# MiniRLG2

## Technical Manual

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## INTRODUCTION

### 1.0. WARNINGS AND NOTES

Throughout the manual the following symbols are used:

**Indicates a warning**. Failure to follow these instructions will result in serious injury, damage to equipment or incorrect operation of equipment.

**Indicates a note**. This indicates important information that should be followed to ensure correct operation of the unit.

### 1.1. GENERAL DESCRIPTION

#### 1.1.1. System Overview

*Figure 1.1: The MiniRLG 2*

The CDL MiniRLG 2 is a solid state gyro compass based around the Kearfott T16-B Monolithic Ring Laser Gyrocompass (MRLG).

The MiniRLG 2 contains an Inertial Sensor Assembly (ISA) comprised of a three axis MRLG and three single-axis accelerometers. This assembly, together with the navigation processor, provides the MiniRLG 2 a full self contained Attitude Heading Reference Unit. Figure 1.1 shows the MiniRLG2 in its standard 3000m housing.

**The MiniRLG has its alignment time set to 10 minutes! The unit will not have a usable heading until this time has elapsed and it has entered the aided navigation mode (See section 3.1 for mode codes)**

### 1.1.2. Interface Overview

The MiniRLG 2 has two user interface ports available through the umbilical connector on the pod. Both ports allow access to user selectable data strings and to the control interface. Port 1 should be used in preference to Port 2 for the control interface as it has a higher interrupt priority. There are a further two interfaces available through the AUX1/DVL and AUX2/GPS connectors.

The interfaces on the umbilical port can be configured to a number of different user selectable outputs and if required the outputs selected on either of these ports can be duplicated on either or both of the AUX connectors. Furthermore, the high speed HAIN data can be output from either AUX port independently of the outputs selected on Port 1 or Port 2.

It is also possible to aid the MiniRLG2 system using a GPS input. The GPS data can be either differential or non-differential but must have minimal filtering applied to the position and velocity information.

**The GPS data must include the following strings: NMEA GGA, VTG and GSA. If these strings are not available in the GPS input the MiniRLG 2 will not process the data.**

## 1.2. THEORY OF OPERATION

### 1.2.1. General overview

The MiniRLG 2 contains an Inertial Sensor Assembly; this assembly along with the navigation processor provide the heart of the attitude and heading reference unit.

Instantaneous linear accelerations are measured by an array of solid-state accelerometers. Rotational accelerations are measured using a three-axis monolithic ring laser gyrocompass. These readings are fed into an inertial algorithm that computes the unit's attitude relative to true vertical and heading relative to true north.

### 1.2.2. Reference frames

The MiniRLG2 works by using very accurate, sensitive sensors to compare the motion of the unit relative to the Earth and fixed inertial space. The Universal reference frame is related to the 'fixed' stars. This is the only frame where no translation or rotation movements will be detected by navigation quality sensors. This frame has its origin at the centre of the Earth and has axes which are non-rotating with respect to the fixed stars. The Z-axis is co-incident with the Earth's polar axis

The Earth reference frame (e.g. WGS84) is like the Universal reference frame, except for the Earth's rotation about the polar axis at 15 degrees per hour and the Earth's rotation around the Sun at approximately 0.04 degrees per hour, giving a total of 15.04 degrees per hour. The origin is also at the Earth's centre but the axes are fixed with respect to the Earth.

The Geographic reference frame (e.g. UTM) is a local approximation to cartesian co-ordinates. The origin is at the location of the system, with axes aligned to North and Down. This is the frame that we want our measurements to be relative to.

The Vehicle reference frame has axes aligned with the roll, pitch and yaw axes of the vehicle in which the system is installed. The sensors measure motions with respect to this frame directly, i.e. forward motion will produce a response on the X accelerometer only.

The ring laser gyros within the MiniRLG2 are sensitive enough to be able to detect and measure the rotation of the Earth with respect to the Universal reference frame, and the linear accelerometers are sensitive enough to very accurately measure the Earth's gravity vector.

### 1.2.3. Computing attitude

As the linear accelerometers can easily and accurately detect the direction of the Earth's gravity, it is quite simple to provide the vehicle's pitch and roll, which are defined by the difference between the vehicle reference frame Z-axis and the Geographic reference frame Z-axis.

Given the local latitude, the ability to determine the direction of the Earth's gravity vector and the ability to detect the rotation of the Earth about its axis, it is possible to determine the orientation of the Earth's polar axis relative to the Vehicle reference frame and therefore the heading of the vehicle can be computed.

### 1.2.4. How the linear accelerometers work

The linear accelerometers in the unit are of the single-axis pendulous force-rebalance type. They consist of a small proof mass suspended on a flexible joint. Acceleration causes displacement of the mass which is detected by a coil. A feedback loop is used to drive the mass back to its null point and as the force required to do this is proportional to the acceleration experienced by the sensor, it is possible to measure the force and therefore measure the acceleration.

### 1.2.5. How the ring laser gyros work

The ring laser gyros work by generating a laser beam, splitting it into two and sending each beam in a different direction around the same closed path, figure 1.2 shows the lasing RLG crystal.

*Figure 1.2: Lasing RLG Crystal*

This path takes the form of a square ‘loop’. If this loop is rotating about the axis orthogonal to the plane of the loop, the light which has gone one way round will have to travel very slightly further to get back to the start, whilst the light travelling the other way will have to travel a very slightly shorter path. This difference in path lengths leads to a measurable phase difference between the two beams which is proportional to the rate of rotation of the sensor.

## 1.3. WARRANTY

CDLtd UK warrants ‘MiniRLG 2’ products to be free from defects in materials or workmanship for one year beginning on the date when the equipment was shipped from the CDL base or from their authorised distributor.

Units must be packaged with care when returning to the CDLtd base. CDLtd recommends that the original packing material is retained for this purpose.

The responsibility of CDLtd in respect of this warranty is limited solely to product replacement or repair at an authorised location only. Determination of replacement or repair will be made by CDLtd personnel or by personnel expressly authorised by CDLtd for this purpose.

This warranty will not extend to damage or failure resulting from misuse, neglect, accident, alteration, improper installation, non-approved cables or accessories, or operation in an environment other than intended.

In no event will CDLtd be liable for any indirect, incidental or consequential damages whether through tort, contract or otherwise. This warranty is expressly in lieu of all other warranties, expressed or implied, including without limitation the implied warranties of merchantability or fitness for a particular purpose. The foregoing states the entire liability of CDLtd with respect to the products described herein.

## 2.0. SYSTEM CONTENTS


*Figure 2.1: System Contents*

When the system is received is should comprise of the following items:

1. MiniRLG 2 subsea unit
2. Transit Case
3. 1.2 m tail for connection to the umbilical connector
4. Instruction Manual
5. Calibration Certificate
6. Connector Blanks

## 2.1. UNPACKING AND INSPECTION

The system was shipped from CDL in a specially designed transit case that contains cavities that exactly fit each system component.  This transit case should ensure that the equipment reaches its destination in perfect working order.

**Retain the original transit case so that this may be used to transport the system when necessary.  Improper packing whilst the unit is being transported will invalidate the warranty of the unit.**

On receipt of the equipment, the contents of the packing case should be carefully unpacked and checked against the items on the shipping documents for any errors or omissions. If the equipment or transit case has been fitted with a CDL MicroShock device (or similar) then the device should be checked in case the system has suffered any damage during transit. It is recommended that the original packing case be used for subsequent transportation of the equipment.

## 2.2. PHYSICAL INSTALLATION

The CDL MiniRLG 2 should be installed on a level flat surface in a manner to give the unit maximum physical protection from accidental damage.

The MiniRLG 2 weighs 9.8Kg so a location must be chosen that will support this load whilst giving convenient access to the unit and sub connectors.

The location of the unit must not be near any sources of extreme mechanical noise.

As standard the MiniRLG 2 is shipped in a 3000M housing, however there are 4000M and 6000M options. Under no circumstances should the unit be subjected to forces greater than that stated on the unit.

**The depth rating of the MiniRLG 2 housing is stated clearly on the side label. Should you wish to use a MiniRLG beyond its stated rating please contact CDL for assistance BEFORE using the unit.**

### 2.2.1. System Orientation

In order to gain an accurate heading reference the unit's heading axis should be aligned accurately with the vehicle's fore-aft axis. The unit can be mounted in different orientations, refer to Section 2.2.2.

The position read from the unit is referenced to a non-central point. Sections 7.0 and 7.1 give offsets for the reference point to allow all readings to be referenced correctly to the base of the unit.

The reference frame of the unit is defined as follows-
The unit's X-axis is the roll axis and should be aligned with the fore-aft axis of the vehicle. The unit's Y-axis is the pitch axis and should be aligned with the port-starboard axis of the vehicle. The unit's Z-axis is the yaw axis and should be aligned with the azimuth if the vehicle is level. These definitions are illustrated in Figure 2.2

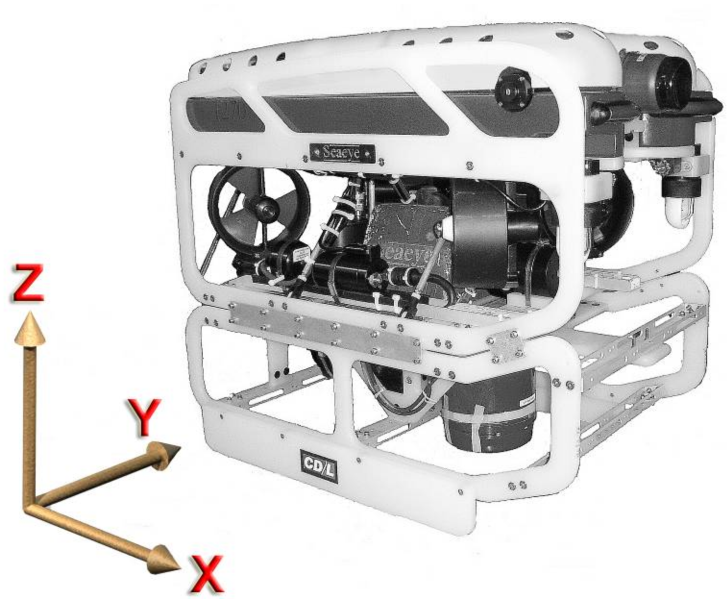



*Figure 2.2 Vehicle reference frame*
*Image used courtesy of Seaview Systems and Seaeye Marine*

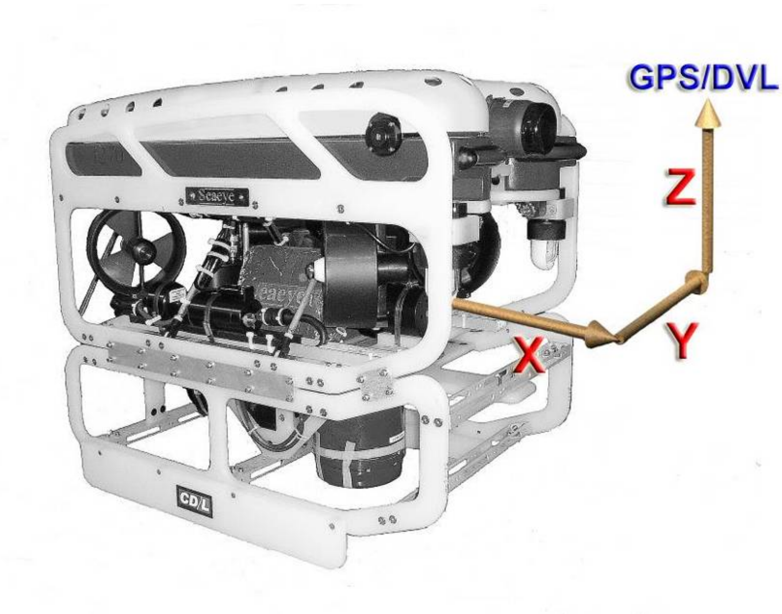
**Heading** is defined as the angle between true north and the projection of the vehicle X-axis onto the horizontal plane.

**Pitch** is defined as the angle between the vehicle X-axis and the horizontal plane.

**Roll** is defined as the angle between the vehicle Y-axis and the horizontal plane.

Lever arm offsets for both DVL and GPS are shown in figure 2.3. The offsets are positive if the DVL/GPS is in front of, to port, and above the MiniRLG 2.

The DVL should be mounted with the alignment notch towards the PORT side of the vehicle (Beams 2 and 3 should face forwards).




*In this example, X, Y and Z are all **positive***
*Image used courtesy of Seaview Systems and Seaeye Marine*

### 2.2.2. System Mounting

The MiniRLG2 can be mounted in a choice of orientations. The standard orientation is with the connectors at the top, and heading reference in the direction of the “heading” arrow on the lid. This is how CDL delivers the MiniRLG2 unless otherwise requested.

Alternatively, it can be mounted on its side. In this orientation, there are four further horizontal alignment options, in 90 degree steps i.e. connector end of housing points: bow, starboard, stern, or port. If your MiniRLG2 is set to one of these four alignments, the mounting rotation is as given in Table 2.1.

Note that the three columns to the right give the offsets to apply in the firmware for each orientation. These are presently preset by CDL but may be applied by the user in future firmware versions.

| Orientation | Direction of “heading” arrow | Azimuth bore sight | Pitch bore sight | Roll bore sight |
|---|---|---|---|---|
| Connectors to bow (front) | Points vertically down | 0 | -90 | 0 |
| Connectors to starboard (right) | Points to bow (front) | 0 | 0 | +90 |
| Connectors to stern (back) | Points vertically up | 0 | +90 | 0 |
| Connectors to port (left) | Points to bow (front) | 0 | 0 | -90 |

*Table 2.1: Mounting Orientation Offsets*

This configuration setup is made in the MiniRLG2 firmware. At the time of writing it has to be done by CDL. In future firmware revisions, we do intend to allow the user to reconfigure this through the user interface.

**Note that the MiniRLG2 has to be recalibrated each time the orientation is changed, so it should not be done unless absolutely necessary**.

Please contact CDL to find out about firmware versions if you want this configuration changed for your MiniRLG2.

## 2.3. ELECTRICAL INSTALLATION

The MiniRLG2 has three connectors, one Burton 20-13 for power and data and two Burton 15-08s for GPS, DVL and auxiliary communication functions.

**If any of these connectors are not in use they MUST be fitted with blanking plugs.**

Interface with the unit can be by RS232 or RS422 serial communications at standard baud rates in the range 9600 – 115200 bps.

### 2.3.1. Umbilical Connector

The umbilical connector is a Burton 20-13 connector. This connector supplies power to the unit and has 2 serial ports. These provide the primary and secondary ports to the device. The pin out for this connector is given in Table 2.2 and the pin orientation is shown in Figure 2.4.

| Pin | Name | Function | RS 232 | RS 422 |
|---|---|---|---|---|
| 1 | AC Live | Live | | |
| 2 | Port 2 TxA | Secondary Port | Tx | Tx + |
| 3 | AC Earth | Earth | | |
| 4 | +24v Rtn | Power Ground | | |
| 5 | Port 1 TxA | Primary Port | Tx | Tx + |
| 6 | Port 1 TxB | Primary Port | N/C | Tx - |
| 7 | Port 1 RxA | Primary Port | Rx | Rx + |
| 8 | Port 1 RxB | Primary Port | Ground | Rx - |
| 9 | +24v DC | +24v DC | | |
| 10 | AC Neutral | Neutral | | |
| 11 | Port 2 TxB | Secondary Port | N/C | Tx - |
| 12 | Port 2 RxA | Secondary Port | Rx | Rx + |
| 13 | Port 2 RxB | Secondary Port | Ground | Rx - |

*Table 2.2: Umbilical Connector*

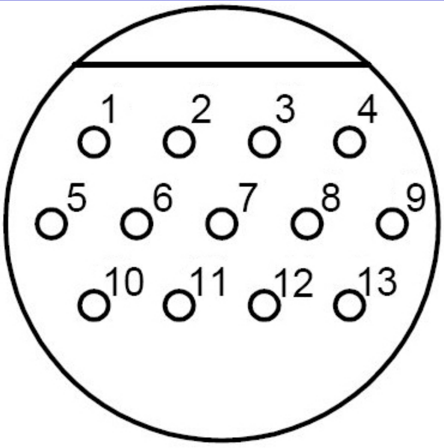



*Figure 2.4: Burton 20-13 Female face view*

### 2.3.2. AUX1/DVL connector

The auxiliary 1/DVL connector is a Burton 15-08 connector. This allows a DVL input to be supplied to the unit to aid navigation. In addition the Aux1 port can also output a fast raw binary string used in the Hydro-Acoustic Inertial Navigation (HAIN) system, or a duplication of either of the data strings on Ports 1 or 2. Table 2.3 shows the pin outs for this connector. Figure 2.5 shows the pin orientation on the connector.

| Pin | Name | Function | RS 232 | RS 422 |
|---|---|---|---|---|
| 1 | +24v DC out | +24v DC | | |
| 2 | +24vRtn | DC Ground | | |
| 3 | DVL TxA | DVL | Tx | Tx + |
| 4 | DVL TxB | DVL | N/C | Tx - |
| 5 | DVL RxA | DVL | Rx | Rx + |
| 6 | DVL RxB | DVL | Ground | Rx - |
| 7 | N/A | | | |
| 8 | N/A | | | |

*Table 2.3: AUX1/DVL connector*

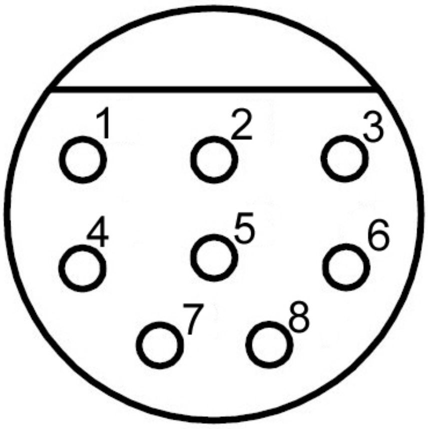



*Figure 2.5: Burton 15-08 Female Face View*

### 2.3.3. AUX2/GPS connector

The auxiliary 2/GPS connector is Burton 15-08 connector. This allows a GPS input to be supplied to the unit to aid navigation. In addition the Aux2 port can also output a fast raw binary string used in the Hydro-Acoustic Inertial Navigation (HAIN) system, or a duplication of either of the data strings on Ports 1 or 2. Table 2.4 shows the pin outs for this connector. Figure 2.6 shows the pin orientation on the connector.

| Pin | Name | Function | RS 232 | RS 422 |
|---|---|---|---|---|
| 1 | +24v DC out | +24v DC | | |
| 2 | +24vRtn | DC Ground | | |
| 3 | GPS TxA | GPS | Tx | Tx + |
| 4 | GPS TxB | GPS | N/C | Tx - |
| 5 | GPS RxA | GPS | Rx | Rx + |
| 6 | GPS RxB | GPS | Ground | Rx - |
| 7 | 1PPS Rtn | 1 PPS Ground | | |
| 8 | 1PPS | 1 PPS Signal | | |

*Table 2.4: AUX1/DVL connector*

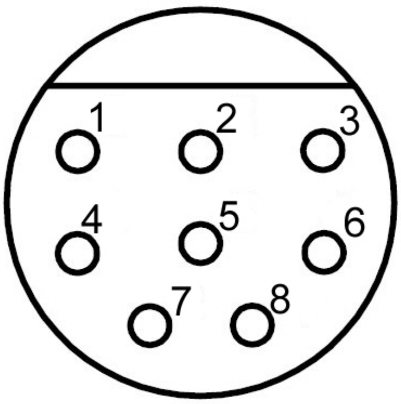



*Figure 2.6: Burton 15-08 Female Face View*

### 2.3.4. Summary

As a minimum to use and configure the MiniRLG 2 the power source and either port 1 or port 2 need to be connected.

When using a 24v DC power source care must be taken to avoid reverse polarisation of the connection. The positive supply should be connected to pin 9 and the 0v connection should be connected to pin 4 on the umbilical connector.

When using an AC power source for the unit care must be taken to ensure the correct pins are used for the umbilical connection. AC live MUST be connected to Pin 1, AC neutral must be connected to pin 10 and AC earth must be connected to pin 3 on the umbilical connector.

**Failure to connect AC power supply to the correct pin on the umbilical connector will result in permanent damage to the unit**

## 3.0. INITIAL POWER-ON

The MiniRLG 2 unit runs automatically on power up. The system has been set for a 10 minute run-up period but will generally be within 1 degree of accuracy after 3 minutes.

Please note that severe motion during the run-up period will cause the settling period to increase slightly.

After initial power on the system executes a short self test procedure which lasts approximately 10 seconds. Once this is completed the embedded control software is initialised and the four communication ports are configured with the last known settings. The system always operates with 8 bit data, no parity and one stop bit.

**Port 1 and Port 2 can be configured to output data and to access the Main Menu. Aux 1 can be configured for DVL I/O, raw binary data (HAIN) or duplicate ports 1 or 2. Aux 2 can be configured for GPS I/O, raw binary data (HAIN) or duplicate ports 1 or 2.**

All Ports are initially configured with 9600 baud, 8 bit data, no parity and one stop bit.

**If any connectors are not in use they MUST be fitted with blanking plugs.**

## 3.1. EMBEDDED SOFTWARE MAIN MENU

Customisation of the MiniRLG 2's operation is allowed through embedded firmware. The various configuration options allowed in the embedded firmware have been compiled into a logical hierarchical menu structure and are accessible on either Port 1 or Port 2. The menu is accessed through any PC terminal program by pressing the Escape key, this then stops data output and displays the Main Menu.

The Main Menu provides control of the MiniRLG 2 and allows configuration of the communication ports. Configuration instructions for Ports 1 and 2 are detailed in Section 3.2 and Aux 1 and Aux 2 in Sections 3.5 and 3.6 respectively. The Main Menu also provides options to restart the MiniRLG 2 and to set latitude.

**To retain configuration during power off the "X" command must be executed to write settings to EEPROM. This process will take several seconds during which power must be maintained. If changes do not need to be saved wait for approximately 20 seconds until data reappears, or press q.**

**During Menu operations the output to data port 2 is disabled.**

The Main Menu for the embedded control software is shown in Figure 3.1. Note that in the menu the figure shown to the right of option 4 is the current Latitude setting. This convention is used throughout the sub-menus to allow current settings to be quickly checked.

```
**************** Ser No 00000 ******************
* CDL RLG2 Firmware Rev 3.11 - RLG mode = 0x00 *
************************************************


MiniRLG Menu
============
1       Config Port 1
2       Config Port 2
3       Config Gyro
4       (Re)start Alignment
5       Set Latitude ... +57.19099807
6       Config Aux 1
7       Config Aux 2
8       Reset factory defaults
BkSp    Up one menu level
Esc     Main Menu
X       Exit Menu and Save
Q       Quit Without Saving
```

*Figure 3.1: Main Menu*

## 3.2. CONFIGURE PRIMARY PORTS (PORT 1 AND PORT 2)

Options 1 and 2 from the main menu provide access to the configuration menus for Ports 1 and 2 respectively.

The sub-menu for Port 1 is shown in Figure 3.2. Current settings for the Output Format, Baud Rate, Output Rate and serial mode are shown to the right of the corresponding options.

```
**************** Ser No 00000 ******************
* CDL RLG2 Firmware Rev 3.11 - RLG mode = 0x00 *
************************************************


MiniRLG Port 1 Menu
===================
1        Config Output Format ... CDL1
2        Set Baud Rate ... 9600 baud
3        Set Output Rate ... 10 Hz
4        Set RS232/RS422 ... RS232
BkSp     Up one menu level
Esc      Main Menu
X        Exit Menu and Save
Q        Quit Without Saving
```

*Figure 3.2: Config Port 1 Menu*

### 3.2.1. Configuration of Output Format (Port 1 and Port 2)

Option 1 on the Port 1 Menu allows configuration of the output string format. Figure 3.3 shows the output strings that are currently supported on Port 1.

```
**************** Ser No 00000 ******************
* CDL RLG2 Firmware Rev 3.11 - RLG mode = 0x00 *
************************************************


MiniRLG Output Format Port 1 Menu
=================================
1       CDL1
2       CDL2
3       MDL
4       MiniRLG1
5       MiniRLG2
6       MiniRLG3
7       Tokimec1
8       Tokimec2
9       EM3000
a       SGB
b       DLOG
c       SKR
d       NMEA
e       MRU
f       Next Page
BkSp    Up one menu level
Esc     Main Menu
X       Exit Menu and Save
Q       Quit Without Saving
```

*Figure 3.3: Output Format Port 1 Menu*

If a new Output Format is selected a confirmation message will be displayed and confirmation of the change is required.

```
**************** Ser No 00000 ******************
* CDL RLG2 Firmware Rev 3.11 - RLG mode = 0x00 *
************************************************


MiniRLG Change Output Format on Port 1 - Confirm =
Y(es) Cancel = N(o)
=====================================================
```

*Figure 3.4: Change Output Format Confirmation*

```
**************** Ser No 00000 ******************
* CDL RLG2 Firmware Rev 3.11 - RLG mode = 0x0A *
************************************************

MiniPOS Output Format Port 1 Menu Page 2
========================================
1       Kearfott Raw Binary (Hain)
2       GyroCompass1
3       GyroCompass2
4       TCM-2
5       Custom String
6       Config Custom String
BkSp    Up one menu level
Esc     Main Menu
X       Exit Menu and Save
Q       Quit Without Saving
```

*Figure 3.3: Output Format Continued Port 1 Menu*

### *3.2.1.1. Config Custom String*

In order to configure the custom string, select option 6 on the menu depicted in Figure 3.4. When selected, the menu below will appear (Figure 3.6).

```
**************** Ser No 00000 ******************
* CDL RLG2 Firmware Rev 3.11 - RLG mode = 0x0A *
************************************************

MiniRLG CDL Port 1 Custom String Configuration
==============================================
1 Sys Depth ...    Off  B Y Accel ...      Off
2 Height ...       Off  C Z Accel ...      Off
3 Heading ...      Off  D X Angle Rate ... Off
4 Pitch ...        Off  E Y Angle Rate ... Off
5 Roll ...         Off  F Z Angle Rate ... Off
6 Heave ...        Off  G Mode ...         Off
7 North Vel ...    Off  H Temp ...         Off
8 East Vel ...     Off  I Depth ...        Off
9 Down Vel ...     Off  J Batt Voltage ... Off
A X Accel ...      Off

S       Set
BkSp    Up one menu level
Esc     Main Menu
X       Exit Menu and Save
```

*Figure 3.3: Configure Custom String Port 1 Menu*

Toggle each required field using the characters and use ‘S’ to set the custom string to the defined format.

### 3.2.2. Set Baud Rate (Port 1 and Port 2)

Option 2 on the Port 1 Menu allows configuration of the output Baud Rate. Figure 3.5 shows the Baud Rates supported by Ports 1 and 2. As with the change of Output Format option changes in Baud Rate must be confirmed.

```
**************** Ser No 00000 ******************
* CDL RLG2 Firmware Rev 3.11 - RLG mode = 0x00 *
************************************************

MiniRLG Baud Rate Port 1 Menu
=============================
1         9600 baud
2        19200 baud
3        38400 baud
4        57600 baud
5       115200 baud
BkSp    Up one menu level
Esc     Main Menu
X       Exit Menu and Save
Q       Quit Without Saving
```

*Figure 3.5: Output Format Port 1 Menu*

### 3.2.3. Set Output Rate (Port 1 and Port 2)

Option 3 on the Port 1 Menu allows configuration of the Output Rate. Figure 3.6 shows the Output Rates supported by Port 1. Changes in Baud Rate must be confirmed.

**Maximum frequency for the data output may be limited when large data strings and/or low baud rates are selected. Exceeding these limits on Port 1 will result incorrect operation.**

```
**************** Ser No 00000 ******************
* CDL RLG2 Firmware Rev 3.11 - RLG mode = 0x00 *
************************************************

MiniRLG Output Rate Port 1 Menu
===============================
1       50 Hz
2       25 Hz
3       10 Hz
4        5 Hz
5        2 Hz
6        1 Hz
BkSp    Up one menu level
Esc     Main Menu
X       Exit Menu and Save
Q       Quit Without Saving
```

*Figure 3.6: Output Rate Port 1 Menu*

### 3.2.4. Set Output Rate (Port 2)

Option 3 on the Port 2 Menu allows configuration of the Output Rate. Figure 3.7 shows the Output Rates supported by Port 2. Changes in Baud Rate must be confirmed.

Port 2 output data is given a lower priority that Port 1 output data. This results in a slower output rate when port 1 is outputting longer data strings.

**Maximum frequency for the data output may be limited when large data strings and/or low baud rates are selected in either Port 1 or Port 2. Exceeding these will result in slower output rates than anticipated on Port 2.**

```
**************** Ser No 00000 ******************
* CDL RLG2 Firmware Rev 3.11 - RLG mode = 0x00 *
************************************************


MiniRLG Output Rate Port 2 Menu
===============================
1       50 Hz
2       25 Hz
3       10 Hz
4        5 Hz
5        2 Hz
6        1 Hz
BkSp    Up one menu level
Esc     Main Menu
X       Exit Menu and Save
Q       Quit Without Saving
```

*Figure 3.7: Output Rate Port 2 Menu*

### 3.2.5. Set Communication Mode

Option 4 on the Port 1 and Port 2 Menu cycles between the two communication protocols RS232 and RS422.

### 3.3. CONFIGURE GYRO

Option 3 on the main menu brings up the Config Gyro Menu, Figure 3.8.

```
**************** Ser No 00000 ******************
* CDL RLG2 Firmware Rev 3.11 - RLG mode = 0x00 *
************************************************

MiniRLG Config RLG Menu
=======================
1       Config Alignment
2       Config Boresight Angles, Alignment Time and Test Messages
3       Config GPS Lever Arm
4       Config DVL Lever Arm
5       Update RLG
BkSp    Up one menu level
Esc     Main Menu
X       Exit Menu and Save
Q       Quit Without Saving

Info ... when all changes have been made to Boresight and GPS/DVL
Lever Arm
select Update RLG to save the settings and power cycle the RLG. The
new
settings to take effect when the RLG starts up again.
```

*Figure 3.8: Config Gyro Menu*

### 3.3.1. Config Alignment

Option 1 on the Config Gyro Menu brings up the Config Alignment Menu. The alignment mode can be set as either 1,2 or 3 and the last setting is stored during power down in memory. Text “Selected” is shown next to the current mode. Depending on current alignment mode, Options 4,5 and 6 can be chosen simultaneous but selection will return to default on restart.

```
**************** Ser No 00000 ******************
* CDL RLG2 Firmware Rev 3.11 - RLG mode = 0x00 *
************************************************


MiniRLG Config Alignment Menu
=============================
1       Dock Stationary Alignment ...
2       Stationary Alignment ... Selected
3       Stationary Alignment with GPS ...
4       Moving base Alignment with GPS ...
5       Enable GPS aiding ...
6       Enable DVL aiding ...
7       Input Lat/Lon Valid ... True
8       Calibration Check ...
BkSp    Up one menu level
Esc     Main Menu
X       Exit Menu and Save
Q       Quit Without Saving
```

*Figure 3.9: Config Alignment Menu*

### 3.3.2. Config Boresight Angles, Alignment Time and Test Messages

Option 2 on the Config RLG Menu brings up the Config Boresight Menu

```
**************** Ser No 00000 ******************
* CDL RLG2 Firmware Rev 3.11 - RLG mode = 0x00 *
************************************************


MiniRLG Config Boresight Menu
=============================
1       Roll Angle ... +0.0000
2       Pitch Angle ... +0.0000
3       Azimuth Angle ... +0.0000
4       Set Alignment Time ... 10 mins
5       Enable Fast Test Messages ... True
6       Enable Slow Test Messages ... True
BkSp    Up one menu level
Esc     Main Menu
X       Exit Menu and Save
Q       Quit Without Saving
```

*Figure 3.10:* Config Boresight Menu

From this menu you can enter in offsets to the pitch, roll and heading. The values that are shown to the right of each menu option indicate the current values that are stored in the RLG.

The value that you enter is the offset from the known point, not the correction.

```
**************** Ser No 00000 ******************
* CDL RLG2 Firmware Rev 3.11 - RLG mode = 0x00 *
************************************************


Enter Boresight Roll (deg) - hit enter when done,
hit c to cancel
====================================================
```

*Figure 3.11: Enter Roll Boresight Menu*

Once you have entered in the offsets into the unit you must return to the previous menu via the backspace key and press 5 to update the RLG

For Example:

If the unit is sitting against a surveyed heading of 270.0º and the unit is reading 270.15º then you would enter in 0.15 as the azimuth angle.

If the unit is sitting against a surveyed heading of 270.0º and the unit is reading 269.15º then you would enter in -0.85 as the azimuth angle.

### 3.3.3. Fast and Slow Test messages

Options 5 and 6 allow you to enable and disable the fast and slow test messages from the raw Kearfott (Hain) data output.

### 3.3.4. Config GPS Lever Arm Menu

Option 3 on the Config Gyro Menu initialises the Config GPS Lever Arm Menu. Through this menu the x,y and z offsets are entered in whole centimetres. Offsets should be accurate to the nearest 5cm

```
**************** Ser No 00000 ******************
* CDL RLG2 Firmware Rev 3.11 - RLG mode = 0x00 *
************************************************

MiniRLG Config GPS Lever Arm Menu
=================================
1       x Offset ... 0cm
2       y Offset ... 0cm
3       z Offset ... 0cm
BkSp    Up one menu level
Esc     Main Menu
X       Exit Menu and Save
Q       Quit Without Saving
```

*Figure 3.12: Config GPS Lever Arm Menu*

Figure 3.11 shows the offset data entry screen.

```
**************** Ser No 00000 ******************
* CDL RLG2 Firmware Rev 3.11 - RLG mode = 0x00 *
************************************************

Enter Offset - hit enter when done, hit c to cancel
===================================================
```

*Figure 3.13: Offset Menu*

### 3.3.5. Config DVL Lever Arm Menu

As with the GPS Lever Arm offsets, the DVL Lever Arm Offsets are entered in whole centimetres Figure 3.12. Offsets should be accurate to the nearest 25cm.

```
**************** Ser No 00000 ******************
* CDL RLG2 Firmware Rev 3.11 - RLG mode = 0x00 *
************************************************

MiniRLG Config DVL Lever Arm Menu
=================================
1       x Offset ...
2       y Offset ...
3       z Offset ...
BkSp    Up one menu level
Esc     Main Menu
X       Exit Menu and Save
Q       Quit Without Saving
```

*Figure 3.14: Config DVL Lever Arm Menu*

### 3.3.6. Update RLG Command

Option 5 sends configuration data directly to the Kearfott EPROM but will not be effective until power restart.

## 3.4. RESTART ALIGNMENT

The Kearfott RLG can be restarted through option 3 on the main menu. This will generate a confirmation prompt see Figure 3.13. On restart the system will again require a 10 minute run-up period but will generally be within 1 degree of accuracy after 3 minutes

```
**************** Ser No 00000 ******************
* CDL RLG2 Firmware Rev 3.11 - RLG mode = 0x00 *
************************************************

MiniRLG (Re)start Alignment - Confirm = Y(es) Cancel = N(o)
===========================================================
```

*Figure 3.15: Confirm MiniRLG Restart*

## 3.5. SET LATITUDE

The MiniRLG 2 System requires latitude positioning accurate to within one degree to north seek correctly. Latitudes in the northern hemisphere are entered as positive values and latitudes in the southern hemisphere are entered as negative values.

**Incorrect latitude data will result in improper operation**

Latitude can be inputted in three different formats.

Degrees and fractions of a degree (to 5 decimal places): 57.16671
Degrees. minutes and fractions of minutes: 57 9.23
Degrees, minutes and seconds: 57 9 15

## 3.6. CONFIGURE AUXILIARY PORT 1

Auxiliary Port 1 can be configured as a DVL port, to output the Raw Kearfott data or to duplicate the data output on either the primary or secondary port. Figure 3.14 shows the configuration options for Aux 1 with the system set to DVL and RS232 communication.

```
**************** Ser No 00000 ******************
* CDL RLG2 Firmware Rev 3.11 - RLG mode = 0x00 *
************************************************


MiniRLG Config Aux 1 Menu
=========================
1       DVL ... selected
2       Raw data output
3       Duplicate primary port
4       Duplicate secondary port
5       Set RS232/RS422 ... RS232
BkSp    Up one menu level
Esc     Main Menu
X       Exit Menu and Save
Q       Quit Without Saving
```

*Figure 3.16: Configure Auxiliary Port 1*

### 3.7. CONFIGURE AUXILIARY PORT 2

Auxiliary Port 2 can be configured as a GPS Port, to output the Raw Kearfott data or to duplicate the data output on either the primary or secondary port.

**The GPS data must include the following strings: NMEA GGA, VTG and GSA. If these strings are not available in the GPS input the MiniRLG 2 will not process the data. A PPS signal is also required.**

The GPS data can be either differential or non-differential but must have minimal filtering applied to the position and velocity information. The GPS input must be 9600 baud, 8 bit data, no parity and one stop bit.

A PPS input must be supplied to the system with the GPS data see Section 2.3.3 for connection details. For more information on the GPS signals see section 9.

Figure 3.15 shows the configuration options for Aux 2 with the system set to GPS and RS232 communication.

```
**************** Ser No 00000 *****************
* CDL RLG2 Firmware Rev 3.11 - RLG mode = 0x00 *
************************************************

MiniRLG Config Aux 2 Menu
=========================
1       GPS ... selected
2       Raw data output
3       Duplicate primary port
4       Duplicate secondary port
5       Set RS232/RS422 ... RS232
BkSp    Up one menu level
Esc     Main Menu
X       Exit Menu and Save
Q       Quit Without Saving
```

*Figure 3.17: Configure Auxiliary Port 2*

## OPERATIONAL GUIDELINES

### 4.0. INTRODUCTION

In order to get the best performance from your MiniRLG2 it is important to have the unit set up correctly for the task which you are performing. The operation of the unit can be split into two sections, the alignment phase and operational phase.

### 4.0.1. Alignment Phase

**The MiniRLG has its alignment time set to 10 minutes! The unit will not have a usable heading until this time has elapsed and it has entered the aided navigation mode (See section 3.1 for mode codes)**

The primary consideration during the alignment phase is whether or not the unit is being aligned whilst in transit or stationary at a worksite. If the unit is stationary at a worksite, either of the following methods can be used. If the unit is in transit, GPS aided alignment should be used

**Normal vessel wave motion is acceptable during a stationary alignment**

To aid the alignment process, particularly at higher latitudes, one or more 90 degree rotations can be performed after the unit has reached mode 09 (aided navigation).

#### *4.0.1.1. Stationary alignment*

This is the factory default. The unit uses the user-supplied latitude stored in EEPROM and assumes that the unit is stationary. Note that normal vessel wave motion is acceptable. If a GPS input is available, it can be used by selecting option 2, ‘Stationary alignment with GPS’ in the ‘Config alignment’ menu. See section 3.3.1

#### *4.0.1.2. Stationary alignment with GPS*

When doing an alignment with GPS it is necessary for the MiniRLG2 to “see” some motion in the GPS data to allow it to align properly.  In situations where the vessel is near stationary a stationary alignment with GPS will need to be done rather than a Moving Base Alignment.

The correct GPS offsets must be added as described in section 3.3.2

#### *4.0.1.3. Moving base alignment*

If the unit is to be aligned whilst moving, i.e. on board a steaming vessel, the ‘Moving base alignment with GPS’ option should be selected. Again, this can be found in the ‘Config alignment’ menu. See section 3.3.1

The correct GPS offsets must be added as described in section 3.3.2

#### 4.0.2. Operational Phase

Once the unit has finished the alignment phase, the type of task being performed and the availability of GPS or DVL aiding will determine which settings should be used.

**Flag settings set in the 'Config Alignment Menu' (figure 3.9, items 4,5 and 6) are not saved to EEPROM and so are not remembered after a power cycle.**

##### *4.0.2.1. Operations in a restricted area*

If the unit is to be used within a small restricted area, for example on an ROV deployed from a vessel on DP, or from a rig or platform, the choice of settings is less important. Ideally, the unit will have DVL aiding available, the 'Enable DVL aiding' flag should be set to 'True', and the Enable GPS aiding' and 'Input lat/lon valid' flags should be cleared.

If a DVL is not available, then either GPS aiding should be supplied, the 'Enable GPS aiding' flag set to 'True' and the 'Input lat/lon valid' flag cleared, or the unit should be supplied with a latitude correct to within ±1º and the 'Input lat/lon valid' flag should be set to 'True'.

##### *4.0.2.2. Operations over a wide area*

If the unit is to be used over a wide area, for example on an ROV performing long survey lines or performing a pipeline survey, the following settings should be used. Ideally, the unit will have DVL aiding available, the 'Enable DVL aiding' flag should be se to 'True', and the 'Enable GPS aiding' and 'Input lat/lon valid' flags should be cleared.

If a DVL is not available, the 'Input lat/lon valid' flag should be cleared and the 'Enable GPS aiding' flag should be cleared. In periods when the ROV is at a fixed location the latitude should be updated and the 'Input lat/lon valid' flag should be set to true. Before the ROV moves off the 'Input lat/lon valid' flag should be cleared again.

#### *4.0.2.3. Surface vessel use*

If the unit is mounted on a moving surface vessel, ideally GPS aiding will be available and the ‘Enable GPS aiding’ flag should be set and the ‘Input lat/lon valid’ flag should be cleared.

If GPS is not available then the ‘Input lat/lon valid’ flag should be set to ‘False’. In periods when the vessel is at a fixed location the latitude should be updated and the ‘Input lat/lon valid’ flag should be set to ‘True’.  The correct GPS offsets must be added as described in section 3.3.2

DVL aiding can be used, especially if GPS aiding is not available.  The correct DVL offsets must be added as described in section 3.3.3 and the ‘Enable DVL aiding’ flag should be set to ‘True’.   Again, in periods when the vessel is at a fixed location the latitude should be updated and the ‘Input lat/lon valid’ flag should be set to ‘True’.

## 5.0. DATA FORMATS

The MiniRLG 2 is able to output a range of industry standard ASCII and binary strings to enable it to be interfaced to other systems.

These string outputs are listed below and are changed via the menu system, see Section 3.2.1.

Figures 5.1 shows the sign convention for the MiniRLG 1, MiniRLG 2, MiniRLG 3 and EM3000 strings. Figure 5.2 shows the sign convention for the CDL 1, CDL 2, MDL, Digilog, Tokimec.

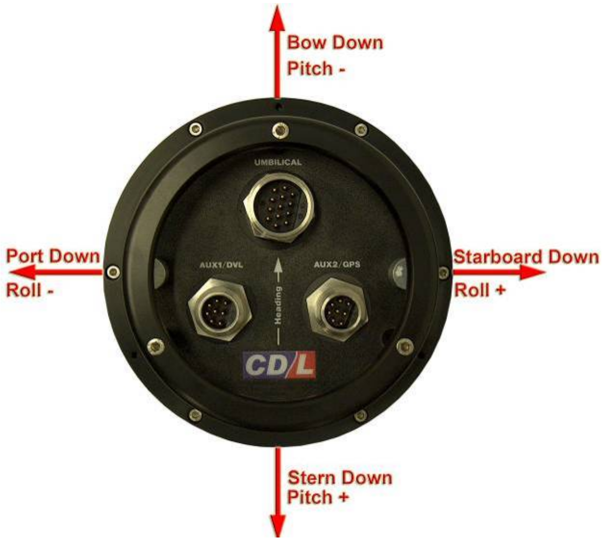



*Figure 5.1: Pitch and roll convention (MiniRLG,EM3000)*

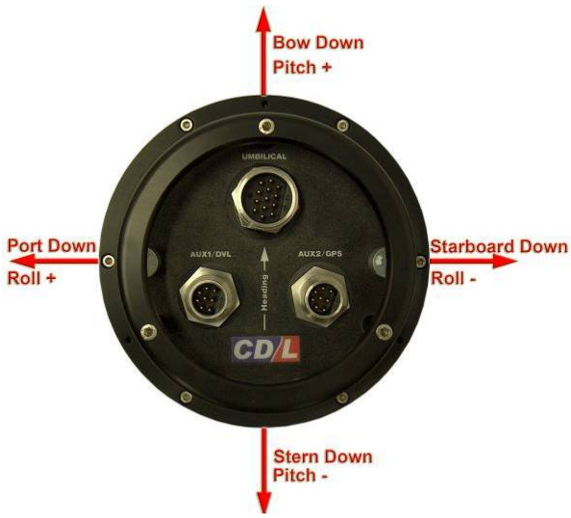



*Figure 5.2: Pitch and roll convention (Other)*

Where <CR><LF> is shown this refers to ASCII characters 0Dh and 0Ah respectively.

### 5.0.1. CDL1 Format

**H**aaa.a**P**bccc.cc**R**deee.ee**T**ff.f**D**gggg.gg**B**hh.h**A**ii**W**jj**LN**kk**F**l**<CR><LF>**

Where:

| | |
|---|---|
| aaa.a | is Heading in degrees<br>aaa(deg).a(decimal) |
| bccc.cc | is Pitch in degrees<br>ccc(deg).cc(decimal)<br>b [+] bow down / [-] stern down see figure 5.2 |
| deee.ee | is Roll in degrees<br>eee(deg).ee(decimal)<br>d [+] port down / [-] starboard down see figure 5.2 |
| ff.f | Not used |
| gggg.gg | Only available in POS units |
| hh.h | Not used |
| ii | Not used |
| jj | Not used |
| kk | Latitude |
| l | Fault flag |

Number of characters in the string (including carriage return line feed): 54

### 5.0.2. CDL 2 Format

**H**aaaa**P**bccccc**R**deeeee**T**fff**D**gggggg**B**hhh**A**ii**W**jj**LN**kk**F**l**<CR><LF>**

Where:

| | |
|---|---|
| aaaa | is Heading in degrees<br>aaa(deg).a(decimal) |
| bccccc | is Pitch in degrees<br>ccc(deg).cc(decimal)<br>b [+] bow down / [-] stern down see figure 5.2 |
| deeeee | is Roll in degrees<br>eee(deg).ee(decimal)<br>d [+] port down / [-] starboard down see figure 5.2 |
| fff | Not used |
| gggggg | Only available in POS units |
| hhh | Not used |
| ii | Not used |
| jj | Not used |
| kk | Latitude |
| l | Fault flag |

Number of characters in the string (including carriage return line feed): 48

### 5.0.3. MDL Format

**H**aaaa**P**bcccc**R**deeee**<CR><LF>**

Where:

| | |
|---|---|
| aaaa | is Heading in degrees<br>aaa(deg).a(decimal) |
| bcccc | is Pitch in degrees<br>cc(deg).cc(decimal)<br>b [+] bow down / [-] stern down see figure 5.2 |
| deeee | is Roll in degrees<br>ee(deg).ee(decimal)<br>d [+] port down / [-] starboard down see figure 5.2 |

Number of characters in the string (including carriage return line feed): 19

### 5.0.4. MiniRLG1

**H**aaa.aa**P**bcc.ccc**R**deee.eee**M**fgghhii**W**jjjj.jj**U**kk.k**<CR><LF>**

Where:

| | |
|---|---|
| aaa.aa | is Heading in degrees<br>aaa(deg).aa(decimal) |
| bcc.ccc | is Pitch in degrees<br>cc(deg).ccc(decimal)<br>b [-] bow down / [+] stern down see figure 5.1 |
| deee.eee | is Roll in degrees<br>eee(deg).eee(decimal)<br>d [-] port down / [+] starboard down see figure 5.1 |
| f | is status digit see section 4.1 for details |
| gg | is the navigation monitor in ASCII hex |
| hh | is the validity byte in ASCII hex |
| ii | is the mode control logicals byte in ASCII hex |
| jjjj.jj | Only available in POS units |
| kk.k | Not used |

Number of characters in the string (including carriage return line feed): 47

### 5.0.5. MiniRLG2

**H**aaaaa**P**bccccc**R**deeeeee**M**fgghhii**W**jjjjjj**U**kkk**<CR><LF>**

Where:

| | |
|---|---|
| aaaaa | is Heading in degrees<br>aaa(deg).aa(decimal) |
| bccccc | is Pitch in degrees<br>cc(deg).ccc(decimal)<br>b [-] bow down / [+] stern down see figure 5.1 |
| deeeeee | is Roll in degrees<br>eee(deg).eee(decimal)<br>d [-] port down / [+] starboard down see figure 5.1 |
| f | is status digit see section 4.1 for details |
| gg | is the navigation monitor in ASCII hex |
| hh | is the validity byte in ASCII hex |
| ii | is the mode control logicals byte in ASCII hex |
| jjjj.jj | Only available in POS units |
| kk.k | Not used |

Number of characters in the string (including carriage return line feed): 42

### 5.0.6. MiniRLG3

**H**aaa.aa**P**bcc.ccc**R**deee.eee^fgg.ggg**M**hiijjkk**W**llll.ll**U**mm.m**<CR><LF>**

Where:

| | |
|---|---|
| aaa.aa | is Heading in degrees<br>aaa(deg).aa(decimal) |
| bcc.ccc | is Pitch in degrees<br>cc(deg).ccc(decimal)<br>b [-] bow down / [+] stern down see figure 5.1 |
| deee.eee | is Roll in degrees<br>eee(deg).eee(decimal)<br>d [-] port down / [+] starboard down see figure 5.1 |
| fgg.ggg | is heave in meters f[+] upward motion / [-] downward motion |
| h | is status digit see section 4.1 for details |
| ii | is the navigation monitor in ASCII hex |
| jj | is the validity byte in ASCII hex |
| kk | is the mode control logicals byte in ASCII hex |
| llll.ll | Only available in POS units |
| mm.m | Not used |

Number of characters in the string (including carriage return line feed): 55

### 5.0.7. Tokimec 1 Format

$PTVF,abbbbP,cddddR,eee.eT,fgg.gPR,hii.iRR,jkk.kAR,lmm.mN,yyyMD,zzzzAL<CR><LF>

Where:

| | |
|---|---|
| abbbb | is Pitch in degrees<br>bb(deg).bb(min)<br>a[-] bow up / [space] bow down |
| cdddd | is Roll in degrees<br>dd(deg).dd(min)<br>c[-] port up / [space] port down |
| eee.e | is Heading in degrees |
| fgg.g | is the rate of pitch in degrees/sec<br>f[-] bow up / [space] bow down |
| hii.i | is the rate of roll in degrees/sec<br>h[-] port up / [space] port down |
| jkk.k | is the rate of turn in degrees/sec<br>j[-] CCW / [space] CW |
| lmm.m | is the vessel speed in Knots<br>l[-] is astern / [space] ahead |
| yyy | not used |
| zzzz | status |

Number of characters in the string (including carriage return line feed): 72

### 5.0.8. Tokimec 2 Format

$PTVF,abbbbP,cddddR,eee.eT,fgg.gPR,hii.iRR,jkk.kAR,lmm.mN,yyyMD,zzzzAL*nn<CR><LF>

Where:

| | |
|---|---|
| abbbb | is Pitch in degrees<br>bb(deg).bb(min)<br>a[-] bow up / [space] bow down |
| cdddd | is Roll in degrees<br>dd(deg).dd(min)<br>c[-] port up / [space] port down |
| eee.e | is Heading in degrees |
| fgg.g | is the rate of pitch in degrees/sec<br>f[-] bow up / [space] bow down |
| hii.i | is the rate of roll in degrees/sec<br>h[-] port up / [space] port down |
| jkk.k | is the rate of turn in degrees/sec<br>j[-] CCW / [space] CW |
| lmm.m | is the vessel speed in Knots<br>l[-] is astern / [space] ahead |
| yyy | not used |
| zzzz | status |
| hh | checksum of all in string but $ and * characters |

Number of characters in the string (including carriage return line feed): 75

### 5.0.9. EM3000 Format

The Simrad EM3000 format consists of a fixed length message using single byte unsigned, 2-byte unsigned and 2-byte twos-complement integer data elements. For the 2-byte elements, the least significant byte is transmitted first.

| **Status** | **Header** | **Roll** | | **Pitch** | | **Not Used** | | **Heading** | |
|---|---|---|---|---|---|---|---|---|---|
| A0 | 90 | LSB | MSB | LSB | MSB | FF | FF | LSB | MSB |

Where:

| Element | Scaling | Format | Size | Value |
|---|---|---|---|---|
| Status | | Unsigned | 1 Byte | 90h,91h,A0h |
| Header | | Unsigned | 1 Byte | 90h |
| Roll | 0.01 degrees | 2's compliment | 2 Bytes | -999 to 999 |
| Pitch | 0.01 degrees | 2's compliment | 2 Bytes | -999 to 999 |
| Heading | 0.01 degrees | Unsigned | 2 Bytes | 0 to 35999 |

*Table 5.1: EM3000 Fields*

Roll is positive with port side up. Pitch is positive with bow up. Status Byte indicates the following:

| Value | Status |
|---|---|
| 90h | Normal |
| 91h | Reduced Performance |
| A0h | Invalid Data |

Number of bytes in the string: 5

### 5.0.10. SGB Format

aaaa**<CR><LF>**

where:

aaaa is Heading in Degrees
aaa(deg).a(decimal)

Number of characters in the string (including carriage return line feed): 6

### 5.0.11. DLOG Format

**H**aaaa**P**bcccc**R**deeeef**<CR><LF>**

Where:

| | |
|---|---|
| aaaa | is Heading in degrees |
| bcccc | is Pitch in degrees<br>b [+] bow down / [-] stern down see figure 5.2 |
| deeee | is Roll in degrees<br>d [+] port down / [-] starboard down see figure 5.2 |
| f | final flag:<br>E Exact heading available<br>S Gyro settling |

Number of characters in the string (including carriage return line feed): 20

### 5.0.12. SKR Format

4 characters (most significant first)

UART encoded with address encoding in bits 4 and 5 and BCD digit in bits 0-3

Bits 6 and 7 always zero

| | |
|---|---|
| 00110011=Hundreds digit | 3 |
| 00100101=Tens digit | 5 |
| 00010111=Units digit | 7 |
| 00000010=Tenths digit | 2 |

Heading 357.2 degrees

Number of characters in the string (including carriage return line feed): 4

### 5.0.13. NMEA HEHDT Format

**$HEHDT**,aaa.a,**T<CR><LF>**

Where:

| | |
|---|---|
| aaa.a | is Heading in degrees<br>aaa(deg).a(decimal) |

Number of characters in the string (including carriage return line feed): 16

### 5.0.14. MRU Format

**$PSXN**,aa,bbb,cd.ddd*e*+00,fg.ggg*e*+00,hi.iii*e*+00,jk.kkk*e*+00,lm.nnn*e*+00,op.pppe*e*+00*qq**<CR><LF>**

Where:

| | |
|---|---|
| aa | is a message identifier, 10 = stable, 11 = unstable |
| bbb | is user defined token, this needs to be 014 |
| cd.ddd*e*+00 | is Pitch in radians, in exponent mantissa format<br>c [+] bow up / [-] bow down |
| fg.ggg*e*+00 | is Roll in radians, in exponent mantissa format<br>f [+] port up / [-] starboard up |
| hi.iii*e*+00 | is heading in radians, in exponent mantissa format<br>h [+] heading through east to south / [-] heading through west to south |
| ,jk.kkk*e*+00 | is angular pitch rate in radians/sec, in exponent mantissa format |
| lm.nnn*e*+00 | is angular roll rate in radians/sec, in exponent mantissa format |
| op.ppp*e*+00 | is angular heading rate in radians/sec, in exponent mantissa format |
| qq | is the NMEA checksum |

This string is not fixed field and varies in the number of characters. In exponent mantissa format 2.072 is expressed as 2.072e+00, 14.768 is expressed as 1.477e+01 and -0.08701 is expressed as -8.701e-02.

### 5.0.15. Gyrocompass 1 Format

**$HEHDT,**a.aa**,T***bb**<CR><LF>**
**$PHTRO,**c.cc,d,e.ee,f*gg**<CR><LF>**
**$PHINF,**hhhhhhhh*hh**<CR><LF>**

Where:

| | |
|---|---|
| a.aa | is the heading in degrees |
| bb | bb is the checksum |
| c.cc | is the pitch in degrees |
| d | is 'M' for bow up |
| | is 'P' for bow down |
| e.ee | is the roll in degrees |
| f | is 'B' for port down |
| | is 'T' for port up |
| gg | gg is the checksum |
| hhhhhhhh | is the hexadecimal value of the status |

### 5.0.16. Gyrocompass 2 Format

**$HEHDT,**a.aa**,T***bb**<CR><LF>**
**$PHTRH,**c.cc,d,e.ee,f,g.gg,h*ii**<CR><LF>**
**$PHINF,**jjjjjjjj*jj**<CR><LF>**

Where:

| | |
|---|---|
| a.aa | is the heading in degrees |
| bb | is a checksum |
| c.cc | is the pitch in degrees |
| d | is 'M' for bow up |
| | is 'P' for bow down |
| e.ee | is the roll in degrees |
| f | is 'B' for port down |
| | is 'T' for port up |
| g.gg | is the heave in meters |
| h | is 'U' if the MiniRLG2 goes up |
| | is 'O' if the MiniRLG2 goes down |
| ii | is a checksum |
| jjjjjjjj | is the hexadecimal value of the status |

### 5.0.17. TCM2 Format

**C**aaa.a**P**bb.b**R**cc.c*dd **<CR><LF>**

Where:

| | |
|---|---|
| Aaa.a | is the heading |
| bb.b | is the pitch in degrees |
| cc.c | is the roll in degrees |
| dd | is the checksum |

## 5.1. STATUS FLAG

The MiniRLG 2 outputs a status flag in some of the strings.  This flag has the following meanings.

| Status Flag | Meaning |
|---|---|
| 0 | Idle |
| 1 | Coarse stationary align |
| 2 | Fine stationary align – not complete |
| 3 | Fine stationary align – complete |
| 4 | Coarse GPS align |
| 5 | Fine GPS align – not complete |
| 6 | Fine GPS align – complete |
| 9 | Aided navigation |
| A | System failure |

*Table 5.2: Status flag*

## 5.2. LATENCY

The latency between movement of the RLG2 and that movement being displayed in the raw output from the inertial sensor is 5ms.

The Latency between a movement of the RLG2 and outputting heading on Port 1 is 9.8ms

## 6.0. MAINTENANCE OF EQUIPMENT

The CDL MiniRLG 2 is a self contained system which requires no regular maintenance other than a yearly calibration check (see Section 5.3).

All casings should be checked regularly for signs of damage.

All connections on the surface and subsea units should be checked regularly for fouling, bent pins or signs of damage.

## 6.1. CHECKOUT PROCEDURE

1. Connect the MiniRLG 2 to the RS232 port on a PC
2. Connect a suitable power supply to the MiniRLG 2.
3. Examine the connections and ensure they are secure
4. Power up the MiniRLG.
5. The MiniRLG unit should now begin to dither (a high pitched humming sound can be heard).
6. Heading should appear within 2 minutes when coarse stationary alignment is complete.

## 6.2. ANNUAL CALIBRATION

This equipment requires an annual calibration to be carried out at the CDL base (or approved authorised distributor). The equipment will be calibrated and fully function checked to ensure continued reliable operation. When returned, the equipment will carry both function test and calibration check certificates. Contact CDL for current calibration charges for this equipment. The turn-around time for this service is normally 1-2 days.

The accuracy of the MiniRLG2 may be increased by CDL performing a calibration of the RLG Laser during the annual calibration check. This procedure involves aligning the three inertial gyro sensors so that they are sequentially aligned with the horizontal component of the earth's rotation (15 º/hour at the equator) over a period of 5 hours. The Laser is then instructed to save a percentage of the observed parameters in its EEPROM. This procedure is repeated 8 times to fully update the EEPROM with the current RLG observed parameters. The turn-around time for this service is normally 2-3 weeks.

# SPECIFICATIONS

## 7.0. PERFORMANCE

| | | |
|---|---|---|
| Heading accuracy | ±0.169 | ° up to 65º latitude |
| Pitch and Roll | 0.028 | °RMS |
| Angle random walk | 0.02 | °/root hour |
| Bias Repeatability | 0.1 | °/hour |
| Scale Factor Repeatability | 75 | PPM |
| Axis Alignment | 20 | Arc-Second |
| Settling Time | 10 | Minutes |
| Speed | 0 to 90 | Knots |

## 7.1. ELECTRICAL AND DIGITAL

| | | |
|---|---|---|
| Operating Power | 35W | Max |
| AC Voltage | 100 – 240 | VAC |
| DC Voltage | 18-30 | VDC |
| Digital Interface | RS232 or RS422 selectable | |
| Baud Rate | 9600 to 115200 | bps |
| Data Output Rate | upto 50 | Hz |

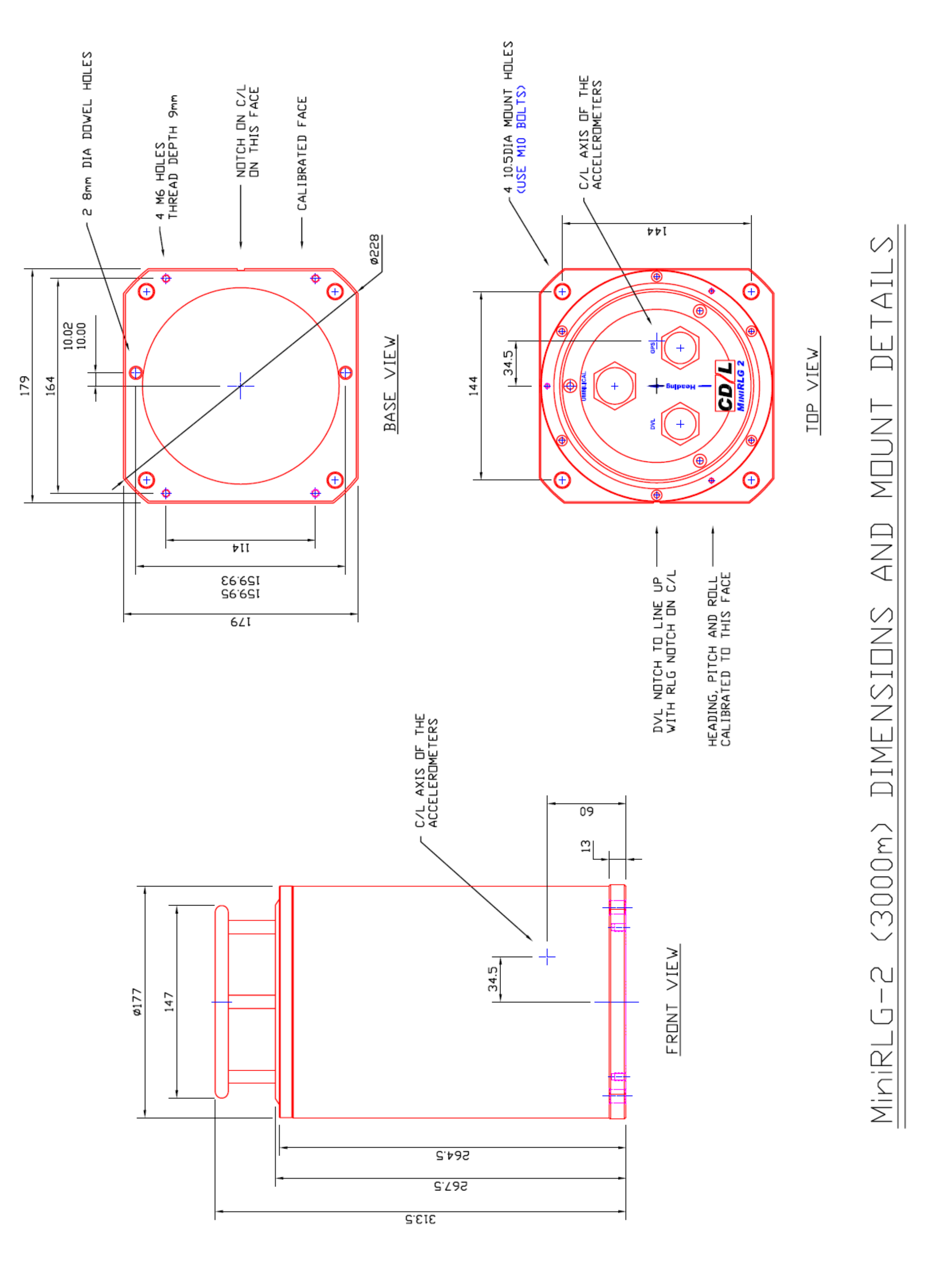
## 7.2. PHYSICAL

| | | |
|---|---|---|
| Standard Depth Rating | 3000 | Meters |
| Sub Sea Unit Dimensions | ø177 x 268 | mm |
| In air weight (excluding cable) | 9.8 | Kg |
| In water weight (excluding cable) | 2.5 | Kg |
| Finish | Hard anodised aluminium | |

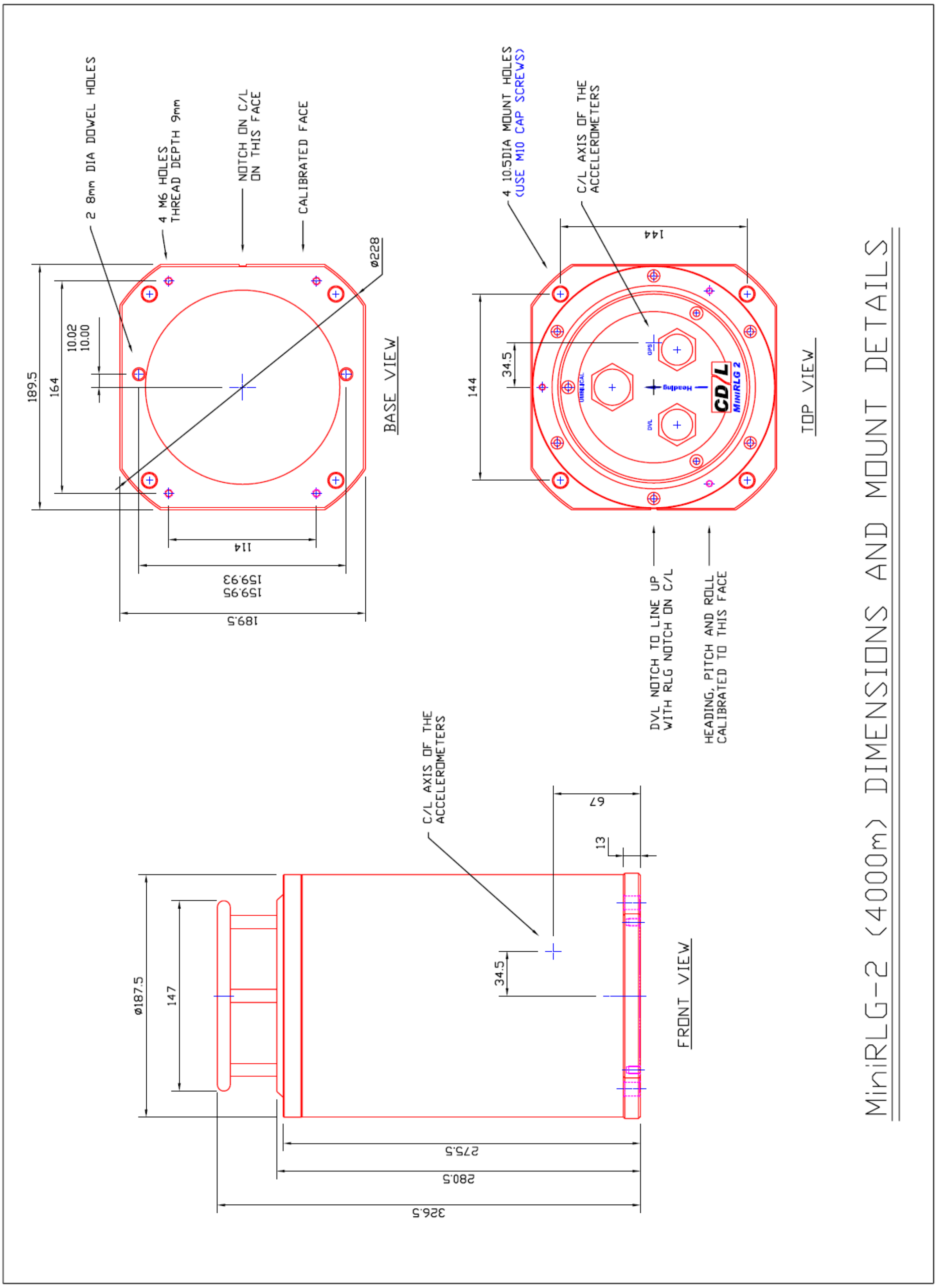
## 7.3. ENVIRONMENTAL

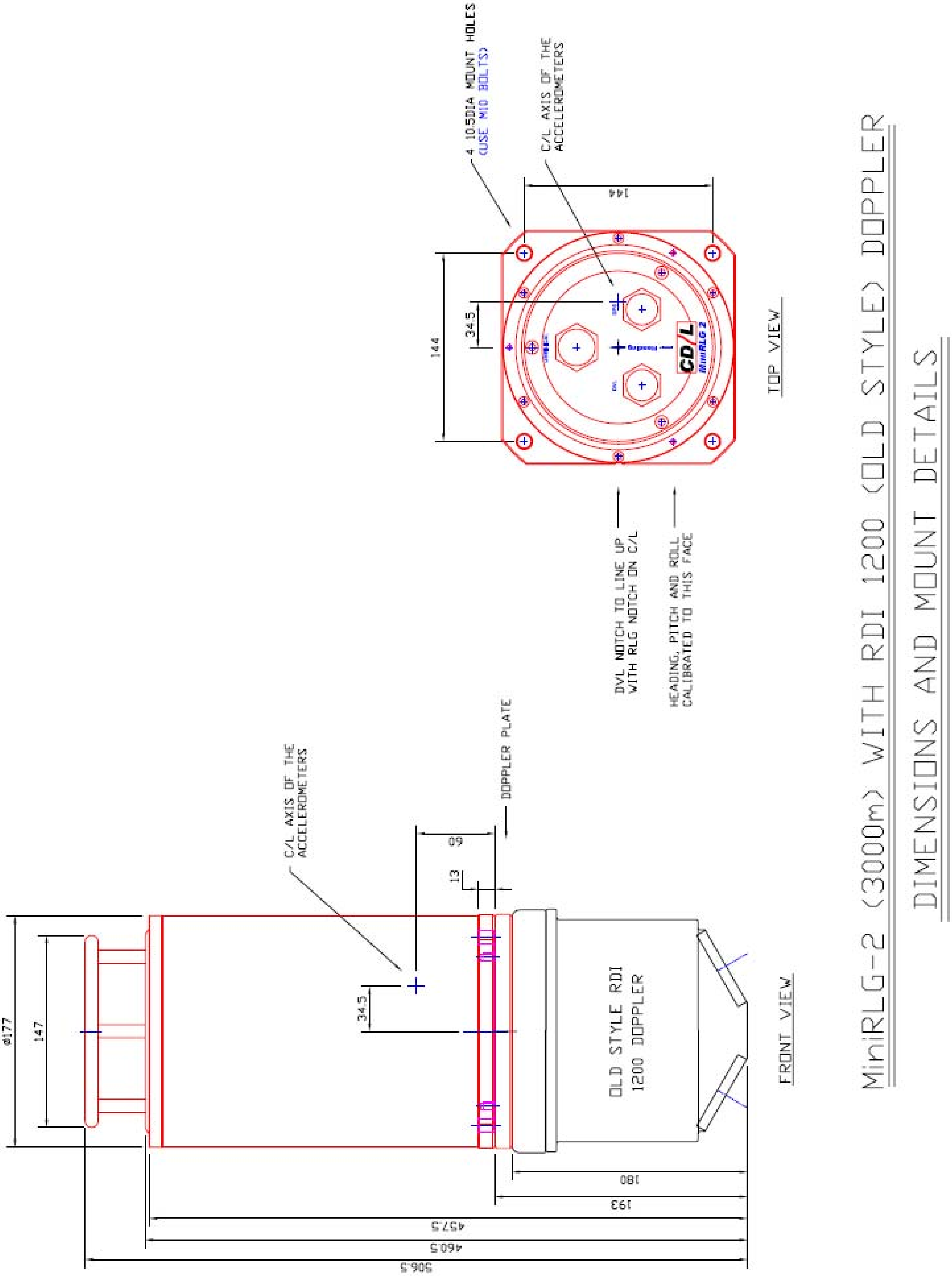
| | | |
|---|---|---|
| Operational Life | >19,000 | hours |
| Random vibration | 4.13 | G RMS |
| Shock | 30 | G 11ms half sine pulse |
| Temperature | -40 to + 60 | °C |

## 8.0. 3000M VERSION



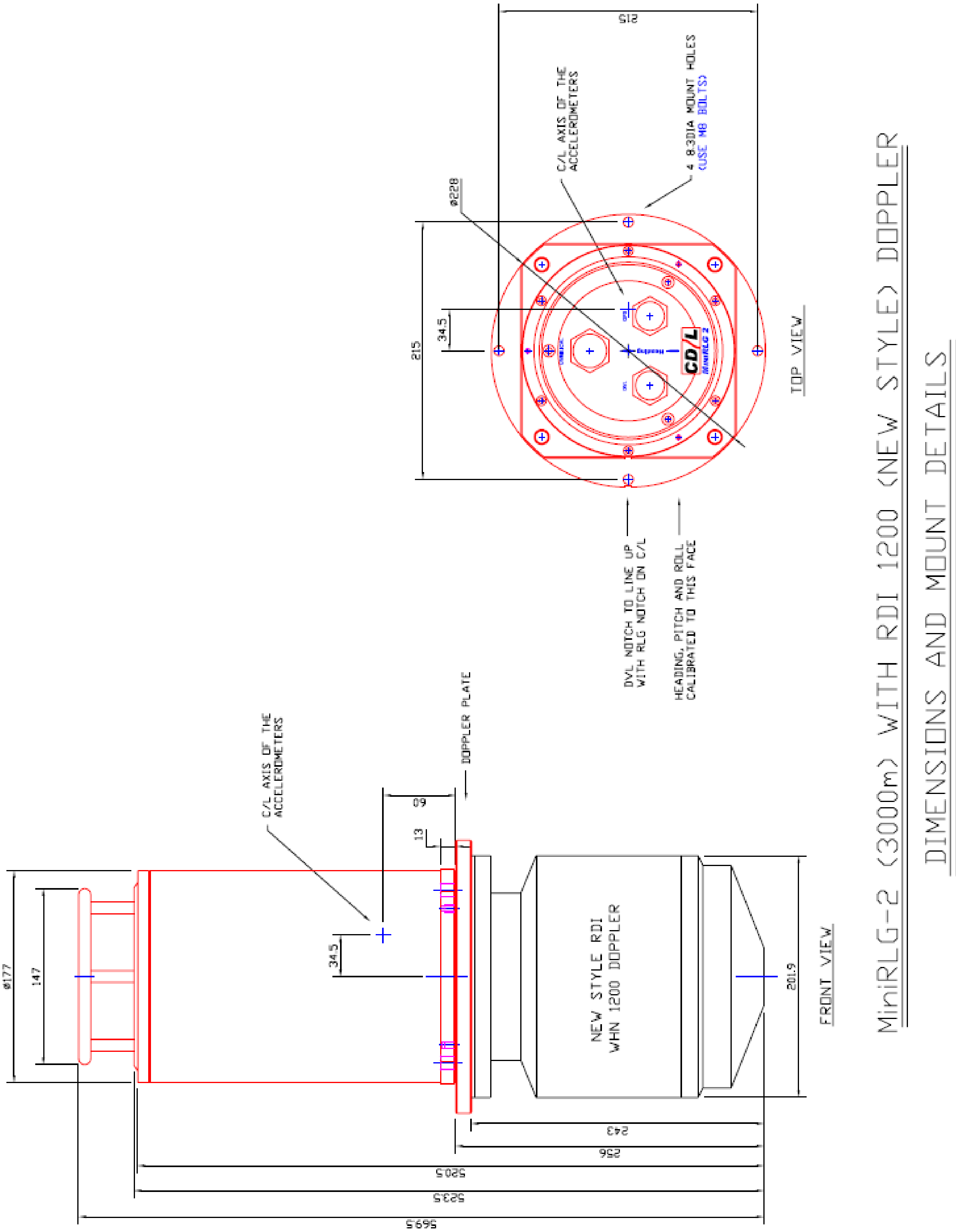
## 8.1. 4000M VERSION






## 8.2. MINIRLG 2 (3000 M) WITH OLD STYLE RDI WORKHORSE DVL

### 8.3. MINIRLG 2 (3000 M) WITH NEW STYLE RDI WORKHORSE DVL



## GPS INTERFACE

### 9.0. INTRODUCTION

To enable the MiniRLG2 to use GPS as an aiding input the GPS MUST have the following:

A 1pps signal
A GGA string output
A VTG string output
A GSA sting output

The GPS input to the MiniRLG2 is currently set at 9600 bps, 8 data bits, no parity and 1 stop bit.

In addition to this to allow the unit to align the GPS input should have enough satellites/information to give a figure of merit of above 5 with a 3D solution.

**The unit will NOT align if the system velocities and/or position diverge drastically from those of the GPS.**

A GPS receiver with minimal filtering on the outputs should be used.

To enable as many GPS receivers to be used as possible the MiniRLG2 has a dedicated GPS processor on it. This formats the GPS strings and, if necessary, adds a checksum to the strings for input into the IMU.

Figure 9.1 and 9.2 give examples of tested GPS strings.

```
$GPGGA,130953.00,5711.45867,N,00204.92652,W,1,06,3,22.39,M,48,M,-1.0,0000
$GPVTG,148.0,T,,,0.01,N,,
$GPGSA,A,3,27,13,04,20,23,24,,,,,,,4,3,3
```

*Figure 9.1: GPS strings with no checksum*

```
$GPGGA,000359.0,5711.4631956,N,00205.0128725,W,1,08,1.3,19.75,M,,,,*16
$GPVTG,82.062,T,82.062,M,0.0103019,N,0.019079,K*72
$GPGSA,M,3,10,27,29,21,17,24,26,08,,,,,2.2,1.3,1.7*3A
```

*Figure 9.2: GPS strings with a checksum*

The following sections describe the fields in the GPS strings which are used.

### 9.1. GGA STRING

| Name | Data Type | Units | Field | Note |
|---|---|---|---|---|
| UTC | CHAR | Hr-Min-Sec | 1 | Not Used |
| Latitude | CHAR | Deg-Min | 2 | |
| Latitude Direction | CHAR | n/a | 3 | N = +, S = - |
| Longitude | CHAR | Deg-Min | 4 | |
| Longitude Direction | CHAR | n/a | 5 | E = +, W = - |
| GPS Quality<br>0 = Invalid<br>1 = SPS Mode<br>2 = DGPS Mode<br>3 = PPS Mode | CHAR | n/a | 6 | |
| Number of Satellites | CHAR | n/a | 7 | 00-12 |
| HDOP | CHAR | n/a | 8 | Not Used |
| Altitude (Mean Sea Level) | CHAR | Meters | 9 | |
| Altitude Units | CHAR | n/a | 10 | Not Used |
| Geoid Separation | CHAR | n/a | 11 | Not Used |
| Geoid Separation Units | CHAR | n/a | 12 | Not Used |
| Data Age | CHAR | n/a | 13 | Not Used |
| Station ID | CHAR | n/a | 14 | Not Used |

*Table 9.1: GGA String*

### 9.2. VTG STRING

| Name | Data Type | Units | Field | Note |
|---|---|---|---|---|
| Manual/Auto Mode | CHAR | n/a | 1 | Not Used |
| Fix Mode<br>1 = No Fix<br>2 = 2D Fix<br>3 = 3D Fix | CHAR | n/a | 2 | |
| Satellite ID's | CHAR(12) | n/a | 3-14 | |
| PDOP | CHAR | n/a | 15 | Not Used |
| Expected Horiz DOP | CHAR | n/a | 16 | |
| Expected Vert DOP | CHAR | n/a | 17 | |

*Table 9.2 VTG String*

### 9.3. GSA STRING

| Name | Data Type | Units | Field | Note |
|---|---|---|---|---|
| True Course | CHAR | Deg | 1 | |
| True Course Units | CHAR | n/a | 2 | Not Used |
| Magnetic Course | CHAR | Deg | 3 | Not Used |
| Magnetic Course Units | CHAR | n/a | 4 | Not Used |
| Speed N | CHAR | Knots | 5 | |
| Speed N Units | CHAR | n/a | 6 | Not Used |
| Speed K | CHAR | Kmph | 7 | |
| Speed K Units | CHAR | n/a | 8 | Not Used |

*Table 9.3: GSA String*

## 9.4. USEFUL INFORMATION ASSOCIATED WITH GPS

### 9.4.1. UTC

UTC – Coordinated Universal Time

UTC is a high-precision atomic time standard which approximately tracks Universal Time (UT). It is the basis for legal civil time all over the Earth. Time zones around the world are expressed as positive and negative offsets from UTC

As a time scale, UTC divides time up into days, and days into hours, minutes, and seconds. Days are conventionally identified using the Gregorian calendar, but Julian Day Numbers can also be used. Each day contains 24 hours and each hour contains 60 minutes, but the number of seconds in a minute is slightly variable.

Most UTC days contain exactly 86400 seconds, with exactly 60 seconds in each minute. Occasionally the last minute of a day has 59 or 61 seconds, or prior to 1972 other lengths. These irregular days have 86399 seconds, 86401 seconds, or some other number of seconds. The irregular day lengths mean that Julian Dates don't work properly with UTC. The intercalary seconds are known as "leap seconds".

*Information obtained from: http://en.wikipedia.org/wiki/Coordinated_Universal_Time*

### 9.4.2. DOP

DOP - Dilution of precision

DOP is a GPS term used in geomatics engineering to describe the geometric strength of satellite configuration. When visible satellites are close together in the sky, the geometry is said to be weak and the DOP value is high; when far apart, the geometry is strong and the DOP value is low.

Factors that affect the DOP are, besides the satellite orbits, the presence of obstructions which make it impossible to use satellites in certain sectors of the local sky. Especially in urban measurements, this may be limiting.

We speak of HDOP, VDOP, PDOP and TDOP respectively, for Horizontal, Vertical, Position (3-D) and Time Dilution of Precision. These quantities follow mathematically from the positions of the useable satellites on the local sky. GPS receivers allow the display of these positions ("skyplot") as well as the DOP values.

*Information obtained from: http://en.wikipedia.org/wiki/Dilution_of_precision_(GPS)*

### 9.4.3. Geoid Separation

Geoid separation is the distance between the geoid and ellipsoid. Where the ellipsoid is a mathematical model of Earth formed by rotating an ellipse about its minor axis. The geoid is a gravitational equipotential surface that approximates mean sea level.

Information obtained from: http://www.geoplace.com/uploads/featurearticle/0501sgi.asp

## DVL INTERFACE AND SETUP

### 10.0. INTRODUCTION

The MiniRLG 2 can be interfaced to an RDI Workhorse Navigator or Explorer DVL. The DVL provides the MiniRLG 2 IMU with additional velocity information that aids the unit, improving drift rates and increasing accuracies. To allow successful communications between the MiniRLG 2 and the DVL the setup as detailed in the following sections should be carried out.

### 10.1. MOUNTING THE DVL

The DVL can be mounted directly to the MiniRLG using a plate supplied by CDL. The plate can be seen in figure 10.1. Section 8.3 details the mechanical drawing of the mounting arrangement.


*Figure 10.1: Mounting plate*

The mounting points shown in figure 10.1 are described below:

A – Countersunk bolt points to connect to threaded holes on the MiniRLG (M6 x 16 cap screws)
B – Dowel between MiniPOS and mounting plate
C – Threaded holes to attach the DVL (M8 thread)
D – Dowel between mounting plate and DVL
E – Mounting holes

The hole pitches are described in section 8.3.

## 10.2. INTERFACE TO A DVL

**The following setup must be completed before the DVL can be connected to the MiniRLG 2**

The MiniRLG 2 can be interfaced to an RDI Workhorse Navigator or Explorer DVL. For correct operation beams 2 and 3 of the DVL should face forward. Figure 10.1 shows the relation ship between the alignment notch and the beam numbers.

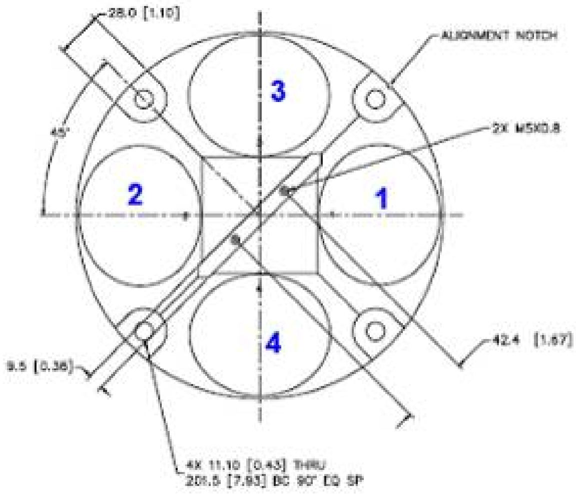



*Figure 10.2: DVL Beam Numbers*

The DVL can be configured, via and internal switch, to be either RS232 or RS422, usually it is supplied in RS232 mode. The MiniRLG 2 can accept DVL data in either RS232 or RS422 but this MUST be configured through the menu system, see section 3.6, before the DVL is connected to the MiniRLG 2.

Before a DVL is connected to the MiniRLG 2 the output format, ping scheme and other parameters need to be set. This is done by sending the commands listed in table 10.1.

The configuration changes shown in table 10.1 can be performed using the test equipment supplied by RDI with each DVL.

**Factory default values are NOT the required values for many parameters and the configuration procedure must be performed to guarantee compatibility between the MiniRLG2 and the DVL.**

| Command | Function |
|---|---|
| BF0 | Depth guess – 0 for "automatic" |
| BK0 | Bottom track pings only (BK1, BK2 or BK3 can also be used) |
| BL40,30,70 | Water mass layer parameters |
| BM5 | Bottom track mode – 5 for "Workhorse" |
| BP1 | One bottom track ping/ensemble |
| BR1 | Bottom range resolution – 2% |
| BX300 | 300 decimetres maximum bottom track |
| CF11110 | Flow control parameters |
| EA04500 | Heading alignment – DVL clocked 45º |
| EX10010 | Co-ordinate transformation parameters |
| EZ0000001 | Sensor source parameters |
| PD4 | Output PD4 velocity message |
| TP000002 | Time between pings – minimum 20ms |
| TE00000000 | Time per ensemble |
| CB831 | Set output protocol to 115.2kb, odd parity, 1 stop bit |
| CK | Store configuration to EEPROM |

*Table 10.1: DVL configuration commands*

**All commands must be sent in the order shown in table 10.1**

**The DVL needs to be awake to have the commands sent to it. This is done by sending the Break Command to it. This is a menu item in the terminal programme supplied with a DVL - BBTalk**

Note that a CR command cannot change the current output protocol – only a CB followed by a CK transmitted with the new protocol can reconfigure DVL communication parameters. The test equipment must be able to change baud rates in real time. If this is not available, the DVL may be reset by RDI to the desired 115.2kb prior to delivery.

The DVL is now ready to be connected to the MiniRLG 2

## 10.3. IMU DVL COMMUNICATIONS

Once the configuration procedure detailed in section 10.1 has been completed and the DVL is connected to the MiniRLG the IMU initiates communications as follows:

Immediately following system power-up and start-up processing, the MiniRLG 2 establishes communication with the DVL via a "break" command (via a discrete that is mechanized to hold the RS-422 voltage in a logic "0" state). This is the "wake-up" command to the DVL, which puts it into an I/O mode (the DVL I/O mode suspends DVL ping and velocity data acquisition, and allows configuration and mode commands to be entered with echo verification).

2) The DVL responds to the "wake-up" with an ASCII ">" output indicating it is ready to receive input commands. When this has been received by the MiniRLG 2 it transmits a "CR0" command that restores configuration/mode settings preset in EEPROM to RAM.

3) Following the configuration command sequence, the DVL clock used to time-tag pings is initialized (synchronized) to the MiniRLG 2 internal time, including hour, minute, second. Fractional second input is not provided (ping time from DVL does include .01 sec resolution). The internal time used to time tag the received DVL data must be set to an even second at the time the DVL clock synch command is sent. The 50Hz counter for IMU Kalman timing can be reset to zero and zero sent to the DVL when re-synching. The DVL echo of the input time is verified and if a discrepancy detected, the time input is commanded again.

4) The DVL is maintained in the I/O mode (no pinging) until ‘enable DVL aiding’ has been set to ‘True’, see section 3.3.1. The DVL is then commanded into "autonomous" mode. In this mode the DVL suspends Command I/O, pings at a variable rate determined by the DVL for maximum data under current conditions, and outputs velocity data messages without request at a rate consistent with the ping rate. This mode of operation is commanded via a "CS" command (start pinging) and maintained except for occasional periodic re-synchronization of the DVL clock. The DVL is commanded out of this mode via a "break" if ‘enable DVL aiding’ is set to false. To command DVL to "Autonomous mode" requires transmitting to the DVL a "BK2" command.

5) The DVL time is re-synched to the IMU once every 30 minutes. This requires suspension of the "autonomous" mode and commanding the DVL into I/O mode via a "break" command, with the DVL response of a ">" character. When the IMU has received this response, it issues a clock reset command per the initial clock synch scenario. The DVL is commanded back to the operational "autonomous" mode immediately following the DVL re-

synch echo unless a discrepancy is detected in which case a retry is performed.

# CONTACTING CDL

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| Nick Murray | nm@cdltd.net |
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**In case of faults or queries please contact the Development personnel in the first instance.**