Model 803 ECM Operating Manual

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Valeport Limited
St Peters Quay
Totnes
Devon, TQ9 5EW

Tel: +44 1803 869292
e mail: sales@valeport.co.uk | support@valport.co.uk
Web: www.valeport.co.uk

United Kingdom

1. Introduction

This document covers the operation of the Valeport Model 803 2 axis ROV Electromagnetic Current Meter. The instrument may be supplied with Titanium or Acetal underwater housings in a choice of configurations, and with a choice of communications options. This manual describes the operation of all versions.

The Model 803 ROV Current Meter is a unique instrument, providing ROV pilots with relative water velocity data in real time. It may be fitted to ROV's to provide actual through the water speeds, or fitted to Tether Management Systems to give a measurement of local flow conditions.

The Model 803 consists of a Valeport 2 axis electromagnetic flow sensor, with processing electronics capable of giving a variety of output formats for easy interface to almost any system.

The sensor should be mounted in clear flow on the ROV or TMS. When power is applied to the sensor, it measures the water velocity in 2 axes across the sensor surface. The data is updated at regular intervals (user selectable), to provide X and Y axis flow information: the X axis is the flow across the vehicle and the Y axis is flow into the vehicle.

The lightweight design of the instrument leads to minimal effect on the vehicle balance, yet permits a depth rating of up to 3000m (Titanium version).

Available as a complete self-contained instrument, or with a separate sensor and electronics package, or even as an OEM system, the Model 803 will appeal both to operators who wish to improve their existing vehicles, and to manufacturers who want to offer it as an additional item in the sensor package.

1.1. Description

The system comprises the following:

- Electronics housing containing the system electronics
- EM sensor mounted on the electronics housing.

Or

- Electronics housing containing the system electronics
- EM sensor mounted separately from the electronics housing

Or

- An OEM system

The flow is measured by a Valeport Series 800 2 Axis Electromagnetic sensor that uses the Faraday principle to measure the flow past the sensor in two orthogonal axes. The magnetic field is generated within the sensors by a coil, and the electronics detects the signal generated across two pairs of electrodes, one pair for each axis.

The electronics carry out all the signal detection and processing, including digital filtering and power/data isolation, and data output in digital format, in millimetres per second, metres per second or knots. The calibration is held within the electronics. An optional analogue output signal is also available.

1.2. Specification

1.2.1. Power Supply

- 7 to 29V DC | 2W nominal

1.2.2. Data Acquisition

Sample rate	Raw signal sampling at 96 Hz
Filter	Digital FIR filter, automatically set to suit data rate. Fixed time delay for output for each data rate [i.e. no frequency dependent phase shift]

Data Rate [Hz]	-3dB point [Hz]	Cut off [Hz]	Data delay [secs]	Data delay [samples]
16	3.56	8	0.3125	5
8	3.01	4	1.875	15
4	1.17	2	1.75	7
2	0.61	1	4	8
1	0.30	0.5	8	8

1.2.3. Data Output

Data Rate:	1Hz Factory default, but user settable to 1, 2, 4, 8 or 16 Hz. Output on demand mode also available
Communications:	RS232 or RS485 (factory set). Factory default is 4800 baud, 8 data bits, 1 stop bit, no parity bits. Baud rate can be changed by user to 2400, 4800, 9600 or 19200.
String format:	
Knots	sXX.XX<TAB>sYY.YY<cr><lf>
m/s	sX.XXX<TAB>sY.YYY<cr><lf>
mm/s	sXXXXX<TAB>sYYYYY<cr><lf>
	Where XXXXX, XX.XX or X.XXX and YYYYY, YY.YY or Y.YYY are the speeds for the X and Y axis (including leading zero) s is the sign(+ or -) Fixed length 15 character string
Range:	Standard range of +/- 10knots (+/-5m/s) on each axis
Resolution:	A/D resolution of 0.01kts (0.001m/s)
Accuracy:	± 1% of reading on each axis.
Analogue Output (option)	-5 to +5v for each channel. Reconstituted at +/- 12 bits from digital output and updated at the data rate (1 Hz default). Alternative formats are 0 – 10v (zero speed at 5v), or 0 – 5v (zero speed at 2.5v) for each channel.
Calibration	Held in EEPROM in unit.

1.2.4. Physical

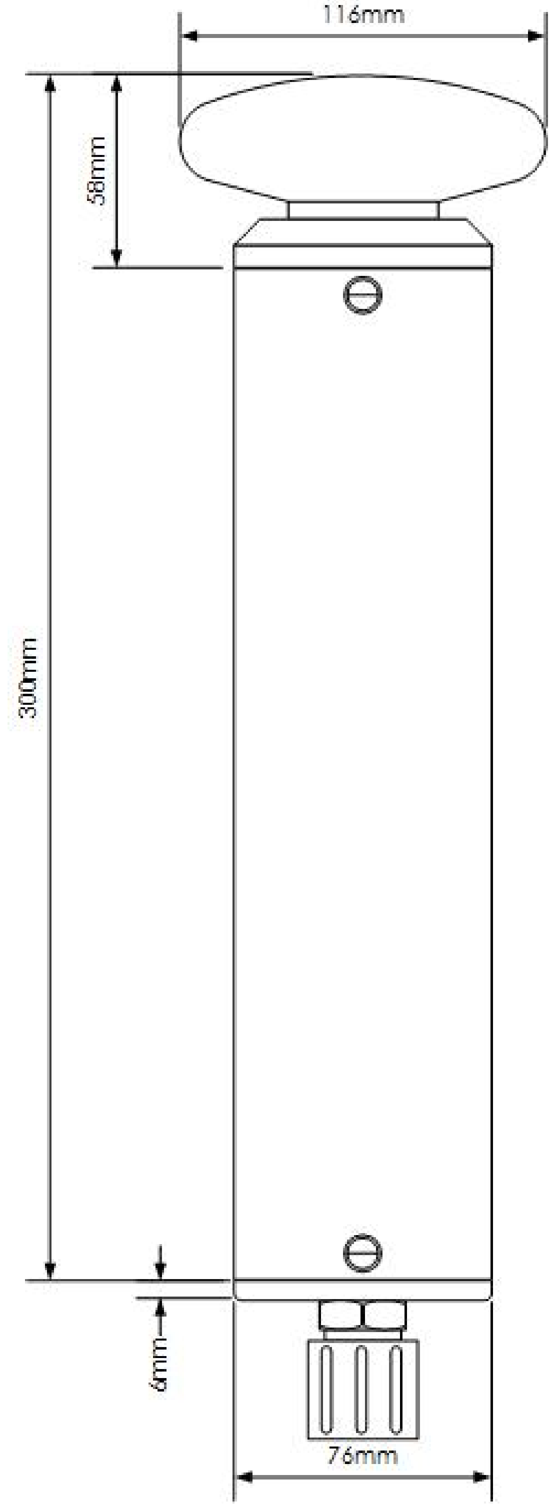
1.2.4.1. Electronics Housing

Integral Mount	Material:	Black Acetal or Titanium
	Size:	92mm Ø x 237mm length (Acetal)
		76mm Ø x 237mm length (Titanium)
	Depth Rating:	1000m (Acetal), 3000m (Titanium)
	Weight:	0.5 kg in water (Acetal), 3.5kg (Titanium)
Remote Sensor	Material:	Black Acetal or Titanium
	Size:	92mm Ø x 237mm length (Acetal)
		76mm Ø x 237mm length (Titanium)
	Depth Rating:	1000m (Acetal), 3000m (Titanium)
OEM Head and Electronics	Size:	76mm Ø x 250mm length
	Depth Rating:	3000m

1.2.4.2. Sensors

Integral Mount	**Size:**	11.5cm diameter
	Materials:	Polyurethane, silver and 316 stainless steel
Remote Sensor	**Size :**	11.5cm diameter
	Materials:	Polyurethane, silver and 316 stainless steel
OEM Head and Electronics	**Size :**	11.5cm diameter
	Materials:	Polyurethane, silver and 316 stainless steel

1.2.4.3. Dimensions

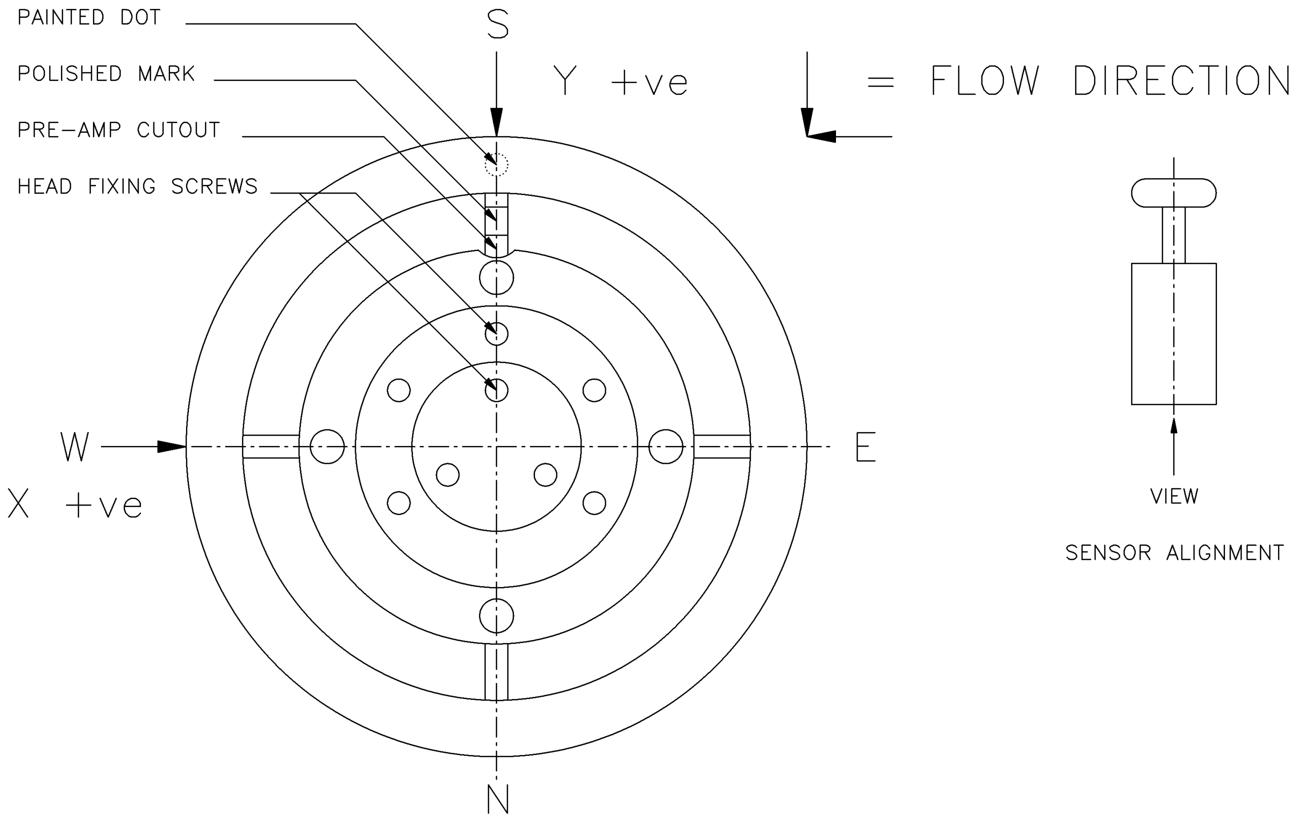


2. Installation and Operation

2.1. Hardware

2.1.1. Physical Installation

The EM sensor should be mounted in free flow and the X and Y axes are normal to the stem. The sensor has a flat surface on the Titanium sensor end cap, indicating that flow from that direction is Y +ve. The instrument should be positioned with this flat edge facing forwards. The flat edge takes the place of the polished mark or painted dot in diagram below.



The approximate measurement volume for the sensor is a cylinder projecting from the face of the sensor, of diameter 90mm (approximate electrode spacing), and height of 45mm. These dimensions should be taken into account when deploying the sensor.

The rear face of the sensor is fitted with an earthing ring for the EM system and should not therefore be covered in paint or tape.

If a sensor has been stored out of water for some time, when it is re-immersed the readings may take a few minutes to settle while the electrode contact with the water stabilises.

2.1.2. Electrical Connections

Pin out details are provided in Appendix 1.

2.1.3. Communications Leads

For test, setup and evaluation purposes, the unit should be connected to a PC using the interface lead (Y Lead) supplied.

The Model 803 can output digital data in either RS232 or RS485 formats. Units are supplied as standard with RS232 interface leads, but if the user intends to operate the instrument in RS485 mode, then an RS485 interface lead should be purchased in place of or as well as an RS232 lead.

The Y lead consists of a short Subconn type pigtail, which connects to the instrument. A small polycarbonate box sits in the centre of the lead, with two further cables exiting. The first is terminated with a 9 pin D type connector, which should be connected to the serial port of a PC. The second lead terminates in two 4mm banana pins for application of DC power – connect the red pin to +ve voltage, and the black pin to ground or –ve voltage.

The user will also notice that the polycarbonate box has 4 jack sockets in the side. These are for the analogue output option of the instrument, if fitted.

In RS485 systems, the polycarbonate enclosure contains an RS485/RS232 adaptor. The user will be able to communicate with the PC perfectly normally when using this interface unit, but the differential signal allows communications over long cable lengths.

2.2. Operation

The unit is made operational by applying power. A software program, ROVLog, is provided to allow easy setup and data display, but some users may wish to simply take the ASCII text output into other systems. Such users will need to be aware of how to setup and operate the unit using the following commands.

Note that instructions for operation of ROVLog are in a separate document.

2.2.1. Data Output Communications

The data output communications protocol is:
Selectable baud, 8 data bits, No Parity, 1 stop bit

In order to change the set up of the unit and enter the desired baud rate it is necessary to interrupt the unit and send the appropriate "#" code. For sensible data to be displayed the baud rate at which the unit is running needs to be known. The original factory baud rate is 19200. The baud rate may be found by disconnecting, scanning through the four possible baud rates (2400, 4800, 9600 and 19200) in terminal and re-connecting each time. It should be noted that high sampling rates and low baud rates will not work. This is due to clashes between the sampling and data output times.

1. Connect directly to the unit using a terminal program [such as HyperTerminal].
2. Switch on power and repeatedly send a "#" character to interrupt the unit. The unit will respond with a "«" when interrupted. This interrupting "#" command can be sent at any time when the unit is powered up in order to interrupt the unit.
3. The commands which are available are detailed below.
   Please note that <cr> denotes the Enter (or Return) key should be pressed.

2.2.2. Changing the Baud Rate

There are four possible baud rates that may be set. They are 2400, 4800, 9600 and 19200. To enter the baud rate having already interrupted the unit with the "#" code, send the command:

#210 followed by "**space**" and **one of the four possible baud rates** (e.g. 2400) then **<cr>**

To read the selected baud rate that has been sent, send the command:

#211 and the unit will send the baud rate (2400, etc)

If the unit has been set with a new baud rate, remember to set it into RUN before trying to obtain data, either by switching power off and on or by sending the **#028** command.

In RS485 systems, the baud rate of the RS485 adaptor unit located in the box of the configuration lead must also be altered before further commands can be given. This is necessary each time the baud rate is changed. Please see section 2.3.6 for details of changing the baud rate of the RS485 adaptor unit.

The unit will output data at the data rate which has been set, or on demand depending on which output mode has been selected. The output string format is shown below and is dependant upon the units last entered into the unit:

sXX.XX<TAB>sYY.YY<cr><lf>
or **sX.XXX<TAB>sY.YYY<cr><lf>**
or **sXXXXX<TAB>sYYYYY<cr><lf**

Where: XX.XX and YY.YY are the speeds for the X and Y axis in knots
X.XXX and Y.YYY are the speeds for the X and Y axis in M/s
XXXXX and YYYYY are the speeds for the X and Y axis in mm/s
s is the sign(+ or)
Leading zeroes are included, so the string is always fixed at 15 characters.

After the unit has been interrupted and any changes made, the unit can be put back into **RUN** mode either by switching power off and on again or by sending the command **#028**.

2.2.3. Changing Data Rate

To change the data rate, send the command:

#020 followed by a "**space**" and **2<cr>, 4<cr>, 8<cr> or 16<cr> as** required

To read the data rate that has been set, send the command:

#021 and the unit will send the data rate set [1, 2, 4, 8 or 16]

2.2.4. Changing the Data Format

To change the data format, (millimetres, metres and knots respectively) send the command:

#212 followed by a "**space**" and **mm<cr>, m<cr>, or knots<cr> as** required

To read the data format that has been set, send the command:

#213 and the unit will send the data format [m, mm, or knots]

2.2.5. Reading Serial Number and Software Version

To read the serial number of the unit, send the command:

#003 and the unit will send the serial number

To read the software version of the unit, send the command:

#015 and the unit will send the software version

2.2.6. Changing the Baud Rate of the RS485 Adaptor

The Model 803 can operate in RS232 or RS485 modes. If the user wishes to operate in RS485 mode, then an RS485/RS232 adaptor interface lead should be purchased in place of or as well as an RS232 lead.

The RS 485 interface lead contains a KK systems RS485/RS232 adaptor. This adaptor can be used to input and output data at different baud rates, so if the user had changed the baud rate of the Model 803 itself, it will also be necessary to change the baud rates of the adaptor.

Install the KDCFG.exe (supplied on the KK systems disk) program on to the PC.

Remove the lid of the Y lead box. With the Y lead connected to a PSU and the PC, turn the power on and press the push button on the side of the KD 485 unit until the EXE led flashes. Release the button and after a short while the EXE led should continue to flash. The KD 485 is then in its executive mode.

Start the KDCFG.exe program and select the port in use.

If successful the program will display the current settings of the KD485 ADE unit and allow the new baud rate to be set. The default settings are as follows

Port 1	Port 2	ADE fixed program
4800 BAUD	4800 BAUD	mode 1
8 bits	8 bits	
No parity	No parity	
1 stop bit	1 stop bit	
RX Disabled	RX Disabled	
TX Disabled	TX Disabled	

To enter a new baud rate change the number of baud in ports 1 and 2. After setting these parameters input the changes by selecting the Update button to re-program the unit with the desired baud rate.

With HyperTerminal or ROVLog configured to the appropriate baud rate then successful communications should be achieved.

For further details of the KD485 unit please consult the manufacturer's manual.

2.2.7. Optional Analogue Output

The Model 803 has an optional analogue output made available by the addition of an extra circuit board inside the instrument (board number 0801507A).

If fitted, this board gives a standard analogue output of +/- 5V full scale with +/- 11bit resolution, for each of the two channels (X and Y axes). This will give 0.01kts (0.001m/s) resolution for the +/- 10knots (+/-5m/s) range required.

Alternative voltage ranges are available on request.

The output connections are given in Appendix 3.

3. Filters

The data filter is a digital FIR filter and the unit automatically sets the filter to suit the selected data output rate. So that the 803 can be used for turbulent flow applications where users wish to recreate the flow characteristics, the filters are set so that the cut-off frequency is half the data rate. Attenuation [dB and Signal ratio] are given in both graphical and tabular form in Appendix 2.

A characteristic of the filters are that they have a fixed time delay for the output signal [i.e. phase delay is independent of signal frequency]. If data is being synchronised with other sources of data, then this delay needs to be taken into account in data processing – note that the delay times are exact multiples of the time between data points.

The filter characteristics can be summarised as follows:

Data Rate [Hz]	-3dB point [Hz]	Cut off [Hz]	Data delay [secs]	Data delay [samples]
16	3.56	8	0.3125	5
8	3.01	4	1.875	15
4	1.17	2	1.75	7
2	0.61	1	4	8
1	0.30	0.5	8	8

4. Selecting the Output Protocol

The 803 can output data via RS232 or RS485 communications, selectable by moving a single connector inside the instrument housing, or optionally in analogue format via an additional circuit board

To gain access to this connector, the housing for the electronics must be removed by unscrewing the 6 x M5 Titanium counter sunk slotted screws that hold the housing on the bulkhead and sensor end cap.

Undo the 3 screws at the connector end of the 803 and ease the end plate from the housing. There is an internal flexible cable at this end of the module. This requires disconnecting at the pye connector before proceeding to the electronics.

Unscrew the 3 screws at the EM sensor end of the housing and ease this from the Titanium housing. The boards should now be exposed.

4.1. RS232 Communications

To communicate with the instrument via RS232 communications the three way Harwin connector with the brown, yellow & orange wires should be connected to the 3 way connection on the 0801509D circuit board labeled RS232.

Do not adjust the position of the four way Harwin connector with the red and blue wires.

If the unit has the optional analogue output board fitted, a third connector with white, green and black wires should be connected to this extra board. *Otherwise this lead should be left disconnected*.

4.2. RS485 Communications

To communicate with the instrument via RS485 communications the three way Harwin connector with the brown, yellow & orange wires should be connected to the 3 way connection on the 0801509D circuit board labeled RS485.

Do not adjust the position of the four way Harwin connector with the red and blue wires.

If the unit has the optional analogue output board fitted, a third connector with white, green and black wires should be connected to this extra board. *Otherwise this lead should be left disconnected*.

4.3. Analogue Output

If the instrument has the optional 0801507A analogue output board fitted, then the 4 way Harwin connector with the green, white and black wires should be connected to the connector labeled J4 on this board. *Under no circumstances should this connector be connected to the J4 connector on the main 0801509D circuit board.*

5. Trouble Shooting

The following table is designed to assist the user with problems commonly experienced while using the instrument.

Symptom	Probable Cause	Remedy
No output	Incorrect comm port selected on PC	Check comm port choice in HyperTerminal or ROVLog
	Incorrect output format selected	Check that instrument is set to RS232 or RS485 output, as required.
	Insufficient power	If running on external power, voltage too low or external supply current limiting at switch on.
	Incorrectly fitted cable	Check connections and try again.
Illegible characters	Incorrect baud rate	In RS232 mode, check instrument baud rate and HyperTerminal or ROVLog baud rate In RS485 mode, check instrument baud rate, HyperTerminal or ROVLog baud rate, and KK systems RS485 adaptor baud rates.
Spurious Readings:	Proximity of sensor to interfering sources	Check location
	Growth on sensor	Clean sensor head at regular intervals.

Most faults are due to:
1. Incorrect communications settings.
2. Incorrectly connected leads.
3. Low battery power, low external voltage, current limit on external supply.

If in any doubt about the performance of the unit, please contact the factory at the address shown on the front page of this manual.

6. Maintenance

6.1. Cleaning

The EM sensor calibration will be affected by large amounts of marine growth as the water flow characteristics will be altered, so it advisable to periodically clean the sensor.

The sensing electrodes should not be covered in grease or any form of insulating substance.

6.2. Seal Sizes

Underwater Housing

End Cap, sensor end	2x O-Ring 200-143-4470
End Cap, sensor end	2x Anti-Extrusion Ring BS143
End Cap, connector end	2x O-Ring 200-143-4470
End Cap, connector end	2x Anti-Extrusion Ring BS143

SubConn Connector	2x O-ring 200-121-4470

7. Appendix 1 - Electrical Connections

7.1. RS232 Communications Lead

SubConn Cable		Analogue Signal (Sockets in cable box)	Power In (Banana Pins		RS232 9 way D type
Pin	**Function**	**Pin**	**Colour**	**Pin**	**Pin**
1	+ve Supply		Brown / Red	Red plug	
2	Analogue X	X			
3	Analogue Ground	X & Y			
4	0v supply		Blue / Black	Black Plug	
5	Analogue Y	Y			
6	RS232 ground				5 (link to 1,6,8,9)
7	RS232 out of unit				2
8	RS232 into unit				3

7.2. RS485 Communications Lead

SubConn Cable		Analogue Signal (Sockets in cable box)	Power In (Banana Pins)		RS232 9 way D type	
Pin	**Function**	**Pin**	**Pin**	RS232\RS485 Adaptor	**Function**	**Pin**
1	+ve Supply		Red plug			
2	Analogue X	X				
3	Analogue Gnd	X & Y				
4	0v supply		Black Plug			
5	Analogue Y					
6	RS485B				RS232 Out of unit	2
7	RS485 Gnd				RS232 Gnd	5 (link to 1,6,8,9)
8	RS485A				RS232 Into Unit	3

Note that there is no accepted standard for the orientation of RS485 A and B functions. The system will work with the communications lead provided, but if the user is fitting a pigtail and operating the unit via an independent RS485 system, it may be necessary to swap the RS485 A and B connections to communicate successfully.

7.3. RS232 Communications Lead with 4-20mA Analogue Output

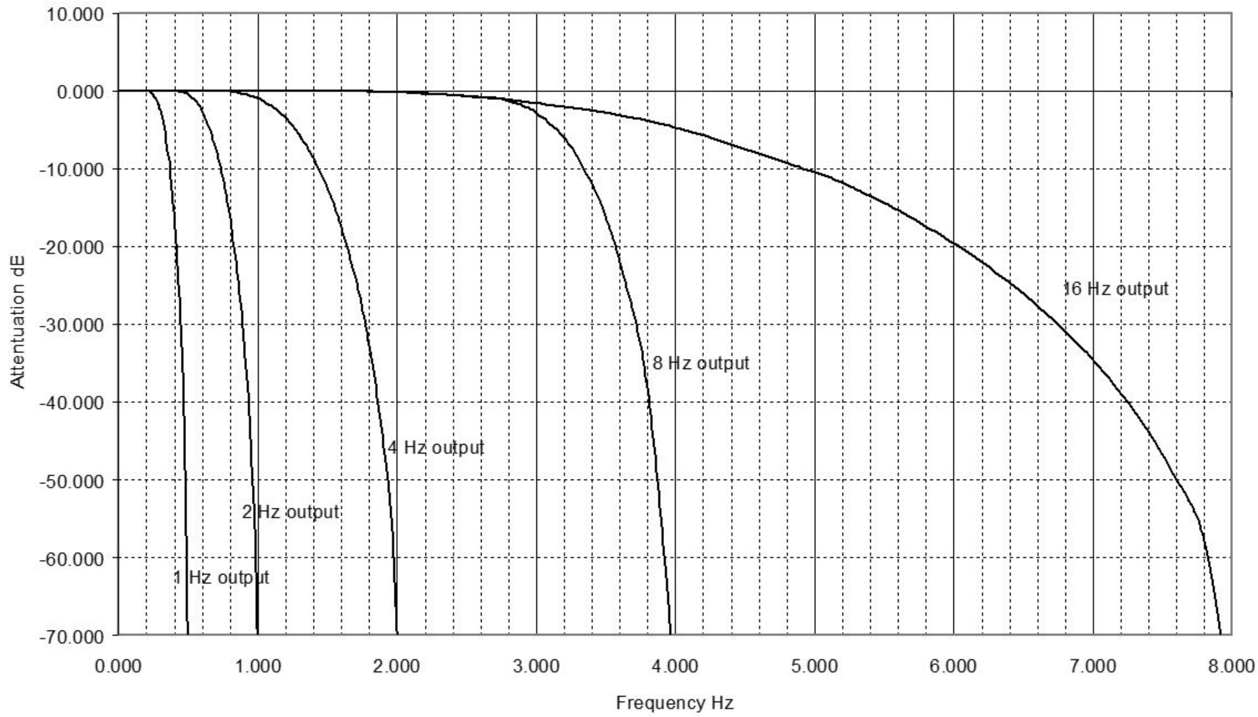
MCIL10F SubConn Cable		Analogue Signal (Sockets in cable box)	Power In (Banana Plugs)	RS232 9 way D type
Pin	**Function**	**Pin**	**Pin**	**Pin**
1	0v Supply		Black plug	
2	+ ve supply		Red plug	
3	Analogue X +ve	4mm socket Red X Right		
4	Analogue X -ve	4mm socket Red X Right		
5	Analogue Y +ve	4mm socket Red Y left		
6	Analogue Y -ve	4mm socket Black Y left		
7	RS232 out of unit			2
8	RS232 into unit			3
9	RS232 ground			5 (link to 1,6,8,9)
10	No connection			

7.4. RS232 Communications Lead with 4-20mA Analogue Output Pigtail

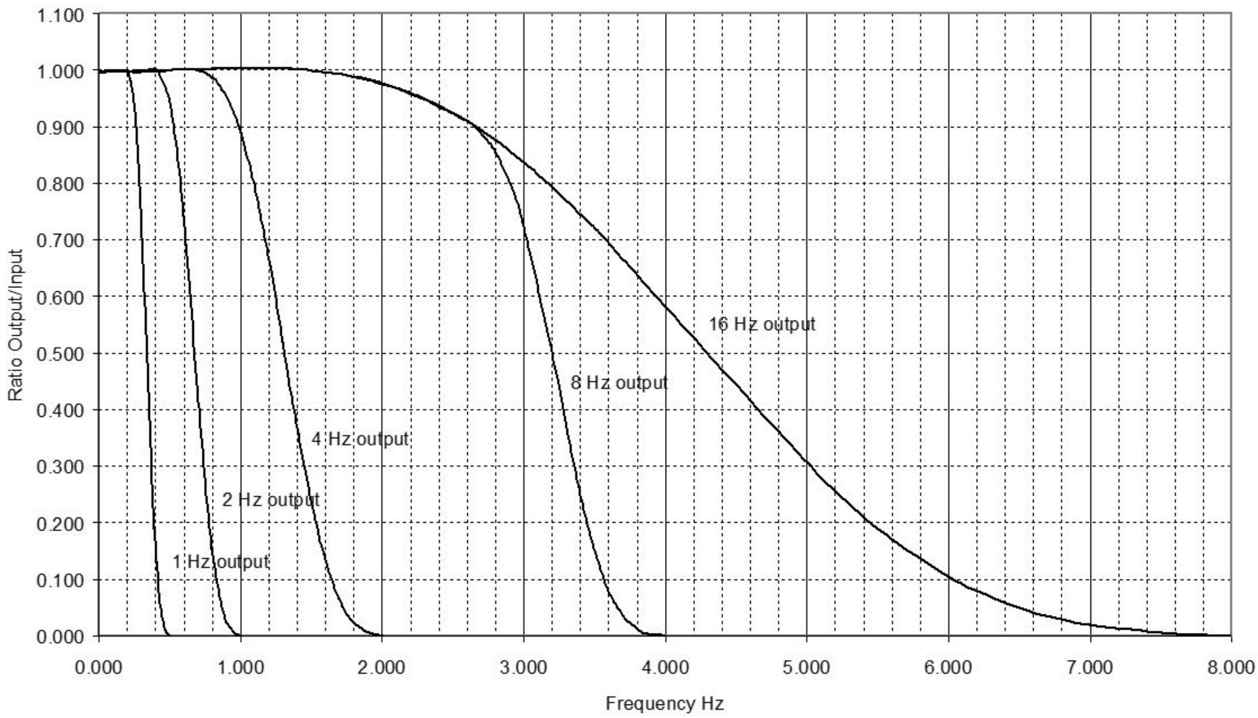
SubConn Cable		Blue 10 core
Pin	**Function**	**Pin**
1	0v Supply	1
2	+ ve supply	2
3	Analogue X +ve	3
4	Analogue X -ve	4
5	Analogue Y +ve	5
6	Analogue Y -ve	6
7	RS232 out of unit	7
8	RS232 into unit	8
9	RS232 ground	9
10	No connection	10

8. Appendix 2 - Filter Characteristics

8.1. 801/802/803 Digital Filter Characteristics - Attenuation dB



8.2. 801/802/803 Digital Filter Characteristics - Signal Ratio



16 Hz	-3 dB point =	3.56 Hz
Delay =	0.3125 Sec	5 Samples
Hz	dB	Ratio
0.000	-0.029	0.997
0.094	-0.028	0.997
0.188	-0.026	0.997
0.282	-0.022	0.998
0.376	-0.016	0.998
0.470	-0.010	0.999
0.564	-0.002	1.000
0.658	0.005	1.000
0.752	0.013	1.001
0.845	0.019	1.002
0.939	0.025	1.003
1.033	0.028	1.003
1.221	0.027	1.003
1.503	-0.005	0.999
1.785	-0.092	0.989
2.067	-0.253	0.971
2.536	-0.734	0.919
3.006	-1.551	0.836
3.476	-2.773	0.727
3.570	-3.072	0.702
4.039	-4.870	0.571
5.072	-10.913	0.287
5.354	-13.163	0.220
5.636	-15.728	0.164
6.011	-19.714	0.103
6.294	-23.208	0.069
6.575	-27.232	0.043
6.857	-31.926	0.025
7.045	-35.532	0.017
7.327	-41.932	0.010
7.609	-50.214	0.003
7.797	-57.770	0.001
8.070	-86.890	0.000

8 Hz	-3 dB point =	3.01 Hz
Delay =	1.875 Sec	15 Samples
Hz	dB	Ratio
0.000	-0.031	0.997
0.094	-0.029	0.997
0.188	-0.025	0.997
0.282	-0.020	0.998
0.376	-0.014	0.998
0.470	-0.009	0.999
0.564	-0.003	1.000
0.658	0.003	1.000
0.752	0.012	1.001
0.845	0.020	1.002
0.939	0.027	1.003
1.033	0.030	1.003
1.221	0.025	1.003
1.503	-0.004	0.999
1.785	-0.093	0.989
2.067	-0.252	0.971
2.192	-0.349	0.960
2.301	-0.461	0.948
2.411	-0.572	0.934
2.505	-0.689	0.923
2.599	-0.831	0.909
2.630	-0.877	0.904
2.708	-0.944	0.886
2.802	-1.353	0.854
2.912	-1.986	0.795
2.990	-2.694	0.735
3.209	-6.214	0.488
3.412	-12.523	0.236
3.600	-22.029	0.079
3.804	-38.957	0.011
3.992	-75.487	0.000

4 Hz	-3 dB point =	1.17 Hz
Delay =	1.75 Sec	7 Samples
Hz	dB	Ratio
0.000	-0.019	0.998
0.094	-0.020	0.997
0.188	-0.024	0.997
0.282	-0.028	0.997
0.376	-0.026	0.997
0.470	-0.015	0.998
0.564	0.005	1.001
0.658	0.011	1.001
0.752	-0.038	0.995
0.845	-0.215	0.975
0.939	-0.601	0.933
0.986	-0.904	0.901
1.002	-1.024	0.889
1.033	-1.294	0.862
1.111	-2.172	0.778
1.158	-2.855	0.720
1.205	-3.668	0.656
1.252	-4.625	0.588
1.299	-5.736	0.517
1.315	-6.143	0.493
1.393	-8.482	0.376
1.503	-12.711	0.232
1.597	-17.421	0.135
1.707	-24.581	0.059
1.800	-32.761	0.023
1.910	-46.628	0.005
1.973	-59.831	0.001
2.004	-72.505	0.000

2 Hz	-3 dB point =	0.61 Hz
Delay =	4 Sec	8 Samples
Hz	dB	Ratio
0.000	-0.048	0.995
0.031	-0.044	0.995
0.063	-0.033	0.997
0.094	-0.021	0.998
0.125	-0.011	0.999
0.157	-0.009	0.999
0.188	-0.016	0.998
0.219	-0.027	0.997
0.251	-0.036	0.995
0.266	-0.039	0.995
0.282	-0.039	0.995
0.313	-0.030	0.997
0.360	-0.003	1.000
0.407	-0.008	0.999
0.501	-0.516	0.942
0.595	-2.487	0.751
0.704	-7.863	0.405
0.798	-16.289	0.154
0.892	-30.394	0.030
0.970	-52.279	0.002
0.986	-60.253	0.001
1.002	-74.896	0.000

1 Hz	-3 dB point =	0.30 Hz
Delay =	8 Sec	8 Samples
Hz	dB	Ratio
0.000	-0.043	0.996
0.016	-0.040	0.996
0.031	-0.033	0.997
0.047	-0.027	0.998
0.063	-0.022	0.998
0.078	-0.018	0.998
0.094	-0.024	0.998
0.110	-0.030	0.997
0.125	-0.034	0.996
0.141	-0.033	0.996
0.157	-0.025	0.997
0.172	-0.015	0.998
0.188	-0.014	0.998
0.204	-0.040	0.995
0.227	-0.193	0.978
0.251	-0.579	0.935
0.274	-1.317	0.859
0.298	-2.527	0.747
0.329	-5.069	0.558
0.360	-8.943	0.357
0.391	-14.515	0.188
0.431	-24.822	0.058
0.470	-41.659	0.009
0.501	-74.410	0.000

9. Appendix 3 - Configuration Codes

Code	Followed By Space and	Operation
#000	Password	Sends the password for setting serial number etc
#003	Nothing	Returns the Serial number of the unit
#004	New_serial_no<cr>	Changes serial no. in serial eeprom to new_serial_no floating point number do not use decimal point serial numbers at the moment.
#007	Output_Format	Sets the output format of the unit to Cal or Nocal
#015	Nothing	Returns the software version of the unit
#020	Sample_rate <cr>	Sets the sample rate of the unit to 2, 4 ,8 or 16 Hz
#021	Nothing	Returns the sample rate of the unit
#028	Nothing	Sets the unit into run mode
#030	Nothing	Returns the output format of the unit [Cal or Nocal]
#170	X_Gain_offset	Sets the zero offset for channel X
#171	Y_Gain_offset	Sets the zero offset for channel Y
#172	Nothing	Returns the zero offset for channel X
#173	Nothing	Returns the zero offset for channel Y
#174	X_Gain_Factor<cr>	Sets the GAIN_FACTOR for channel X
#175	Y_Gain_Factor<cr>	Sets the GAIN_FACTOR for channel Y
#176	Nothing	Returns the GAIN_FACTOR for channel X
#177	Nothing	Returns the GAIN_FACTOR for channel Y
#180	Tx_Mode	Sets the transmit mode to TX (Always) Or TXDEMAND (Request)
#181	Nothing	Returns the transmit mode of the unit
#184	Em_X_Scaling	Sets the resolution
#185	Nothing	Returns the scaling for X
#186	Em_Y_Scaling	Sets the resolution
#187	Nothing	Returns the scaling for Y
#190	Nothing	Returns the hydro calibration for the X axis
#191	Nothing	Returns the hydro calibration for the Y axis
#192	X_Axis_Calibration	Sets the X Axis Hydro Calibration
#193	Y_Axis_Calibration	Sets the Y Axis Hydro Calibration
#194	Nothing	Returns X DAC cal.
#195	Nothing	Returns Y DAC cal.
#196	X_DAC_cal	Sets X DAC cal.
#197	Y_DAC_cal	Sets Y DAC cal.
#203	Dac_counts	Sets both dac's to output voltage at desired counts.
#204	Speed	Sets both dac's to output voltage for desired speed.
#210	Baud Rate <cr>	Sets the baud rate to 2400, 4800, 9600, 19200

Code	Followed By Space and	Operation
#211	Nothing	Returns baud rate set into unit
#212	Output Format (units) <cr>	Sets the output format units- mm (mm/s), m (m/s) or knots
#213	Nothing	Returns Output Format units mm/s, m/s or knots
#214	X_DAC_Cal_Knots<cr>	Sets X DAC cal for Knots
#215	Nothing	Returns X DAC cal for Knots.
#216	Y_DAC_Cal_Knots<cr>	Sets Y DAC cal for Knots.
#217	Nothing	Returns DAC cal for Knots.
#218	Speed	Sets both DAC output voltages for desired speed (only used when in knots output mode). Factory set.

10. Appendix 4 - Calibration

The calibration certificates for the X and Y channels are provided separately from this manual together with the instrument's warranty certificate. The calibration certificates also include the serial numbers of the electronics unit and sensor. Calibrations are normally carried at the 2 Hz output rate, and at speeds up to 1 M/sec, and linear extrapolation is used above that speed [the sensors have a linear characteristic at higher speeds].

The calibration function of the EM sensor has 3 elements to it:

Hydrodynamic Calibration

This is the "shape" of the calibration curve and is a function of the type and size of sensor. The equation used is based on normalised output of zero counts at zero speed and a standard number of counts per metre/sec [usually 1000]. The hydrodynamic calibration takes the form of a number of straight line fits and the number of lines used and the slope, offset and break point for each line is shown on the calibration sheet. The same calibration is used for +ve and –ve flow.

Zero Offset

This is the number of counts [output before calibration conversion output] at zero flow, and is particular to a sensor, sensor axis and electronics. The zero counts are shown on the calibration sheet.

Gain Factor

This is the factor by which the sensors counts per metre/sec must be multiplied to normalise it to the standard counts/metre per second [e.g. 1000 counts/metre/sec]. The gain factor is particular to a sensor, sensor axis and electronics and is shown on the calibration sheet.

The complete calibration function takes off the Zero Offset from the raw data count, multiples the result by the Gain Factor and then calculates the flow from the Hydrodynamic Calibration.

Users can read the calibration factors by sending the following control codes [after interrupting the unit]:

#172	Reads the X channel Zero Offset in counts
#173	Reads the Y channel Zero Offset in counts
#176	Reads the X channel Gain Factor
#177	Reads the Y channel Gain Factor
#190	Reads the X channel Hydrodynamic Calibration
#191	Reads the Y channel Hydrodynamic Calibration

The calibration factors can be changed, but users should fully understand what they are doing before doing this.

Calibrations should be carried out with the unit in NOCAL mode, in which no calibration calculations are carried out and the unit outputs raw data counts. To move in to or out of this mode:

#007 NOCAL	Sets the unit into NOCAL mode [raw counts output]
#007 CAL	Sets the unit into CAL mode [Speed output]
and	
#030	Reads if unit is set in CAL or NOCAL mode

To alter calibration coefficients, the following commands and data entries can be sent:

Code	Followed by "space" and	Operation
#170	X counts at zero flow<cr>	Sets the X channel Zero Offset in counts
#171	Y counts at zero flow<cr>	Sets the Y channel Zero Offset in counts
#174	X gain factor<cr>	Sets the X channel Gain Factor
#175	Y gain factor<cr>	Sets the Y channel Gain Factor
#192	X channel Hydro cal<cr>	Sets the X channel Hydrodynamic Calibration
#193	Y channel Hydro cal<cr>	Sets the Y channel Hydrodynamic Calibration

The format of the Hydrodynamic Calibration is as follows:

Calibration Function No.	OPERATION
1	One straight line fit
2	Two straight line fit
3	Three straight line fit
4	Four straight line fit
5	Five straight line fit

Thus, for example, a three line fit calibration for the X channel will be entered in the format shown below (note the single space between each value):

#192 3 Coefficient1 Offset1 Max_lt1 Coefficient2 Offset2 Max_lt2 Coefficient3 Offset3 Max_limit3<cr>

1. The Coefficient is the slope of the straight line segment in engineering units per count.

2. The Offset is the Y axis [engineering value output] intercept at zero counts for the straight line segment

3. The Max_lt is the maximum counts [must be a whole number] up to which, but not including, the straight line operates .

The first straight line starts from 0 up to Max_lt1 in A/D counts, but not including it.
The second straight line starts from Max_lt1 and including it, up to Max_lt2 but not including it.
The Third straight line starts from Max_lt2 and including it, up to Max_lt3 but not including it.