# THE MULTIBEAM LOGGER

SENSORS · OFFSETS · COVERAGE · LOGGING

## User Manual

Multibeam acquisition
for vessels, ROVs and AUVs

**Version 1.0**

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# 1 Introduction

**The Multibeam Logger** gathers multibeam data on a vessel, ROV or AUV. It reads the position, heading, motion and depth sensors and one or more multibeam heads, puts every sounding in the right place on the grid, shows the coverage and the swath as the data comes in, and logs each line - a raw log you can replay, the XYZ soundings and a line log.

It is kept simple: one window, three tabs, and a driver list for each kind of sensor. Every sensor has its port, latency, mount offsets from the CRP and C-O values, and the instrument list shows straight away if anything stops or slows down.

| You want to | Use |
|---|---|
| **Say what the vehicle is and where its CRP is** | Set-up: System parameters (section 4) |
| **Set the datum and projection** | Set-up: Geodesy (section 5) |
| **Use ZDA + PPS time** | Set-up: Time (section 6) |
| **Add a sensor or a multibeam head** | Set-up: + Sensor (sections 7 to 10) |
| **Check everything is coming in** | Online: the instruments and alarms (section 11) |
| **Log a line** | Start logging / End line, F9 (section 12) |
| **Play a line back, or see what was logged** | The Lines tab (section 13) |

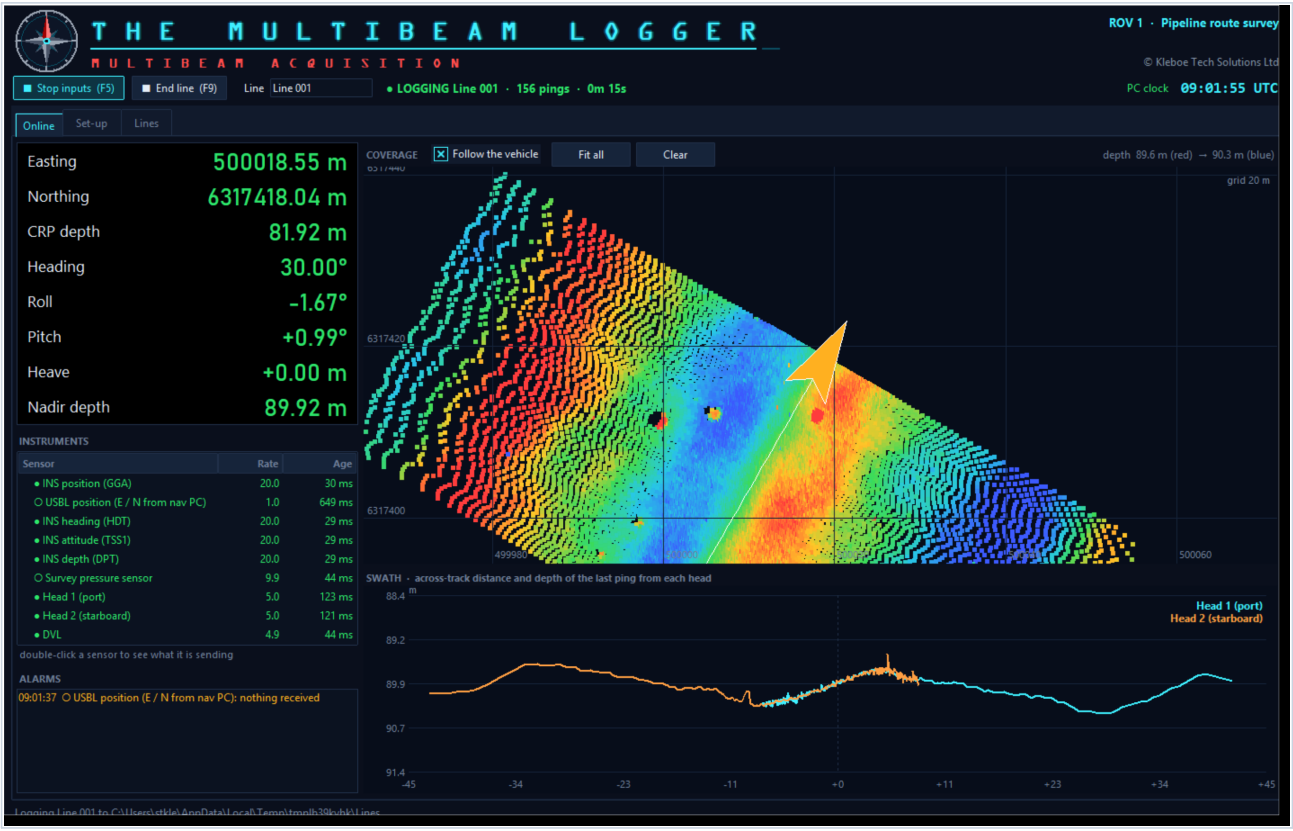
# 2 Getting started

## 2.1 Installing and starting

Copy **MultibeamLogger.exe** into a folder of your choice and double-click it. There is no installer. The program opens the last set-up you used. You can also drag a set-up file (.mbl) onto MultibeamLogger.exe to open it.

> **Note**
> The first time you start the program, Windows may show a **Windows protected your PC** message. Click **More info**, then **Run anyway**. If Windows Firewall asks, allow the program on the network you use for the survey - otherwise the UDP data can't come in.

## 2.2 The main window




*The Online tab while a line is being logged: an ROV with a dual-head multibeam.*

Under the title are the two buttons you use most: **Start inputs (F5)** opens every port and starts reading, and **Start logging (F9)** starts a line (it becomes **End line** while logging). Next to them is the **line name**, the logging status (line, pings and time), and on the right the **time** and where it comes from.

- **Online** - the numbers, instruments, alarms, coverage and swath (section 11).
- **Set-up** - the system, geodesy, time and every sensor (sections 4 to 10).
- **Lines** - the lines logged, and replay (section 13).

## 2.3 Set-ups and saving

A set-up (.mbl file) holds the system, geodesy, time, sensors and logging settings. **File > Save set-up** (Ctrl+S) saves it. Once it has a file name, every change is saved straight away. **File > New set-up** starts with a GGA position, an HDT heading, a TSS1 motion sensor and one multibeam head, ready to change.

> **Tip**
>
> **File > Open the example set-up** opens an ROV with a dual-head multibeam, a USBL, two depth sensors, a DVL and an altimeter. The pictures in this manual are of the example.

# 3 How each sounding is placed

Everything is measured from one point on the vehicle, the **CRP** (common reference point) - usually the INS or motion sensor's centre. The offsets of every sensor and head are measured from the CRP in the vehicle's own frame:

| Offset | Positive |
|---|---|
| **X** | to starboard |
| **Y** | forward |
| **Z** | down |

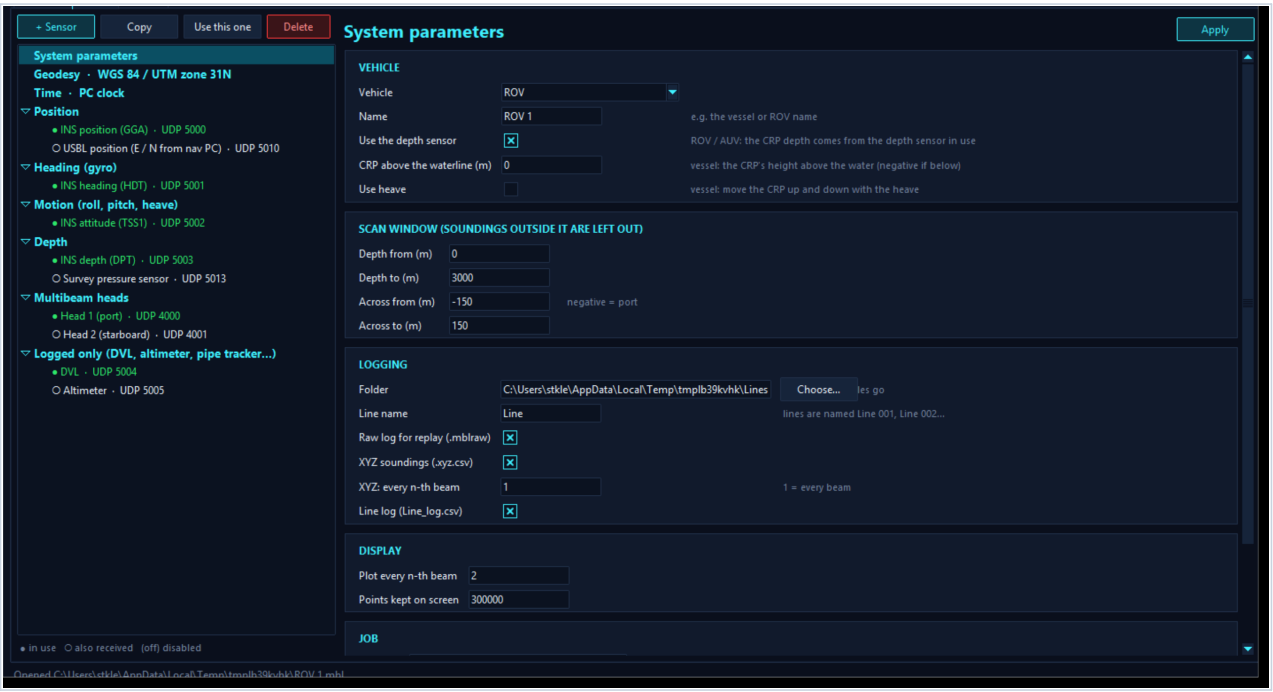
For every ping the program:

- takes the position, heading, roll, pitch and heave (and the depth for an ROV or AUV) at the ping's time, from the sensors in use - each one corrected for its latency;
- moves the position from its sensor's offsets to the CRP, then out to the head's offsets, turned by the heading, roll and pitch;
- turns each beam by the head's mount angles and the vehicle's attitude, and runs it out along a straight line at the sound speed at the head;
- gives each sounding an Easting, Northing and depth, and leaves out any outside the filters and the scan window.

Roll is positive with the port side up, pitch positive with the bow up, and heave positive up.

> **Note**
> The program uses straight-line ray paths with the sound speed at the head. That is right for checking coverage and quality online. Process the final data with a full sound velocity profile in your processing software, from the raw log.

# 4 System parameters




*System parameters.*

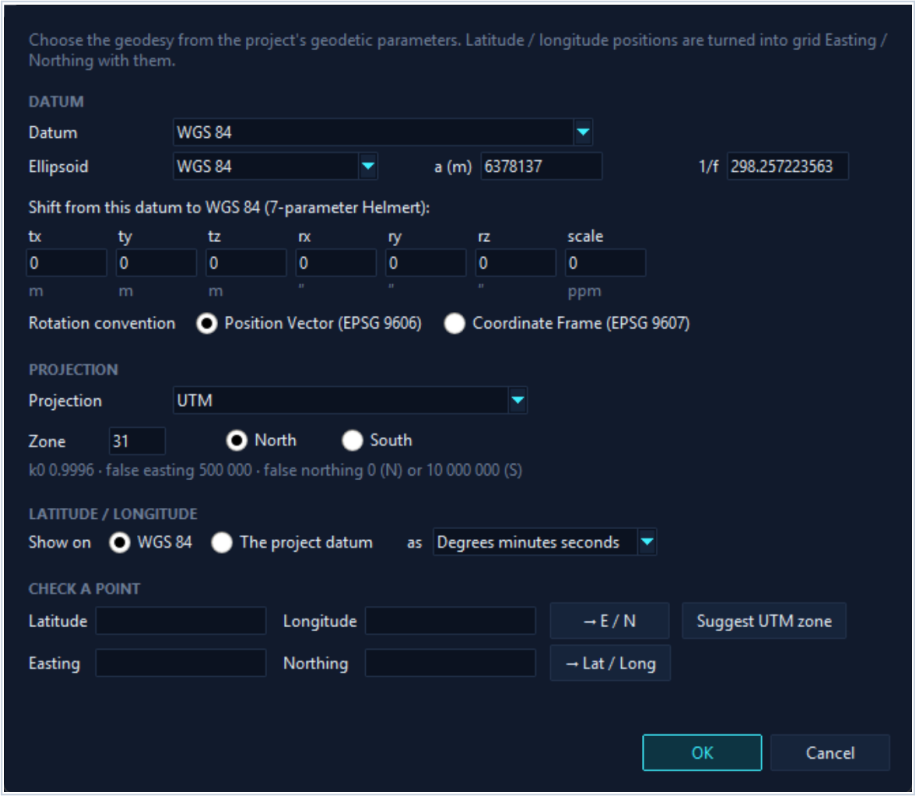
| Setting | What it does |
|---|---|
| **Vehicle** | Vessel, ROV or AUV. |
| **Name** | The vessel or vehicle name, shown at the top of the window. |
| **Use the depth sensor** | ROV / AUV: the CRP depth comes from the depth sensor in use. |
| **CRP above the waterline** | Vessel: the CRP's height above the water (negative if it is below). |
| **Use heave** | Vessel: the CRP moves up and down with the heave. |
| **Scan window** | Depth from / to and across from / to (negative = port). Soundings outside it are left out - an easy way to stop spikes and the far outer beams. |
| **Logging** | The folder for the line files, the line name, which files to write, and every n-th beam in the XYZ file (section 12). |
| **Display** | Plot every n-th beam, and how many points are kept on screen. |
| **Job** | Project, client, vessel, area and surveyor, written in the line log. |

Click **Apply** after changing a page. If the inputs are running, stop and start them (F5 twice) so the changes are used.

# 5 Geodesy

Positions in latitude / longitude (GGA, LLD) are turned into grid Easting / Northing on the datum and projection set here. Positions that already come as grid Easting / Northing are used as they are.

Click **Geodesy** in the set-up list, then **Edit geodesy…**. Choose the datum (or a custom ellipsoid and datum shift) and the projection: UTM with its zone, Transverse Mercator, Lambert or others. Take them from the project's geodetic parameters.




*The Geodesy window.*

# 6 Time

Every reading is given a UTC time when it arrives. Choose where the time comes from:

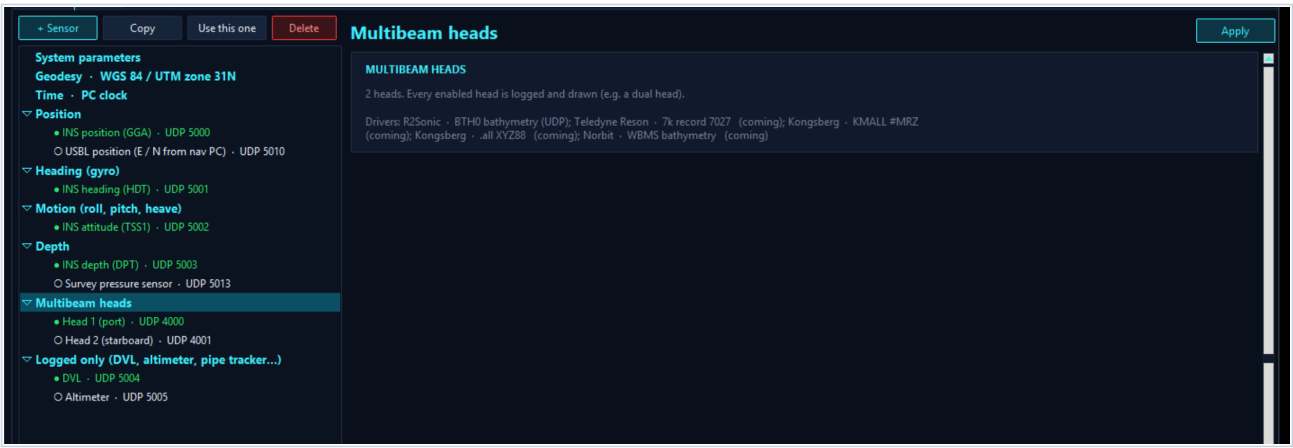
- **The PC clock** - fine when the PC is kept on GPS time by a time program.
- **A ZDA string (with PPS)** - the ZDA gives the date and time, and the PPS pulse on a serial pin marks the exact start of each second. Set the port, tick **Use the PPS pulse** and choose the pin (Ring indicator, pin 9, is usual). Without PPS, set the **ZDA delay** - how late the ZDA arrives.

*Time from ZDA with PPS on COM3.*

The time and its source are shown on the right of the toolbar: green when it is good, amber when the ZDA or the PPS has stopped.

> **Tip**
> Each ping uses the multibeam's own time stamp when it is within 10 seconds of this time. So put the sonar on the same ZDA + PPS, and every ping lines up exactly with the navigation.

# 7 Sensors




*The Set-up tab: the sensors on the left, and the drivers for multibeam heads.*

## 7.1 Kinds of sensor

The sensors are listed in six groups: **Position**, **Heading (gyro)**, **Motion (roll, pitch, heave)**, **Depth**, **Multibeam heads** and **Logged only**. Click a group to see its drivers.

## 7.2 Adding, copying and deleting

- Select a group (or a sensor in it) and click **+ Sensor**. It is added with the next free UDP port.
- **Copy** makes a copy of the selected sensor on the next port - quick for a second head or a backup.
- **Delete** deletes the selected sensor.

## 7.3 The one in use

Where there are several sensors of one kind - two positions, two depth sensors - the one marked ● (green) is used for the soundings. The others (○) are still read, shown and logged, so you can compare them. Select one and click **Use this one** to swap. Every enabled multibeam head is always used. Untick **Enabled** to leave a sensor out without deleting it.

## 7.4 Input, latency and alarm

| Setting | What it does |
|---|---|
| **Driver** | How the string or packet is read (see the table below). |
| **Port** | UDP (with the port number) or Serial (with the COM port and baud). The COM ports on the PC are listed next to it. |
| **Latency (ms)** | How late the data arrives after it was measured. It is taken off the time, so the reading is used for when it was measured. |
| **Alarm below (per second)** | An alarm is shown if the rate drops below this. |

## 7.5 Data from another PC or instrument

There is no IP address to enter. A UDP input listens on its port on **every network card** of this PC, so data sent from another PC or instrument on the network comes in the same way as data from this PC. The IP address is set at the **sending** end:

- On the other PC or instrument, send the data to **this PC's IP address** and the port set here - for example the navigation PC's UDP output to this PC on port 5010.
- For a multibeam, set the sonar's data destination (in the sonar's own settings) to this PC's IP address, and its port to the head's port here (4000, 4001…).
- Data broadcast to the whole network (for example to 192.168.1.255) is received too.
- To find this PC's IP address, type **ipconfig** in a Command Prompt and look for the IPv4 address on the survey network card.

> **Note**
> Allow The Multibeam Logger through Windows Firewall on the survey network. If data from this PC comes in but data from another PC doesn't (the sensor stays red), the firewall is the usual cause.

| Not supported yet | What to do |
|---|---|
| **Instruments you connect to (TCP)** | Some instruments wait for the PC to connect to them. Set the instrument to send UDP instead, or use its serial output. |
| **Two senders on one port** | Their data would be mixed. Give each sender its own port. |
| **Multicast** | Set the sender to send to this PC's IP address (unicast) or to broadcast instead. |

## 7.6 The drivers

| Kind | Drivers |
|---|---|
| **Position** | NMEA GGA; USBL LLD; grid Easting / Northing in a text string (with an optional time column) |
| **Heading** | NMEA HDT / THS / HDG; heading in a column of a text string; heading from the motion string |
| **Motion** | $PRDID; TSS1; $PASHR; $PSXN,23; EM3000 binary |
| **Depth** | NMEA DBT / DPT; depth in a column; pressure in a column; Paroscientific pressure; depth from the position sensor |
| **Multibeam** | R2Sonic BTH0. Coming: Teledyne Reson 7027, Kongsberg KMALL and .all, Norbit |
| **Logged only** | Any text string, logged as received |

> **Note**
> Drivers marked **coming** are listed but can't be used yet - they need sample data to test. An INS native binary output (position, attitude and depth in one) is also coming. Ask if you need one of these.

# 8 Position, heading and motion

## 8.1 Position

A GGA or LLD position is given with the sensor's mount offsets, so it can be moved to the CRP. A grid Easting / Northing string - for example a USBL position sent from the navigation PC - is read from columns: set what the string **starts with**, the **separator**, and the **Easting** and **Northing** columns (counting from 1).

*A USBL position from the navigation PC, with its time in column 2.*

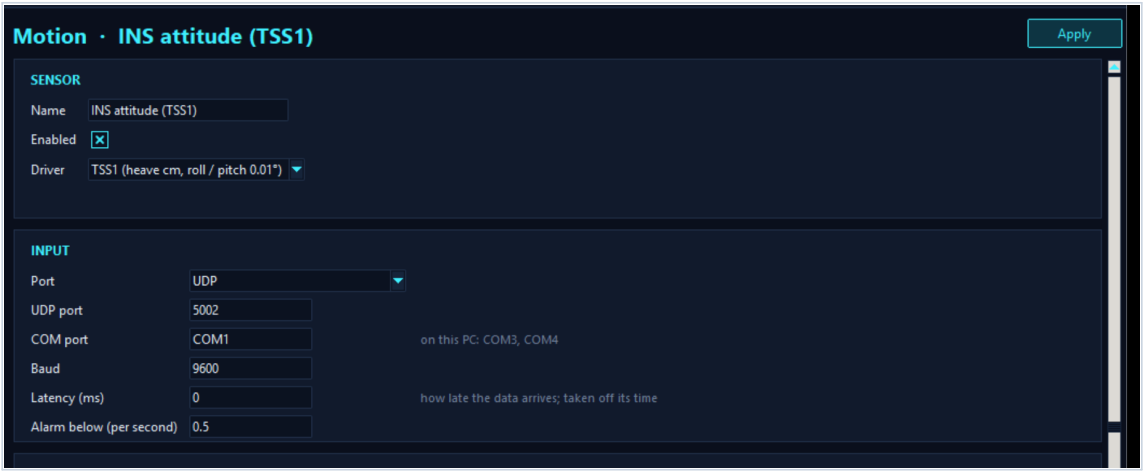
> **Tip**
> Give a **time column** when the string has its own time (hh:mm:ss). The position is then used for that time rather than when it arrives - best for positions sent over the network, which can arrive late.

## 8.2 Heading

Set the **Gyro C-O** - the correction from the gyro calibration. It is added to the heading. A heading can also be taken from the motion sensor's own string, if it has one.

## 8.3 Motion

Set the **Roll C-O**, **Pitch C-O** and **Heave C-O** from the calibration. Heading and motion sensors have no offsets - they are taken at the CRP.




*A TSS1 motion sensor and its C-O values.*

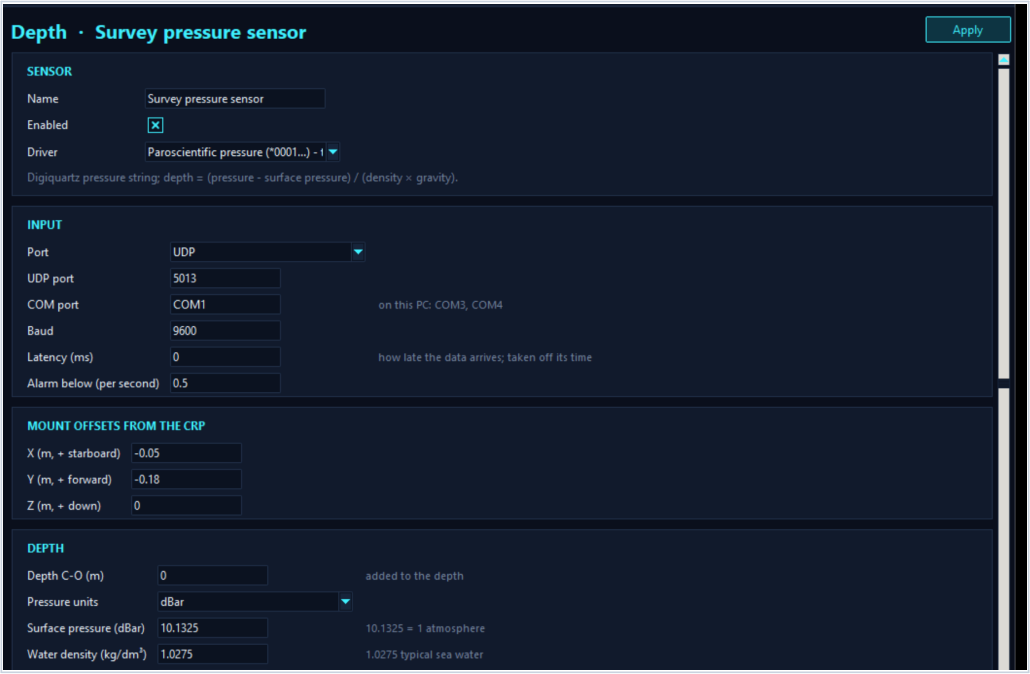
# 9 Depth

On an ROV or AUV the CRP depth comes from the depth sensor in use (tick **Use the depth sensor** in the system parameters). Its offsets are used to move the depth to the CRP, taking the pitch and roll into account. Set the **Depth C-O** from the calibration; it is added to the depth.

A pressure sensor gives pressure, which is turned into depth:

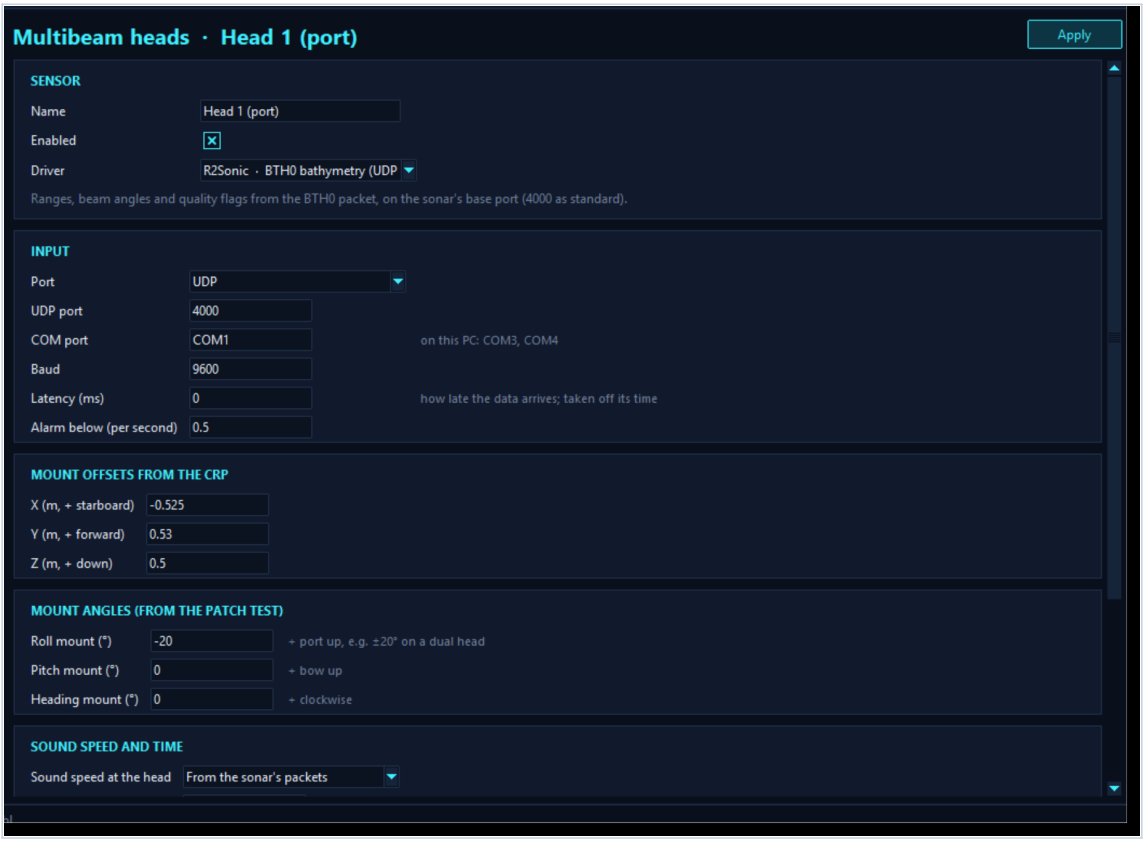
depth = (pressure - surface pressure) / (density × gravity)

| Setting | Usual value |
|---|---|
| **Pressure units** | dBar, bar, kPa, psi or MPa |
| **Surface pressure** | 10.1325 dBar (1 atmosphere), or the measured air pressure |
| **Water density** | 1.0275 kg/dm³ for typical sea water, or from a CTD |
| **Gravity** | 9.81 m/s², or the local value |




*A Paroscientific pressure sensor.*

# 10 Multibeam heads




*Head 1 of a dual head, mounted 20° to port.*

## 10.1 Port

An R2Sonic sends its BTH0 bathymetry over UDP to the sonar's base port (4000 as standard). For a dual head, give each head its own port. In the sonar's own settings, set the data destination to this PC's IP address (section 7.5).

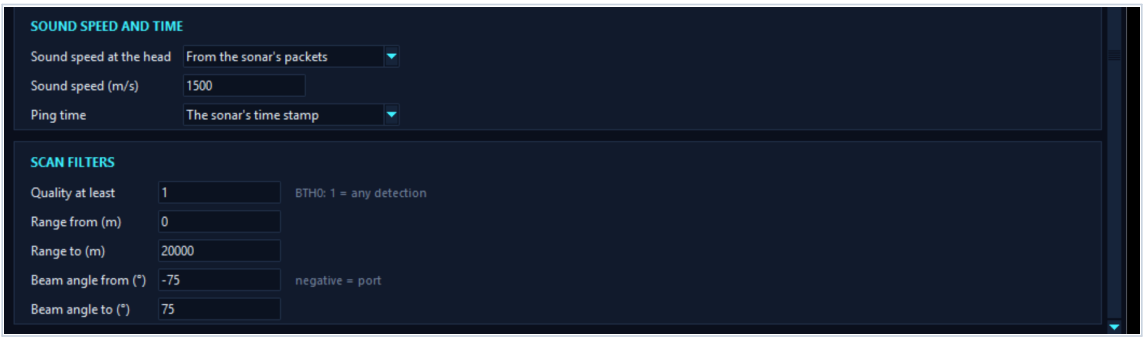
## 10.2 Offsets and mount angles

The **mount offsets** are the head's acoustic centre from the CRP. The **mount angles** come from the patch test: roll (+ port up), pitch (+ bow up) and heading (+ clockwise). On a dual head the heads are usually tilted about ±20° in roll - the port head negative, the starboard head positive. The angles turn the beams; they don't move the head.

## 10.3 Sound speed and time

- **Sound speed at the head** - from the sonar's packets (from its SV probe), or a fixed value.
- **Ping time** - the sonar's time stamp (best, when the sonar is on ZDA + PPS) or when the packet arrives.

## 10.4 Scan filters




*The rest of the head's page: sound speed, time and the scan filters.*

Soundings are left out when their **quality** is below the setting, their **range** is outside the range from / to, or their **beam angle** is outside the beam angle from / to (negative = port). Together with the scan window in the system parameters, these keep the spikes out of the coverage and the XYZ file. The raw log always keeps everything.

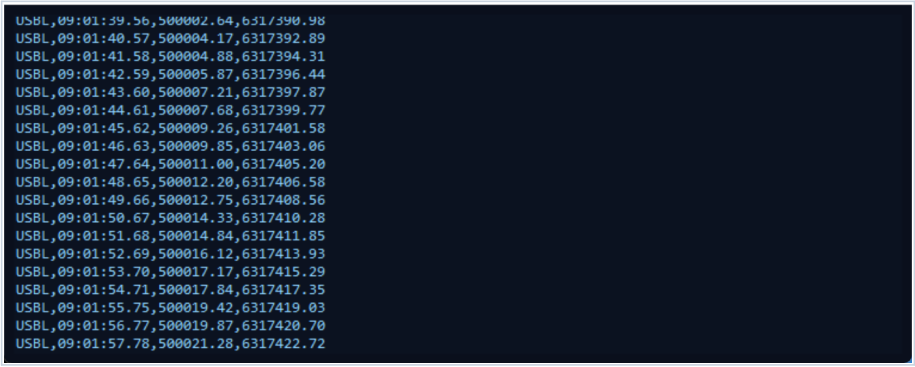
# 11 The Online tab

## 11.1 The numbers

The large numbers on the left are the CRP's **Easting**, **Northing** and **depth**, the **heading**, **roll**, **pitch** and **heave**, and the **nadir depth** - the depth under the head - from the last ping.

## 11.2 Instruments and alarms

Every enabled sensor is listed with its **rate** (readings per second) and **age** (time since the last one): green when it is fine, amber when it is slow or a string can't be read, red when nothing is coming in. **Double-click a sensor** to see what it is sending.



```
USBL,09:01:39.56,500002.64,6317390.98
USBL,09:01:40.57,500004.17,6317392.89
USBL,09:01:41.58,500004.88,6317394.31
USBL,09:01:42.59,500005.87,6317396.44
USBL,09:01:43.60,500007.21,6317397.87
USBL,09:01:44.61,500007.68,6317399.77
USBL,09:01:45.62,500009.26,6317401.58
USBL,09:01:46.63,500009.85,6317403.06
USBL,09:01:47.64,500011.00,6317405.20
USBL,09:01:48.65,500012.20,6317406.58
USBL,09:01:49.66,500012.75,6317408.56
USBL,09:01:50.67,500014.33,6317410.28
USBL,09:01:51.68,500014.84,6317411.85
USBL,09:01:52.69,500016.12,6317413.93
USBL,09:01:53.70,500017.17,6317415.29
USBL,09:01:54.71,500017.84,6317417.35
USBL,09:01:55.75,500019.42,6317419.03
USBL,09:01:56.77,500019.87,6317420.70
USBL,09:01:57.78,500021.28,6317422.72
```

*What the USBL is sending.*

Under them, the **alarms** list each problem once, with the time, when it starts or changes - for example *DVL: nothing received* or *Head 2: rate 2.1 per second is below 4*.

## 11.3 Coverage

The coverage shows every sounding on the grid, coloured by depth from red (shallow) to blue (deep), with the track in white and the vehicle as an arrow. The depth range of the colours is shown above it.

- **Follow the vehicle** keeps the vehicle in the middle.
- **Fit all** fits all the coverage on screen; **Clear** clears it.
- **Drag** to move round, and use the **mouse wheel** to zoom.

## 11.4 Swath

The swath shows the last ping from each head across the track: distance across (negative = port) against depth, each head in its own colour. Soundings left out by the filters are grey. On a dual head the two swaths should overlap neatly in the middle - if they don't, check the mount angles and offsets.

## 11.5 Logged only

Sensors in **Logged only** - a DVL, an altimeter, a pipe tracker - aren't used for the soundings. They are shown in the instrument list and written to the raw log with their times and offsets, for processing.

# 12 Logging lines

With the inputs running, type the line name (or keep the one given) and press **Start logging** (F9). Press **End line** (F9) at the end. The next line name is ready, numbered on from the last (Line 001, Line 002…). The first time, you are asked for the logging folder.

| File | What is in it |
|---|---|
| ***Line 001_<UTC date and time>*.mblraw** | Every string and packet from every sensor, with its time, exactly as received - to replay or process. |
| ***Line 001_<UTC date and time>*.xyz.csv** | The soundings: UTC, head, ping, beam, Easting, Northing, depth. |
| **Line_log.csv** | One row per line: name, start and end time, duration, pings, soundings, start and end Easting / Northing, and the files. |

Each of these can be switched off in the system parameters. The XYZ file can be thinned to every n-th beam.

> **Note**
> Ending a line, stopping the inputs or closing the program all close the files properly.

# 13 The Lines tab and replay

*The Lines tab: the lines in the logging folder.*

The Lines tab lists the lines from the logging folder's line log. **Open the folder** opens it in Windows.

## 13.1 Replay

**Replay a raw log…** (also on the File menu) plays a .mblraw file back through the same processing, at the speed you choose (1 = real time). The coverage, swath and numbers show as if it were live, and you can log it again as a new line - for example after correcting an offset or a C-O. Press F5 to stop.

## 13.2 Exporting the coverage

**File > Export the coverage (XYZ)…** saves the points on screen as an XYZ text file - a quick check or a picture of the coverage for the client. The full soundings are in the lines' .xyz.csv files.

# 14 Trial and licence

The program runs as a free 48-hour trial with everything working. A bar under the title shows how long is left. After that it needs a Survey Software Suite licence key: click **Enter licence key…**, paste the key from the email and click **Activate**. One key unlocks every program in the suite on the PC, on up to 4 PCs. With a licence the bar goes, and the window title shows **Licensed until** and the date. The licence is checked online now and then and works for up to 30 days at a time without internet. Your set-ups and logged lines are never affected.

# 15 Troubleshooting

| Problem | What to check |
|---|---|
| **A sensor is red (nothing received)** | The port number or COM port; that the data is sent to this PC's IP address; Windows Firewall; that another program isn't already using the COM port. |
| **A sensor is amber** | Double-click it to see what it sends. Check the driver matches the string, and the columns for a text string. |
| **Pings come in but nothing is plotted** | The position, heading and motion in use must all be coming in. Check the scan window and filters aren't leaving everything out. |
| **The swaths of a dual head don't meet** | The roll mount angles (port head negative) and the X offsets. |
| **The seabed tilts with the roll** | The roll mount angle or the roll C-O; then the latency of the motion sensor. |
| **A driver says it can't be used yet** | It is still coming. Choose another, or ask for it to be added. |
| **The time is amber** | The ZDA or the PPS has stopped. Check the time port and the PPS pin. |
| **A change has no effect** | Click Apply, then stop and start the inputs (F5 twice). |

## Keyboard shortcuts

| Keys | Command |
|---|---|
| **F5** | Start / stop the inputs (or stop a replay) |
| **F9** | Start logging / end the line |
| **Ctrl+O / Ctrl+S** | Open and save a set-up |