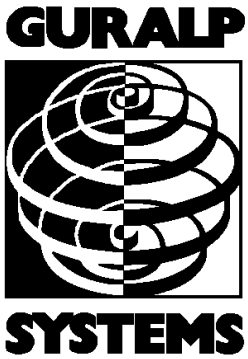

Neptune OBS

Operation Guide.

Part No. MAN-OBS-0002

Designed and manufactured by
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Issue A 2009-08-21

Table of Contents

1 Introduction

Güralp Systems' “Neptune” Ocean Bottom System is a state-of-the-art multi-sensor unit comprising:

- a CMG-5T triaxial true broadband feedback strong motion (±2g) accelerometer;
- a CMG-1T triaxial true broadband (360s - 50Hz) feedback seismometer;
- a CMG-DM24/7 24-bit, seven channel digitiser module;
- a CMG-EAM enhanced acquisition and communications module; and
- GSL's unique “Virtual Sphere” microprocessor-controlled orientation and levelling system

all encased in a cast titanium sphere capable of withstanding immersion in up to 3,000 metres of water.

A submersible 25-pin connector provides inputs for an external Nortek Aquadopp triaxial Doppler-effect current flow rate meter, an external differential pressure gauge, main 48V power and an auxiliary 12V back-up battery as well as data outputs via RS232 and TCP/IP Ethernet.

The integrated CMG-EAM provides a single, easy-to-use, web-based interface for control, configuration and monitoring of all components. Sophisticated power-control electronics provide fine-grained monitoring and control of power consumption, minimising current requirements and maximising battery life.

The CMG Neptune OBS embodies more than twenty years of experience in designing and deploying ocean-bottom seismometry systems in some of the harshest and most challenging environments on the planet.

2 Operation Guide

2.1 Principals of operation

The CMG Neptune OBS contains two seismometers, a CMG-5T strong motion triaxial accelerometer and a CMG-1T weak motion triaxial seismometer.

Full details and specifications of the CMG-5T components are contained in Güralp manual MAN-050-0001, available for download from http://www.guralp.com/documents/MAN-050-0001.pdf.

Full details and specifications of the CMG-1T components are contained in Güralp manual CMG-1OBS, available for download from http://www.guralp.com/support/manuals/pdf/1OBS.pdf.

The outputs from these two systems, along with the output of the differential pressure gauge, are connected internally to a CMG-DM24/7 digitiser module. Full details and specifications for this module are contained in Güralp manual MAN-D24-0004, available for download from http://www.guralp.com/documents/MAN-D24-0004.pdf.

The outputs from the CMG-DM24/7 and the Aquadopp flow meter are connected internally to an embedded CMG-EAM acquisition and communication module. Full details for this module are contained in Güralp manual MAN-EAM-0001, available for download from http://www.guralp.com/documents/MAN-EAM-0001.pdf.

The EAM software has been extended to include functions specific to the CMG Neptune OBS. These are:

- an enhanced power monitoring and control system; and
- deployment and recovery sequence automation.

These functions are described in the sections that follow.

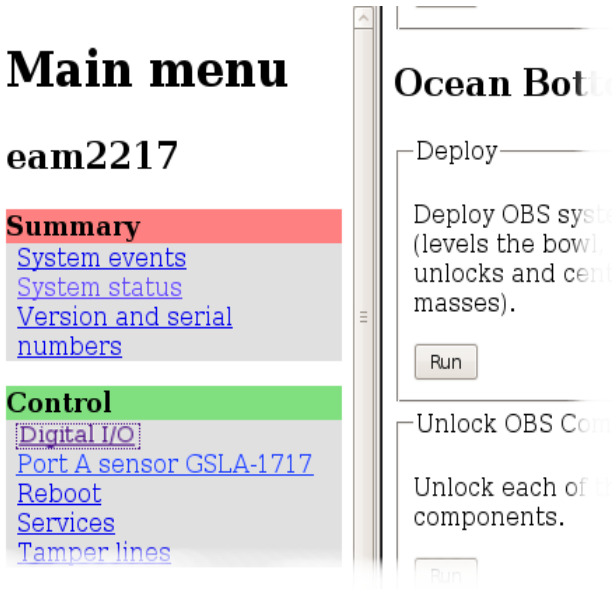
2.2 Power monitoring and control

2.2.1 Operation

The CMG Neptune OBS includes a power monitoring and control facility which can measure and switch the current flowing to and from the various components of the system. This can be accessed via the configuration interface of the CMG-EAM using a web browser.

The configuration interface of the CMG-EAM is described in detail in MAN-EAM-0001. The following description assumes some familiarity with the use of this interface.

To access the power monitoring and control facility, select “Digital I/O” from the Control menu:



The following screen will appear:

I/O line status

I/O line status and control.

Line	Status		Operations
Aux_power **Auxiliary (battery) power**	Output, low (off)		
	voltage Bus Voltage (V)	11.54	View details/settings Set to input
	current Current (A)	0.001	Set output low (switch off)
	power Power (W)	0.01	Set output high (switch on)
Data_Out **Data Out power**	Output, low (off)		
	voltage Bus Voltage (V)	11.53	View details/settings Set to input
	current Current (A)	0.107	Set output low (switch off)
	power Power (W)	1.23	Set output high (switch on)
Ethernet_power **Ethernet auxiliary power**	Output, high (on)		
	voltage Bus Voltage (V)	11.53	View details/settings Set to input
	current Current (A)	0.001	Set output low (switch off)
	power Power (W)	0.01	Set output high (switch on)
Ext0_power **External power outlet 0**	Output, low (off)		
	voltage Bus Voltage (V)	11.53	View details/settings Set to input
	current Current (A)	0.001	Set output low (switch off)
	power Power (W)	0.02	Set output high (switch on)

The screen is divided into sections, each dealing with a different current switch/measurement point, known as a “line”.

Each line has a system name and a user name. User names can be configured individually (see Section 2.2.2 on page 8). For example, the first line displayed in the previous diagram has a system name of “Aux_power” and a user name of “Auxiliary (battery) power”.

Next to the name of each line is displayed the line's status: low (off) or high (on). A line can be turned on and off with the “Set output low” and “Set output high” buttons. **Note**: the Neptune OBS systems are shipped with many power lines set low (turned off) in order to avoid unintentional battery drain. The default status of each line at power-up can be configured (see Section 2.2.2 on page 8).

Below the status is displayed the measured voltage, current and power.

The buttons marked “View details/settings” displays a screen similar to the following. The screen for Aux_power is used for illustration:

Line details

Auxiliary (battery) power

Line ID: Aux_power

I/O control

Driver type	Output only
Impedance	Low (output)
Pin level	Low (off)

Set to input

Set output low (switch off)

Set output high (switch on)

Properties

Property	Type	Current value	Change
voltage Bus Voltage (V)	Read only	11.54	
current Current (A)	Read only	0.001	
power Power (W)	Read only	0.01	
low_voltage_threshold Low voltage cut-off threshold (V)	Read/write	0.000	0.000 Set
cutoff_hysteresis Cut-off hysteresis (V)	Read/write	0.000	0.000 Set
system True if this line is internal to the system	Read only	false	
Property	**Type**	**Current value**	**Change**

Refresh

Return to front page

Most of the features of this screen duplicate those on the main “Digital I/O” display. A “Refresh” button provides quicker access to the latest figures if a line is being monitored in real time.

The two fields not present on the main “Digital I/O” display allow the configuration of under-voltage monitoring. If a voltage is typed into the “Lower voltage cut-off threshold” field and the “Set” button pressed, the system will cut power to the associated subsystem if the supply voltage falls below the figure entered. In order to prevent rapid switching when the supply power is very close to the threshold, a hysteresis value can also be entered. The supply voltage must rise to the sum of the threshold voltage and the hysteresis voltage before power to the associated subsystem is restored.

The allocation of lines to hardware components for the CMG Neptune OBS is as follows:

Line (system name)	**Function**
Data_Out	Main 48V power feed (conditioned)
Aux_power	Auxiliary battery
Port_A	Power to embedded DM24/7
Sensor_power	Power to CMG-1T sensor
Ext0_power	Power to CMG-5T sensor
Ext1_power	Power to D.P.G.
Port_D	Power to Aquadopp

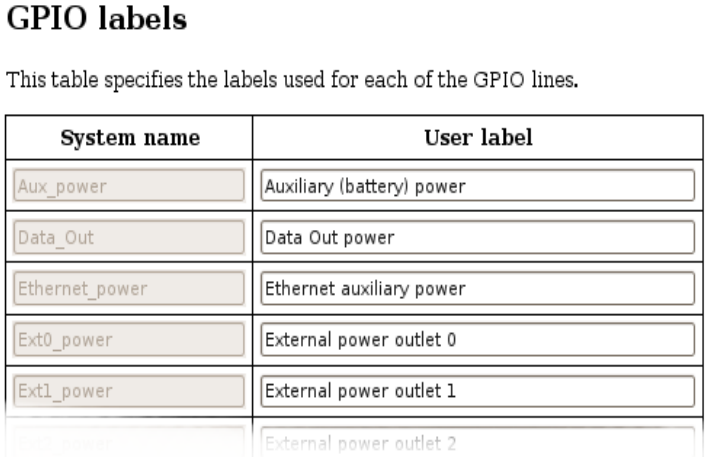
Note: both the incoming 48V power and the auxiliary battery power are both fed through a power conditioning circuit before being routed to the power control sensors, so it is the conditioned voltage that is monitored, not the supplied voltage.

Note: The auxiliary battery will not be used unless the output for Aux_power is set high, in order to conserve battery life during shipping and deployment. The status of this line immediately after the unit boots can be configured: see Section 2.2.2 on page 8.

2.2.2 Configuration

To configure the user names of the power lines, select “All options” from the “Configuration” section of the main menu:

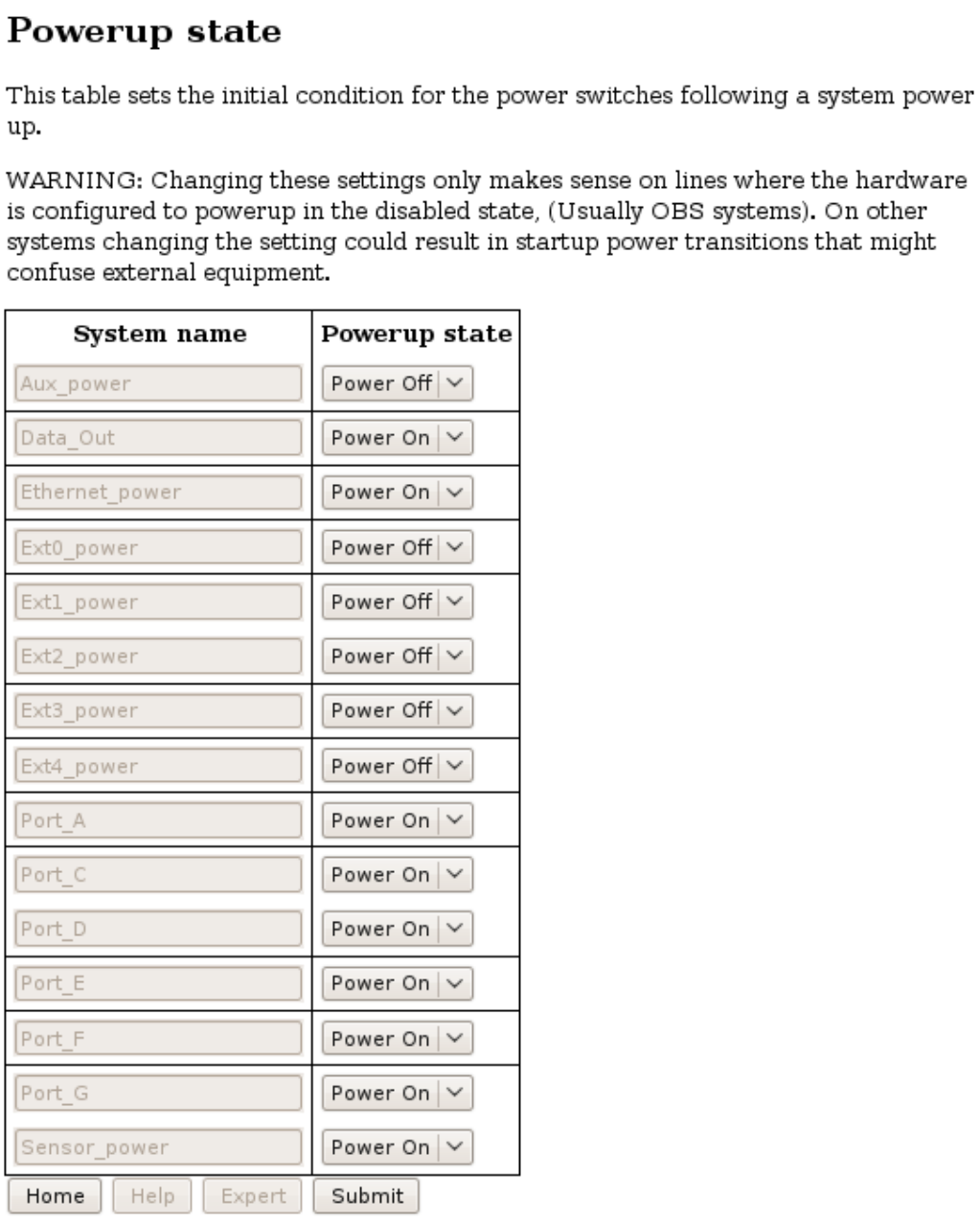
From the resulting menu, select “GPIO labels and power switch settings. The following screen is displayed, from where it is possible to edit the user labels of the :power lines. Press the “Submit” button after making any changes.



Below the GPIO labels configuration section, a number of drop-down menus allow you to configure the state (on or off) which each line will assume when the unit boots when power is first applied or after a power interruption. This part of the screen is shown overleaf.

For each line, select the desired start-up state, then click the “Submit” button to save your changes.

Note: no immediate changes to individual lines will be made as a result of using this feature. The settings only affect the lines after a re-boot of the unit.



Powerup state

This table sets the initial condition for the power switches following a system power up.

WARNING: Changing these settings only makes sense on lines where the hardware is configured to powerup in the disabled state, (Usually OBS systems). On other systems changing the setting could result in startup power transitions that might confuse external equipment.

System name	Powerup state
Aux_power	Power Off
Data_Out	Power On
Ethernet_power	Power On
Ext0_power	Power Off
Ext1_power	Power Off
Ext2_power	Power Off
Ext3_power	Power Off
Ext4_power	Power Off
Port_A	Power On
Port_C	Power On
Port_D	Power On
Port_E	Power On
Port_F	Power On
Port_G	Power On
Sensor_power	Power On

Home Help Expert Submit

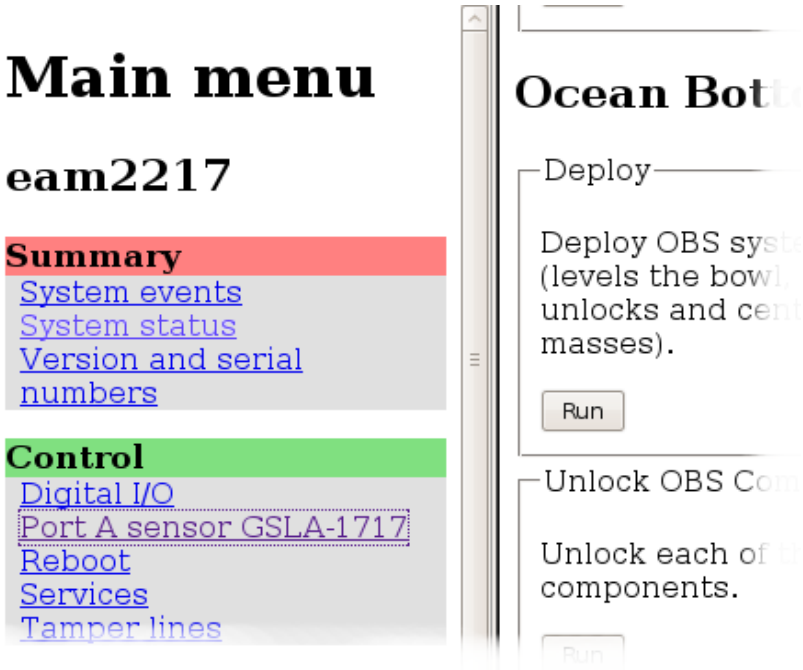
Note: The auxiliary battery will not be used after the unit is rebooted unless the power-up state for Aux_power is set to “Power On”, in order to conserve battery life during shipping and deployment. The battery can still be turned on and off using the appropriate controls on the “I/O Line Status” screen, as described in Section 2.2.1 on page 4.

2.3 Deployment

The CMG-EAM embedded in the Neptune OBS has a facility for automating the instrument deployment sequence, which involves checking the position of the OBS bowl (the internal, moveable instrument carrying platform) and, if it needs to be moved, locking the sensor masses (if not already locked) and then entering an iterative sequence of tilts, turns and orientation measurements until the bowl is precisely level. The instrument masses are then individually unlocked and centred. This whole sequence is triggered via controls within the configuration interface of the CMG-EAM, using a web browser.

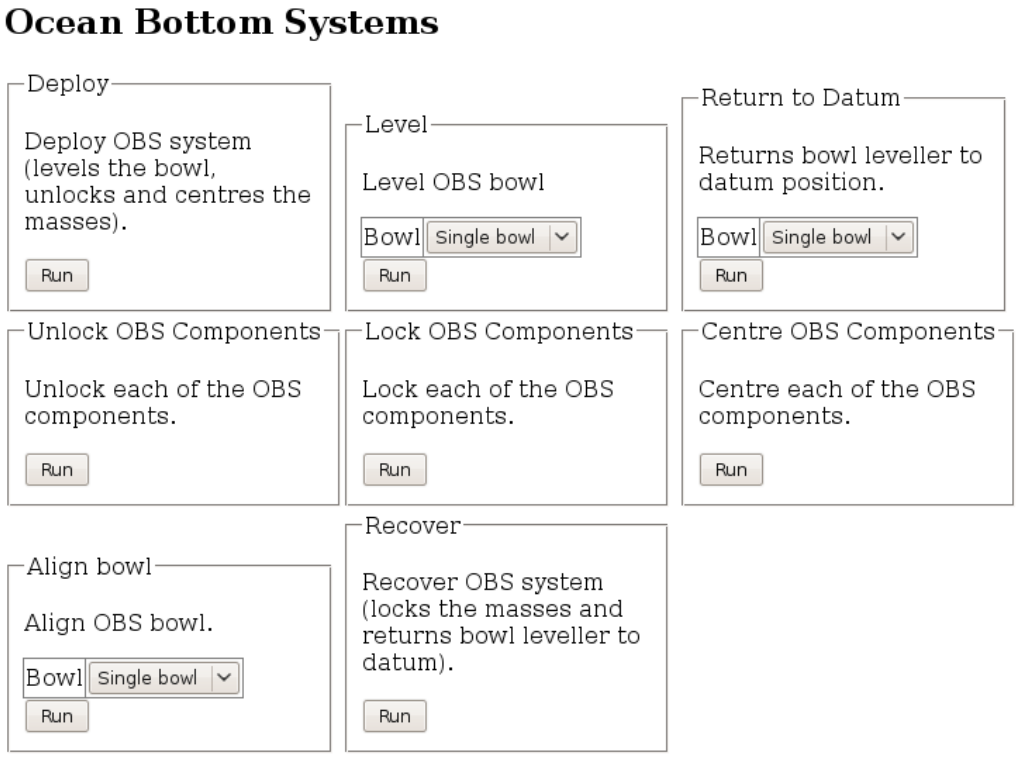
The configuration interface of the CMG-EAM is described in detail in MAN-EAM-0001. The following description assumes some familiarity with the use of this interface.

To initiate the deployment sequence, choose the entry for the sensor from the "Control" menu (the name of this entry will change with the serial number of the component).



Scroll down the resulting page to the section headed "Ocean Bottom Systems"

The following screen is displayed:



In normal use, only "Deploy" (described here) and "Recover" (described in Section 2.4 on page 17) will be required. Both of these run sequences of individual commands and it is possible to run any of these individual commands from this screen.

The deployment sequence is:

- Level - level the OBS bowl;
- Align - Align the OBS bowl (to magnetic north);
- Unlock OBS Components- unlock each sensor in turn; and
- Centre OBS Components - centre each sensor masses in turn.

The entire sequence can be run in the correct order by clicking the "Run" button in the "Deploy" box. This produces a large amount of diagnostic output to signify the progress of the operation. The bowl alignment procedure is iterative and several passes may be needed to achieve an acceptable attitude. Typical output is reproduced here, with explanatory notes in blue:

Digitiser Control

GSLA-1717

Deploy

```
GSLA 171700 CMG1T2M Command Mode
0 blocks in buffer | 256 blocks free
Guralp Systems Ltd - DM+FW  v.106  mgs  17/08/09 (Build 33)

  ok_1717
DEPLOY
 Deploy System? y/n
? y x-3  y-258
Z Mass Locking..
   0  249
Success
Vertical Mass_Locked (Turned)
Mass Position -102%
N/S Mass Locking..
   7  249
Success
North/South Mass_Locked (Not Turned )
Mass Position 102%
E/W Mass Locking..
  10  249
Success
East/West Mass_Locked (Not Turned )
Mass Position 102%

    42
    42
    41
    39
    40 Limit Switch   1 1 0 1 1 1 1 1now  1 1 1 0 1 0 1 1

    39  1 1 0 1 1 1 1 1
    40  1 1 0 1 1 1 1 1
    40  1 1 0 1 1 1 1 1
    40  1 1 0 1 1 1 1 1
    41  1 1 0 1 1 1 1 1
    41  1 1 0 1 1 1 1 1
    42  1 1 1 1 1 1 1 1 TiltNull set 41

     2
     1
|  Tilt |Rotate|   X  |   Y  |
      0      0     -3   -260 << Bowl Datum x-3  y-258  x-4
Y450

     0
    11
    48
    84
   120
```

(the bowl is not aligned, so we will lock the masses before moving it)

(these numbers show the current bowl tilt value...)

(...and these the rotation value)

(bowl now at datum and a new target orientation has been calculated)

(bowl tilting)

```
154
190
224
261
295
331
365
404
440
455
453
451 x-5  y249  T62
```

(bowl rotating)

```
  0
  1
  5
 10
 12
 16
 18
```

this sequence will continue changing gradually. Several hundred lines of output have been suppressed.

```
 59
 60
 60
 60
 60
 60
 60
 61
|  Tilt |Rotate|   X  |   Y  |
    61    452     51    -20 x50  y20  R447
```

(1st approximation achieved, 2nd calculated)

```
451
451
449
446 x50  y19  T78

 61
 61
 61
 61
 62
 62
 62
```

(bowl tilting)

(bowl rotating)

this sequence will continue changing gradually. Several hundred lines of output have been suppressed.

```
 76
 76
 76
 76
 76
```

```
 77
  77    447     63     44 x62  y-43  x62  y-43  R432

447
447
443
442
441
439
437
435
433 x50  y-50  T77

 77
  77    433     50     50 x49  y-50  x49  y-50  R419

434
433
431
430
428
426
424
422
419 x33  y-53  T72

 77
 77
 77
 77
 77
 77
 77
 77
 77
 77
 76
 76
 76
 76
 75
 76
 75
 75
 75
 74
 74
 74
 74
 73
  73    420     27     35 x27  y-35  x27  y-35  R411

419
419
417
415
413
411 x20  y-32  T71
```

```
 73
 74
 73
 73
 72
  72    411     19     31 x18  y-31  x19  y-31  R404

411
411
409
407
405 x14  y-28  T70

 72
 72
 72
 72
 72
 71
  71    405     12     27 x12  y-26  x11  y-26  R400

404
404
402
400 x8  y-24  T67

 71
 72
 71
 70
 71
 70
 70
 70
 70
 69
 68
  69    400      6     17 x5  y-17  x5  y-18  R397

400
400
397 x4  y-16  T66

 69
 69
 69
 68
 68
 68
 68
 67
  67    398    2     11 x2  y-12  x2  y-11  < Bowl Level
SingleBowl System : Levelled
Z LOCKED N/S LOCKED E/W LOCKED
|  Tilt |Rotate|   X  |   Y  |
     67    398      3     11
Z Mass UnLocking..
  54  249
```

(success)

(now unlock the masses)

```
  59  248
  61  247
  59  246
  57  245
  54  244
  53  243
  57  242
  57  241
  56  240
  56  239
  60  238
  60  237
  61  236
  61  235
  61  234
  61  233
  61  232
  56  231
  56  230
  56  229
  57  228
  58  227
  59  226
  56  225
  56  224
  59  223
  61  222
  59  221
  59  220
  54  219
  57  218
  54  217
  60  216
  32  215
Success
Z Mass Centring..
  -85   59
Success
Vertical Mass_Unlocked Centred Turned
Mass Position  -4%
N/S Mass UnLocking..
   8  249
Success
N/S Mass Centring..
 2047   59  1 1 1 1 1 1 1 1  128 -1   0
-1693   58  1 1 1 1 1 1 1 1   96  1   0
 2047   57  1 1 1 1 1 1 1 1   72 -1   0
-1122   56  1 1 1 1 1 1 1 1   54  1   0
 2047   55  1 1 1 1 1 1 1 1   40 -1   0
  342   54  1 1 1 1 1 1 1 1   40 -2   0
-1582   53  1 1 1 1 1 1 1 1   30  1   0
 -823   52  1 1 1 1 1 1 1 1   30  2   0
 2047   51  1 1 1 1 1 1 1 1   22 -1   0
 2047   50  1 1 1 1 1 1 1 1   22 -2   0
   -4   49
Success
North/South Mass_Unlocked Centred Not Turned
Mass Position   0%
```

(the first number is the current drawn by the locking motors, the second a simple count-down timer)

```
E/W Mass UnLocking..
  10  249
Success
E/W Mass Centring..
 -772   59  1 1 1 1 1 1 1 1  128  1   0
 2047   58  1 1 1 1 1 1 1 1   96 -1   0
 -254   57  1 1 1 1 1 1 1 1   72  1   0
 1379   56  1 1 1 1 1 1 1 1   54 -1   0
   85   55
Success
East/West Mass_Unlocked Centred Not Turned
Mass Position   4% ok_1717
```

Command 'Deploy' run successfully

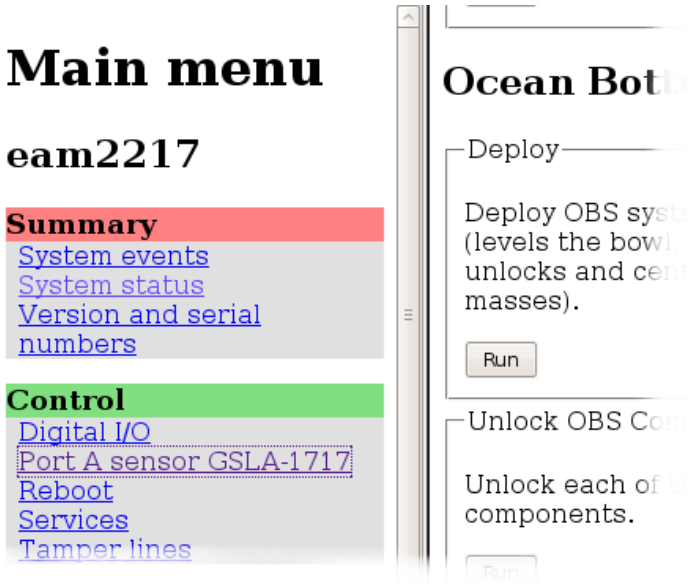
Generated at 2009-08-18T11:19:11Z by `digitiser-control.cgi 2.0.2` .
Portions of output copyright (c)2009, Guralp Systems Ltd..

2.4 Recovery

The CMG-EAM embedded in the Neptune OBS has a facility for automating the instrument pre-recovery sequence, which involves locking the instrument masses prior to any potentially violent movements. This is accessed via the configuration interface of the CMG-EAM using a web browser.

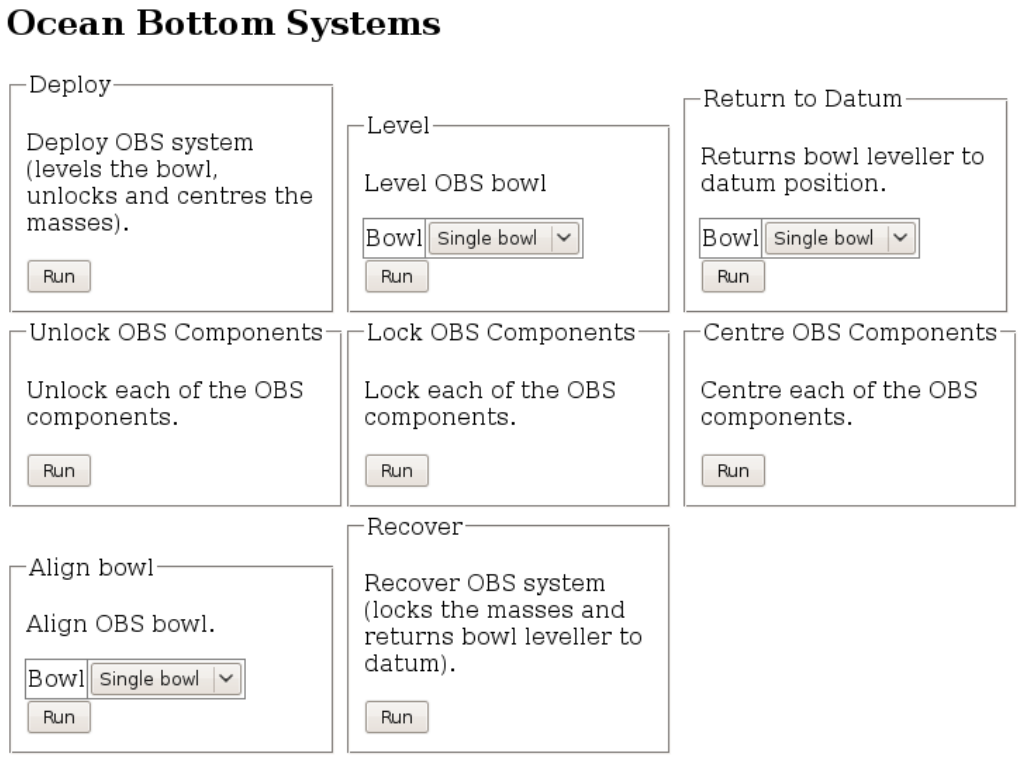
The configuration interface of the CMG-EAM is described in detail in MAN-EAM-0001. The following description assumes some familiarity with the use of this interface.

To initiate the deployment sequence, choose the entry for the sensor from the “Control” menu (the name of this entry will change with the serial number of the component).



Scroll down the resulting page to the section headed “Ocean Bottom Systems”

The following screen is displayed:



In normal use, only “Deploy” (described in section 2.3 on page 10) and “Recover” (described here) will be required. Both of these run sequences of individual commands and it is possible to run any of these individual commands from this screen.

The recovery sequence is:

- Lock OBS Components- lock each sensor in turn; and
- Return to Datum - return the bowl leveller to the “home” position

The entire sequence can be run in the correct order by clicking the “Run” button in the “Recover” box. This produces diagnostic output to signify the progress of the operation. Typical output is reproduced here, with explanatory notes.

Digitiser Control

GSLA-1717

Recover

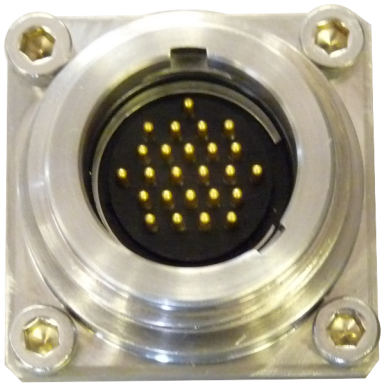
```
GSLA 171700 CMG1T2MCommand Mode
1 blocks in buffer | 255 blocks free
Guralp Systems Ltd - DM+FW  v.106  mgs  17/08/09 (Build 33)

  ok_1717
RECOVER
 Lock sensors for recovery? y/n
? y
Z Mass Locking..
  86  249
Success
Vertical Mass_Locked Turned
Mass Position -102%
N/S Mass Locking..
  82  249
Success
North/South Mass_Locked Not Turned
Mass Position 102%
E/W Mass Locking..
  86  249
Success
East/West Mass_Locked Not Turned
Mass Position 102%

    41
    41
    41
    40
    39
    39 Limit Switch   1 1 0 1 1 1 1 1now  1 1 1 0 1 0 1 1

    39  1 1 0 1 1 1 1 1
    39  1 1 0 1 1 1 1 1
    40  1 1 0 1 1 1 1 1
    40  1 1 0 1 1 1 1 1
    41  1 1 0 1 1 1 1 1
    41  1 1 0 1 1 1 1 1
    41  1 1 1 1 1 1 1 1 TiltNull set 42

     1
|  Tilt |Rotate|   X  |   Y  |
     -1      1     -3   -258 ok_1717
```

Command 'Recover' run successfully

Generated at 2009-08-18T11:19:11Z by `digitiser-control.cgi 2.0.2` .

3 Appendices

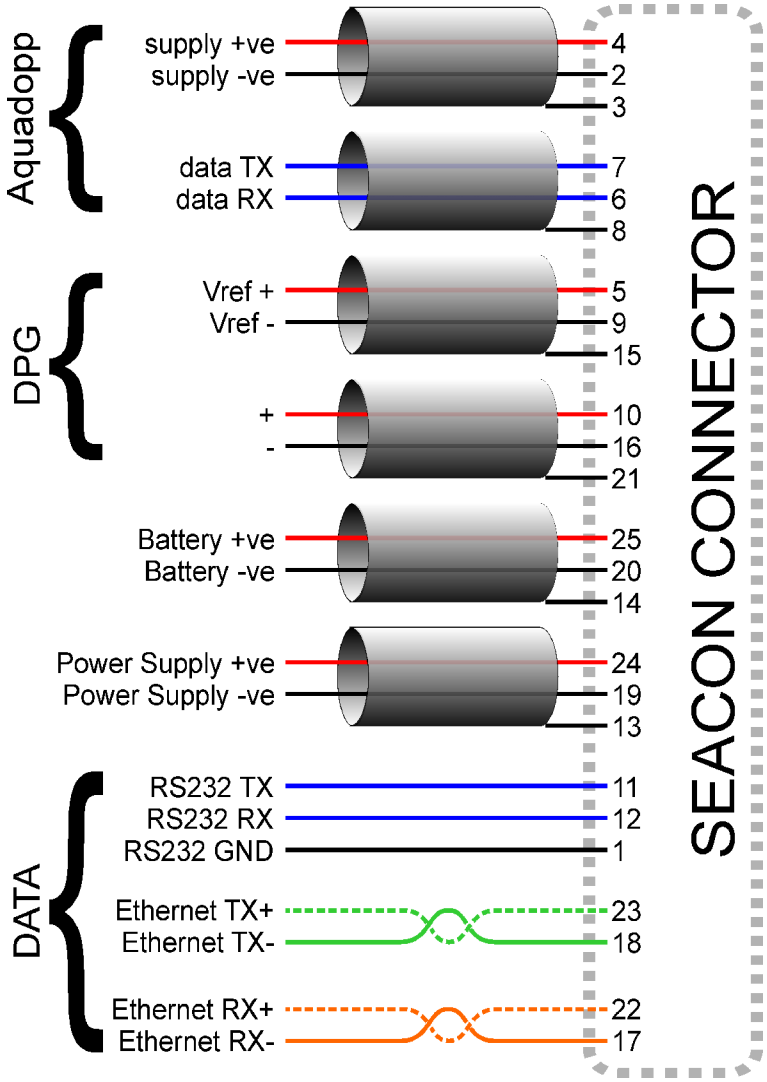
3.1 Main Connector pin-out



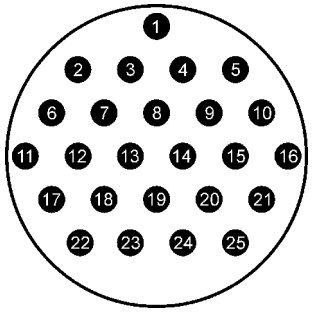
This is a SEACON MIN-M-25-FSS 25-pin male connector.

A suitable mating connector is provided. Additional connectors are available from Güralp Systems Ltd. or from Seacon directly at http://www.seaconbrantner.com/.

The pin use is illustrated below and tabulated overleaf:



Pin	Function
1	EAM data ground
2	Aquadopp positive supply V+
3	Aquadopp supply ground
4	Aquadopp power cable braid (shield)
5	DPG positive reference voltage +Vref
6	Aquadopp receive data
7	Aquadopp transmit data
8	Aquadopp data cable braid (shield)
9	DPG negative reference voltage -Vref
10	DPG +
11	EAM DATA OUT transmit data
12	EAM DATA OUT receive data
13	main power supply cable braid (shield)
14	battery supply cable braid (shield)
15	DPG reference voltage cable braid (shield)
16	DPG -
17	Ethernet Rx-
18	Ethernet Tx-
19	main power supply -ve
20	battery -ve
21	DPG signal? cable braid (shield)
22	Ethernet Rx+
23	Ethernet Tx+
24	Main power supply +ve
25	battery +ve

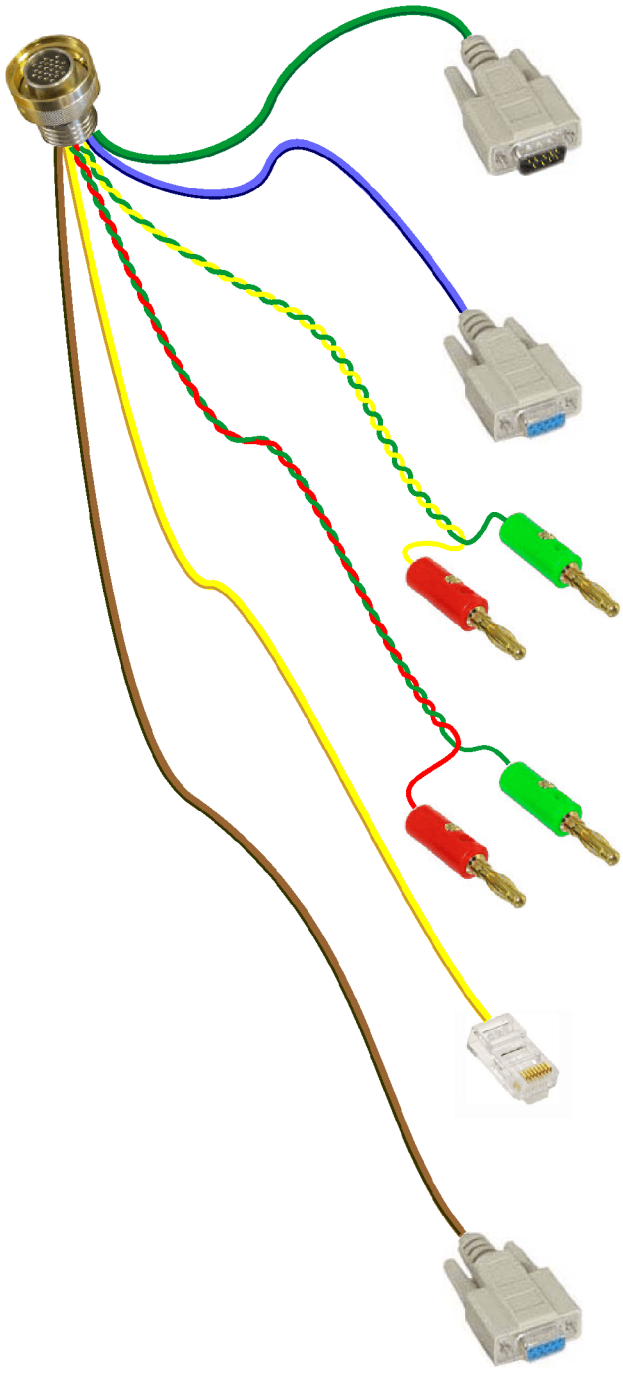


Wiring details for the compatible socket, as seen from the cable end.

3.2 Test harness pin-outs

3.2.1 Overview

The test harness is shown below. Pin numbers in *italics* refer to the pins in the Seacon connector, as documented in Section 3.1 on page 20. The individual connectors are described in the following sections.



Aquadopp

Pin	Function	
8	+ve	*(from pin 4)*
5	0V	*(from pin 2)*
2	TxD	*(from pin 7)*
3	RxD	*(from pin 6)*

DPG

Pin	Function	
4	+Vref	*(from pin 5)*
2	-Vref	*(from pin 9)*
3	+DPG	*(from pin 10)*
1	-DPG	*(from pin 16)*

Battery

Red: +ve *(from pin 25)*
Green: -ve *(from pin 20)*

Power Feed

Red: +ve *(from pin 24)*
Green: -ve *(from pin 19)*

Ethernet

Standard TIA/EIA-568 wiring
(from pins 17, 18, 22 & 23)

Data Out

Pin	Function	
2	TxD	*(from pin 11)*
3	RxD	*(from pin 12)*
5	Ground	*(from pin 1)*

3.2.2 Aquadopp test connector

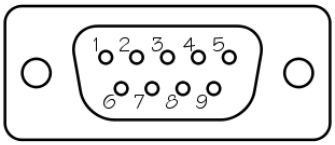
These are standard DE9M (TIA-574) sub-miniature (D-sub) plugs, conforming to DIN 41652 and MIL-DTL-24308. They are very widely available, as are suitable mating connectors.

Pin	Function	Associated Seacon pin
1	*not connected*	
2	RS232 transmitted data*	7
3	RS232 received data*	6
4	*not connected*	
5	Ground	2
6	*not connected*	
7	*not connected*	
8	Supply voltage +ve	4
9	*not connected*	

***Note**: The Aquadopp is considered the DTE and the Neptune OBS the DCE for this connection, so "transmitted" refers to data *from* the Aquadopp and "received" to data received by the Aquadopp.

Note: the supply lines are shielded with the cable braid connected to pin 3 of the Seacon connector.

Note: the data lines are shielded with the cable braid connected to pin 8 of the Seacon connector.



Wiring details for the compatible socket, DE9F, as seen from the cable end.

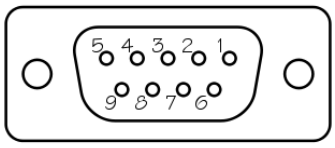
3.2.3 Differential Pressure Gauge test connector

These are standard DE9F (TIA-574) sub-miniature (D-sub) line sockets, conforming to DIN 41652 and MIL-DTL-24308. They are very widely available, as are suitable mating connectors.

Pin	Function	Associated Seacon pin
1	-DPG	16
2	- Vref	9
3	+DPG	10
4	+Vref	5
5	*not connected*	
6	*not connected*	
7	*not connected*	
8	*not connected*	
9	*not connected*	

Note: the '+' and '-' lines are shielded with the cable braid connected to pin 21 of the Seacon connector.

Note: the reference lines are shielded with the cable braid connected to pin 15 of the Seacon connector.



Wiring details for the compatible plug, DE9M, as seen from the cable end.

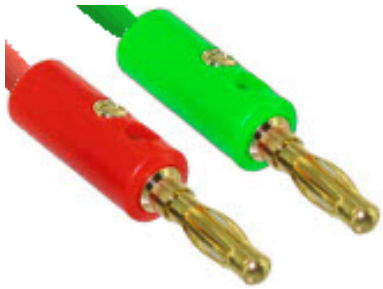
3.2.4 Battery test connectors

These are standard 4mm “banana” plugs. They are very widely available, as are suitable mating connectors.

Cable / Plug	Function	Associated Seacon pin
Yellow / Red	+ve	25
Green / Green	-ve	20

Note: if the battery cable is shielded, the cable braid should be connected to pin 14 of the Seacon connector.

3.2.5 Power Supply test connectors



These are standard 4mm “banana” plugs. They are very widely available, as are suitable mating connectors.

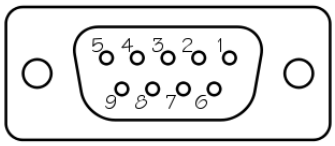
Cable / Plug	Function	Associated Seacon pin
Red / Red	+ve	24
Green / Green	-ve	19

Note: if the power supply cable is shielded, the cable braid should be connected to pin 13 of the Seacon connector.

3.2.6 RS232 Data Out test connector

This is a standard DE9F (TIA-574) sub-miniature (D-sub) line sockets, conforming to DIN 41652 and MIL-DTL-24308. They are very widely available, as are suitable mating connectors.

Pin	Function	Associated Seacon pin
1	*not connected*	
2	Transmitted data*	11
3	Received data*	13
4	*not connected*	
5	Ground	1
6	*not connected*	
7	*not connected*	
8	*not connected*	
9	*not connected*	



Wiring details for the compatible plug, DE9M, as seen from the cable end.

Note: The embedded CMG-EAM is considered to be the DTE for this connection, so “Transmitted” refers to data *from* the CMG-EAM and “Received” refers to data received by the CMG-EAM.

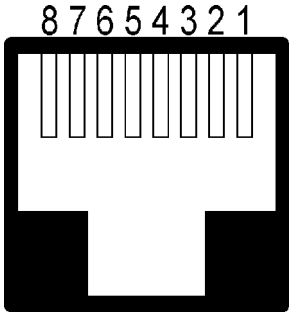
3.2.7 Ethernet test connector

This is a standard 8P8C modular line jack, conforming to ANSI/TIA-968-A and IEC 60603. They are very widely available, as are suitable mating connectors.

Pin	Function	Associated Seacon pin
1	Rx +	22
2	Rx -	17
3	Tx +	23
4	*not connected*	
5	*not connected*	
6	Tx -	18
7	*not connected*	
8	*not connected*	

Note: the connector is wired in "MDI" mode, which is suitable for connection to a hub, switch or router. In order to make a direct connection to, for example, a PC's network adaptor, it may be necessary to use a cross-over adaptor.

Note: the colour-codes of the individual cable cores conform to TIA/EIA-568-B.



Wiring details for the compatible socket, as seen from the back, e.g. when soldering.

4 Revision history

2009-08-19 A New Document