VALEPORT LIMITED

Model 802
2 Axis Electromagnetic Current Meter
Desktop Control Display Unit Versions

Operation Manual

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1 INTRODUCTION

This document covers the operation of the Valeport Model 802 2 axis Electromagnetic Current Meter with Desktop Control Display Unit (CDU).

The Model 802 is the latest version of Valeport's successful 800 Series of electromagnetic current meters. Using state of the art electronics design techniques, we have produced a highly accurate, stable, solid state instrument that is greatly reduced in size and power consumption from earlier versions. These improvements, together with a selection of sensor shapes and a versatile range of electronics packages ensure that the Model 802 is the instrument of choice in a variety of applications, from sediment transport studies to modelling flow patterns or real time monitoring of current flow.

1.1 Features

High accuracy
High stability
Low noise
Low power consumption
Choice of sensor shapes
Choice of configurations
Digital or analogue output
Wide measurement range
Corrosion resistant materials

1.2 Applications

Sediment transport studies
Hydraulic modelling
Open channel current measurement
Ship's log
ROV / AUV speed
Fixed site current measurement

2 EQUIPMENT

2.1 Standard 802 System

The equipment supplied is defined in the equipment checklist, APPENDIX 2.
The standard 802 system has a choice of sensors and electronics packages and comprises the following:

2.1.1 Sensors with Control Display Units

2 axis EM sensor and pre-amps c/w 3m cable and connectors, CDU c/w RS232 o/p, operation manual and transit case

0802002 System c/w 3.2cm spherical sensor
0802003 System c/w 5.5cm discus sensor
0802004 System c/w 5.5cm spherical sensor
0802005 System c/w 11cm discus sensor
0802006 System c/w 17cm annular sensor
0802025 Analogue output option for control unit

2.1.2 Sensors only

08020323.2cm Discus sensor and stem c/w flange
08020333.2cm Spherical sensor and stem c/w flange
08020345.5cm Discus sensor and stem c/w flange
08020355.5cm Spherical sensor and stem c/w flange
080203611cm Discus sensor and stem c/w flange
0802037 Annular sensor and stem c/w flange
0802044 Flush series - shaped to suit outline of body in which they are fitted

2.1.3 Sensor assemblies c/w Pre-amps and Connectors

0802038 3.2cm Discus sensor and stem c/w flange and pre-amp assembly with bulkhead connector
0802039 3.2cm Spherical sensor and stem c/w flange and pre-amp assembly with bulkhead connector
0802040 5.5cm Discus sensor and stem c/w flange and pre-amp assembly with bulkhead connector
0802041 5.5cm Spherical sensor and stem c/w flange and pre-amp assembly with bulkhead connector
0802042 11cm Discus sensor and stem c/w flange and pre-amp assembly with bulkhead connector
0802043 Annular sensor and stem c/w flange and pre-amp assembly with bulkhead connector
080204511cm Discus sensor c/w stainless steel Ship's Log Spar/Flange (as per GECO issue)

2.1.4 Cable and Connector assemblies

08020463m sensor cable c/w connectors (EM sensor to CDU or electronics)
0802047 Sensor cable, per metre
0150027 Underwater line connector, sensor cable
0150028 Bulkhead connector (underwater housing), for sensor
08020483m Power in (volts) / signal out (RS232 / Analogue) cable
0150047 Signal cable, per metre
0150021 Underwater line connector - signal cable
0150022 Bulkhead connector (underwater housing) for signal

2.1.5 Electronics assemblies

0802026 Standard board set
0802027 Standard board set (OEM) c/w wiring loom and connector
0802025 Analogue output board
0802028 Pre - amp board set
0802029 CDU
0802030 Desk top display unit
0802031 Standard board set in underwater housing c/w connectors

2.1.6 Spares

0801011 Transit case
0802803 Manual

2.2 Specification

2.2.1 Data acquisition

Sample rate: Raw signal sampling at 96 Hz
Data rate: 2Hz only when using the LCD display. Selectable 1,2, 4, 8 or 16Hz when bypassing the LCD screen and entering Direct EM communications mode.

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]	Delay [Secs]
16	3.51	8	0.5
8	2.56	4	2.25
4	1.31	2	4
2	0.27	1	3.5
1	0.14	0.5	8

2.2.2 Data output

Output rate: User settable when bypassing the LCD screen and entering Direct EM communications mode to free run at data rate [1, 2, 4, 8 or 16 Hz] or only output latest data value [at the data rate set] on demand. [Only available via PC Communications]
When using the LCD display facility, he EM system is set to measure the flow twice every second, and calculates the real time flow every second as the average of the half-second readings.

Communications: RS232. 19200 baud. 8 data bits. No parity. 1 stop bit.

String format: sXXXX<TAB>sYYYY<cr><lf>

Where XXXX and YYYY are the speeds for the X and Y axis and
s is the sign(+ or-). Factory set calibration is in mm/sec
Leading zeroes are included.

Range: Standard range of +/- 5000 mm/sec on each axis [other ranges optional]
Resolution: A/D resolution of 1 mm/sec
Accuracy: ± 5 mm/sec plus 1% of reading on each axis [averaged data]

2.2.3 Analogue output [optional]

Reconstituted at +/- 12 bits from digital output and updated at the data rate set. ± 5V for each axis for full scale [optional 0 – 10V, with zero at 5V, for each axis].

2.2.4 Calibration

Held in EEPROM in unit.

2.2.5 Power Supply

External 12 VDC. Internal: 8 alkaline C cells
Maximum current at 12 VDC is 230 – 240 mA (backlight off)

2.2.6 Physical

Electronics housing: Desktop unit 305mm W x 280mm D x 133mm H.

Sensors: Size dependent on sensor

Materials: 316 stainless steel stems, Polyurethane sensor mouldings, and Titanium support arms for annular sensors.

3 DESCRIPTION

The system comprises the following:

Desktop CDU containing the system electronics

EM sensor, either mounted remotely with integral pre-amp housing and an interconnection cable to CDU

Power in cable for CDU

RS232 cable for CDU

Analogue out cable for CDU

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 is in engineering units. The calibration is held within the electronics in the CDU.

The system is calibrated as a combination of sensor with electronics in the CDU.

The system will operate in any conducting fluid, and the conductivity does not effect calibration. At low conductivities the signal will, however, become noisier. A simple check is to check the noise in still water.

The CDU has bulkhead connectors for the data interface to PC, analogue data out, power in and the sensor. The CDU is designed for desktop operation and is not waterproof.

The EM system measures the flow twice every second, and calculates the real time flow every second as the average of the half-second readings. The REAL TIME display is updated every second. The average speeds are computed as the average of the one second real time values over the averaging period which has been set [maximum period of 600 seconds]. If an average period is terminated early, then the calculation is based on the time since the average was started.
The flow reading has a directional component. This can be displayed on the CDU in Polar or Cartesian formats. See Figure in 4.1 for convention used.

The STANDARD DEVIATION [SD] is calculated from real time samples taken during the averaging period and gives an indication of the quality of the measurements. A high standard deviation indicates either a high variability in the flow, or the probe has not been held steady during the measurement.

There are 3 types of Averaging Modes**:**

Fixed average

The unit performs one average over the period set. At the end of the averaging period the unit stops and displays the average and SD. It will commence another averaging period when requested by pressing START.

Free running

This is fixed average with automatic restart of averaging period at the end of each period. The average and SD from the previous period are displayed and held during the subsequent period, until updated.

Moving average

The average and SD are calculated over the averaging period set, and is updated every second. When STOP is selected, the display is frozen at the last average.

If the measurement period is terminated prematurely [by pressing the STOP key], the average values and standard deviation will be calculated over the time since the start of the current averaging period.
The data [speed, SD, averaging period] is available for direct interfacing to a PC in real time [see Section 5.6.3. for interfacing information]:

In fixed average a data string of average data is outputted at the end of averaging period.
In moving average the last saved average is outputted when the user presses the STOP key.
In free running mode the data is outputted at the end of each fixed average period and also when the user presses the STOP key.

The CDU can optionally log up to 999 averages for subsequent display and/or transfer to a PC.

3.1 D/A Conversion

The analogue output is +/- 5V full scale with +/- 11bit resolution. This will give 1mm/sec resolution for the +/- 2m/sec range required.

The output connections are given in APPENDIX 1.

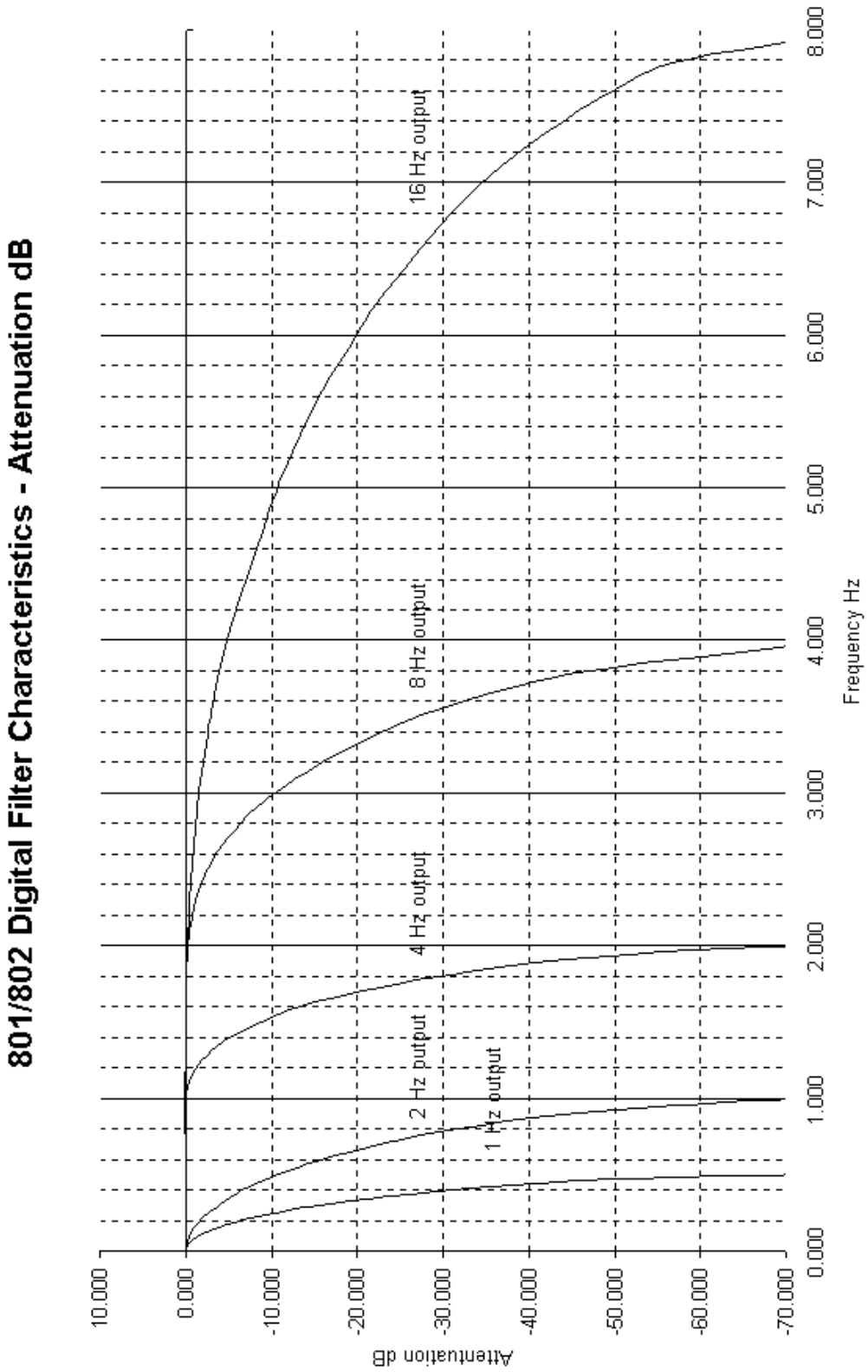
3.2 Filters

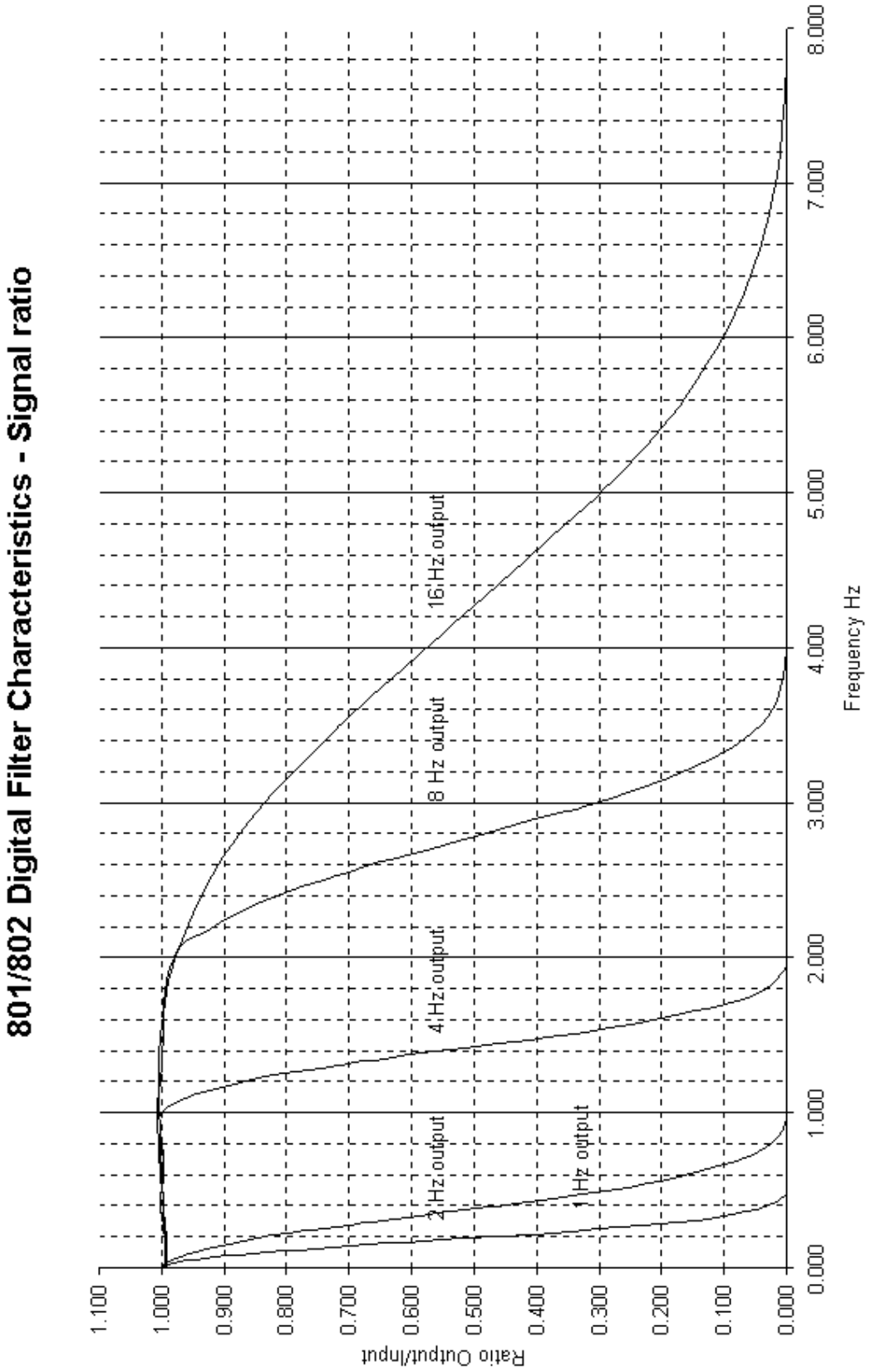
The data filter is a digital FIR filter and the unit automatically sets the filter to suit the selected data output rate. So that the 802 can be used for turbulent flow applications where users wish to recreate the flow characteristics, the filters are set so that the cut-off frequency is half the data rate. Attenuation [dB and Signal ratio] are given in both graphical and tabular form. See Over.

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]	Delay [Secs]
16	3.51	8	0.5
8	2.56	4	2.25
4	1.31	2	4
2	0.27	1	3.5
1	0.14	0.5	8


801/802 Digital Filter Characteristics - Attenuation dB
16 Hz output
8 Hz output
4 Hz output
2 Hz putput
1 Hz output
10.000
0.000
-10.000
-20.000
-30.000
-40.000
-50.000
-60.000
-70.000
Attenuation dB
0.000
1.000
2.000
3.000
4.000
5.000
6.000
7.000
8.000
Frequency Hz


801/802 Digital Filter Characteristics - Signal ratio
Ratio Output/Input
1.100
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
Frequency Hz
0.000
1.000
2.000
3.000
4.000
5.000
6.000
7.000
8.000
16 Hz output
8 Hz output
4 Hz output
2 Hz output
1 Hz output

	16 Hz	
Delay 0.5 secs		
Hz	dB	Ratio
0.000	-0.040	0.995
0.094	-0.039	0.995
0.188	-0.036	0.995
0.282	-0.031	0.996
0.376	-0.024	0.997
0.470	-0.016	0.998
0.564	-0.007	0.999
0.658	0.003	1.000
0.752	0.012	1.001
0.845	0.022	1.002
0.939	0.030	1.003
1.033	0.036	1.004
1.221	0.040	1.004
1.503	0.013	1.001
1.785	-0.072	0.991
2.067	-0.233	0.973
2.536	-0.727	0.919
3.006	-1.569	0.834
3.476	-2.826	0.722
3.570	-3.133	0.697
4.039	-4.973	0.564
5.072	-11.100	0.278
5.354	-13.365	0.215
5.636	-15.937	0.159
6.011	-19.910	0.100
6.294	-23.393	0.068
6.575	-27.383	0.043
6.857	-32.023	0.025
7.045	-35.570	0.016
7.327	-41.877	0.008
7.609	-50.015	0.003
7.797	-57.445	0.001
8.070	-86.830	0.000

	8 Hz	
Delay 2.25 secs		
Hz	dB	Ratio
0.000	-0.070	0.991
0.094	-0.128	0.991
0.188	-0.061	0.992
0.282	-0.050	0.994
0.376	-0.031	0.996
0.470	-0.012	0.998
0.564	0.008	1.001
0.658	0.028	1.003
0.752	0.043	1.004
0.845	0.053	1.005
0.939	0.055	1.006
1.033	0.049	1.006
1.221	0.024	1.002
1.503	-0.012	0.998
1.785	-0.044	0.994
2.067	-0.333	0.971
2.192	-0.697	0.923
2.301	-1.159	0.874
2.411	-1.841	0.809
2.505	-2.572	0.742
2.599	-3.562	0.664
2.630	-3.913	0.637
2.708	-4.948	0.568
2.802	-6.390	0.480
2.912	-8.371	0.381
2.990	-10.075	0.314
3.209	-15.891	0.160
3.412	-23.287	0.067
3.600	-32.567	0.023
3.804	-47.033	0.004
3.992	-75.164	0.000

	4 Hz	
Delay 4.0 secs		
Hz	dB	Ratio
0.000	-0.073	0.991
0.094	-0.065	0.992
0.188	-0.041	0.994
0.282	-0.012	0.998
0.376	0.009	1.001
0.470	0.008	1.001
0.564	-0.011	0.998
0.658	-0.028	0.996
0.752	-0.013	0.998
0.845	0.036	1.004
0.939	0.059	1.006
0.986	0.024	1.003
1.002	0.002	1.000
1.033	-0.069	0.992
1.111	-0.411	0.953
1.158	-0.764	0.915
1.205	-1.253	0.865
1.252	-1.899	0.803
1.299	-2.723	0.731
1.315	-3.040	0.704
1.393	-4.983	0.564
1.503	-8.836	0.361
1.597	-13.427	0.213
1.707	-20.740	0.092
1.800	-29.386	0.034
1.910	-44.450	0.006
1.973	-59.180	0.001
2.004	-75.203	0.000

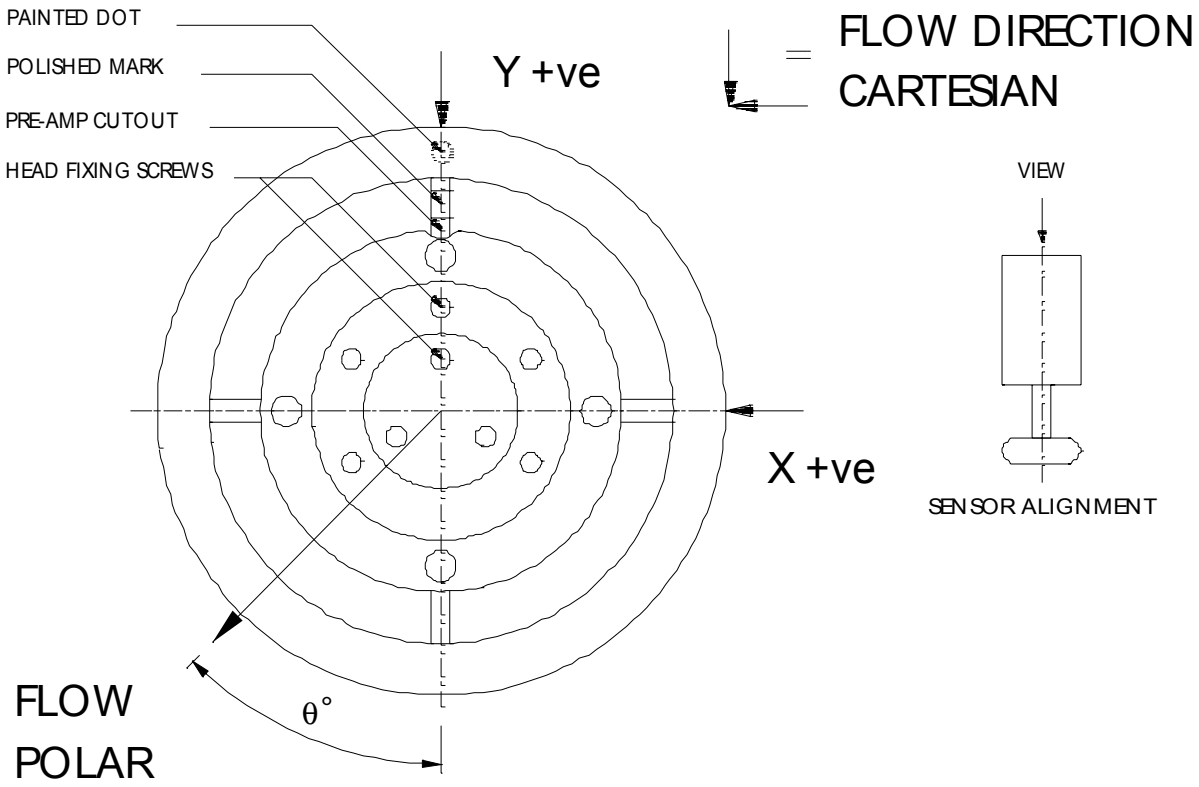
	2 Hz	
Delay 3.5 secs		
Hz	dB	Ratio
0.000	-0.008	0.998
0.031	-0.047	0.994
0.063	-0.165	0.980
0.094	-0.361	0.958
0.125	-0.637	0.928
0.157	-0.993	0.891
0.188	-1.431	0.847
0.219	-1.952	0.798
0.251	-2.557	0.743
0.266	-2.891	0.716
0.282	-3.248	0.687
0.313	-4.027	0.628
0.360	-5.371	0.538
0.407	-6.929	0.450
0.501	-10.763	0.289
0.595	-15.694	0.164
0.704	-23.213	0.069
0.798	-31.813	0.026
0.892	-43.845	0.006
0.970	-60.498	0.001
0.986	-66.168	0.000
1.002	-75.075	0.000

	1 Hz	
Delay 8.0 secs		
Hz	dB	Ratio
0.000	-0.011	0.999
0.016	-0.049	0.994
0.031	-0.161	0.981
0.047	-0.350	0.960
0.063	-0.614	0.931
0.078	-0.957	0.896
0.094	-1.376	0.853
0.110	-1.876	0.805
0.125	-2.456	0.753
0.141	-3.121	0.698
0.157	-3.870	0.640
0.172	-4.708	0.581
0.188	-5.639	0.523
0.204	-6.664	0.464
0.227	-8.393	0.380
0.251	-10.364	0.303
0.274	-12.601	0.234
0.298	-15.134	0.175
0.329	-19.038	0.112
0.360	-23.669	0.066
0.391	-29.234	0.035
0.431	-38.097	0.012
0.470	-50.953	0.003
0.501	-72.422	0.000

4 INSTALLATION

4.1 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 mark to indicate which are the X and Y axes, and the following diagram defines the positive flow direction.



The approximate measurement volumes for each type of sensor are as follows, and these should be taken into account when deploying the sensor:

Discus:	Across the face of the discus on the electrode side. The sensing volume is a cylinder with a diameter of the electrode spacing, and height out from the discus face of half this diameter.
Annular	Inside the annulus, and the sensing volume is a sphere with a diameter of the electrode spacing
Spherical	A sphere outside the spherical sensor, with a diameter of 3 times the sensor diameter

The stem of the sensor is also used as an earth for the EM system and should not therefore be covered in paint or tape.

When using two EM systems in close proximity [closer than 1 metre], the electronics need to be synchronised. Please refer to the factory for this at it requires the fitting of the optional analogue output pcb, which also has the synchronisation circuitry, and the two sets of electronics need to be interconnected.

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.

4.2 Electrical Connections

The CDU has bulkhead connectors for the data interface to PC, analogue data out, power in and the sensor. The appropriate leads should be connected to the CDU. Pin out details are provided in APPENDIX 1.

5 SYSTEM OPERATION

5.1 Setting up

To prepare the system for use:

i] Clean the probe electrodes to remove any grease or dirt.

ii] Connect cables for particular combination of hardware being used.

iii] Connect external power source to CDU.

iv] When mounting the probe, it should be noted that the mounting might affect the flow characteristics and thus introduce an error into the measurement. Users can of course adjust results by carrying out their own calibration.

Once the system has been connected up, it is ready for use. For testing purposes, all of the CDU operations can be carried out without the sensor in water, but the real time data will be meaningless.

5.2 Switch on

ON Switch unit On using ON button. This is acknowledged by a double beep from the unit. This key is also used to switch the unit Off at any point during operation. Switching the unit On causes the following display to appear:

```
        802 DUAL AXIS EM FLOW METER

       VALEPORT MODEL 802 VER 1.02

   EM Ser No 1234 UNIT Ser No 65535

<<<OPTIONS SETUP                CONTINUE>>>
```

CONTINUE Places the unit in Run Mode. See Section 5.3.

OPTIONS SETUP This key selects the OPTIONS menu, which allows the user to set up various hardware configurations [Logging On/Off (optional), Beeper On/Off, Backlight On/Off and Direct EM Comms]. This menu also allows access to the USER CALIBRATION menu, and to the LOGGING MENU (optional). For further information refer to Section 5.5.

5.3 Running the unit

Pressing **CONTINUE** at the title screen, or pressing **EXIT** at any of the OPTION MENU screens [see Section 5.5] reveals one of the three possible displays shown below, depending on what mode the unit was in when last used [note that until START is pressed, no flow data is displayed].

DISPLAY 1: FIXED AVERAGE

```
   FIXED AVERAGE   802    HH:MM:SS
                                      STOP>>>
REAL      AVERAGE              SSS  SECS
                                     SETUP>>>
                      m/s    XSD=X.XXX
                      m/s    YSD=X.XXX  START>>>
                                    LOW BATT
```

DISPLAY 2: MOVING AVERAGE

```
   MOVING AVERAGE   802    HH:MM:SS
                                      STOP>>>
REAL      AVERAGE              SSS  SECS
                                     SETUP>>>
                      m/s    XSD=X.XXX
                      m/s    YSD=X.XXX  START>>>
```

DISPLAY 3: FREE RUNNING

```
    FREE RUNNING   802    HH:MM:SS
                                      STOP>>>
REAL      AVERAGE              SSS  SECS
                                     SETUP>>>
                      m/s    XSD=X.XXX
                      m/s    YSD=X.XXX  START>>>
```

An explanation of the different averaging modes can be found in the Description, Section 3.

SETUP Press this key to alter current sampling regime. See Section 5.4.

START After an initialisation period of about 10 seconds, during which the following display will appear, the unit will begin sampling in the mode that has been set. The real time data will be displayed at the bottom of the screen, updated every second. In Free Running and Fixed Average modes, the count down within the average period is displayed. If the unit is in logging mode, the current record number will be displayed at the top right hand side of the screen. If the data interface lead is connected, the end of average values will also be sent to the PC.

I N I T I A L I S I N G E M

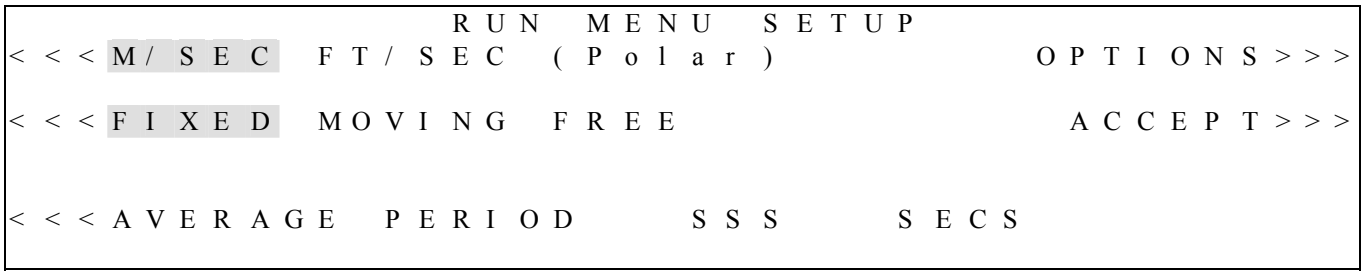
P L E A S E W A I T

STOP Press to cease sampling. This will force an early end to an averaging period at the next second.

LOW BATT When there is approximately 4 hours of battery life remaining [with backlight]; this message will be displayed at the bottom right hand corner of the screen [see DISPLAY 1 for an example].

5.4 Setting Units, Averaging Mode and Averaging Period

Selecting **SETUP** in the RUN menu reveals the following display.



M/SEC FT/SEC — Toggles between measuring the Speed in metres and feet per second and also Polar and Cartesian co-ordinates. Refer to Section 3 for further details.

FIXED MOVING FREE — Toggles the averaging mode between the three states. Refer to Section 3 for further details.

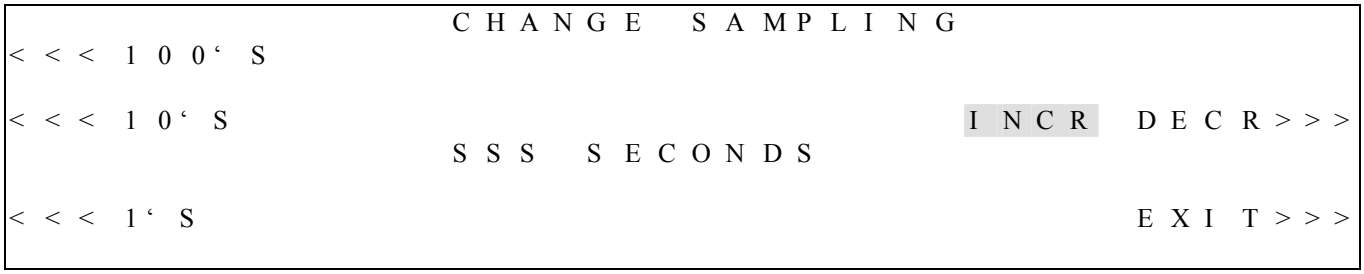
AVERAGING PERIOD — The Averaging Period which has been set is displayed. If it is required to change this, then press the key to move to the CHANGE SAMPLING page. Refer to Section 5.4.1.

OPTIONS — Press this key to return to the OPTIONS MENU [Section 5.5.]

ACCEPT — When the sampling regime is correctly set up; press this key to return to the RUN menu [Section 5.3.].

5.4.1 Changing Averaging Period

Selecting **AVERAGE PERIOD** in the RUN MENU SETUP screen reveals the following display:



INCR DECR	Toggles between increasing and decreasing the number of seconds when the relevant key is pressed.
100'S	Changes the number of 100's of seconds in the averaging period.
10'S	Changes the number of 10's of seconds in the averaging period.
1's	Changes the number of 1's of seconds in the averaging period.
EXIT	Returns to the RUN MENU SETUP screen [Section 5.4].

Note that "000" seconds cannot be set, and the maximum is 600 seconds.

5.5 OPTIONS MENU [Logging, Beeper, Backlight, Direct EM Comms]

Pressing **OPTIONS SETUP** at the Title Screen or **OPTIONS** in the RUN MENU SETUP screens reveals the following display.

```
                    O P T I O N S   M E N U
< < < L O G G I N G   Y E S / N O          L O G G I N G   M E N U > > >

< < < B E E P E R   O N / O F F            D I R E C T   E M   C O M M S > > >


< < < B A C K L I G H T   O N / O F F                        E X I T > > >
```

LOGGING YES/NO — This key switches the logging facility (Optional) On and Off. Up to 999 records may be stored.

BEEPER ON/OFF — Toggles audible indication [once per second] that measurements are being made.

BACKLIGHT ON/OFF — This key toggles it On and Off. Refer to POWER SUPPLY, Section 6 for details of current consumption with and without backlight.

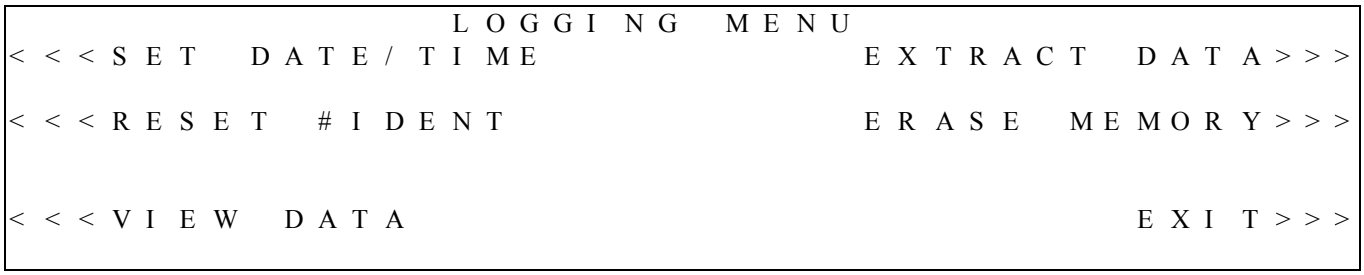
LOGGING MENU — Allows access to the (Optional) LOGGING MENU. This enables the user to view or erase stored data, to extract it to a PC [via data interface lead], and to set the unit date and time. Refer to Section 5.6.

DIRECT EM COMMS — This enables the user to read and set with a PC [via data interface lead] the calibration coefficients. Refer to Section 7.

EXIT — Puts the unit into Run Mode, using the hardware configurations selected [see Section 5.3].

5.6 LOGGING MENU

Selecting **LOGGING MENU** at the OPTIONS MENU reveals the following display.



SET DATE/TIME — Allows access to the CHANGE DATE/TIME screen. This allows the user to alter the unit's internal clock, for the purpose of correctly time stamping the recorded data. See Section 5.6.1.

RESET #IDENT — Sets the memory pointer to record #1 and updates the series letter. For example, a second series of records would begin with record #001B.

VIEW DATA — Allows user to see logged data. See Section 5.6.2.

EXTRACT DATA — Allows user to upload stored data to a PC. See Section 5.6.3.

ERASE MEMORY — Clears all stored data from the unit and resets data series identification to "A"; it does not reset #IDENT to zero which has to be done by the RESET #IDENT key, which should be done first otherwise the series B identification will be set. A screen will appear, requesting confirmation that the user wishes to erase memory. Press **YES** to continue, or **EXIT** to return to LOGGING MENU. If **YES** is pressed, a message will confirm that memory has been erased. Press **EXIT** to return to LOGGING MENU.

EXIT — Returns user to OPTIONS MENU. Refer to Section 5.5.

5.6.1 CHANGE DATE/TIME

Selecting **SET DATE/TIME** at the LOGGING MENU reveals the following display.

INCREASE Increases the currently selected number by 1.

DECREASE Decreases the currently selected number by 1.

NEXT Selects the next number in the time/date sequence.

EXIT Returns user to LOGGING MENU. Refer to Section 5.6.

5.6.2 Viewing stored data

Selecting **VIEW DATA** at the LOGGING MENU reveals a display similar to that shown below. If no data has been stored, the message NO DATA STORED will be displayed.

```
# I D E N T   F F F R
E M   S E R   N O .  X X X X X                                    U P > > >
U N I T S   X X X X X X   ( X x x x x x x x x )
R U N   M O D E     X X X X X   X X X X X X X X                  D O W N > > >


< < < V I E W                                                    E X I T > > >
```

The display shows the record number, serial number, units in which velocity is measured [metres or feet per second], run mode, and time at which the record was stored [i.e. the end of the averaging period].

UP — Toggles the record to be viewed up by one.

DOWN — Toggles the record to be viewed down by one

VIEW — Allows user to view the record currently selected. A display of the format shown below will be seen. Press **EXIT** on this screen to return to the VIEW DATA screen, allowing another record to be seen.

EXIT — Returns to the LOGGING MENU. Refer to Section 5.6.

```
# I D E N T   F F F R

X   S P E E D       + X . X X X   Y   S P E E D       + X . X X X

X   S D =           + X . X X X   Y   S D =           + X . X X X

A V   P E R I O D   S E C S     S S S                          E X I T > > >
```

```
# I D E N T   F F F R

X   S P E E D       + X . X X X   Y   S P E E D       + X . X X X

X   S D =           + X . X X X   Y   S D =           + X . X X X

A V   P E R I O D   S E C S     S S S                          E X I T > > >
```

5.6.3 Extracting data

Selecting **EXTRACT DATA** at the LOGGING MENU reveals the following display.

```
                    E X T R A C T   D A T A
                                              U P L O A D > > >


            P L E A S E   C O N N E C T   P C


                                              E X I  T > > >
```

Connect the unit to a PC via the data interface lead supplied. Run a terminal emulation program on the PC, ensuring that communications are correctly set to 4800 baud, 8 data bits, 1 stop bit, no parity bits. If the data is to be saved on the PC, make sure that the data is directed to a file name. It is uploaded as a text file, with "Tab" delineators, so it can be read into a word processor or spreadsheet application.

UPLOAD Begins to upload data to PC. Screens similar to those shown below will appear, and during uploading the #IDENT will increment.

EXIT Returns to LOGGING MENU. Refer to Section 5.6.

```
                    U P L O A D I N G   D A T A


                          # I D E N T   F F F R

                                              E X I  T > > >
```

When data uploading is finished, the following screen appears, showing the #IDENT of the last record to be uploaded.

```
                F I N I S H E D   U P L O A D I N G   D A T A


                          # I D E N T   F F F R

                                              E X I  T > > >
```

EXIT Returns to LOGGING MENU. Refer to Section 5.6.

6 POWER SUPPLY

6.1 External power

The current consumption of the units is as follows [all measured at 12vDC]:

	Backlight On	Backlight Off
Standby	100 mA	27 mA
Run	300 mA	220 mA

The unit will operate on an input voltage of 12 V DC. The optional External DC power cable has 4mm plugs [Red +ve, Black -ve]. If these are connected using the wrong polarity, an internal fuse will blow (on the printer circuit board set).

If the unit is left in standby, then if no button has been pressed for 5 minutes, the beeper emits 5 beeps to remind the user that the unit is still switched on [this feature does not operate when the CDU is connected to a PC for communications such as downloading data].

7 CALIBRATION

Selecting **DIRECT EM COMMS** at the OPTIONS MENU enables the user, using a PC in terminal mode via the optional DC data lead to read and alter the EM calibration.

Connect the unit to a PC via the data interface lead supplied. Connection details are given in APPENDIX 1. Run a terminal emulation program on the PC, ensuring that communications are correctly set to 4800 baud, 8 data bits, 1 stop bit, no parity bits.

The EM calibration has 3 parts to it:

1. **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 mm/sec [usually 1]. 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.

2. **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.

3. **Gain Factor**

   This is the factor by which the sensors counts per mm/sec must be multiplied to normalise it to the standard counts/mm per second [e.g. 1 count/mm/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.

Having connected up the CDU and PC and entered DIRECT EM COMMS, the unit will output EM data at a rate of 2 Hz. To communicate to the unit and interrupt it, press the "#" key on the PC. The unit will respond with a " " and then await a command. These commands are a series of "#" 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	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.

If the user wishes to alter the calibration from the factory setting, they will be required to enter the calibration coefficients. The calibration coefficients are stored within the microcontroller in an ASCII text string. The format of this string depends on the type of calibration (line fit or polynomial fit). The first part of the string will be the calibration function number, selected from the table below, which defines the type of fit.

Calibration Function No.	OPERATION
0	Not defined
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
12	Two order polynomial - 3 Coefficients
13	Third order polynomial - 4 Coefficients
14	Fourth order polynomial - 5 Coefficients

The calibration takes the A/D counts, and calculates the engineering value from calibration coefficients. In all cases it is assumed that the –ve and +ve flow characteristics are the same.

Straight Line fits

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

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

The offset is the y axis [engineering value output] intercept at zero counts for the straight line segment
The coefficient is the slope of the straight line in engineering units per count.
The limit is the number of counts up to which the straight line is to be used [must be a positive number]

Where Max_lt is the range up to but not including, which the straight line operates over.
The first straight line starts from 0 up to Max_lt1 in A/D counts (WHOLE numbers).
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.

Polynomial fits

The Y-axis is the engineering units output and the X axis is the A/D counts

For a third order polynomial, in the form:

X^3 * Coefficient3 + X^2 * Coefficient2 + X * Coefficient1 + Constant

the calibration string would be entered thus:

13 Coefficient3 Coefficient2 Coefficient1 Constant

8 CARE AND MAINTENANCE

8.1 Cleaning

While the instrument has been designed for field use, it is not indestructible and care should be taken not to damage either the sensor, cable or CDU.

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.

In principle the calibration is for life, but as with most instruments it is advisable that check calibrations should be carried out on an annual basis.

8.2 Troubleshooting

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

SYMPTOM	PROBABLE CAUSE	REMEDY
No output	Incorrect communications settings on PC	Check settings
	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.
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.

8.3 O-Ring Sizes

Sensor Line connector bore seal	1 x 200-021-4470
Pre-amp housing	1 x 200-126-4470
	1 x 200-128-4470

APPENDIX 1 ELECTRICAL CONNECTIONS

The External DC Power Cable connection details are:

CDU End	Function	Free End
3 way in-line male MilSpec connector [sockets] LMH06F 08 33 SN		4mm “banana” plugs
Pin A	+ve	Red
Pin B	-ve	Black

The RS232 Lead connection details are:

CDU End	Function	PC End
4 way in-line male MilSpec connector [pins] LMH06F 08 04 PN		9 way “D” type female [sockets]
	RTS from PC [not used]	Socket 7
Pin B	Tx RS232 from PC to CDU	Socket 3
Pin C	Gnd	Socket 5
Pin D	Rx RS232C to PC	Socket 2

The Analogue Lead connection details are:

CDU End	Function	Free End
4 way in-line male MilSpec connector [pins] LMH06F 08 04 PN		4mm “banana” plugs
Pin A	Screen	Black
Pin B	Y Axis Output	Red
Pin C	Screen	Black
Pin D	X Axis Output	Red

The EM Sensor Cable connection details are:

CDU End	Function	Sensor End
Valeport 15-way line connector [pins]		Valeport 15-way line connector [socket]
Pin A	COIL +	Socket A
Pin B	COIL-	Socket B
Pin M	COIL SCREEN	Socket M
Pin C	CH 2 SIG + (Y)	Socket C
Pin D	CH 2 SIG - (Y)	Socket D
Pin N	CH 2 SCREEN (Y)	Socket N
Pin E	+ VE SUPPLY	Socket E
Pin H	- VE SUPPLY	Socket H
Pin J	0 V SUPPLY	Socket J
Pin K	OVERALL SCREEN	Socket K
Pin F	CH 1 SIG + (X)	Socket F
Pin G	CH 1 SIG - (X)	Socket G
Pin P	CH 1 SCREEN (X)	Socket P
Pin L	N/C	Socket L
Pin R	N/C	Socket R

APPENDIX 2 EQUIPMENT SUPPLIED

Serial No.	Model No.....
Customer:	Con Number: .....
.....	Customer Ref:.....
.....	Del. Note: .....
.....	Calibration Cert.: .....

ITEM	Items Required		Quantity & length	Serial Number	Checked By	Date
	Yes	No				
802 Desktop Control Display Unit						
3.2cm Discus sensor						
3.2cm Spherical sensor						
5.5cm Discus sensor						
5.5cm Spherical sensor						
11cm Discus sensor						
17cm Annular sensor						
Power In Lead						
Sensor Lead						
RS232 Lead						
Analogue Output Lead						
Operating Manual						
Calibration certificate [in manual]						
Transit Case						
Spare set O-rings						

APPENDIX 3 GUARANTEE CERTIFICATE

G U A R A N T E E C E R T I F I C A T E

****

All goods are subject to a 36-month guarantee against faulty materials and bad workmanship. This does not apply to batteries and consumables
Any faults are to be declared within 36 months from date of despatch, in writing to Valeport Limited, who will replace or repair [at their option] any faulty items, caused by bad workmanship or materials.

Valeport Limited shall be under no liability for:

1] Any consequential loss or damage of any kind whatsoever.

2] For any defect or deficiency judged by Valeport Limited to be caused by wear and tear or by improper or unskilled handling of the goods or by any repair or attempted repair or dismantling by any one other than Valeport Limited or persons authorised to do so by Valeport Limited.

3] Batteries and other consumables supplied with the equipment that are not covered by this guarantee.

Due to the specialised nature of the instrument it should, if possible, be returned to the factory for repair or servicing. The type and serial numbers of the instrument should always be quoted, together with full details of any fault or the service required.

Equipment returned to Valeport Limited for servicing must be adequately packed, preferably in the special box supplied and shipped with transportation charges prepaid. Return transport charges are also to the account of the customer.

Note: Any items supplied as part of a system, which are not manufactured by Valeport Limited, are covered by the individual manufacturer's guarantee of the equipment supplied.

MODEL NUMBER..... SERIAL NUMBER .....

DATE OF DESPATCH..... SIGNATURE.....

APPENDIX 4 CALIBRATION INFORMATION

The following sheets provide the calibration information for the instrument. Calibrations are carried out in Valeport's Tow tank at speeds up to about 1100 mm/sec and extrapolation is used to 5000 mm/sec. Specific calibrations can be carried to 5000 mm/sec at HR Wallingford.