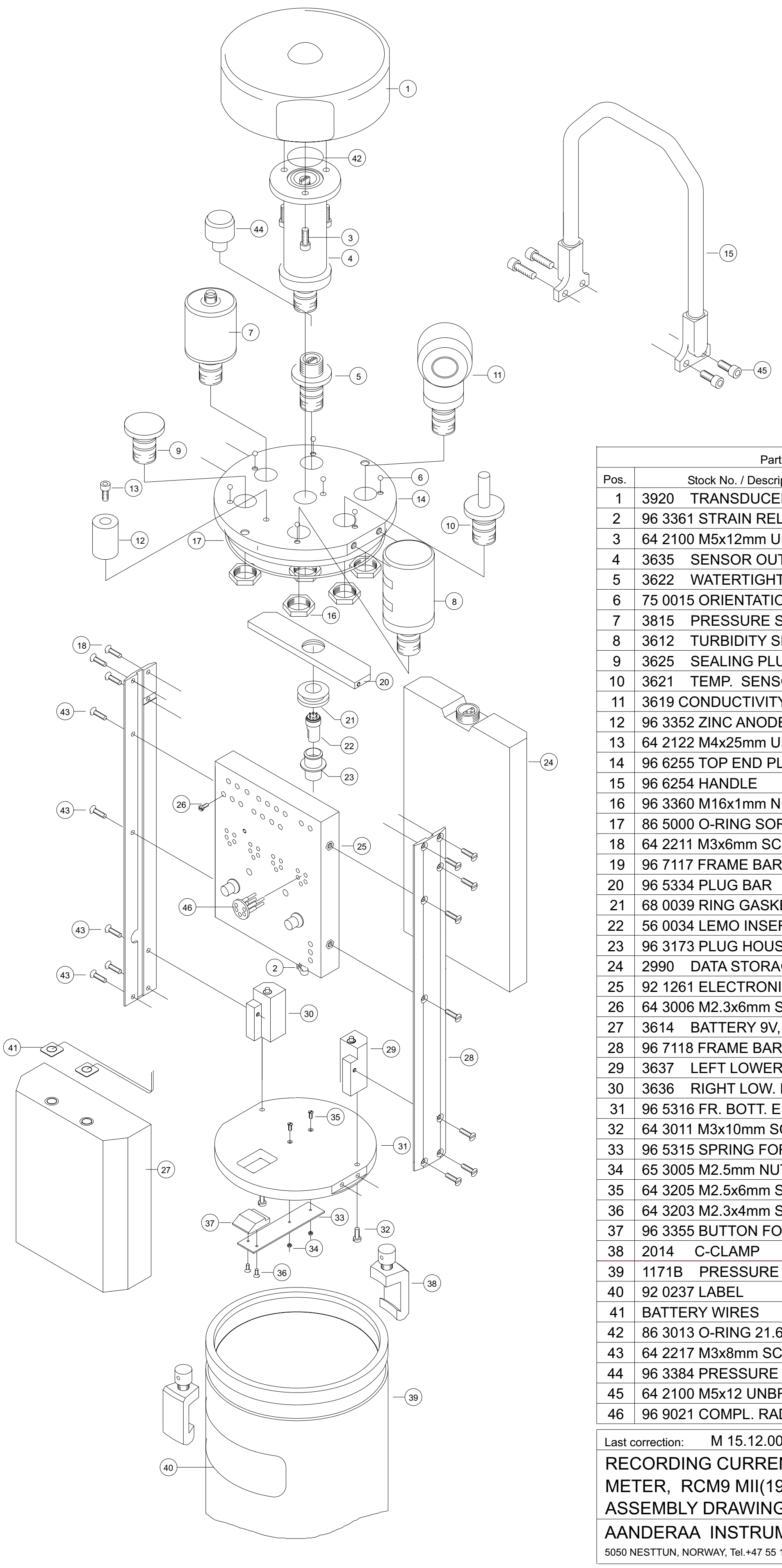


Fig. 7.10 Pressure case with top end-plate



Part-List			
Pos.	Stock No. / Description	Dwg. No.	Qty.
1	3920 TRANSDUCER HEAD	V-7590	1
2	96 3361 STRAIN RELIEVER	V-7602	1
3	64 2100 M5x12mm UNBRACO		3
4	3635 SENSOR OUTLET	V-7591	1
5	3622 WATERTIGHT RECEPT.	V-5591	1
6	75 0015 ORIENTATION BALL		7
7	3815 PRESSURE SENSOR	V-7655	-
8	3612 TURBIDITY SENSOR	V-7593	-
9	3625 SEALING PLUG	V-7572	3
10	3621 TEMP. SENSOR	V-7571	1
11	3619 CONDUCTIVITY CELL	V-7665	-
12	96 3352 ZINC ANODE	V-7550	1
13	64 2122 M4x25mm UNBRACO		1
14	96 6255 TOP END PLATE	V-3903	1
15	96 6254 HANDLE	V-7528	1
16	96 3360 M16x1mm NUT	V-7668	-
17	86 5000 O-RING SOR72		1
18	64 2211 M3x6mm SCREWDIN963		4
19	96 7117 FRAME BAR I	V-7829	1
20	96 5334 PLUG BAR	V-7828	1
21	68 0039 RING GASKET		1
22	56 0034 LEMO INSERT		1
23	96 3173 PLUG HOUSING	V-5594	1
24	2990 DATA STORAGE UNIT	V-5701	-
25	92 1261 ELECTRONIC BOARD	V-7493	1
26	64 3006 M2.3x6mm SCREW		18
27	3614 BATTERY 9V, 15Ah	V-7660	-
28	96 7118 FRAME BAR II	V-7830	1
29	3637 LEFT LOWER FR.BLOCK	V-7658	1
30	3636 RIGHT LOW. FR. BLOCK	V-7659	1
31	96 5316 FR. BOTT. END PLATE	V-7583	1
32	64 3011 M3x10mm SCREW		2
33	96 5315 SPRING FOR BATTERY	V-7596	1
34	65 3005 M2.5mm NUT		2
35	64 3205 M2.5x6mm SCREW		2
36	64 3203 M2.3x4mm SCREW		2
37	96 3355 BUTTON FOR SPRING	V-7597	1
38	2014 C-CLAMP	V-5296	2
39	1171B PRESSURE CASE	V-5302	1
40	92 0237 LABEL	V-7539	1
41	BATTERY WIRES	V-7656	1
42	86 3013 O-RING 21.6X2.4		-
43	64 2217 M3x8mm SCREWDIN963		12
44	96 3384 PRESSURE INLET	V-8049	1
45	64 2100 M5x12 UNBRAKO		4
46	96 9021 COMPL. RADIAL PLUG		2

Last correction: M 15.12.00 ERM	Date 28.03.96	Constr. by
RECORDING CURRENT METER, RCM9 MII(1909) ASSEMBLY DRAWING	Scale	Drawn by E.R-M
	Refer to:	Contr. by
AANDERAA INSTRUMENTS 5050 NESTTUN, NORWAY, Tel.+47 55 132500	Drawing no. V-3910M	

Fig. 7.11 Exploded view, Part List

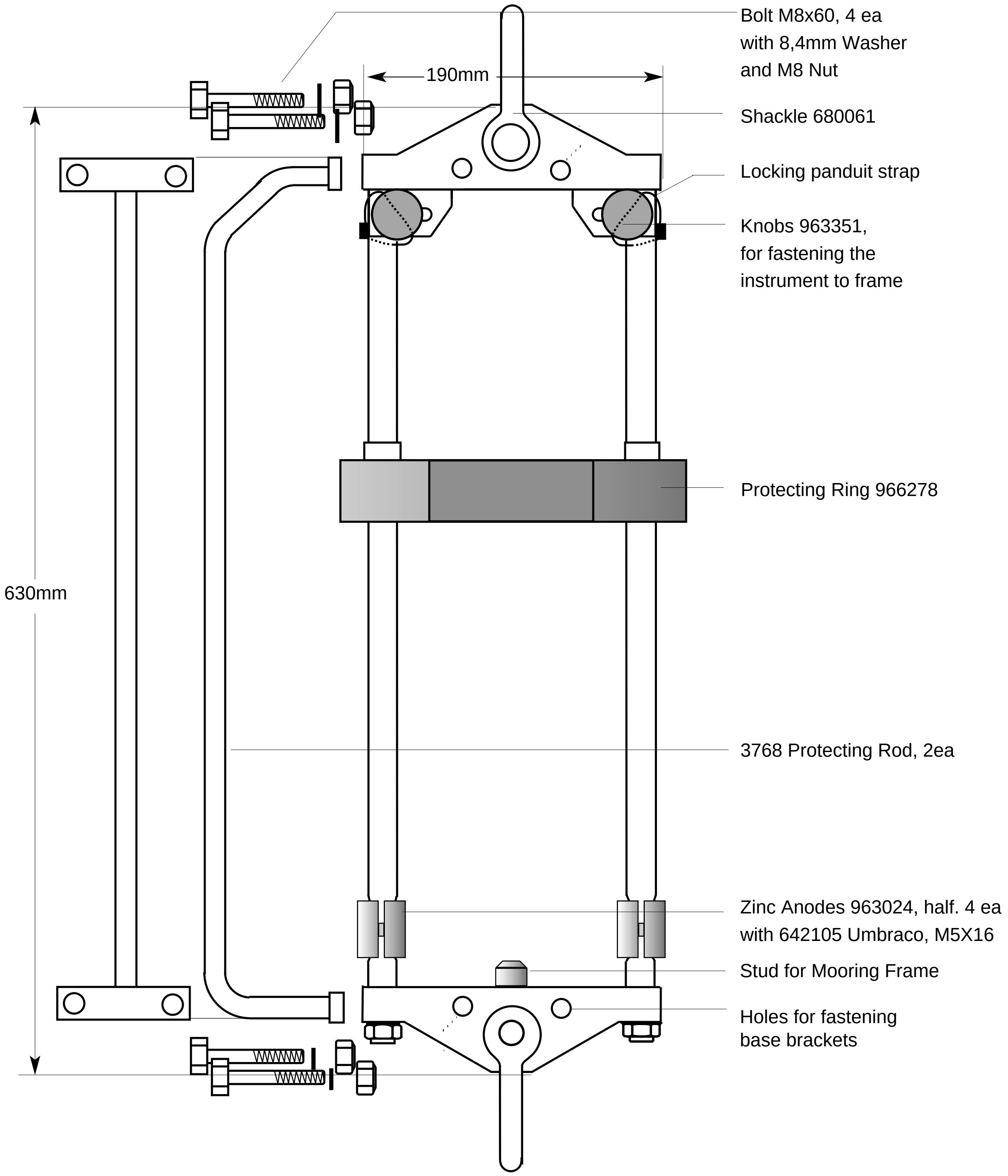


Fig. 7.12 Mooring frame 3624 with a set of 2 ea Protecting Rods 3768, optional .

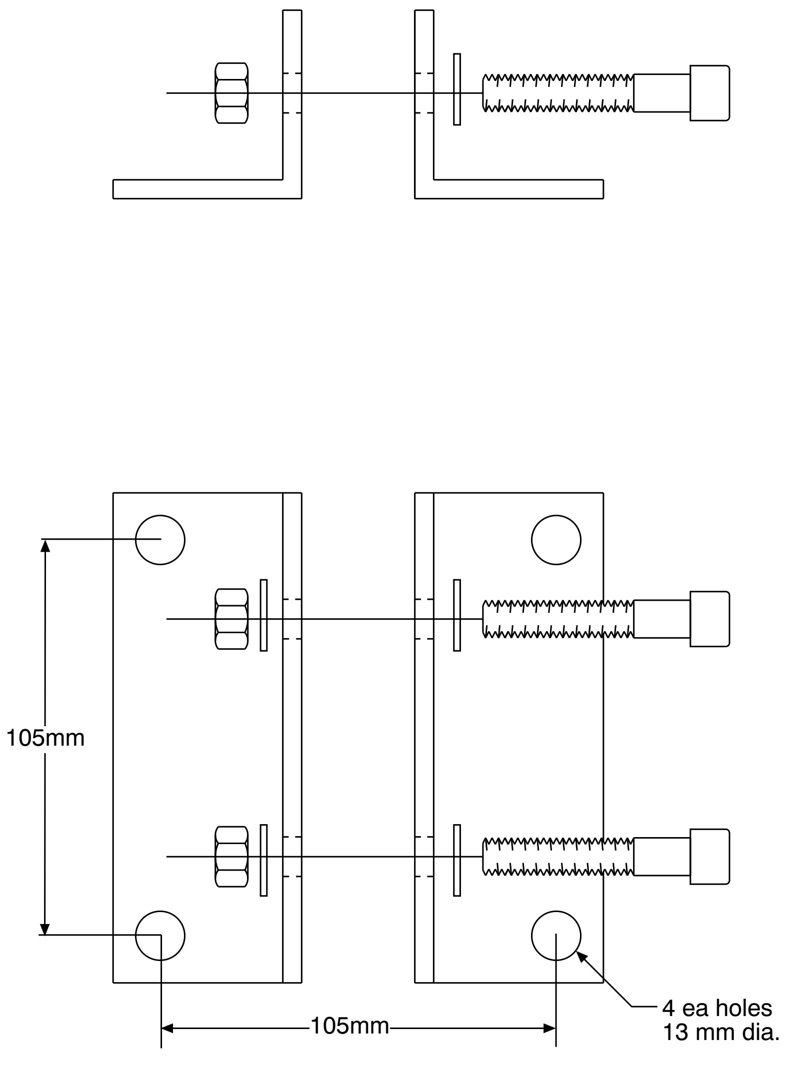


Fig. 7.13 Base Brackets 3627 (Optional)

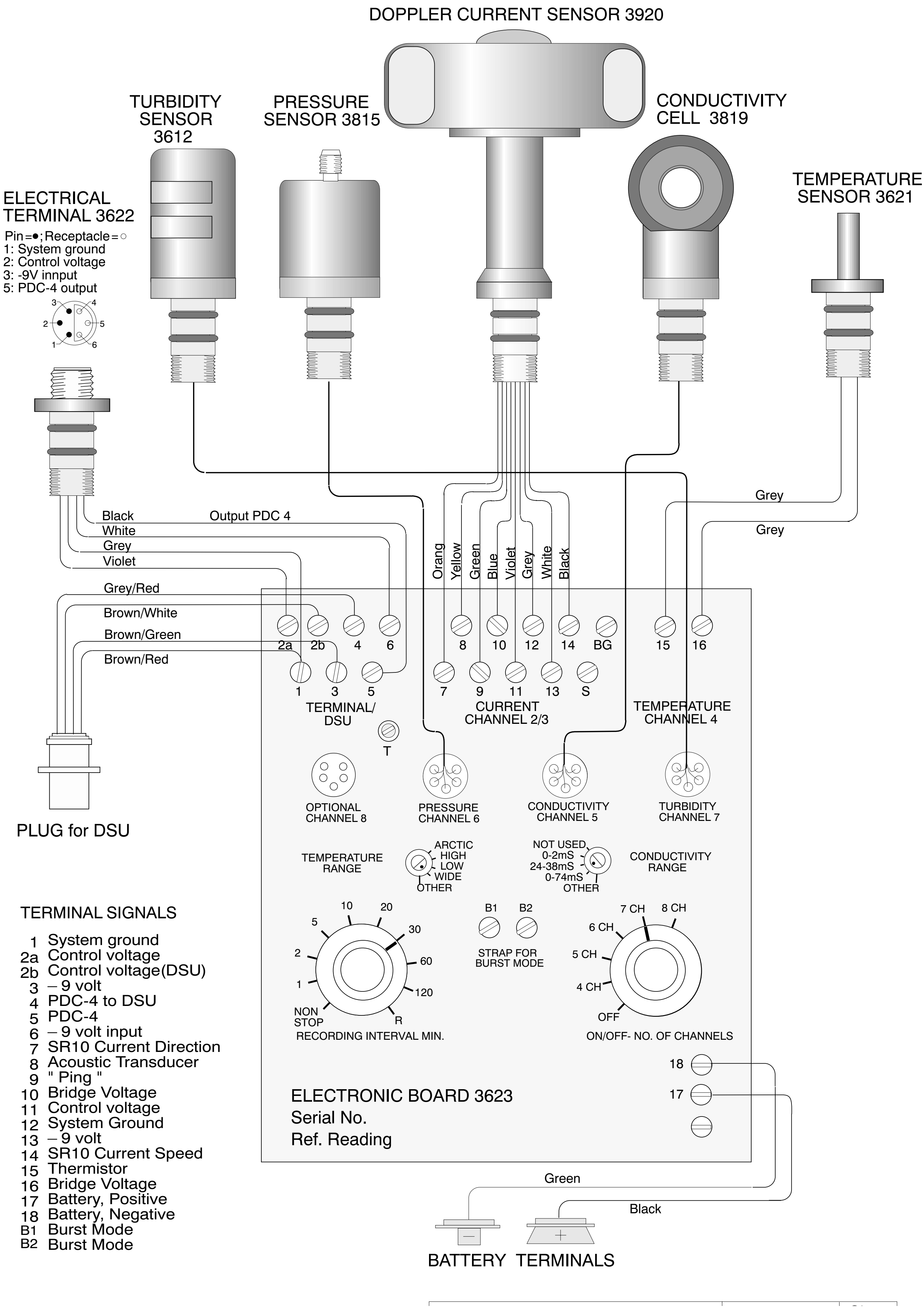


Fig. 7.14 Wiring Diagram (04.04.00)

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Test and Specification Sheet
Recording Current Meter,
RCM 9, Mk II ☐
RCM 11 ☐
Serial No. ....

Main Components

Component	Serial No.	Remarks
Electronic Board 3623		Reference reading:
Data Storage Unit 2990		Standard ☐ Extended ☐
Doppler Current Sensor 3920/3820		
Temperature Sensor 3621		
Conductivity Cell 3619/3819		
Pressure sensor 3815		
Turbidity sensor 3612		
Oxygen Sensor 3675		

Mechanical Checks:
Sensors fixed in correct position .... ☐
Wire harness, screws and sensor plugs .... ☐
Epoxy coating intact .... ☐
Zinc anode installed .... ☐
Clean and inspect O-ring groove .... ☐

Performance Tests of complete instrument:
Tune the transducer so that the acoustic output of 16.384 KHz is equal to the output of 15.7 KHz .... ☐
Current consumption at continuous operation, maximum 100 mA .... mA
Current consumption between measurements at 120 min. interval. Maximum 1.0 mA average .... mA
Field test 8 hours, 5 min. interval recording in DSU 2990 .... ☐
Check operation with Test Unit 3731, -5°C to +35°C, (all channels tested, 16 hour run, data stored in DSU 2990 .... ☐
Check remote start, PDC-4 output and external powering .... ☐
Electrical isolation between system ground and Top end-plate .... ☐
Test of Operation in Burst Mode, 2 minutes interval .... ☐

Date. .... Sign. ....

Final Check prior to Shipment:
Doppler Current Sensor is tested with Test Unit 3731 .... ☐
Temperature readings correspond to room temperature .... ☐
Conductivity Sensor reads correct with sea water loop .... ☐
Pressure Sensor gives correct reading at air pressure .... ☐
Turbidity reading increases when a reflector is placed 20cm in front of it .... ☐
The oxygen sensor reads maximum in air .... ☐

Optional Sensor checked by:(sign.) ....

Set temperature range switch to ”Low” and conductivity range to 0-74 mS .... ☐
Set interval switch to 10 minutes and turn channel selector switch to OFF position .... ☐
Erased DSU installed .... ☐
Install fresh battery, type Alkaline 3614, Open loop voltage: .... Voltage with 100ohms load: ....
Inspect O-ring groove and clean and grease O-ring .... ☐
Check that the pressure sensor is oil filled .... ☐

Fig. 7.15 Test and Specification Sheet, RCM 9 Mk II

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Calibration Sheet
Recording Current Meter,
RCM 9, Mk II/ RCM 11

Serial No.:..........................

Reference(channel 1):..........

The calibration coefficients listed below are valid for the sensors with the following serial numbers

Sensor	Range	Serial No.
Doppler Current Sensor 3920/3820		
Temperature Sensor 3621		
Conductivity cell 3619		
Pressure sensor 3615/3815		
Turbidity sensor 3612		
Oxygen Sensor 3675		

Calibration Coefficients:

Ch.No.	Parameter	A	B	C	D	Unit
1	Reference	0	1.000E+00	0	0	
2	Current Speed	0	2.933E-01	0	0	cm/s
3	Current Direction	0	3.516E-01	0	0	Deg.M
4	Temperature					
	Wide range			-6.292E-06	4.800E-09	Deg.C
	Low range			-2.238E-06	2.056E-09	Deg.C
	High range			-5.941E-07	2.820E-09	Deg.C
	Arctic range			-3.476E-07	1.134E-10	Deg.C
5	Conductivity					
	0-74mS/cm			0	0	mS/cm
	24-38mS/cm			0	0	mS/cm
	0-2mS/cm			0	0	mS/cm
6	Pressure				0	kPa/MPa
7	Turbidity					NTU
	Oxygen			0	0	% *

*
Oxygen saturation with respect to nominal air pressure (1013.2 hPa)
To obtain the density of oxygen in mg/l, see calibration sheet for the Oxygen Sensor, Form 533

Date:.............................Sign...

Fig. 7.16 Calibration Sheet, RCM 9 Mk II

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Test and Specification Sheet

Electronic Board 3623

Serial No..................

Lay out No. 1261
Circuit Diagram No. V-3901

1. Visual and Mechanical Checks:

1.1 Components correctly installed .... ☐

1.2 Soldering Quality .... ☐

2. Electrical check.

	Before Casting	After Casting
2.1 Quiescent current consumption, max. 30 µA.	..............µA	..............µA
2.2 Current consumption while reading (without transducer), max. 5 mA.	..............mA	..............mA
2.3 Connect the ‘S’ terminal to Control Voltage (T11), set channel switch to 5 channels. A buzzer on the PDC4 output will now produce a different sound for each position on the intervall switch. A different sound will also be produced when the channel switch is set to 6, 7, 8 channels.	☐	☐
2.4 Check Control Voltage, fall and rise time max. 3mS, voltage -5V±4%.	☐	☐
2.5 Check Bridge Voltage, fall and rise time max. 100µS, voltage -5V±4%.	☐	☐
2.6 Check PDC4 Output, fall and rise time max. 100µS, voltage -5V±4%.	☐	☐
2.7 Check PING signal, approximately 19.7 Hz in continuous operation and 0.5 Hz at 20 min. interval. Voltage -5V±4%.	☐	☐
2.8 Check PING signal at 10 min. interval. The periode must be between 999992µs and 1000000µs at room temperature. If not, adjust C5.	☐	☐
2.9 Check that the board also can be powered from the ”-9V in” terminal.	☐	☐

3. Perfomance.

3.1 With the ‘S’ terminal still connected to Control Voltage, set channel switch to 4 channels. A continuous beep will now appear in the buzzer. Connect a nominal acoustical transducer (10nF) between T8 and system ground. Adjust the L1 so that the voltage at T8 in the short periodes of 15.7 KHz is equal to the voltage in the rest of the period (16.384 KHz). Check that the tuning screw is approximately in the middle of the tuning range.	☐	☐
3.2 Set R8 to 10KΩ. Find value of R8 and R9 by checking the readings with a low and a high VR22 reference. Adjust offset (P1) with a middle VR22 reference.	☐	☐
3.3 Connect a low reference in one channel and a high reference in another channel, and check that the readings are correct.	☐	☐
3.4 Check that a positive 5 volts pulse of 100ms on the PDC4 output trigger a measuring cycle without influencing the measuring interval.	☐	☐

Fig.7.17 Test and Spec. Sheet. El.board 3623, page 1 of 2

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Test and Specification Sheet

Electronic Board 3623

Serial No...

3.5 Take high and low conductivity readings at all three ranges, using a reference conductivity cell with 'sea loop' resistors. If necessary, adjust value of R11-R14 to obtain correct readings.

Range	Sea loop	Nom. Reading	Actual Reading
0 mS	∞ Ω	162 ± 10	
2 mS	1390 Ω	947 ± 10	
24 mS	120.5 Ω	14 ± 2	
38 mS	77 Ω	918 ± 2	
0 mS	∞ Ω	2-6 ± 0	
74 mS	40 Ω	938 ± 6	

Before Casting **After Casting**

3.6 Check that the board is starting correctly even with fast toggling of the off/channel switch, and also with a slow rise and fall of the supply. ☐ ☐

3.7 Test temperature ranges by connecting fixed resistors between T14 and T15.

Range		Resistance	Nom.Reading	Actual Reading
Wide	- 0.34°C	5788 Ω	9 ±2	
	32.17°C	1523 Ω	1003 ±2	
Low	- 2.46°C	6090 Ω	52 ±2	
	21.48°C	2298 Ω	1011 ±2	
High	10.08°C	3668 Ω	11 ±2	
	36.04°C	1320 Ω	1003 ±2	
Arctic	- 2.64°C	6140 Ω	153 ±8	
	5.62°C	4443 Ω	987 ±8	

4. Finish

4.1 Control that switch stoppers in channel switch and interval switch are correctly inserted. ☐ ☐

4.2 Check finish after molding. ☐

4.3 Internal reference reading (Ch1). ....
....

Date ....Sign...

Fig. 7.18 Test and Spec. Sheet, El. Board 3623. page 2 of 2

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Test and Specification Sheet

Doppler Current Sensor 3920 ☐

Doppler Current Sensor 3820 ☐

Serial No. ....

1. Digital board:

1-01. Tested according to Test Procedure Form 588. .... ☐

2. Analog Board:

2-01. Tested according to Test Procedure Form 589. .... ☐

3. Complete Sensor DCS 3620:

3-01. Tested according to Test Procedure Form 590. .... ☐

4. Performance test and results from Test Procedure Form 590:

4-01. Visual check .... ☐

4-02. Inspection of o-ring grove .... ☐

4-03. Pressure tested .... ☐

4-04. Electrical isolation to flange after pressure test .... ☐

	Before casting	After casting
4-05. Current consumption, quiescent, no ping (maximum 190µA)	..........µA	.........µA
4-06. Current consumption, total with one ping each second (maximum 5.5mA)	..........mA	.........mA

5. Compass Compensation, result from Test Procedure Form 590:

5-01. After autocompensation of compass reading with 0° tilt. Maximum error < ± 3.5° .... Max. error:..................°

6. Tilt Compensation, result from Test Procedure Form 590:

6-01. After autocompensation of tilt reading. Max.error < ± 2.0°.

X- direction Max.error:..............°

Y- direction Max.error:..............°

7. Reading with Test Unit 3731:

7-01. Speed (950 - 990) ....

7-02. Direction change 180° when the Test Unit is turned 180°.. ☐

Date .... Sign ....

Fig. 7.19 Test and Spec. Sheet . DCS 3920

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Test, Spec and Calibration Sheet

Temperature Sensor 3621

Serial No: - - - - - - - - - - - - - - --

Visual and Mechanical checks

Visual check.. ☐
O-ring groove inspected, cleaned and greased........................ ☐
Check that all conductors are electrically isolated from the sensor foot........ ☐
Satisfactory soldering quality...................................... ☐

Date:.................................... Signature: ....

Calibration

Calibration is performed in a temperature stabilized water bath, where the temperature of the water is determined by a reference thermometer. The reading of the sensor is dependent on the sensor itself and the temperature range selected on the Electronic Board 3623.

General formula: Temperature (°C) = $A + BN + CN^2 + DN^3$ (N = raw data reading).

<u>Wide Temp. Range. -0.64 to 32.87°C</u>

Calibration points used.

Temperature,°C		
Reading, N		

The coefficients are: A:........................ B: ...., C : - 6.292E-06, D : 4.800E-09

<u>Low Temp. Range. -2.70 to 21.77°C</u>

Calibration points used.

Temperature,°C		
Reading, N		

The coefficients are: A:........................ B: ...., C : - 2.238E-06, D : 2.056E-09

<u>High Temp. Range. 9.81 to 36.66°C</u>

Calibration points used.

Temperature,°C		
Reading, N		

The coefficients are: A:........................ B: ...., C : - 5.941E-07, D : 2.820E-09

<u>Arctic Temp. Range. -3.01 to 5.92°C</u>

Calibration points used.

Temperature,°C		
Reading, N		

The coefficients are: A:........................ B: ...., C : - 3.476E-07, D : 1.134E-10

Date ....

Fig. 7.20 Test & Spec. Cal. Sheet, Temp.Sensor 3621

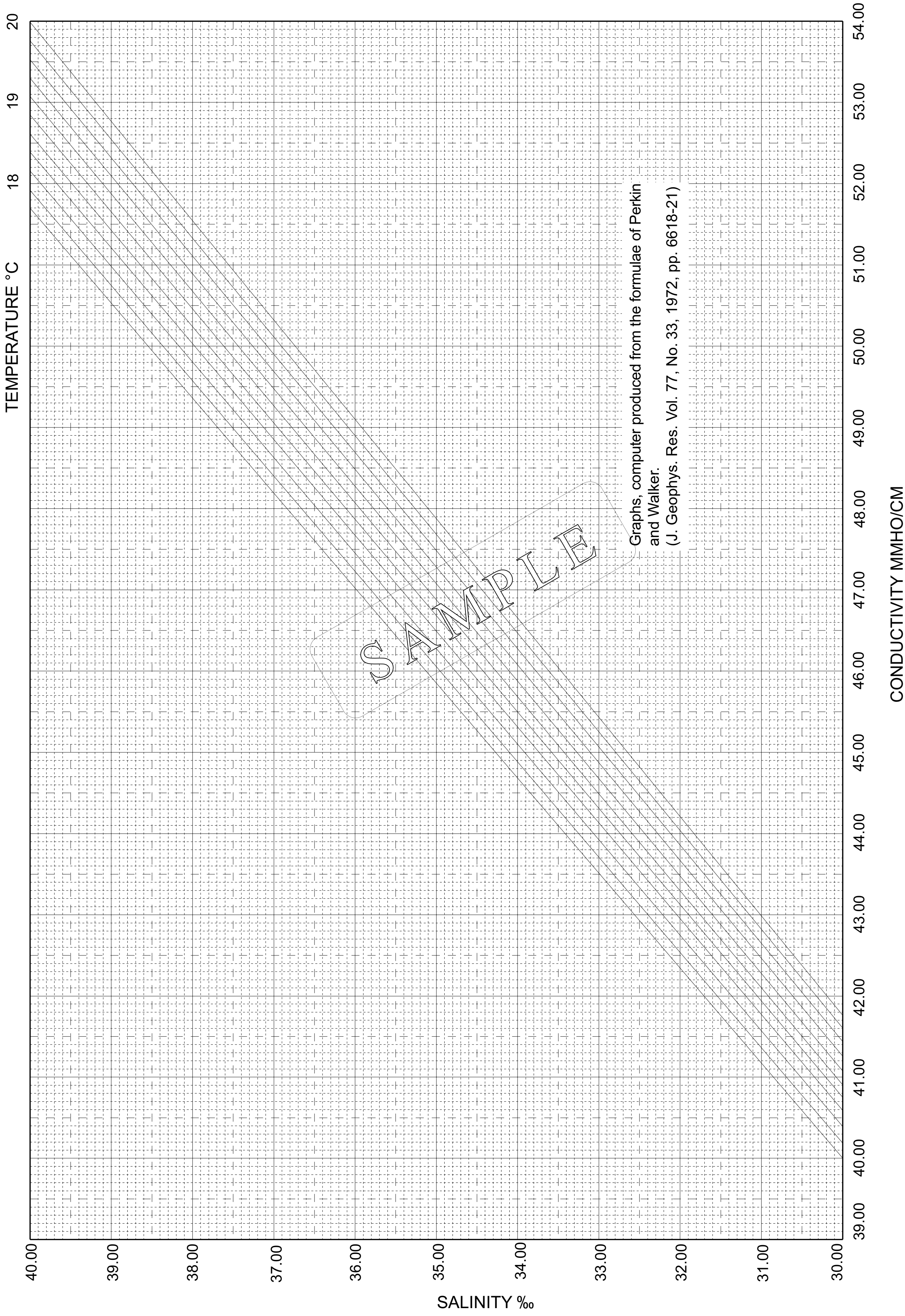


Fig. 7.21 Salinity Conversion Graph. 18-20°C

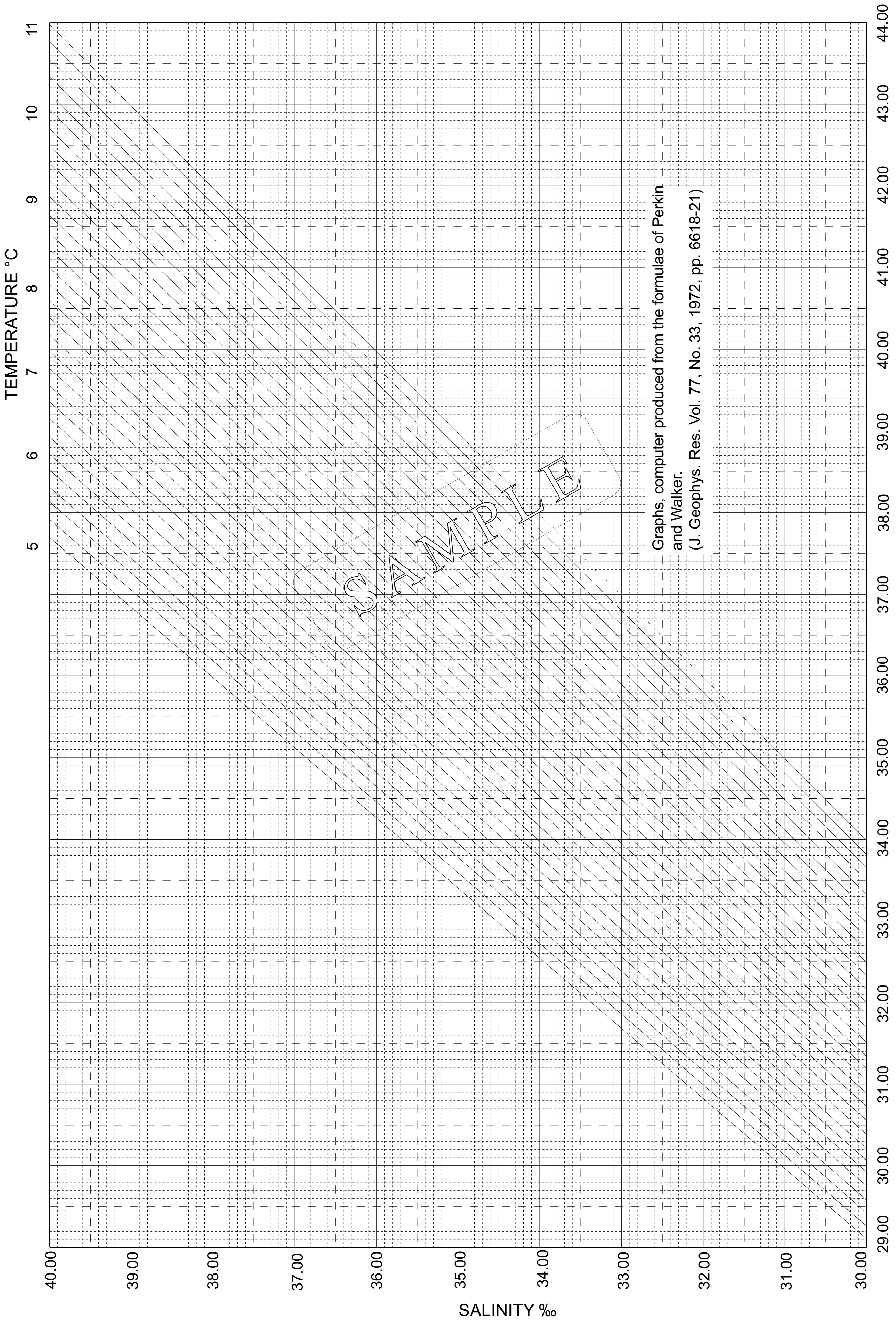


Fig. 7. 22 Salinity Conversion Graph. 5-11°C

CHAPTER EIGHT

RECORDING CURRENT METER MODEL 11

Introduction.

Chapters 1 7 are also valid for the Deep-Water Version, RCM 11. This version has the same features as the RCM 9 Mk II except for the physical dimensions of the pressure case, the top end plate and the Doppler Current Sensor 3820, see figure 8.01. These parts are strengthened to meet the requirements of a depth capability of 6000 meters.

Note!

The Turbidity, Conductivity and Oxygen Sensors for the RCM 9 Mk II can only be used on the RCM 11 down to 2000m. For deployment deaper than 2000m replace the sensor with sealing plug 3625.

This chapter only describes the specifications and parts specific to the RCM 11.

Description.

Figure 8.01 shows the pressure case with top end plate. In order to withstand the pressure of up to 60 MPa, the thickness of the top and bottom end plates has been increased to 30 mm. Two O-rings, one on the top end plate and one on the bottom end plate, are located in circular grooves to give proper sealing against the inside of the pressure case. The bottom end plate is press fitted to the tube.

As the inside height of the RCM 11 is the same as for the RCM 9 Mk II, the pressure tube is made 14 mm longer to compensate for the increased thickness of the end plates, and the groove for the C-clamp is reduced to two small grooves to obtain better mechanical strength.

The top end plate, seen on figure 8.02, requires specially designed fastening nuts for the temperature sensor, acoustic transducer, watertight receptacle and sealing plug.

Parts, specifically for the RCM 11.

965365	Top End Plate, RCM 11
2175B	Pressure Case, RCM 11
963398	Nut, for 16mm Sealing Plug, Watertight Receptacle 3622 and Sensors

ILLUSTRATIONS

Fig. 8.01 Doppler Current Meter, RCM 11

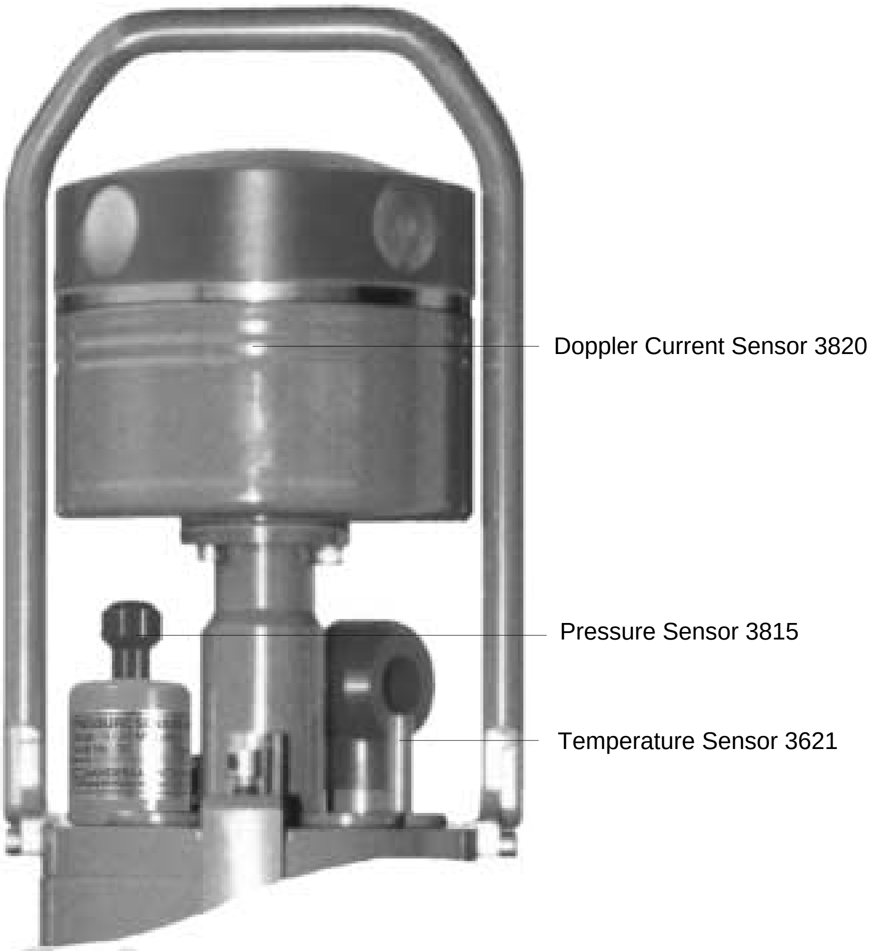


Fig. 8.02 Doppler Current Sensor 3820

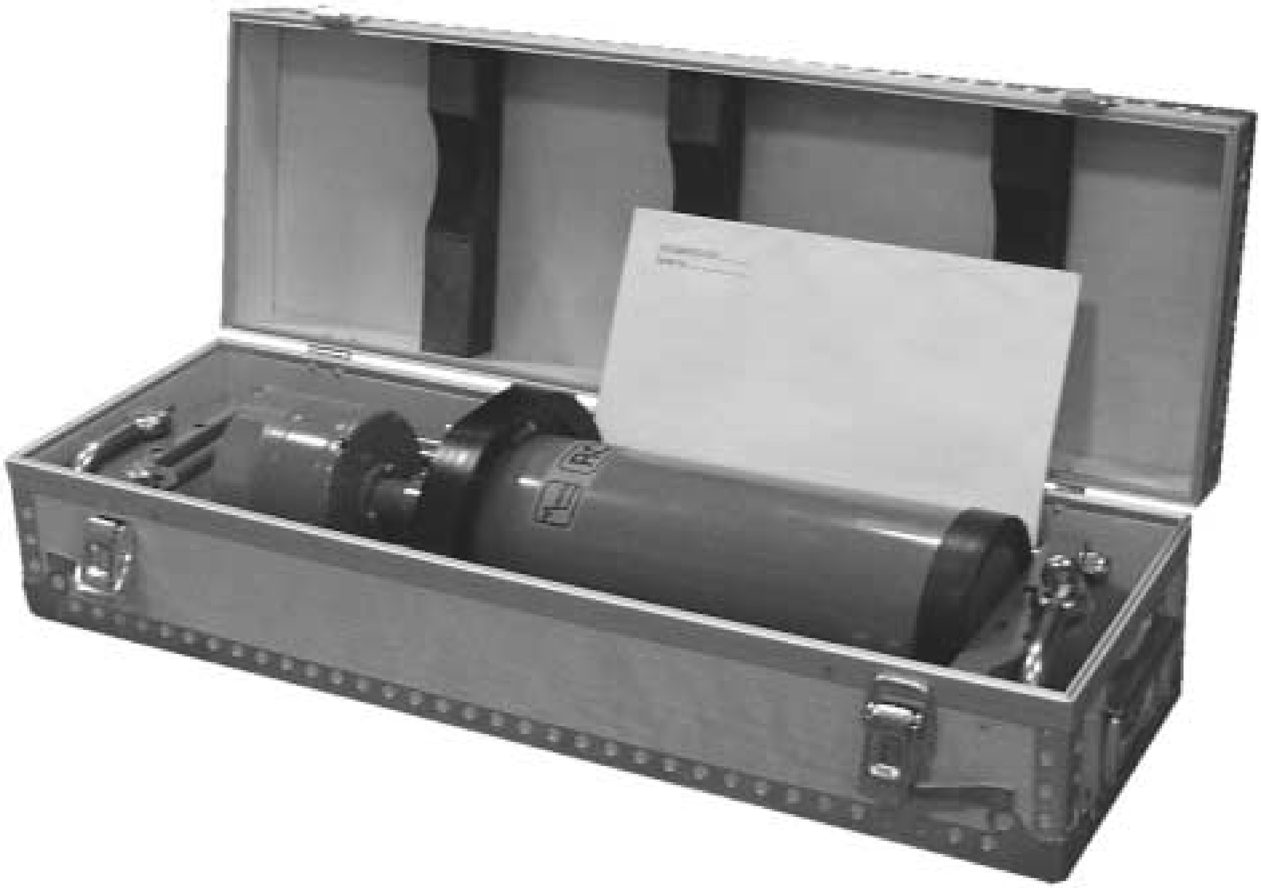


Fig. 8.03 RCM 11 as shipped

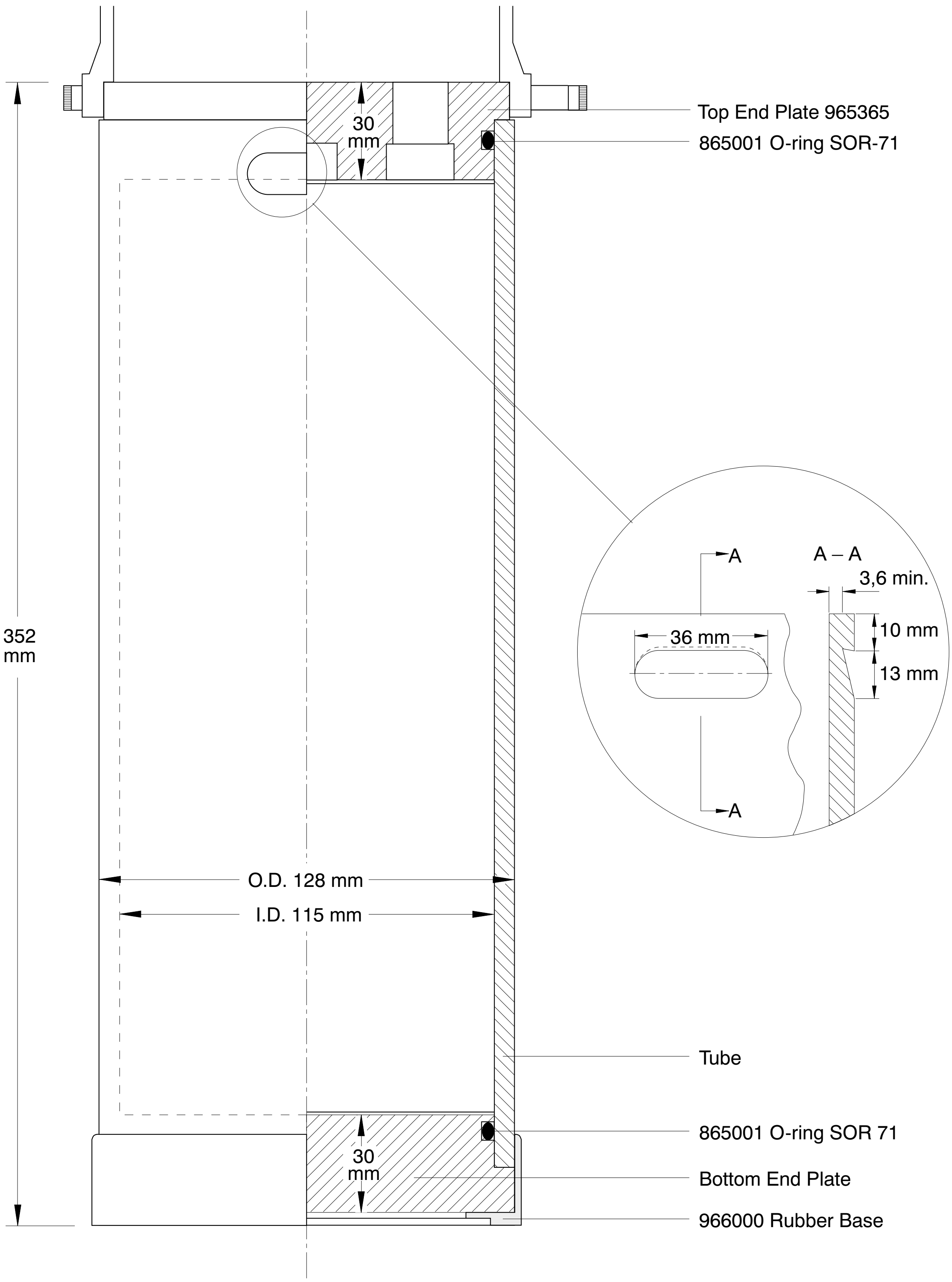
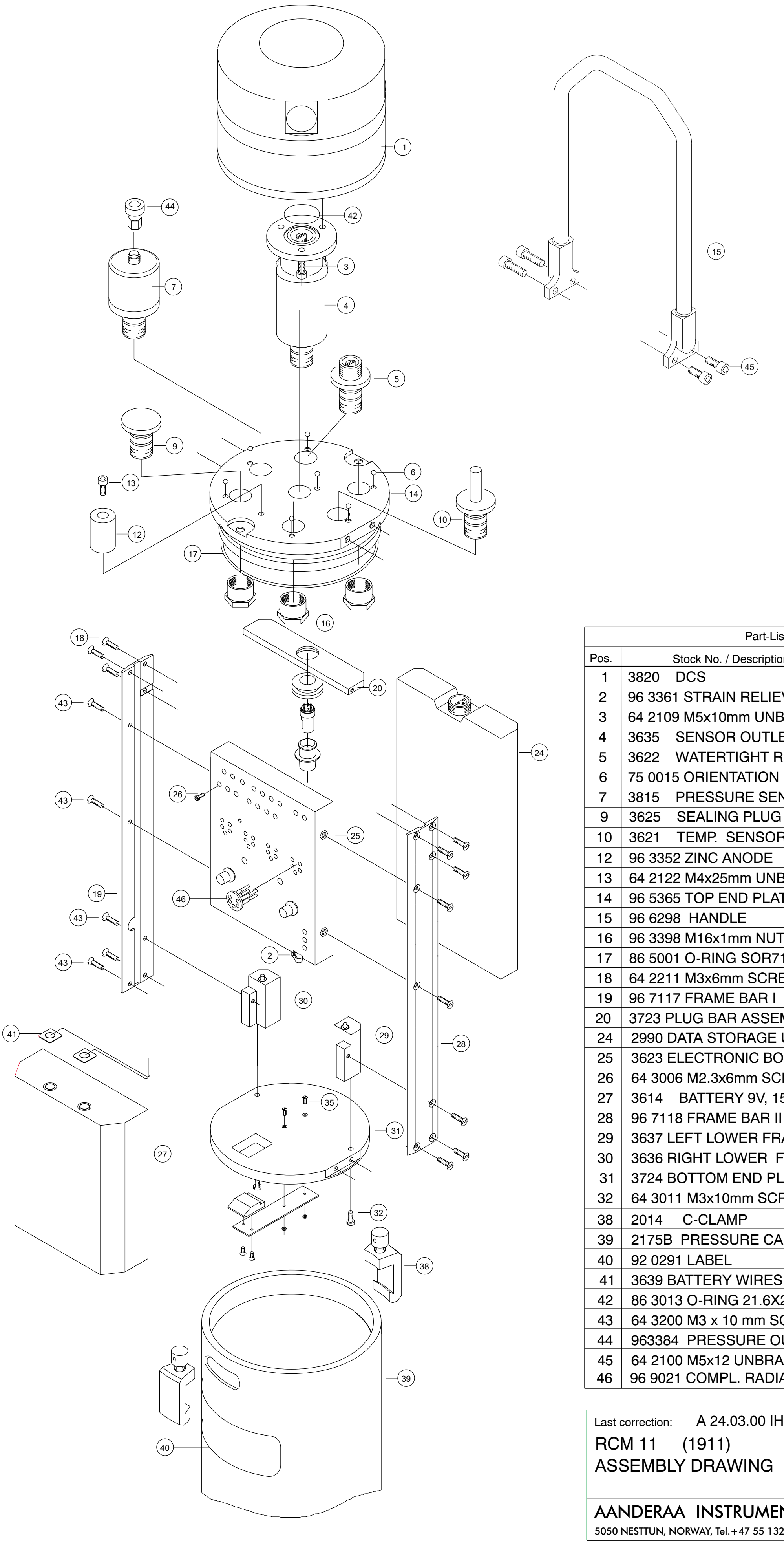


Fig. 8.04 Pressure case 2175B, for RCM 11



Part-List			
Pos.	Stock No. / Description	Dwg. No.	Qty.
1	3820 DCS	V-8324	1
2	96 3361 STRAIN RELIEVER	V-7602	1
3	64 2109 M5x10mm UNBRACO		3
4	3635 SENSOR OUTLET	V-7591	1
5	3622 WATERTIGHT RECEPT.	V-5591	1
6	75 0015 ORIENTATION BALL		7
7	3815 PRESSURE SENSOR	V-7655	-
9	3625 SEALING PLUG	V-7572	4
10	3621 TEMP. SENSOR	V-7571	1
12	96 3352 ZINC ANODE	V-7550	1
13	64 2122 M4x25mm UNBRACO		1
14	96 5365 TOP END PLATE	V-8013	1
15	96 6298 HANDLE	V-8363	1
16	96 3398 M16x1mm NUT EXT.	V-8014	7
17	86 5001 O-RING SOR71		1
18	64 2211 M3x6mm SCREWDIN963		4
19	96 7117 FRAME BAR I	V-7829	1
20	3723 PLUG BAR ASSEMBLY	V-7828	1
24	2990 DATA STORAGE UNIT	V-5701	-
25	3623 ELECTRONIC BOARD	V-7493	1
26	64 3006 M2.3x6mm SCREW		18
27	3614 BATTERY 9V, 15Ah	V-7660	-
28	96 7118 FRAME BAR II	V-7830	1
29	3637 LEFT LOWER FRAME BLOCK	V-7658	1
30	3636 RIGHT LOWER FRAME BLOCK	V-7659	1
31	3724 BOTTOM END PLATE ASSY.	V-7583	1
32	64 3011 M3x10mm SCREW		2
38	2014 C-CLAMP	V-5296	2
39	2175B PRESSURE CASE	V-5139	1
40	92 0291 LABEL	V-8405	1
41	3639 BATTERY WIRES	V-7656	1
42	86 3013 O-RING 21.6X2.4		-
43	64 3200 M3 x 10 mm SCREW		12
44	963384 PRESSURE OUTLET	V-8749	1
45	64 2100 M5x12 UNBRAKO		4
46	96 9021 COMPL. RADIAL PLUG		3

Last correction: A 24.03.00 IH	Date 05.11.99	Constr. by
RCM 11 (1911) ASSEMBLY DRAWING	Scale	Drawn by JEL
	Refer to:	Contr. by
AANDERAA INSTRUMENTS 5050 NESTTUN, NORWAY, Tel.+47 55 132500	Drawing no. V-8365A	

Fig. 8.06 Spare Part List, RCM 11

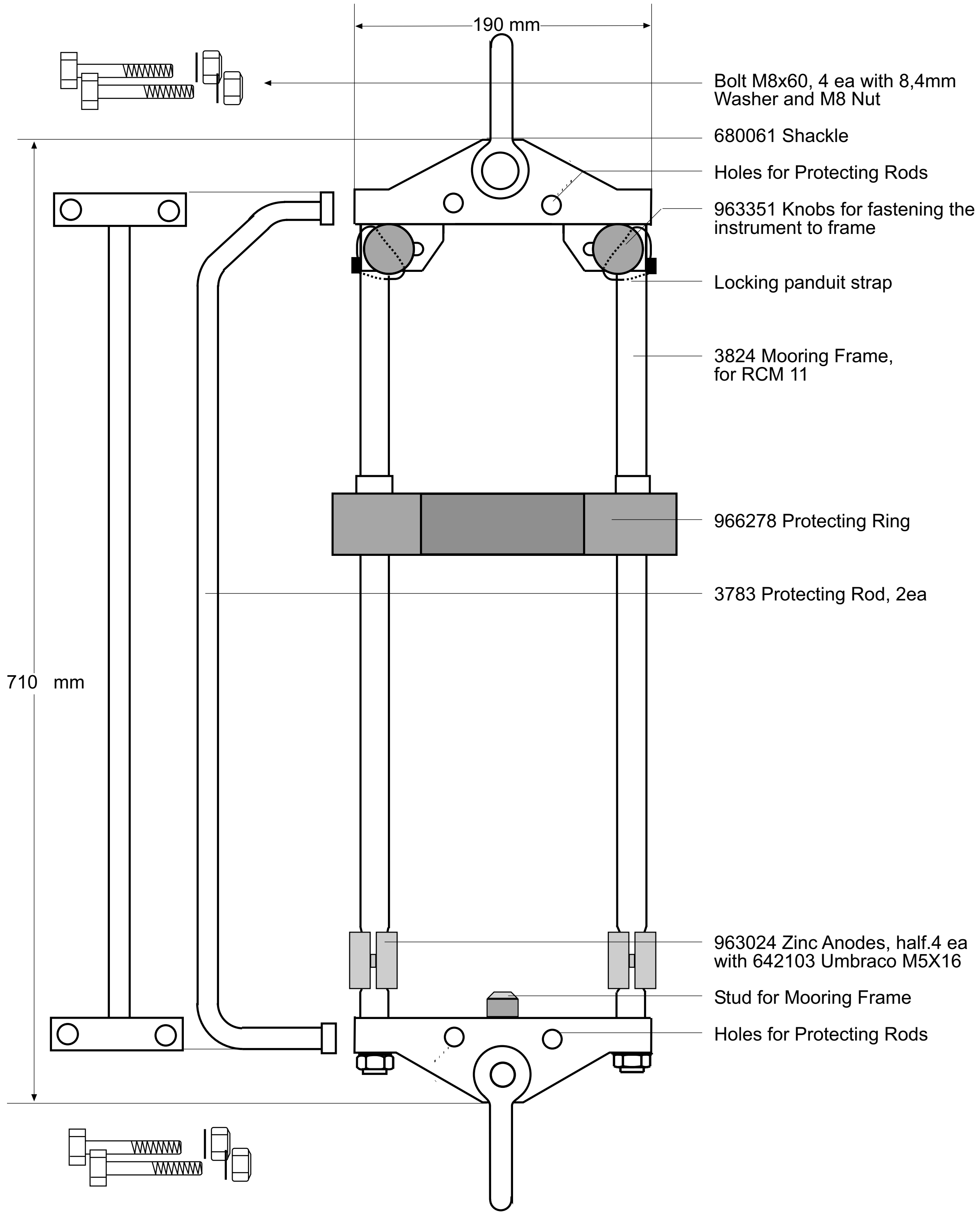


Fig. 8.07 Mooring Frame 3824 with Protecting Rod 3783, optional