

# **AquaTrak™ CVL**

## **Product Manual**

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## Help & Support

First please read this manual thoroughly (particularly the Troubleshooting section, if present). If a warranty is applicable, further details can be found in the Warranty Statement, 0080-STF-00139, available upon request.

*Tritech International Ltd* can be contacted as follows:

	Mail	<i>Tritech International Ltd</i> Peregrine Road Westhill Business Park Westhill, Aberdeenshire AB32 6JL, UK
	Telephone	+44 (0)1224 744111
	Email	<a href="mailto:support@tritech.co.uk">support@tritech.co.uk</a>
	Website	<a href="http://www.tritech.co.uk">www.tritech.co.uk</a>

Prior to contacting *Tritech International Ltd* please ensure that the following is available:

1. The Serial Numbers of the product and any *Tritech International Ltd* equipment connected directly or indirectly to it.
2. Software or firmware revision numbers.
3. A clear fault description.
4. Details of any remedial action implemented.



### Contamination

If the product has been used in a contaminated or hazardous environment you *must* de-contaminate the product and report any hazards *prior* to returning the unit for repair. *Under no circumstances should a product be returned that is contaminated with radioactive material.*

The name of the organisation which purchased the system is held on record at *Tritech International Ltd* and details of new software or hardware packages will be announced at regular intervals. This manual may not detail every aspect of operation and for the latest revision of the manual please refer to [www.tritech.co.uk](http://www.tritech.co.uk)

*Tritech International Ltd* can only undertake to provide software support of systems loaded with the software in accordance with the instructions given in this manual. It is the customer's responsibility to ensure the compatibility of any other package they choose to use.

---

## Warning Symbols

Throughout this manual the following symbols may be used where applicable to denote any particular hazards or areas which should be given special attention:



### Note

This symbol highlights anything which would be of particular interest to the reader or provides extra information outside of the current topic.



### Important

When this is shown there is potential to cause harm to the device due to static discharge. The components should not be handled without appropriate protection to prevent such a discharge occurring.



### Caution

This highlights areas where extra care is needed to ensure that certain delicate components are not damaged.



### Warning

DANGER OF INJURY TO SELF OR OTHERS

Where this symbol is present there is a serious risk of injury or loss of life. Care should be taken to follow the instructions correctly and also conduct a separate Risk Assessment prior to commencing work.

---

## Special Considerations

Running the CVL out of water, or even partially submerged, can cause serious damage to the unit. Therefore the following warnings should be considered at all times when using the CVL.



### Warning

The CVL must be fully immersed in water before starting the unit pinging. Failure to do so will damage the CVL.



### Warning

When retrieving the CVL from water, pinging must be stopped prior to it surfacing. Failure to do so will damage the CVL.

Details on the process of switching pinging off and on can be found in Chapter 4, *Operation*.

---

# 1. Introduction

## 1.1. Overview

The AquaTrak™ Correlation Velocity Log (CVL) is an underwater sensor which estimates along track and across track speed over the ground using coherent pulses in a single vertical sonar beam. It is designed as a direct drop-in replacement for a Doppler Velocity Log (DVL) but offers improved performance over a wide operating envelope from a single package.

The speed is calculated from the position of the highest cross correlation between pulses which are transmitted along the beam with a known time separation. The peak displacement is directly proportional to the movement of the unit in the interval between the start of the pulses. This approach avoids the need for spectral estimation from tilted beams as used in a DVL, and does not require multiple narrow beams to limit spectral spread and de-convolve the contributions to the total Doppler shift. This complexity is avoided. The speed is directly coupled into the displacement of the correlation, providing high sensitivity from zero knots to 20 knots. The insonified seabed patch of the CVL increases with altitude, which compensates for the round trip signal loss, allowing performance to be maintained throughout the water column. Since the incidence angle with the seabed is vertical, the impact of a non-flat seabed is avoided, whereas in the DVL can lead to significant bias. The pulses from the CVL follow an identical path, with just the time separation between the transmitted pulses and estimated displacement of the correlation peak used in the calculation of along track and across track speed, and so the accuracy is not dependent on the speed of sound.

The head unit comprises a single transmitter element and a two-dimensional distribution of receiver elements. The element count and positions are designed to provide a minimum redundancy solution, which also minimizes cost and power consumption. The array face is flat, thereby avoiding turbulence and mechanical damage in service. The CVL operates at a centre frequency of 150kHz. As the speed and altitude change, the pulse length and pulse start separation is adjusted to keep the correlation in the 'sweet spot' of the array, thereby maintaining constant performance across the operating envelope. In addition to along track and across track speed, an estimate of altitude is also available from the unit. This is a by-product of the requirement to detect and isolate the pulses.

Mechanical and electrical interfaces match those of contemporary DVLs, with a wide range 18-75VDC supply and RS-232 or RS-485 and Ethernet available as standard.

## 1.2. Features

Features and capabilities of the CVL system include:

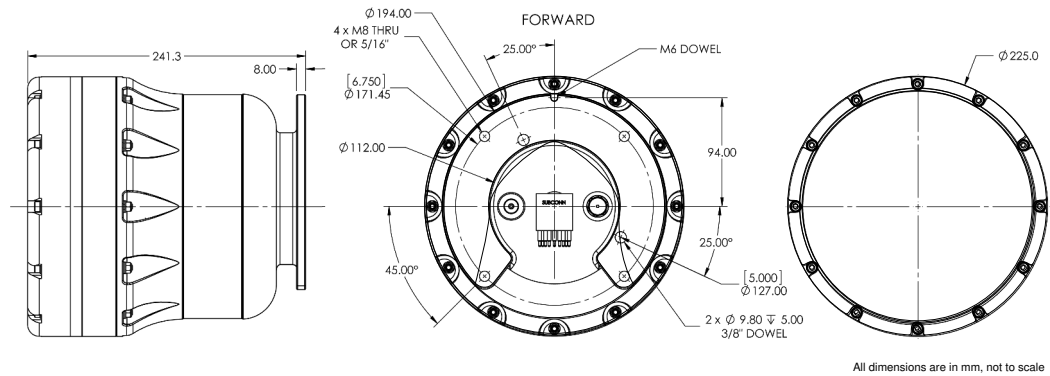
- Form, fit, and function replacement for a standard DVL
- Operation at 150kHz gives high altitude and low dependence of performance on water temperature
- Automatic pulse adjustment from 0 to 20 knots speed, and 0.5m to 300m altitude
- Along track and across track speed to 0.1% accuracy
- Single, vertical beam from simple array configuration
- Planar array face avoids turbulence and mechanical damage

- Fully encapsulated array design to avoid leaks and cathodic delamination
- External trigger input for synchronisation to external systems
- Low transmit signal outside of the main operating band
- Wet mateable connector
- Current limited start up
- Soft shutdown option
- Leak and pressure fault detection
- Pressure relief valve



## 2. Specification

### 2.1. Dimensions



### 2.2. Acoustic Properties

Acoustic Properties	
Property	Details
Center frequency	150kHz
Long term accuracy	$\pm 0.1\% \pm 0.1 \text{ cm} \cdot \text{s}^{-1}$
Bottom velocity precision	$\pm 0.3 \text{ cm} \cdot \text{s}^{-1}$ at $3 \text{ m} \cdot \text{s}^{-1}$
Speed range	0 to 20 knots ( $0$ to $10 \text{ m} \cdot \text{s}^{-1}$ )
Altitude range	0.5 to 300m
Data output rate	10Hz maximum

### 2.3. Physical and Electrical Properties

Physical Properties	
Property	Details
Dimensions	241 x 225mm (height x diameter)
Materials	Aluminum, Hard Anodized Type III, with sacrificial anode
Weights (air)	14.5kg
Weights (sewater)	6.9kg
Depth rating	3000m
Temperature range	$-5^{\circ}\text{C}$ to $+40^{\circ}\text{C}$
Connectors	Subconn DLPBH13M 7 Pin option available

<b>Electrical Properties</b>	
<b>Property</b>	<b>Details</b>
Input voltage	18 to 75 VDC
Power consumption	10-12W average (23W maximum @ 300m altitude and maximum update rate)
Inrush current	1.7A @ 24VDC

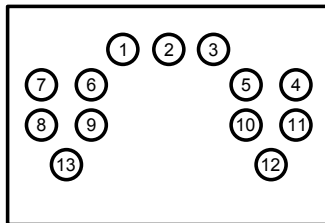
## 3. Installation

### 3.1. Electrical

The CVL includes a wide input range, isolated DC/DC power supply. The CVL supports simultaneous 100Mbps Ethernet and serial communication. The CVL can be factory configured for either full-duplex RS232 or half-duplex RS485 communication. Serial communication ground is isolated from both power ground and the shield.

See Section 2.3, “Physical and Electrical Properties” for more details on the power requirements of the AquaTrak™ CVL.

#### 3.1.1. Bulkhead connection pinout diagram



Male Bulkhead face view

Pin	Signal
1	GND
2	SHIELD
3	TRIGGER-
4	RS485 + / RS232 TX
5	RS485 - / RS232 RX
6	COMMS GND
7	N/C
8	ETH TX-
9	ETH TX+
10	ETH RX-
11	ETH RX+
12	POWER
13	TRIGGER+

### 3.1.2. Test Cable

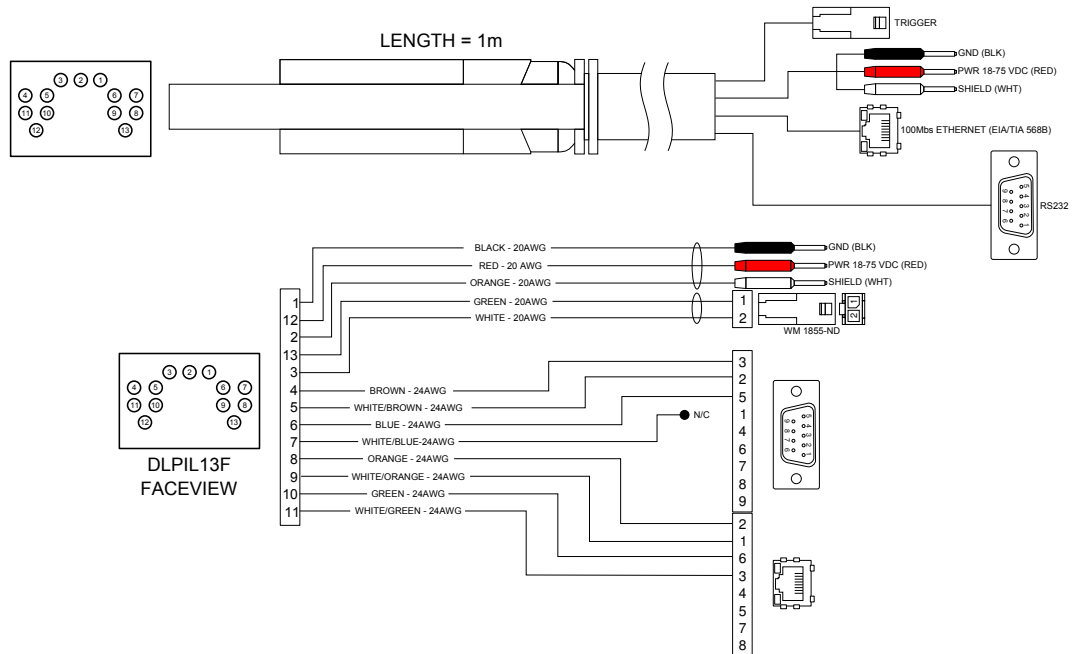


Figure 3.1. AquaTrak™ CVL Test Cable Schematic

DB-9 SERIAL PINOUT		CAT 5 PINOUT		TRIGGER PINOUT	
PIN	SIGNAL	PIN	SIGNAL	PIN	SIGNAL
1	N/C	1	A+	1	+
2	RX	2	A-	2	-
3	TX	3	B+		
4	N/C	4	N/C		
5	GND	5	N/C		
6	N/C	6	B-		
7	N/C	7	N/C		
8	N/C	8	N/C		
9	N/C				

### 3.1.3. Triggering

The CVL accepts a RS422 level, differential trigger input. It does not provide a trigger output. The trigger signal is isolated from power-ground (PIN #1 – GND), but is common with communications ground (PIN #6 – COMMS GND).

### 3.1.4. Serial Communication

Unless otherwise requested, the serial communication will be defaulted to the following settings:

- 57600 baud

- 8 data bits
- 1 stop bit
- no parity
- no flow control

The Baud rate can be changed using the serial-speed command. Please refer to Section 4.3, “Commands” for more details.

## 3.2. Mechanical

### 3.2.1. Mounting

The AquaTrak™ CVL is mounted by the top flange with four M8 or 5/16” bolts. The CVL array face should point down, towards the seabed, with the top alignment dowel slot oriented towards the primary direction of travel.

There are two methods available for accurately aligning the CVL with a bracket:

1. Method 1 uses the top internal bore of 112mm diameter and the 6mm dowel alignment slot
2. Method 2 uses two 3/8 Inch dowels as shown in Figure 3.2, “Alignment Methods”

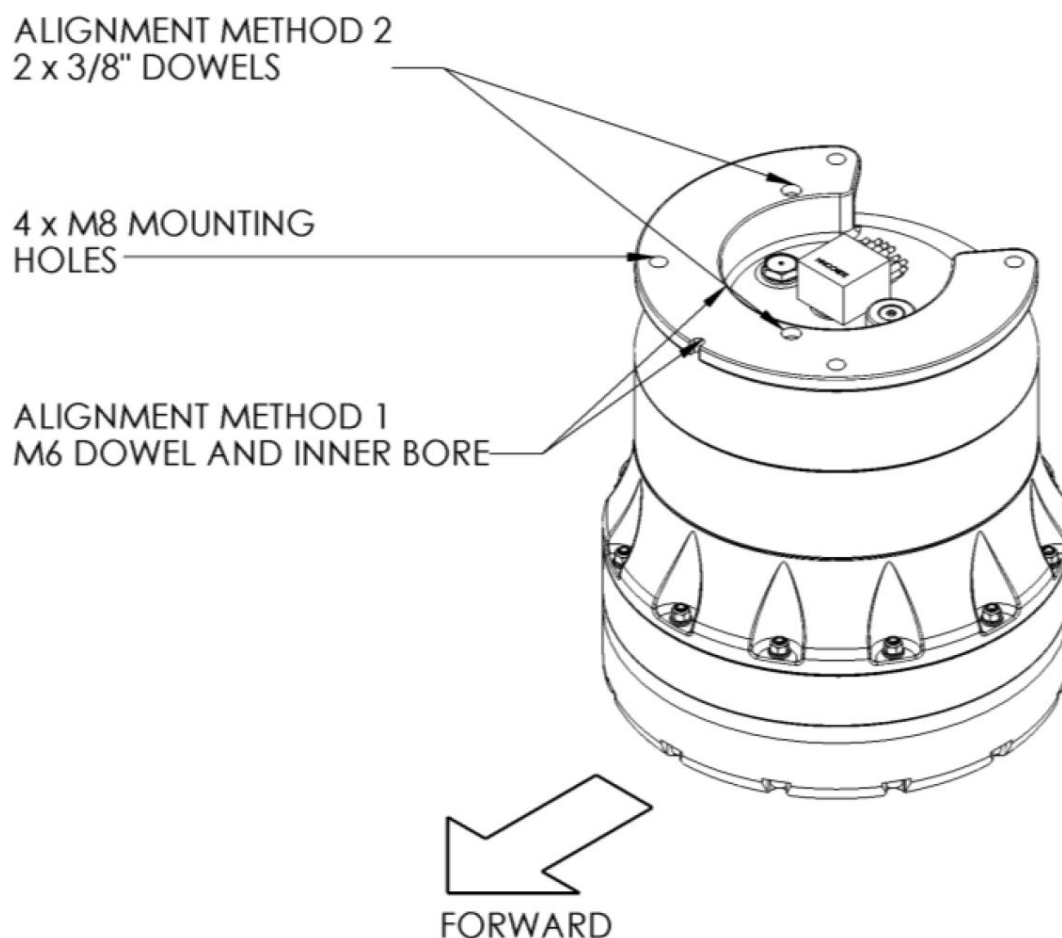


Figure 3.2. Alignment Methods

### 3.2.2. Cables

The mating cable for the CVL is a Subconn DLPIL13F wet-mate low profile power/Ethernet connector. Always follow proper handling procedures when mating and de-mating the connector. Use only Molykote 44 to lubricate the connector.

Always ensure that the restraining strap LPB-STRAP is in place after connecting the cable. See mating of the cable and CVL in Figure 3.3, “CVL and Mating cable” below.

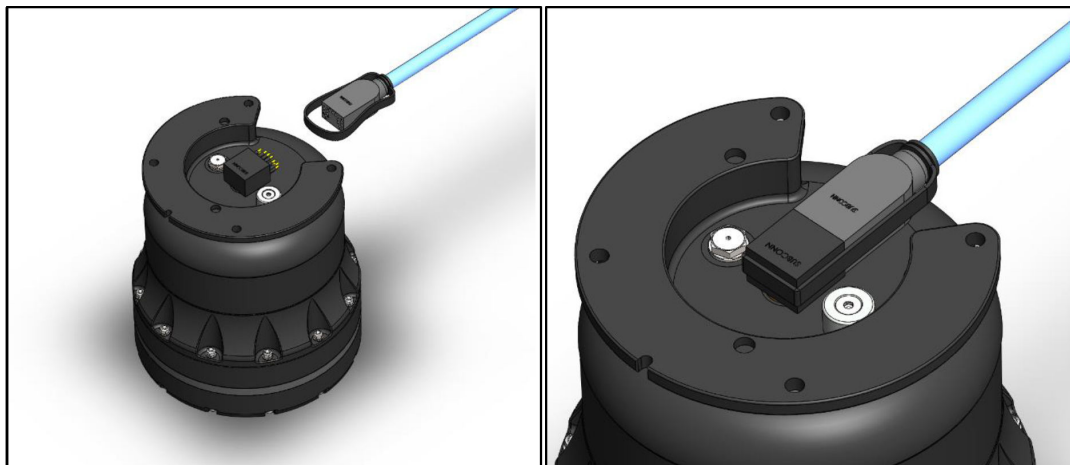


Figure 3.3. CVL and Mating cable

## 4. Operation



### Warning

The CVL must be fully immersed in water before starting the unit pinging. Failure to do so will damage the CVL.



### Warning

When retrieving the CVL from water, pinging must be stopped prior to it surfacing. Failure to do so will damage the CVL.

### 4.1. Software Version

The instructions within this manual apply to any AquaTrak™ CVL unit with software version **1.2.3** or above. To find out the version of software installed on your CVL you can perform one, or all, of the following:

1. Connect to your CVL and use the `version` command
2. Check the Build Record Sheet
3. Contact *Tritech International Ltd* with the Serial Number of your CVL

### 4.2. Software Interface

#### Communication with CVL

The CVL provides command and control via a command-line interface (CLI). This CLI is available via Telnet (on TCP port 4444), or serial communications (RS-232 or RS-485) if supplied.

Each CVL has a factory default static IP address of `192.168.0.100` but can also take on a DHCP-assigned or alternate static IP address.

The CLI client must terminate each command with either a carriage return character or a carriage return followed by a line feed.

The CVL responds to each command issued to it. Every response from the CVL is terminated by carriage return and line feed:

- If a line of the response text starts with “error” (optionally followed by some descriptive text), it indicates failed command execution
- If a line of the response text starts with “warning” (optionally followed by some descriptive text), it indicates successful command execution, but that there was an unexpected condition
- Any other response, including an empty response, indicates successful command execution

When the CVL software can accept the next command, it issues its command prompt, “`cvl>`” (one trailing blank character)

## CLI Client Type

The CVL operates a Telnet server but can accept either Telnet or raw TCP connections. This is convenient for supporting manual or automatic clients:

- Manual client – In this case, a user submits commands to the CVL. A Telnet or serial connection is recommended as it allows for command-line recall and editing
- Automatic client – In this case, a program submits commands to the CVL. A raw TCP connection is recommended. Such a program should discard the few bytes of binary data that it receives upon initial connection (before the first prompt). These bytes are part of the Telnet protocol and can be ignored. No other Telnet-related data will follow

## System Modes

The CVL can be in one of two modes:

1. off: No sonar pulses are being transmitted, and no velocity calculations are being performed. This is the default start-up mode
2. on: Sonar pulses are being transmitted, and velocity calculations are being performed

Table 3 indicates which CLI commands are valid in which modes.

**Table 4.1. CVL Commands**

Command	Mode	
	off	on
alarm-leak	yes	yes
alarm-pressure	yes	yes
altitude	yes	yes
aquatrak-endpoint	yes	read mode only
aquatrak-status	yes	yes
data-received	yes	yes
external-trigger	yes	read mode only
help	yes	yes
mode	yes	yes
monitor	yes	yes
quit	yes	yes
rotation-offset	yes	yes
safe-mode	yes	yes <sup>1</sup>
serial-speed	yes	yes
speed-of-sound	yes	yes
system-health-check	yes	no
version	yes	yes

<sup>1</sup> Note: Applying `safe-mode` while the `mode` is on will automatically change the `mode` to off. The `mode` will need to be reset to on before data can be obtained from the CVL.



## 4.3. Commands

Some commands can be used to either write or read CVL settings. If such a command is submitted with parameters, it writes the corresponding settings. If the command is submitted without parameters, it reads and reports the current values of those settings. Command documentation conventions include:

- Command syntax is written in **bold fixed width font**
- Factory default settings are preceded by a † symbol
- Text within square brackets ( [ ] ) describe optional components of a command's syntax
- A vertical bar ( | ) represents the OR operator
- An italicized identifier represents an unspecified value
- A non-italicized identifier represents a specific value

### 4.3.1. alarm-leak

This will report an `on` message should the internal sensors detect water ingress. In the event of this confirmation the CVL should be powered down, removed from its installation and immediately inspected for damage.

```
† alarm-leak off
```

### 4.3.2. alarm-pressure

This will report an `on` message should the internal sensors detect an abnormality in the internal environmental pressure. This could indicate a loss of integrity and so the unit should be powered down, removed from its installation and inspected for damage.

```
† alarm-pressure off
```

### 4.3.3. altitude

```
altitude [altitude-m | auto]
```

Sets or reports the nominal altitude above the seabed, in metres. If “auto” is specified, the CVL detects the altitude automatically.

```
† altitude auto
```

### 4.3.4. aquatrak-endpoint

```
aquatrak-endpoint [ip-address:port | none]
```

Sets or reports the endpoint (IP address and port) of the internal CVL server. The endpoint must be assigned (that is, not set to “none”) in order to use “mode on”. The endpoint should normally be set to `10.0.100.130:4500`.

```
†aquatrak-endpoint 10.0.100.130:4500
```

### 4.3.5. aquatrak-status

```
aquatrak-status
```

Reports the status of the connection to the internal CVL server. If the “aquatrak-endpoint” command value is set to 10.0.100.130:4500, the connection status should always be “connected”.

#### 4.3.6. data-received

`data-received`

Reports whether the CVL data reception mechanism has functioned since power up. If the CVL is configured correctly, the data-received command should report “true”. If not, the CVL should be power cycled.

#### 4.3.7. external-trigger

`external-trigger [on | off]`

Sets or reports the status of the CVL external trigger mechanism. If set to “on”, the CVL transmits each pulse only on the rising edge of the CVL trigger input. If triggered too frequently, the CVL ignores some triggers as necessary.

#### 4.3.8. help

`help`

Reports all commands (and their parameters) that are available.

#### 4.3.9. mode

`mode [on | off]`

Sets or reports the current system mode. Setting the mode to “on” causes the CVL to start transmitting sonar pulses and start performing velocity measurements. Setting the mode to “off” causes the CVL to stop these activities.

See the section called “System Modes” for more information.



#### Warning

The CVL must be fully immersed in water when setting the mode to “on”. Failure to do so can damage the CVL.

The system mode is “off” upon power-up. See the “safe-mode” command for more information.

`†mode off`

#### 4.3.10. monitor

`monitor velocity | altitude | pd0 | pd4 | pd6 | pd11 | pd13 | alarm-leak | alarm-pressure | noise-floor`

Reports information on the specified activity as available, in real-time. The reporting stops when the client transmits another carriage return. An automatic client may establish multiple connections to the CVL to monitor multiple activities.

Monitoring of each activity behaves as follows:

- `velocity` – Report each velocity as calculated, in metres per second. Surge and sway are reported, in that order, separated by white space.
- `altitude` – Report each altitude as calculated, in metres
- `pd0`
- `pd4`
- `pd6` – Report each velocity as calculated, in PD6 format. Because the CVL measures only velocity relative to the seabed (not relative to the water column), only the “:BI” message is provided, containing the X- and Y-axis velocities. The Z-axis and error velocities are both reported as 0.
- `pd11` – Report each velocity as calculated, in PD11 format. Because the CVL does not have a heading sensor, the course value in the \$PRDIH message is omitted.
- `pd13`
- `alarm-leak` - Continuously reports the status of the `alarm-leak` sensor
- `alarm-pressure` - Continuously reports the status of the `alarm-pressure` sensor
- `noise-floor`

#### 4.3.11. quit

`quit`

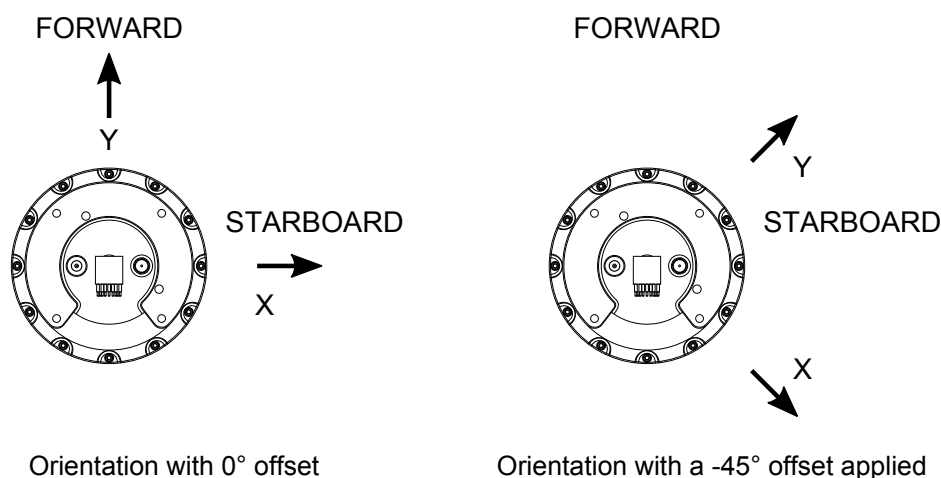
Closes the communication session and terminates the connection (not applicable to the serial interface).

#### 4.3.12. rotation-offset

`rotation-offset [ degree ]`

Applies a rotational offset to the CVL data outputs.

**Table 4.2. CVL Rotation**



A -45° offset should be used to ensure full compatibility when outputting the PD6 output format.

`†rotation-offset -45`

### 4.3.13. safe-mode

```
safe-mode [on | on-restart | off]
```

Sets or returns the current safe mode. The safe mode affects system behaviour as follows:

- `safe-mode on` – The system disallows setting the mode to “on” at any time, which implies that it is not transmitting sonar pulses
- `safe-mode on-restart` – The system starts with the mode set to “off”, which implies that it is not transmitting sonar pulses upon system start
- `safe-mode off` – The system starts in the mode it was in during the last shutdown, which implies that it may be transmitting sonar pulses

To help avoid unintentional sonar pulse transmission, safe mode should be set to “on-restart” or “on” whenever possible.

```
†safe-mode on
```

### 4.3.14. serial-speed

```
serial-speed [9600 | 19200 | 38400 | 57600 | 115200]
```

Sets, or confirms, the Baud rate being used by the Serial interfaces. Some data outputs will override this setting as they have a preset communications profile.



#### Note

The Baud rate for the serial connection can only be set via the serial connection itself. It is not possible to connect using Ethernet and alter the Serial connection.

```
†serial-speed 57600
```

### 4.3.15. speed-of-sound

```
speed-of-sound [value]
```

Sets, or confirms the speed of sound being used by the CVL.

### 4.3.16. system-health-check

```
system-health-check
```

Performs a health check of the CVL and re-initialises the system. The health check can only be performed when the `mode` has been set to `off`. An example output is given below:

```
starting health check
connecting...      pass
testing-connection...  pass
testing-channel-sync... pass
initializing device?
health check - successful
```

### 4.3.17. version

Reports the version of the CVL software.

## 5. Getting Started

The CVL uses a Command-Line-Interface (CLI) for control and monitoring. A Telnet client, such as PuTTY is required to access the CVL CLI. It is assumed that the user has connected power and Ethernet to the CVL as described in the Product Manual. See Table 5.1, “CVL Reference information” for useful reference information.

**Table 5.1. CVL Reference information**

SPECIFICATION	DESCRIPTION
Static IP Address	192.168.0.100
Port	4444
Protocol	Telnet

### 5.1. Initial Connection

Connect to the CVL using the supplied static IP address, or your local network’s DHCP assigned address. Once connected, the CLI prompt appears:

```
cvl>
```

Type the `help` command for a list of the available commands, and the inputs they support:

```
cvl> help
  Available commands:
    alarm-leak
    alarm-pressure
    altitude           <value> | auto
    aquatrak-endpoint [<ip-address>:<port>]
    aquatrak-status
    data-received
    external-trigger  on | off
    help
    mode              off | on
    monitor           velocity | altitude | pd0 | pd4 | pd6 | pd11 | pd13
                    | alarm-leak | alarm-pressure | noise-floor
    quit
    safe-mode         on | on-restart | off
    serial-speed      9600 | 19200 | 38400 | 57600 | 115200
    speed-of-sound    <value>
    system-health-check
    version
```

Check that data is being generated by the CVL with the `data-received` command:

```
cvl> data-received
true
```

If this command returns false, the CVL must be power-cycled.

## 5.2. Altitude Configuration

The operating state can be configured using the `altitude` command. This command accepts either the nominal altitude of the CVL from sea-floor or the parameter, `auto`. When the CVL is operating with `altitude auto`, the range from bottom is determined automatically and the CVL settings are adjusted accordingly. Set the altitude to `auto`:

```
cvl> altitude auto
cvl> altitude
auto
```

If operating in a shallow test-tank, it is better to use a set altitude. In either configuration, the minimum altitude at which the CVL reports correct velocities is 0.5 metres.

## 5.3. Enable Pinging

Before continuing, ensure the CVL is submerged in water. To do otherwise may damage the CVL.

The CVL must exit `safe-mode` before pinging can be enabled. When disabling `safe-mode`, it is best practice to use `on-restart`, which places the CVL back into `safe-mode` if it is power-cycled. Otherwise the CVL may resume pinging the next time it is powered.

Set `safe-mode` to `on-restart` and the enable pinging by setting the `mode` to `on`:

```
cvl> safe-mode on-restart
cvl> mode on
```

## 5.4. Monitor the Output

The CVL outputs the calculated velocities in a variety of different formats such as PD6, PD11, or space-separated values (see the Interface Control Document (ICD) for a description of each). To view the output of the CVL, use the `monitor` command, supplying the string identifying the format desired. While monitoring is enabled, the CVL transmits each estimate as it is generated. To exit monitoring, press the Enter key.

Monitor the velocities in the PD11 format:

```
cvl> monitor pd11
$PRDIG,H,,P,,R,,D,*46
$PRDIH,R,0.51,S,0.019,C,*39
$PRDII,S,,C,*56
$PRDIG,H,,P,,R,,D,*46
$PRDIH,R,0.49,S,0.103,C,*3A
$PRDII,S,,C,*56
cvl>
```

## 5.5. Disable Pinging

Before removing the CVL from water, disable pinging. To do otherwise may damage the CVL.

Setting the mode to `off` disables pinging. Then re-enabling `safe-mode` is recommended.

```
cvl> mode off  
cvl> safe-mode on
```

## 6. Restore to Factory Default

The CVL can be restored to the factory default settings through the admin tool. The admin tool can be accessed using an SSH client such as PuTTY. It is assumed that the user has connected power and Ethernet to the CVL as described in the ICD.

**Table 6.1. Admin-Tool Reference information**

SPECIFICATION	DESCRIPTION
Static IP Address	192.168.0.100
Port	22
Protocol	SSH
Username	admin
Password	Admin

Connect to the CVL using the supplied static IP address, or your local network's DHCP assigned address. Once connected, you are then prompted for a username and password. Use those provided in Table 6.1, "Admin-Tool Reference information".

```
#####
#
#   Kraken Appliance | Administration Tool   #
#                                           #
#####

Thu Aug  4 13:38:59 UTC 2016

System Temperatures:
Core 0:      +35.0°C  (high = +110.0°C, crit = +110.0°C)
Core 1:      +34.0°C  (high = +110.0°C, crit = +110.0°C)
Core 2:      +37.0°C  (high = +110.0°C, crit = +110.0°C)
Core 3:      +37.0°C  (high = +110.0°C, crit = +110.0°C)

Partition Availability and Usage:
/dev/sda4      3.7G  232M  3.2G   7% /kraken
/dev/sda5      969M   58M  845M   7% /kraken/images

#####

Please select from the following options:

1) Upgrade Firmware  4) Factory Reset      7) Shutdown
2) Configure eth1    5) Upgrade Image     8) Refresh
3) Set NTP Server    6) Reboot             9) Quit
Option #:
```

Selecting option 4 initiates the factory reset process:

```
WARNING: This will erase all settings and recorded sonar data from this device
Proceed with factory reset? [y/N]  y
Stopping cvl service...
[sudo] password for admin:
* stop: Job stopped: cvl
* start: Starting job: cvl

Factory image restored successfully
```



## Appendix A. Output Formats

### A.1. Industry Standard formats

The AquaTrak™ CVL can output the PD6 and PD11 data formats, which contain bottom-track instrument referenced data.

#### PD0 format

This is a binary data format that is not human readable. More details are available upon request.

#### PD4 format

This is a binary data format that is not human readable.

**Table A.1.**

Byte	BIT POSITION								
	7	6	5	4	3	2	1	0	
1	DVL DATA ID 7Dh								
2	DATA STRUCTURE								
3	NO. OF BYTES								LSB
4									MSB
5	SYSTEM CONFIG								
6	X-VEL BTM								LSB
7									MSB
8	Y-VEL BTM								LSB
9									MSB
10	Z-VEL BTM								LSB
11									MSB
12	E-VEL BTM								LSB
13									MSB
14	BM1 RNG TO BTM								LSB
15									MSB
16	BM2 RNG TO BTM								LSB
17									MSB
18	BM3 RNG TO BTM								LSB
19									MSB
20	BM4 RNG TO BTM								LSB
21									MSB
22	BOTTOM STATUS								
23	X-VEL REF LAYER								LSB
24									MSB
25	Y-VEL REF LAYER								
26									
27	Z-VEL REF LAYER								
28									

Byte	BIT POSITION							
	7	6	5	4	3	2	1	0
29	E-VEL REF LAYER							
30								
31	REF LAYER START							
32								
33	REF LAYER END							
34								
35	REF LAYER STATUS							
36	TOFP-HOUR							
37	TOFP-MINUTE							
38	TOFP-SECOND							
39	TOFP-HUNDREDTHS							
40	BIT RESULTS							
41								
42	SPEED OF SOUND							
43								
44	TEMPERATURE							
45								
46	CHECKSUM							
47								

## PD6 format

Table A.2.

Line number	Details
1	SYSTEM ATTITUDE DATA  :SA, ±PP.PP, ±RR.RR, HHH.HH<CR><LF>
2	TIMING AND SCALING DATA  :TS, YYMMDDHHmmssh, SS.S, +TT.T, DDDD.D, CCCC.C, BBB<CR><LF>  <ul style="list-style-type: none"> <li>• YYMMDDHHmmssh = Year, month, day, hour, minute, second, hundredths of seconds</li> <li>• SS.S = Salinity in parts per thousand (ppt) (always zero)</li> <li>• TT.TT = Temperature in °C (always zero)</li> <li>• DDDD.D = Depth of transducer face in meters (always zero)</li> <li>• CCCC.C = Speed of sound in meters per second</li> <li>• BBB = Built-in Test (BIT) result code (always zero)</li> </ul>
3	WATER-MASS, INSTRUMENT-REFERENCED VELOCITY DATA  :WI, ±XXXXX, ±YYYYY, ±ZZZZZ, ±EEEE, S<CR><LF>
4	WATER-MASS, SHIP-REFERENCED VELOCITY DATA  :WS, ±TTTTT, ±LLLLL, ±NNNNN, S<CR><LF>
5	WATER-MASS EARTH-REFERENCED VELOCITY DATA  :WE, ±EEEE, ±NNNNN, ±UUUUU, S<CR><LF>
6	WATER-MASS, EARTH-REFERENCED DISTANCED DATA

Line number	Details
	:WD, ±EEEEEEEE.EE, ±NNNNNNNN.NN, ±UUUUUUUU.UU, DDDD.DD, TTT.TT<CR><LF>
7	BOTTOM-TRACK, INSTRUMENT-REFERENCED VELOCITY DATA  :BI, ±XXXXXX, ±YYYYY, ±ZZZZZ, ±EEEE, S, <CR><LF>  <ul style="list-style-type: none"> <li>• ±XXXXXX = X-axis velocity in mm·s<sup>-1</sup></li> <li>• ±YYYYY = Y-axis velocity in mm·s<sup>-1</sup></li> <li>• ±ZZZZZ = Z-axis velocity in mm·s<sup>-1</sup> (always zero)</li> <li>• EEEEE = Error velocity data in mm·s<sup>-1</sup> (always zero)</li> <li>• S = Status of velocity (A = good, V = bad)</li> </ul>
8	BOTTOM-TRACK, SHIP-REFERENCED VELOCITY DATA  :BS, ±TTTTT, ±LLLLL, ±NNNNN, S<CR><LF>  <ul style="list-style-type: none"> <li>• ±TTTTT = Transverse vel. data in mm/s</li> <li>• ±LLLLL = Longitudinal vel. data in mm/s</li> <li>• ±NNNNN = Normal velocity data in mm/s</li> <li>• S = Status of velocity data (A = good, V = bad)</li> </ul>
9	BOTTOM-TRACK, EARTH-REFERENCED VELOCITY DATA  :BE, ±EEEE, ±NNNNN, ±UUUUU, S<CR><LF>
10	BOTTOM-TRACK, EARTH-REFERENCED DISTANCE DATA  :BD, ±EEEEEEEE.EE, ±NNNNNNNN.NN, ±UUUUUUUU.UU, DDDD.DD, TTT.TT<CR><LF>

Only the :TS and :BI lines will contain data from the CVL. All the data fields for the other lines contain zero (0) data.

Example CVL output:

```
:SA, +0.00, +0.00, 0.00
:TS, 16060208211366, 0.0, +0.0, 0.0, 1500.0, 0
:WI, +0, +0, +0, +0, V
:WS, +0, +0, +0, V
:WE, +0, +0, +0, V
:WD, +0.00, +0.00, +0.00, 0.00, 0.00
:BI, +5, +1, +0, +0, A
:BS, +0, +0, +0, V
:BE, +0, +0, +0, V
:BD, +0.00, +0.00, +0.00, 0.51, 0.00
```

## PD11 format

Table A.3.

Line number	Details
1	SENSOR DATA  \$PRDIG, H, w, w, P, x, x, R, y, y, D, z, z *hh<CR><LF>

Line number	Details
2	BOTTOM-TRACK NAVIGATIONAL DATA  \$PRDIH,R,x.x,S,y.y,C,z.z,*hh<CR><LF>  <ul style="list-style-type: none"> <li>• R,x.x = Range to bottom (m)</li> <li>• S,y.y = Speed relative to ground (m·s<sup>-1</sup>)</li> <li>• C,z.z = Course over ground (will always be empty)</li> <li>• hh = Checksum</li> </ul>
3	CURRENT-REFERENCED NAVIGATIONAL DATA  \$PRDII,S,x.x,C,y.y*hh<CR><LF>

Example CVL output:

```
$PRDIG,H,,P,,R,,D,*46
$PRDIH,R,0.51,S,0.136,C,*35
$PRDII,S,,C,*56
```

## PD13 format

Table A.4.

Line number	Details
1	SYSTEM ATTITUDE DATA  :SA,±PP.PP,±RR.RR,HHH.HH<CR><LF>
2	TIMING AND SCALING DATA  :TS,YYMMDDHHmmssh,SS.S,±TT.T,DDDD.D,CCCC.C,BBB<CR><LF>  <ul style="list-style-type: none"> <li>• YYMMDDHHmmssh = Year, month, day, hour, minute, second, hundredths of seconds</li> <li>• SS.S = Salinity in parts per thousand (ppt) (always zero)</li> <li>• TT.TT = Temperature in °C (always zero)</li> <li>• DDDD.D = Depth of transducer face in meters (always zero)</li> <li>• CCCC.C = Speed of sound in meters per second</li> <li>• BBB = Built-in Test (BIT) result code (always zero)</li> </ul>
3	PRESSURE AND RANGE TO BOTTOM DATA  :RA,PPP.PP,RRRR.RR,RRRR.RR,RRRR.RR,RRRR.RR<CR><LF>
4	WATER-MASS, INSTRUMENT-REFERENCED VELOCITY DATA  :WI,±XXXXX,±YYYYY,±ZZZZZ,±EEEE, S<CR><LF>
5	WATER-MASS, SHIP-REFERENCED VELOCITY DATA  :WS,±TTTTT,±LLLLL,±NNNNN, S<CR><LF>
6	WATER-MASS EARTH-REFERENCED VELOCITY DATA  :WE,±EEEE,±NNNNN,±UUUUU, S<CR><LF>
7	WATER-MASS, EARTH-REFERENCED DISTANCED DATA

Line number	Details
	:WD, ±EEEEEEEE.EE, ±NNNNNNNN.NN, ±UUUUUUUU.UU, DDDD.DD, TTT.TT<CR><LF>
8	BOTTOM-TRACK, INSTRUMENT-REFERENCED VELOCITY DATA  :BI, ±XXXXXX, ±YYYYY, ±ZZZZZ, ±EEEE, S, <CR><LF>  <ul style="list-style-type: none"> <li>• ±XXXXXX = X-axis velocity in mm·s<sup>-1</sup></li> <li>• ±YYYYY = Y-axis velocity in mm·s<sup>-1</sup></li> <li>• ±ZZZZZ = Z-axis velocity in mm·s<sup>-1</sup> (always zero)</li> <li>• EEEEE = Error velocity data in mm·s<sup>-1</sup> (always zero)</li> <li>• S = Status of velocity (A = good, V = bad)</li> </ul>
9	BOTTOM-TRACK, SHIP-REFERENCED VELOCITY DATA  :BS, ±TTTTT, ±LLLLL, ±NNNNN, S<CR><LF>
10	BOTTOM-TRACK, EARTH-REFERENCED VELOCITY DATA  :BE, ±EEEE, ±NNNNN, ±UUUUU, S<CR><LF>
11	BOTTOM-TRACK, EARTH-REFERENCED DISTANCE DATA  :BD, ±EEEEEEEE.EE, ±NNNNNNNN.NN, ±UUUUUUUU.UU, DDDD.DD, TTT.TT<CR><LF>

Only the :TS and :BI lines will contain data from the CVL. All the data fields for the other lines contain zero (0) data.

Example CVL output:

```
:SA, +0.00, +0.00, 0.00
:TS, 16060208245869, 0.0, +0.0, 0.0, 1500.0, 0
:RA, 0.00, 0.51, 0.51, 0.51, 0.51
:WI, +0, +0, +0, +0, V
:WS, +0, +0, +0, V
:WE, +0, +0, +0, V
:WD, +0.00, +0.00, +0.00, 0.00, 0.00
:BI, -26, -10, +0, +0, A
:BS, +0, +0, +0, V
:BE, +0, +0, +0, V
:BD, +0.00, +0.00, +0.00, 0.51, 0.00
```

## A.2. Proprietary formats

The AquaTrak™ CVL also has several proprietary output formats. Further details of the definition of these outputs are available on request.

### altitude

```
cvl> monitor altitude
altitude: 1.21
altitude: 1.62
```

## noise-floor

```
cvl> monitor noise-floor  
noise-floor: 3521558 4143570 3926082 3802606 4150980 1858309 2433204 1916663  
noise-floor: 3532067 4144968 3931363 3809594 4143971 1867085 2430690 1921892
```

## velocity

```
cvl> monitor velocity  
velocity: -0.005 0.000  
velocity: 0.000 0.005
```