VALEPORT LIMITED

MIDAS ECM
Electromagnetic Current Meter

Hardware Manual

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CHAPTER	DESCRIPTION	PAGE

1 INTRODUCTION

This manual covers the specification, wiring details and basic maintenance procedures for the Valeport MIDAS ECM Electromagnetic Current Meter. Full details of how to operate the instrument with the DataLog Express software supplied are given in a separate manual.

As standard, the MIDAS ECM system consists of the following components:

- Titanium or Acetal housed instrument
- Stainless steel deployment cage
- 3m Y lead (interface to PC)
- Switching Plug
- Basic maintenance tools and spare o-rings
- DataLog Express Software CD
- Operating Manual
- Transit case

In addition, the following components may be supplied as optional extras:

- RS485 communications adaptor
- RS422 communications adaptor
- FSK modem communications adaptor (includes pcb in instrument)
- Various lengths & types of signal cable are also available

Note that instruments are often supplied (on request) with minor adjustments to the above list, such as a 5m Y lead instead of a 3m Y lead for example. Such variations will be detailed on the instrument packing list, and not in this manual.

1.1 CONTACT INFORMATION

If you have any questions about the operation of the instrument, which are not answered by this manual, please contact your supplier if appropriate, or contact Valeport Ltd directly at the address given at the front of this manual.

2 SPECIFICATIONS

2.1 SENSOR SPECIFICATIONS

The unit is fitted with the following sensors as standard:

	Current Speed	Current Direction
Type:	Valeport 11cm discus EM sensor	Valeport flux gate compass
Range:	0 – 5m/s	0 – 360°
Accuracy:	± (1% of reading + 0.005m/s)	± <1°
Resolution:	0.001m/s	0.001°

It may also be fitted with the following optional sensors:

	Conductivity	Pressure
Type:	Valeport inductive coils	Strain Gauge
Range:	0 - 80mS/cm	Various available to 500Bar max
Accuracy:	± 0.01mS/cm	±0.04% range
Resolution:	0.002mS/cm	0.001% range

	Temperature	Sound Velocity
Type:	Fast response PRT	Valeport digital time of flight
Range:	-5 to +35℃	1400 – 1600m/s
Accuracy:	± 0.01℃	±0.03m/s
Resolution:	0.002℃	0.001m/s

Note that the MIDAS ECM is technically capable of supporting other sensor types, such as Turbidity, Dissolved Oxygen, Fluorometer, Altimeter etc. Such sensors require additional user attention, such as control of output gain or regular calibration. MIDAS ECM units fitted with such sensors are therefore not compatible with DataLog Express software, and users should run DataLog 400 or DataLog Pro software instead.

2.2 MECHANICAL SPECIFICATIONS

Materials

Housing: Titanium or Acetal, as specified at time of purchase

Exceptions: EM current sensor is polyurethane

Cage: Stainless steel (316 grade) with polypropylene clamping brackets

Dimensions: Instrument - 150mm Ø, 700mm long (including connector)
Cage – 210mm Ø x 732mm long

Weight: 20kg (titanium), 11kg (acetal).

Depth Rating: 5000m (titanium), 500m (acetal)

Connectors

Instrument: 10 pin female Subconn bulkhead type (MCBH10F) with lock ring.

(If fitted with altimeter connection– 6 pin male Subconn bulkhead type (MCBH6F) with lock ring)

Comms Cable: Valeport 3m Y lead. 10 pin male Subconn line type (MCIL10M) to instrument, 2 x 4mm bunch pins to external power, 9 pin female D type to PC.

Switching Plug: 10 pin male Subconn line type (MCIL10M), with lock ring. Note that the switch cap contains wiring links to activate the instrument *It is not a dummy plug*

2.3 PERFORMANCE SPECIFICATIONS

Memory: 16Mb solid state memory (upgradeable in 16Mb steps to 64Mb)

Internal Power: 8 x 1.5v alkaline D cells. The unit will accept 8 x 3.6v Lithium D cells with no alterations required. Do not mix battery types.

External Power: Between 9 and 30v DC.

Current Drain: ~140mA at 12v when running, and 0.25mA when in sleep mode.

Sampling Rate: 1, 2, 4 or 8Hz (synchronised)

Data Output: RS232, RS485, RS422, FSK depending on pin selection. Baud rate is user selectable from 2400 to 460800.

NB: If FSK option is fitted, baud rate will be fixed at 34800

2.4 SAMPLE LIFETIME CALCULATIONS

2.4.1 BASED ON MEMORY

Lifetime based on memory is dependent on the sensors fitted. All parameters use 2 bytes of memory per sample, with the exception of the optional sound velocity sensor which uses 4 bytes. With a typical configuration of Speed, Direction and Pressure, lifetime can be calculated as follows:
Total memory used per record is 2 x 3 = 6 bytes. Note that in Profile mode, each record is also assigned a date/time stamp, which uses a further 7 bytes.

The 16 Mbyte memory actually contains 16,777,216 bytes. Allowing a small amount of memory usage for header files, the memory will store over 1.2 million records in Profiling mode, and over 2½ million records in other modes. The length of time that this memory will last for obviously depends on sampling scenario. Here are three examples:

<u>Continuous data sampling, 8Hz:</u>

Memory used per second is 6 x 8 bytes = **48 bytes**.
Total memory fitted is **16,777,216 bytes**.
Seconds before memory full is 16,777,216 / 48 = (approx) **349,500 seconds**.
This is equivalent to **97 hours**.
This period could be doubled by sampling at 4Hz.

<u>Burst sampling, 4Hz, sampling 1 minute in every 10, recording all data points:</u>

Memory used per burst is 6 bytes x 4Hz x 60 seconds = **1440 bytes**.
The memory will therefore be full after 16,777,216 / 1440 bursts = **11650 bursts.**
At a 10 minute cycle time, this is **116500 minutes**, which is equivalent to **80 days**.

<u>Profiling, 5000m cast, measuring every 1 metre:</u>

In this example, the instrument will take 1 reading every metre of both descent and ascent. This means 5000 data points descending, and a further 5000 ascending. Each record consists of 6 bytes of data and 7 bytes of time stamp. Each record therefore uses **13 bytes**. A single cast will take 10,000 such records, and will therefore use **130,000** bytes.

The 16Mbyte memory will therefore hold approximately **125 casts** of data.

A NOTE ABOUT REMOVABLE MEMORY

We are sometimes asked whether we offer these devices with removable memory. The answer is no we don't, but there are sound reasons for this. It is natural to think that since removable memory cards are now the norm in consumer electronics, they must be "state of the art" and therefore desirable in all applications, but this is not necessarily the case.

- An essential feature of an underwater instrument is that it is water-tight; this is achieved by using various seals on the mechanical parts of the device. Every time that one of these seals is broken and remade, it introduces a small risk that the seal is not correctly made, and the instrument could leak. The fewer times that the device has to be opened, the better – you certainly wouldn't want to do it after every profile to get the memory card out.

- All memory cards are susceptible to ESD shock (static electricity) while being handled. We take the view that the value of your data means it shouldn't be exposed to the possibility of this risk, which could result in loss of all data on the card.

- Memory cards are not particularly efficient at storing data – they will only accept minimum sized lumps of data at a time. This may be perfect for a camera where you instantly generate a few Mbytes, not so for an application where you only want to store a few bytes of data at a time.

- From a practical point of view, the time taken to connect a cable and extract the data to PC is actually typically much less than the time to open the device, remove the memory, replace the memory, and close the device up again.

- The implementation of removable memory is not technically difficult, but we believe that the disadvantages currently outweigh any possible advantages in this product and its applications. However, should circumstances change it will of course be considered for future product enhancements.

2.4.2 BASED ON BATTERIES

The MIDAS ECM will function with a voltage supply of between 9 and 30vDC. The voltage output of the 8 x D cell battery pack will vary according to the type of cell fitted. The most likely cells to be used will be standard alkaline type (1.5v each) or Lithium cells (3.6v each), giving a 12v nominal output for alkaline cells, or 28.8v nominal for Lithium cells. The following calculations are based on the same sampling scenarios as the memory calculations, using figures for a 12v alkaline battery pack. Each example also gives a figure for a Lithium battery pack, calculated from a basic ratio of alkaline to Lithium performance.

In all examples, it is taken that an 8 D cell alkaline battery pack will have a nominal capacity of 14Ah, and will be 75% efficient (total available charge, 10.5Ah), and that an 8 D cell Lithium pack will have a nominal capacity of 17.5Ah, and will be 95% efficient (total available charge, 16.6Ah).

Continuous data sampling, 8Hz:

At 12v, the instrument draws **140mA** when sampling.
Total charge available is **10500mAh**.
Number of hours available is therefore 10500mAh / 140mA = **75 hours**.
This is equivalent to just less over **3 days**.
For Lithium cells, a similar calculation gives around **11 days**.

Note that the instrument is effectively operating continuously when in Trip sampling mode, so similar calculations will apply.

Burst sampling, 4Hz, sampling for 1 minute every 10 minutes:

At 12v, instrument draws **140mA** when sampling, plus 140mA for 5 seconds at the start of each burst. It draws **0.25mA** when in sleep mode between bursts.

In this scenario then, the instrument will draw 140mA for 65 seconds, and then 0.25mA for 535 seconds. On average, it will draw:

$$\frac{(140 \times 65) + (0.25 \times 535)}{(65 + 535)} = \mathbf{15.39mA}$$

Total charge available is **10500mAh**.

Number of hours available is therefore 10500mAh / 15.39mA = **682 hours**.

This is equivalent to approx **28 days**.

For Lithium cells, a similar calculation gives approx **105 days**.

The above examples are intended as guides only. Valeport accepts no responsibility for variation in actual performance. Note that performance of individual battery cells is not always consistent.

A NOTE ABOUT RECHARGEABLE CELLS

We are often asked if rechargeable cells can be used. Yes, it is possible to use rechargeable cells, but we do not recommend it:

- Firstly, the cells cannot be recharged in-situ due to the possibility of the cells giving out gas inside a sealed instrument, effectively turning it into an explosive device. Whilst this risk is small, it does exist and therefore must be considered. The risk could be overcome by adding an air vent to the housing, but this could compromise the water-tight nature of the housing. Better to remove the risk altogether.
- Secondly, the most commonly used rechargeable cells are NiCad type. These only operate at around 1.2v maximum and have about 25% of the capacity of an alkaline cell; they therefore give greatly reduced operating times.
- Modern Li-ion or NiMH cells are more efficient than NiCad cells, but do not yet compare with alkaline cells. They are also considerably more expensive.

3 INSTALLATION

The standard system is supplied in an ABS transit case, together with any communications adaptors ordered. Any additional lengths of signal cable are packed separately.

3.1 COMMUNICATIONS WITH PC

The MIDAS ECM can be set up and interrogated using the DataLog Express software supplied (DataLog 400 or DataLog Pro for more complex systems). Please refer to the separate manual for details of how to use the software.

To connect the instrument directly to a PC for RS232 communications, use the 3m Y lead supplied. This lead is fitted with a 10 pin Subconn type connector, which should be plugged directly into the connector on the top of the housing (or to a length of signal cable). The lead also features 2 x 4mm bunch pins for application of external power if required and a 9 way D type connector which should plug directly into a spare communications port on the back of the PC.

If non-RS232 communications are to be used, via the optional RS485, RS422 or FSK methods, then the appropriate adaptor should be used. Each adaptor is supplied with an alternative Y lead, which should be connected as follows:

NB: If FSK option is fitted, baud rate will be fixed at 34800

Comms Method	Adaptor Part No.	Connections
RS485	0400029	Connect 15 pin D type and 4mm plugs from Y lead into adaptor. Connect 9 pin D type from adaptor to PC, and 4mm plugs from adaptor to external power, as indicated on adaptor housing.
RS422	0400030	Connect 15 pin D type and 4mm plugs from Y lead into adaptor. Connect 9 pin D type from adaptor to PC, and 4mm plugs from adaptor to external power, as indicated on adaptor housing.
FSK	0400005	Connect 4mm plugs from Y lead into adaptor, leaving D types unconnected (FSK uses power and signal on just two wires). Connect 9 pin D type from adaptor to PC, and 4mm plugs from adaptor to external power, as indicated on adaptor

3.2 DEPLOYING THE MIDAS ECM

All parts of the standard system (with the exception of the top part of the 3m Y lead) are designed for immersion. All communications adaptors (RS485, RS422, FSK) are splash proof, but should be sited in a dry place, as close to the PC as possible.

The MIDAS ECM is supplied with a stainless steel protective cage, but care should still be taken not to damage the instrument. For profiling work, the recommended deployment method is to suspend the instrument using the stainless steel wire strop fixed to the top of the cage. For fixed deployments, the user may wish to remove the cage, and use the grooves in the instrument housing as clamping points.

3.2.1 REAL TIME OPERATION

For real time data output, connect the signal cable to the 10 pin Subconn connector on the instrument. All Valeport signal cables include a suspension point for strain relief, and a similar arrangement is recommended for other cable types. Connect the top end of the cable to a PC using the appropriate method as described above.

3.2.2 SELF RECORDING OPERATION

For self recording only deployments, the instrument is switched on by insertion of the Subconn style switch plug. This plug must be inserted for the unit to operate.

Note that the switch plug is NOT just a dummy plug; it contains links between some of the pins as described in Section 5, which are used to turn the instrument on.

3.2.3 LED FLASHING SEQUENCE

The MIDAS ECM is fitted with an LED visible through a polycarbonate window in the battery pack. The LED will flash as detailed below to indicate various states.

Continuous ON for 15 seconds	Occurs when the Switch Plug or cable is connected, indicating that instrument is on and awaiting communication
1Hz Continual Flashing	Insufficient Power. Change internal batteries, or completely remove external power, and apply higher voltage
Continuous ON for 2 seconds	Indicates the start of Burst Sampling pattern
5 Rapid Flashes	Indicates the end of Burst Sampling pattern. The duration of the burst may be calculated as the time between the start and stop LED sequences, *less 5 seconds.*

3.3 ALTIMETER CONFIGURATION

Systems can be specified with Tritech PA series Altimeters. For the Midas ECM to correctly communicate with the Altimeter, it needs to be configured as follows:

Communication:	RS232
Use:	Free Run ASCII/Zero No Detect (ZNE)
Data Format:	9600, 1, 8, 1
Power:	12v

3.4 RECOVERY

On recovery, data can be extracted to PC via the 3m Y lead. This procedure is covered in the separate software manual for DataLog Express or DataLog 400 / DataLog Pro as applicable.

To prolong the lifetime of the instrument the following procedures should be carried out once the instrument has been recovered:

- Remove any significant growth from the instrument, paying attention to the face and electrodes of the EM sensor, the core of the conductivity sensor (if fitted), and the face of the sound velocity sensor (if fitted). Be careful not to damage the sensors. A high pressure water jet or stiff (not metal) brush is suitable – a hard toothbrush is ideal.

- Remove any significant growth from the pressure sensor port. Take care not to introduce any sharp objects onto the sensor face – this may result in sensor damage.

- Check instrument for signs of damage.

- Rinse the instrument in fresh water

- Dry the instrument if possible, paying particular attention to the sensors and connector.

- Repack the instrument in the transit case provided.

4 MAINTENANCE

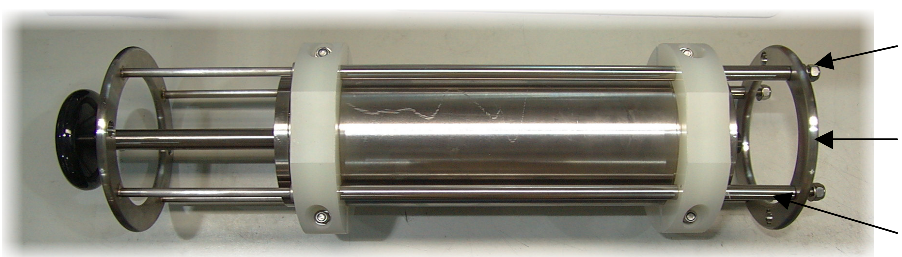
The MIDAS ECM is completely solid state, and therefore requires very little maintenance. Other than keeping the instrument relatively clean (as described in Section 3.3, Recovery), the only procedure that the customer will be required to carry out on a regular basis is to change the batteries. This Chapter also covers details of the o-rings that are fitted to the instrument, and which should be checked periodically for damage and replaced if necessary.

4.1 CHANGING BATTERIES

The MIDAS ECM accepts 8 x D cells, of either 1.5v alkaline or 3.6v Lithium type. These cells are arranged in series, so the output voltage is 12v (alkaline) or 28.8v (Lithium). Some example scenarios for lifetime of these batteries are given in Chapter 2.4.2

The batteries are located in a holder in the top of the instrument, and should be accessed by removing the connector bulkhead.

1. Remove the instrument from the protective cage by loosening the 4 x M10 nuts on the top of the cage. Lift off the top cage ring and the 4 spacer tubes below.

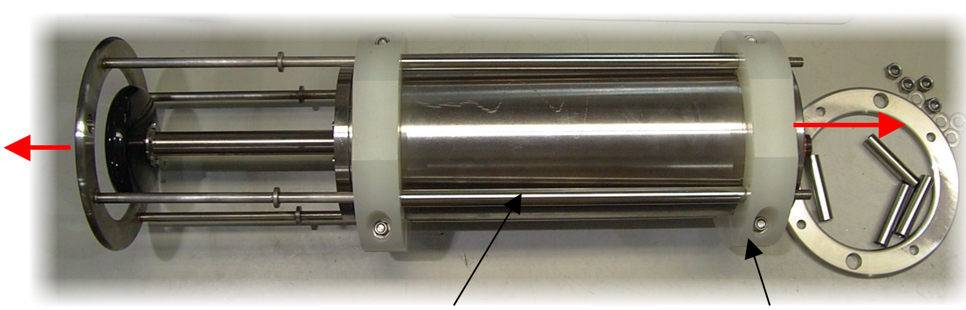


M10

Top cage ring

Spacer

2. Lift the instrument out of the cage, complete with the polypropylene mounting brackets. Take care to catch the central spacer tube as you lift.

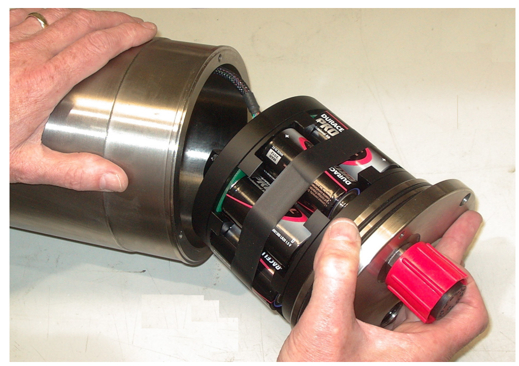


Central spacer tube

Polypropylene mounting bracket

3. Remove the 3 M5 x 20 socket cap screws in the connector bulkhead, using the Allen key provided. Note that on titanium instruments these screws are also titanium, and should be replaced with titanium screws if lost. Other materials may suffer galvanic corrosion and may be destroyed.

4. Without twisting or putting undue stress on the Subconn connector slide the bulkhead and attached battery pack out of the main housing. A slot between the tube and the bulkhead allows levering with a screwdriver if necessary. Take care not to scratch the bore of the tube.



5. A lead connects the battery pack to the electronics inside the tube. This may be disconnected at the battery pack if required, for ease.

6. Replace the batteries.

7. Check the condition of the bore seal o-rings, and apply a light coating of silicon grease. Ensure that both they and the anti-extrusion rings (titanium instruments only) sit in the groove correctly, and are free from damage. Replace them if necessary (refer to Section 4.2).

8. Reattach the connector to the electronics if necessary, and gently slide the battery pack back into the tube, ensuring that the fixing holes are correctly aligned. Again, take care not to scratch the bore.

9. Replace the 3 x M5 titanium screws, using a small amount of grease (supplied). Do not force the screws, just tighten firmly.

10. Finally, slide the instrument back into the protective cage, refitting the spacers and top ring. Secure the ring in place with the 4 x M10 nuts.

4.2 SEALS

The MIDAS ECM is kept watertight by using a double o-ring seal at each end of the housing, although the customer should have no reason to open any seal other than that at the battery end.

A set of spare o-rings is included with the equipment. If an o-ring needs replacing, be sure to use the correct size. If obtaining further spare o-rings from an alternative source, be sure to obtain the correct material (signified by the last 4 digits of the o-ring code number).

O-ring size: 200-158-4470

4.2.1 O-RINGS

To help preserve the watertight nature of the equipment, please observe the following guidelines:

- Ensure that all o-rings are free from cuts, abrasions or perishing.
- Ensure that all-o-rings are free from dirt, grit, sand, hair and other foreign objects.
- Whenever an o-ring seal is opened (e.g. when changing batteries), ensure that a light coating of silicon grease is applied to the o-ring before the seal is closed.
- Ensure that all o-ring protected seals are tightened.

5 WIRING INFORMATION

5.1 SWITCH PLUG

10 Way Male Subconn	Function
1	Link to Pin 10
2	NC
3	NC
4	NC
5	NC
6	NC
7	NC
8	NC
9	NC
10	Link to Pin 1

5.2 3M Y LEAD (RS232)

10 Way Male Subconn	3m Cable	1m Power Cable	4mm Banana Plugs	1m Data Cable	9 Way D Type	Function
1	WHITE	BLUE	BLACK			Power Ground
2	PINK	BROWN	RED			Power +V
3	N/C					
4	N/C					
5	N/C					
6	N/C					
7	GREY			YELLOW	2	RS232 Tx (To PC)
8	BLUE			BLUE	3	RS232 Rx (From PC)
9	GREEN			GREEN	5 (link to 1,6,8,9)	RS232 Ground
	SCREEN			SCREEN	SHELL	
10	YELLOW					Internal Battery Enable Link to RS232 Ground

5.3 3M SWITCHED Y LEAD (RS485 & RS422)

10 Way Male Subconn	3m Blue Polyurethane Cable	SWITCH BOX	1m White Cable	4mm Banana Plugs	1m Grey Cable	15 Way D Type	0.2m Grey Cable	9 Way D Type	Function
1	WHITE		BLUE	BLACK					Power Ground
2	PINK		BROWN	RED					Power +V
3	RED				RED	9			RS422 TxA
4	BLACK				BLACK	10			RS422 TxB
5	ORANGE				VIOLET	11			RS422 RxA
6	BROWN				BROWN	12			RS422 RxB
7	GREY				YELLOW		YELLOW	2	RS232 Tx (To PC)
8	BLUE				BLUE		BLUE	3	RS232 Rx (From PC)
9	GREEN				GREEN	5	GREEN	5 (link to 1,6,8,9)	RS232 Ground
	SCREEN								
10	YELLOW				SCREEN	SHELL	SCREEN	SHELL	
									Internal Battery Enable

5.4 ALTIMETER INTERFACE (OPTIONAL)

END 1: ALTIMETER SUBCON MCIL6M			END 2: TRITECH CONNECTOR (232 Version)			FUNCTION
WIRE LENGTH 400mm	PIN	WIRE COLOUR	WIRE COLOUR	PIN	WIRE LENGTH 600mm	
	1	BLACK	BLACK	4		SENSOR PWR (0V) / RS232 GND
	2	YELLOW	YELLOW	1		RS232 Rx In to Logger
	4	RED	RED	3		SENSOR PWR (+24V)
	6	n/c	n/c			
	3	BLUE	BLUE	2		RS232 Tx Out of Logger
	5	n/c	n/c			
			SCREEN	6		Chasis Ground

APPENDIX 1: FAQ'S

Can I make current profile measurements with the MIDAS ECM?

Yes you can, but not in the way that an ADCP will. The MIDAS ECM is a point current measurement device, i.e. it tells you the current speed and direction at its present location only. You can create a profile by lowering the instrument through the water column, but you have to do this slowly since the instrument will measure the water moving out of its way as it is lowered/raised.

I've fixed it to my ROV and I'm getting strange readings - why?

There are three possible causes of this. Firstly, check that nothing else on the ROV is physically interfering with the current sensor, for example a cable lying across it. Anything that intrudes on the electrical fields (which extend about 6cm from the face of the sensor) may affect the readings.

Secondly, check that the instrument is not positioned adjacent to a source of electro-magnetic interference such as a thruster or other motor. These can generate large electrical fields that may disrupt the EM sensor. Whilst it is designed to reject a certain amount of signal noise, this problem usually manifests as an intermittent fault, coinciding with the thrusters being turned on and off.

Finally, consider the possibility that a thruster from the ROV is actually ejecting water over the device, disrupting its measurement of the ambient current.

How close can I mount it to a solid structure?

There are two issues here. Firstly, the solid structure may actually adjust the local flow conditions, so it is a good idea to fix the instrument where it will be in the prevailing current as far as possible.

Secondly, if the structure is metallic, it may have some effect on the compass. The flux gate compass shouldn't be drawn towards the metal as a hand held compass might be, but large metal objects or electrical signal cables may actually alter the local magnetic field of the earth slightly. The best solution is to slowly move the instrument towards the structure and see how close it can be positioned before the readings are affected.

Is the EM sensor affected by growth?

Yes, growth will affect the sensor. There is a “measuring volume” of water that the sensor is looking at; the value it gives you is the speed of water flowing through that volume, which is best envisaged as small cylinder on the face of the sensor, about the size of half a can of soft drink. If there is growth on the sensor that intrudes on this “measuring volume”, then there will be less water flowing through that volume, and the output from the sensor will decrease. The effect will be proportional; a single barnacle on the sensor face will have a virtually undetectable effect, but a collection of mussels would be significant.

It is also important that the electrodes on the sensor face are kept in contact with the water, although we have noticed that marine growth normally avoids these.

How often does it need calibrating?

It is our experience that in the majority of cases, performance can be maintained by recalibrating at 2-yearly intervals. However, we are aware that many operators’ own QA requirements state annual recalibration, and it is true that most instruments are returned to us on a yearly basis.