THE SURVEY SIMULATOR

STRINGS · SENSORS · MULTIBEAM

User Manual

Test strings for offshore survey systems over serial and UDP,
from a simulated vessel, ROV and multibeam

Version 1.3 · formerly The Stringinator Generator

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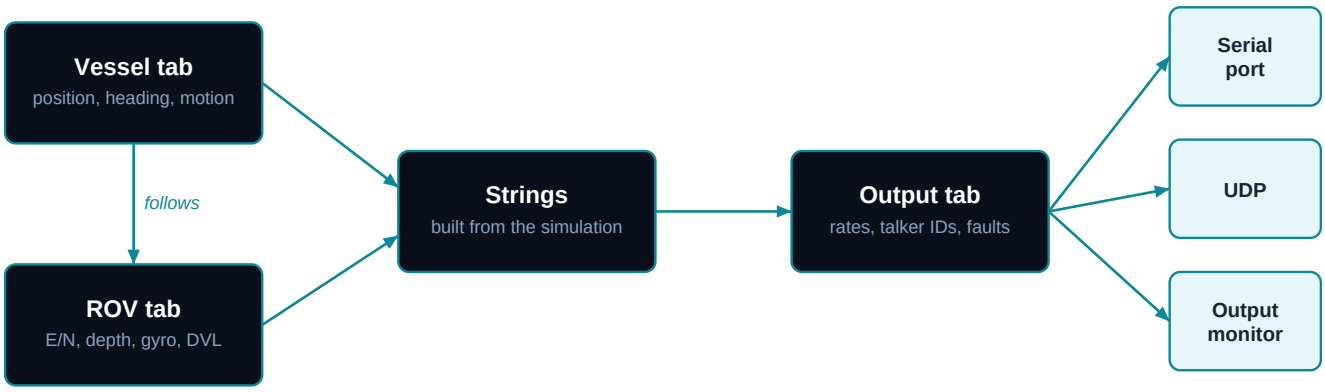
1 Introduction

The Survey Simulator (formerly The Stringinator Generator) produces the kind of data strings that offshore survey equipment sends (GNSS positions, gyro headings, motion sensor data, echo sounder depths, Doppler log speeds and ROV positions) so that you can test navigation, logging and display systems without the real equipment. Strings are sent out of serial (COM) ports and over the network using UDP. A simulated multibeam can also send bathymetry packets.

Instead of random numbers, every string comes from a simulated **vessel** and **ROV**. The vessel moves along its heading at its speed, rolls, pitches and heaves; the ROV follows it or drives on its own. So the GGA position moves in the direction the HDT heading says, the TSS1 heave matches the $PSXN,23 heave, the ROV's easting and northing agree with its latitude and longitude, and so on, just like real sensors.



Every string comes from the same simulated vessel and ROV, so all the strings agree with each other.

Everything is done in tabs:

Tab	What it is for
Vessel	Where the simulated vessel starts, its heading and speed, whether it runs straight or turns, its roll, pitch and heave, GNSS quality and water depth. A live readout shows what the vessel is doing.
ROV	The simulated ROV: following the vessel at an offset or driving on its own, its depth, gyro (heading, roll and pitch), easting and northing, and Doppler log (DVL). A live readout shows what the ROV is doing.
Multibeam	A simulated multibeam on the vessel or the ROV, pinging a made-up seabed and sending BTH0 bathymetry packets over UDP. Shows the swath and the coverage as it builds up.
Output	One destination (a serial port and/or a UDP address) and the strings sent to it, each at its own rate. Fault injection can add errors for testing. You can have as many Output tabs as you need.

The whole set-up can be saved as a **project** and loaded again later (section 11).

> **Note**
> The Survey Simulator is the new name for The Stringinator Generator. Your licence or trial, your saved settings and your .stringgen project files all carry over unchanged.

2 Getting started

2.1 What you need

- A Windows PC.
- The program file, **Data-Test-Centre.exe**. Nothing else needs to be installed.
- For serial output: a COM port (for example a USB-to-serial adapter) with its driver installed, and a cable to the equipment you are testing.

2.2 Installing

Copy **Data-Test-Centre.exe** into a folder of your choice, for example a folder in Documents or on the desktop. There is no installer.

> **Tip**
> For quick access, right-click Data-Test-Centre.exe and choose **Send to > Desktop (create shortcut)**, or pin it to the Start menu or taskbar.

2.3 Starting the program

Double-click **Data-Test-Centre.exe**. The program opens with the Vessel, ROV and Multibeam tabs and one Output tab.

> **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 whether to allow the program on networks, allow it if you will send strings over UDP.

2.4 Sending your first strings

Output 1 is ready to go: it is set to send GGA, RMC, VTG, ZDA and HDT over UDP to 127.0.0.1 (this same PC) on port 5000.

1. Click the **Output 1** tab.
2. Press the cyan **START** button. It turns into a red **STOP** button, the status line turns green and the strings appear in the output monitor at the bottom.
3. Press **STOP** to stop sending.

> **Tip**
> Port 5000 is also where String Format Manager's first Output Formatter listens, so if you run both programs on the same PC, String Format Manager receives the strings straight away (section 12).

3 The main window

The Survey Simulator, showing the Vessel tab.

3.1 Layout

- **Title banner** across the top, with the compass rose. The name of the open project is shown in its top-right corner ("Untitled" until the project has been saved).
- **Trial bar** under the banner while the program is on its free trial (section 13).
- **File menu** for saving and opening projects (section 11).
- **Tabs**: Vessel, ROV, Multibeam, your Output tabs, then **+ Add output**.

3.2 Working with tabs

To...	Do this
Add an output	Click the **+ Add output** tab. A new Output tab is added and shown.
Rename an output	Right-click the tab and choose **Rename tab...**.
Close an output	Right-click the tab and choose **Close tab**. If it is still sending you will be asked to confirm. At least one Output tab must stay open.

The Vessel, ROV and Multibeam tabs cannot be renamed or closed. Settings on every tab can be changed at any time, including while strings are being sent; the strings change straight away.

4 Vessel tab

The Vessel tab sets up the simulated vessel (see the picture in section 3). Type a new value into any box and the vessel changes immediately; if a box holds something that isn't a number, the last good value is kept until it is corrected.

4.1 Position & movement

Setting	Default	Description
Start latitude	57.143500	° (+ N / - S)
Start longitude	-2.072000	° (+ E / - W)
Heading	45.0	° true
Speed	4.0	knots
Rate of turn	30.0	°/min in Turning mode (- = to port)
Max turn rate	60.0	°/min when steering to a new heading
Motion	Straight	**Straight**: the vessel steers to the Heading, turning no faster than the Max turn rate, then holds it. **Turning**: the vessel turns continuously at the Rate of turn.

The start latitude and longitude are only used when the vessel is put back to its start: press **Back to start** (this also puts the ROV back to its start).

4.2 GNSS

Setting	Default	Description
Satellites	14	
HDOP	0.8	
Antenna height	25.0	m above geoid
Geoid separation	50.0	m
Position noise	0.02	m (1 sigma)
Magnetic variation	-1.5	° (+ E / - W)
Magnetic deviation	0.5	° (+ E / - W)
Fix quality	1 - GPS	The quality reported in GGA and other strings: GPS, DGPS, RTK fixed, RTK float, or No fix (which also marks RMC and GLL as invalid).

4.3 Motion

Setting	Default	Description
Roll amplitude	3.0	°
Roll period	8.0	s
Pitch amplitude	1.5	°
Pitch period	6.0	s
Heave amplitude	0.8	m
Heave period	10.0	s

Setting	Default	Description
Heading noise	0.02	° (1 sigma)
Add small random noise	Ticked	Adds a little random variation to every value (vessel and ROV), as real sensors have. Untick for perfectly smooth values.

Roll, pitch and heave each rise and fall smoothly with the amplitude and period you set. Heave is positive upwards.

4.4 Depth & water

Setting	Default	Description
Water depth	85.0	m below transducer
Depth variation	5.0	m (slow rise and fall)
Variation period	120	s
Transducer offset	-4.5	m (DPT offset, - = to keel)
Water temperature	9.5	°C
Current along track	0.3	knots (water speed = SOG - current)

The water depth rises and falls slowly by the Depth variation over the Variation period, like a vessel passing over an uneven seabed. When the Multibeam tab's seabed is used for the depth strings (section 6.5), the depth comes from that seabed instead.

4.5 Live readout

The boxed screen at the bottom shows the vessel as it is now, five times a second: latitude, longitude, UTC time, heading, speed, rate of turn, roll, pitch, heave and depth.

> **Note**
> All times in the strings come from the PC's clock, in UTC. Make sure the PC's clock and time zone are set correctly.

5 ROV tab

The ROV tab, with the ROV following the vessel 25 m astern and 10 m to starboard.

The ROV tab sets up a simulated ROV. Like the vessel, any change takes effect immediately.

5.1 Position & movement

Setting	Default	Description
Offset forward	-25.0	m from vessel (- = astern)
Offset starboard	10.0	m from vessel (- = port)
Heading offset	0.0	° from vessel heading (Follow vessel)
Heading	90.0	° true (Independent)
Speed	0.5	knots (Independent)
Rate of turn	0.0	°/min (Independent, 0 = hold Heading)
Max turn rate	30.0	°/min when steering to a new heading
Mode	Follow vessel	**Follow vessel**: the ROV stays at the forward and starboard offsets from the vessel, facing the vessel's heading plus the Heading offset. **Independent**: the ROV drives on its own Heading and Speed (and turns at its Rate of turn if that isn't 0).

Setting	Default	Description
UTM zone	Auto	The UTM zone used for the ROV's easting and northing (WGS84). Auto picks the zone from the ROV's longitude; choose a number to fix it, for example when working near a zone boundary.

Back to start puts the ROV back at its offsets from the vessel's start position and resets the DVL's distance made good.

5.2 Depth & position noise

Setting	Default	Description
ROV depth	80.0	m below sea surface
Depth variation	0.5	m (slow rise and fall)
Variation period	40	s
Position noise	0.3	m (1 sigma, e.g. USBL)

The ROV's altitude (height above the seabed) is worked out from the vessel's water depth plus the transducer offset, minus the ROV depth, so it changes as the seabed rises and falls. When the Multibeam tab's seabed is used (section 6.5), the altitude comes from that seabed under the ROV.

5.3 Attitude (gyro)

Setting	Default	Description
Roll amplitude	1.0	°
Roll period	7.0	s
Pitch amplitude	2.0	°
Pitch period	9.0	s
Heading noise	0.05	° (1 sigma)

5.4 Doppler (DVL)

Setting	Default	Description
Salinity	35.0	ppt
Speed of sound	1500.0	m/s
Water temperature	6.5	°C at the ROV
Velocity noise	3	mm/s (1 sigma)
Bottom lock	Ticked	Untick to simulate the DVL losing the seabed: its velocities are sent as invalid and it counts the seconds since the last good reading, as a real DVL does.

5.5 Live readout

The screen shows the ROV as it is now: easting, northing, UTM zone, depth, altitude, heading, roll, pitch, speed (forward / starboard, in m/s) and the DVL's lock status.

> **Note**
> Offsets are measured along true north. In UTM coordinates, grid north differs slightly from true north (by about 0.8° off Aberdeen), so an offset of exactly 25 m astern and 10 m to starboard shows small differences in easting and northing. This is correct.

6 Multibeam tab

The Multibeam tab adds a simulated multibeam echo sounder, mounted on the vessel's hull or on the ROV. It pings a made-up seabed and sends BTH0 bathymetry packets over UDP, the same BTH0 packets a real sonar head sends. You can set up and test multibeam acquisition software, check offsets and practise line planning and coverage without the sonar or the vessel.

The sonar moves with the simulated vessel or ROV: every beam is worked out from the transducer, using the heading, roll, pitch and heave of the vessel or ROV it is mounted on, down to the seabed. So the multibeam agrees with the position, heading and motion strings the Output tabs send.

The Multibeam tab with the sonar on the ROV, about 10 m above the seabed. The swath across the track is on the left; the coverage map, with sand waves and boulders, is on the right.

6.1 Quick start

1. Click the **Multibeam** tab.
2. Check the **UDP address** and **Base port**. The default, 127.0.0.1 port 4000, sends to acquisition software on this same PC.
3. Press **Start pinging**. It turns into a red **Stop pinging** button, the status shows PINGING, and the swath and coverage map start to fill.
4. In the acquisition software, add a multibeam that reads BTH0 on UDP port 4000.

5. On an Output tab, send the position, heading, motion and time strings the acquisition software needs, for example GGA, HDT, TSS1 (or $PSXN,23) and ZDA. If the sonar is on the ROV, send the ROV position, gyro and attitude strings instead.

> **Note**
> The sonar is not roll-stabilised. Its beam angles are measured across the sonar itself, as with a real head, so the acquisition software must apply the roll, pitch and heave from the motion strings. Without them the seabed will look tilted and wavy.

6.2 The sonar

Setting	Default	Description
Frequency	400	kHz
Beams	256	per ping (16 - 1024)
Swath angle	130	° total
Max ping rate	30	Hz (slowed by range)
Sound speed	1500	m/s
Range noise	2	cm (1 sigma)
Bad beams	0.5	% spikes and drop-outs
Model	2024	The model number sent in each packet: 2020, 2022, 2024 or 2026.
Beam spacing	Equidistant	**Equidistant**: beams spaced evenly across a flat seabed (closer together in angle at the outer edges). **Equiangular**: beams spaced evenly in angle.
Send intensity (I1)	Ticked	Adds the intensity (backscatter) of each beam to the packet. Hard targets such as boulders, the pipeline and the wreck return more than the sediment.

The sonar pings as fast as the Max ping rate allows, but never faster than the sound can travel to the furthest beam and back. In 90 m of water with a 130° swath this is about 3 pings a second; from an ROV 10 m above the seabed it is about 25.

Range noise is the random error added to each beam's range; it grows towards the outer beams. **Bad beams** is the share of beams that come back as spikes (a wrong range) or drop-outs (no detection), as real sonars have.

6.3 Mounting

Setting	Default	Description
Offset forward	0.0	m from ref point
Offset starboard	0.0	m
Offset down	4.5	m below ref point
Mounted on	Vessel hull	**Vessel hull**: moves with the vessel and its roll, pitch and heave. **ROV**: moves with the ROV, at the ROV's depth and attitude.

The offsets are from the reference point: on the vessel, the vessel's position at the waterline; on the ROV, the ROV's position and depth. They turn with the heading, roll and pitch, like a real lever arm. Enter the same offsets in the acquisition software.

When you change **Mounted on**, offsets left at the defaults switch to the other mount's defaults (4.5 m down on the vessel; 0.5 m forward and 0.8 m down on the ROV), and the coverage map starts afresh.

6.4 Output

Setting	Default	Description
UDP address	127.0.0.1	Where the packets go: this PC, another PC's IP address, or a broadcast address.
Base port	4000	The bathymetry packets go to this port, as with a real sonar's base port setting.
Send BTH0 packets	Ticked	Untick to watch the swath and coverage without sending anything.

Button	What it does
Start pinging / Stop pinging	Starts and stops the sonar.
Clear map	Empties the coverage map and the stored soundings.
Export XYZ...	Saves every sounding so far to a file (section 6.8).

6.5 Seabed

Setting	Default	Description
Depth at start	90.0	m below sea level
Slope	0.5	% (0.5 m per 100 m)
Downhill direction	90	° true
Roughness	0.10	m
DBT / DPT and ROV altitude strings follow this seabed	Ticked	The echo sounder depth strings and the ROV altitude come from this seabed, so they agree with the multibeam. Untick to use the Vessel tab's depth settings instead.

The seabed is fixed in place around the vessel's start position. It does not move with the vessel, so running back over the same ground shows the same seabed.

6.6 Seabed features

Tick the features you want on the seabed. Positions are measured from the vessel's start position: **ahead** along its start heading and **to stbd** to the right of it.

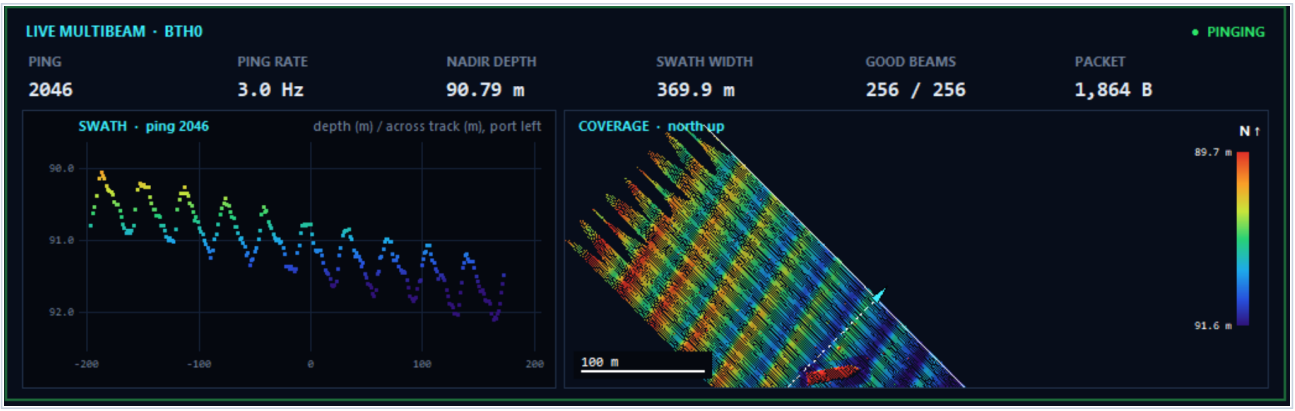
Feature	Settings	What it looks like
Sand waves	height, spacing, crests (direction the crests run, ° true)	Long ridges with a steeper side, slowly varying in height.
Pipeline	diameter, distance ahead, angle to the start heading	A pipe lying on the seabed, slightly embedded, crossing the track.
Trench along the pipeline	depth	A trench under the pipeline with spoil heaps on each side.
Boulders	boulders per hectare	Rounded boulders up to about 2.5 m across.
Wreck	distance ahead, distance to starboard	A 45 m hull, 10 m wide and 5 m high, with a deckhouse and a scour around it.

> **Tip**
> Small features show up best from the ROV. From the vessel in 90 m of water the beams are about 1.5 m apart on the seabed, so a 1 m pipeline is hard to see, just as it would be for real.

6.7 Live screen

Across the top: the ping number, the ping rate, the nadir depth (below the sea surface), the swath width, the number of good beams and the packet size.

- **Swath** (left): the latest ping across the track, port on the left. The depth scale is stretched to show the detail.
- **Coverage** (right): every sounding so far, north up, coloured by depth (red shallow, purple deep) and shaded as if lit from the north-west. The dashed line is the track, the white line is the latest ping and the arrow is the vessel or ROV. The map scale is set from the expected swath width when you start; the cell size is shown on the bottom line.



The sonar on the vessel in 90 m of water, crossing sand waves. The stripes across the coverage come from the vessel's pitch moving the swath backwards and forwards.

> **Note**
> If gaps appear across the coverage, the vessel or ROV is moving too far between pings. Slow it down, or raise the Max ping rate if the depth allows.

6.8 Exporting soundings

Export XYZ... saves every sounding as easting, northing and depth: UTM on WGS84 in the zone of the vessel's start position, with depth in metres below the sea surface. Save as .xyz for values separated by spaces, or .csv for commas. The file can be loaded into most survey and GIS programs to compare with what the acquisition software recorded. Up to 3 million soundings are kept.

6.9 The BTH0 packet

Each ping is sent as one UDP packet in BTH0 format, with all values big-endian. It has these sections:

Section	Contents
H0	Header: model, serial number (SIM100), ping time (UTC from the PC's clock), ping number, ping period, sound speed, frequency, range setting and number of beams.
R0	Two-way travel time of every beam.
A2 or A0	Beam angles across the sonar: A2 for equidistant spacing, A0 for equiangular.
I1	Intensity of every beam (if ticked).
G0	Depth gate (the window of travel times searched).
Q0	Quality of every beam: 1 phase detection (outer beams), 2 magnitude detection (within 20° of vertical), 0 no detection.

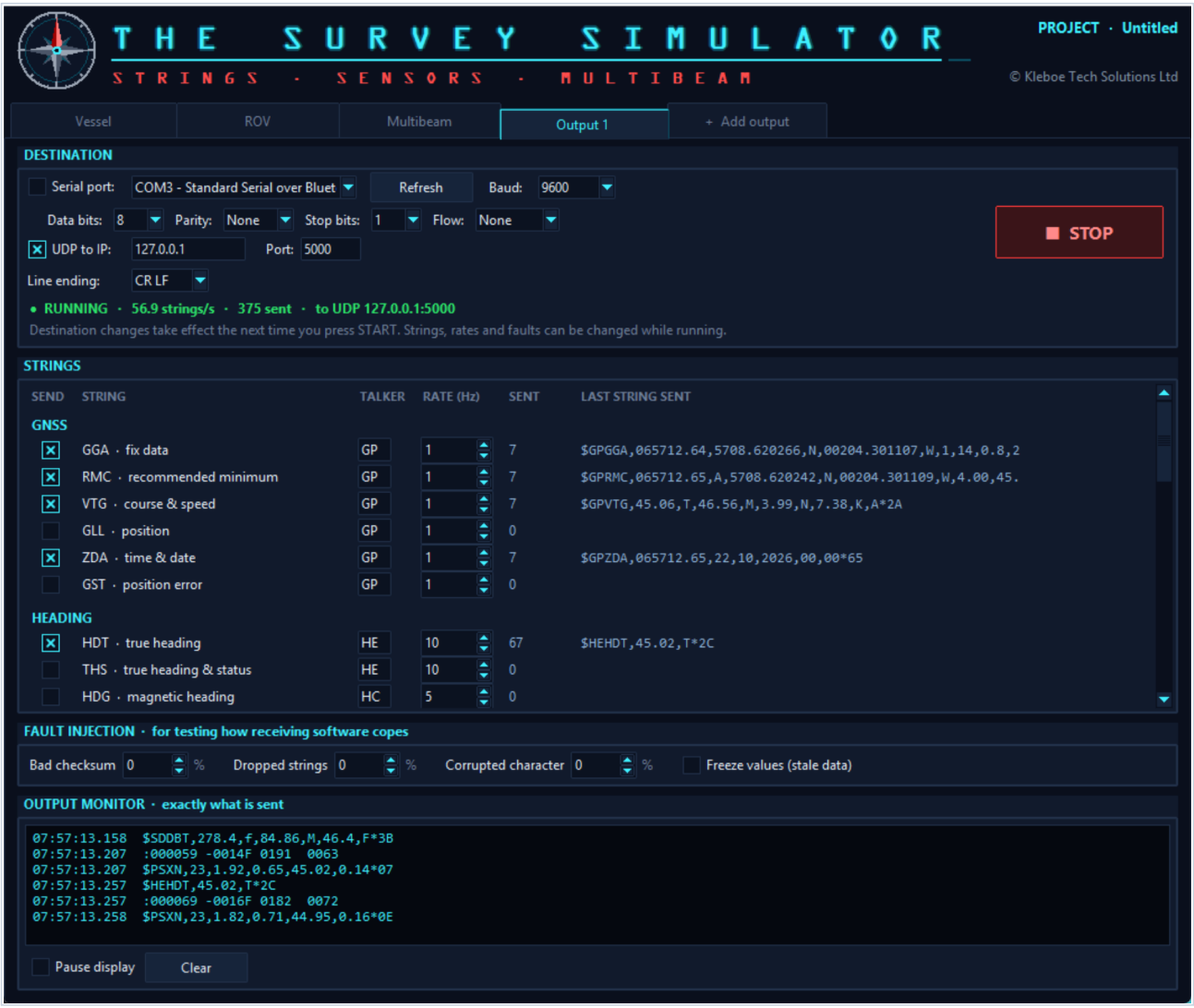
A packet is about 1.9 KB with 256 beams and up to about 6.8 KB with 1,024.

> **Note**

> The ping time comes from the PC's clock, like the times in the strings. Keep The Survey Simulator and the acquisition software on the same clock (the same PC, or both PCs synchronised) so that the pings match the position and motion data.

7 Output tabs

Each Output tab sends a chosen set of strings to one destination. Add as many as you need, for example one per COM port.



Output 1 sending over UDP, with the output monitor at the bottom.

7.1 Destination

Setting	Description
Serial port	Tick to send to a COM port, and choose the port. **Refresh** re-scans the PC's ports (in every tab).
Baud, Data bits, Parity, Stop bits, Flow	The serial line settings. They must match the equipment receiving the strings.
UDP to IP, Port	Tick to send each string as a UDP packet. 127.0.0.1 is this same PC; a broadcast address such as 192.168.1.255 sends to every device on that network. Output 1 uses port 5000, Output 2 port 5001, and so on.

Setting	Description
Line ending	Added to the end of every string: CR LF, CR, LF or None.
START / STOP	Starts and stops sending. You can send to a serial port, to UDP, to both, or to neither (the strings are then only shown in the monitor).

Under the button, the status line shows **RUNNING** (green) with the number of strings per second, the total sent and where they are going, or **STOPPED**.

> **Note**
> The destination is read when you press START, so to change the port, baud rate or UDP address, press STOP, change it and press START again. A COM port can only be used by one Output tab at a time.

7.2 Choosing strings

The strings are listed in groups (section 8). Each row has:

Column	Description
Send	Tick to send the string.
String	Which string it is.
Talker	The two-letter talker ID at the start of NMEA strings, for example GP in $GPGGA or HE in $HEHDT. Change it to match what your equipment sends (such as GN for a multi-constellation receiver). Strings that don't use a talker ID show a dash.
Rate (Hz)	How many times a second the string is sent, from 0.1 (once every 10 seconds) to 100. Pick from the list or type any value.
Sent	How many of this string have been sent.
Last string sent	The most recent one, exactly as sent.

Ticks, talker IDs and rates can all be changed while sending. NMEA checksums are worked out and added automatically.

7.3 Output monitor

The monitor at the bottom shows every string as it is sent, with the PC time to the millisecond. The last 500 lines are kept. Tick **Pause display** to freeze it while you read it (sending carries on), and **Clear** to empty it. Binary strings are shown in hex, marked [binary].

> **Tip**
> At high rates the serial line can fill up. Each character takes about 10 bits, so 9600 baud carries about 960 characters a second. See the appendix for a quick guide.

8 String reference

The examples below were made by the program. The values are from the simulation and will be different when you run it; the layout is exactly what is sent.

8.1 GNSS

String	Talker	Contains
GGA	GP	Time, latitude, longitude, fix quality, satellites, HDOP, antenna height, geoid separation, and age / station of corrections (DGPS and RTK).
RMC	GP	Time, status (A valid, V invalid), position, speed and course over ground, date, magnetic variation, mode.
VTG	GP	Course over ground (true and magnetic) and speed in knots and km/h.
GLL	GP	Position, time, status, mode.
ZDA	GP	UTC time and date.
GST	GP	Position error statistics (based on the Position noise setting).

```
$GPGGA,143201.23,5708.610000,N,00204.320000,W,1,14,0.8,25.31,M,50.00,M,,*4D
$GPRMC,143201.23,A,5708.610000,N,00204.320000,W,4.01,44.98,151026,1.5,W,A*0A
$GPVTG,44.98,T,46.48,M,4.01,N,7.43,K,A*29
$GPGLL,5708.610000,N,00204.320000,W,143201.23,A,A*75
$GPZDA,143201.23,15,10,2026,00,00*61
$GPGST,143201.23,0.028,0.024,0.020,45.0,0.020,0.020,0.032*6D
```

8.2 Heading

String	Talker	Contains
HDT	HE	True heading.
THS	HE	True heading and status.
HDG	HC	Magnetic heading with deviation and variation.
ROT	HE	Rate of turn in degrees per minute (negative = turning to port).

```
$HEHDT,45.02,T*2C
$HETHS,45.02,A*2E
$HCHDG,46.0,0.5,E,1.5,W*63
$HEROT,-0.1,A*07
```

8.3 Motion

String	Contains
TSS1 (standard)	The standard TSS1 layout used by motion sensors: accelerations in hex, then heave in cm, a status letter, roll and pitch in 0.01° units (so -0144 means -1.44°). Use this for software expecting TSS1.
TSS1 (decimal)	The same layout with heave in metres and roll and pitch in degrees. This is not the TSS1 standard; only use it with software set up to read decimal values.
EM3000	EM3000 binary attitude: 10 bytes, no line ending (see below).
$PSXN,23	Attitude: roll, pitch, heading (degrees), heave (metres, positive down).
$PSXN,20	Attitude quality flags (0 = normal, 2 = invalid).
$PASHR	Time, heading, roll, pitch, heave and accuracy values.

```
:01FF20  0035F-0144  0112
:01FF20 +0.35 F -1.44 +1.12
$PSXN,23,-1.44,1.12,45.02,-0.35*0E
$PSXN,20,0,0,0,0*3B
$PASHR,143201.23,45.02,T,-1.44,1.12,0.35,0.010,0.010,0.020,1,1*3D
```

EM3000 binary. Each packet is 10 bytes, values low byte first: status (00 = normal), sync byte 90 hex, roll and pitch in 0.01° units (positive = port up / bow up), heave in cm (positive up) and heading in 0.01° units. No line ending is added. Example, shown in hex:

```
00 90 70 FF 70 00 23 00 96 11
```

> **Note**
> EM3000 is normally sent 50 to 100 times a second. Give it an Output tab of its own (most software expects only binary data on the port) and use 9600 baud or faster.

8.4 Depth & water

String	Talker	Contains
DBT	SD	Depth below the transducer in feet, metres and fathoms.
DPT	SD	Depth, transducer offset (from the Transducer offset setting) and maximum range.
MTW	YX	Water temperature.

```
$SDDBT,279.6,f,85.21,M,46.6,F*36
$SDDPT,85.21,-4.50,200.0*45
$YXMTW,9.5,C*2E
```

8.5 Speed

String	Talker	Contains
VBW	VD	Speed through the water and over the ground (along and across the vessel).
VHW	VW	Heading and speed through the water (speed minus the current setting).

```
$VDVBW,3.71,0.00,A,4.01,0.00,A*51
$VWVHW,45.0,T,46.0,M,3.71,N,6.87,K*5B
```

8.6 ROV: gyro & attitude

The ROV's HDT, THS, ROT, TSS1 (standard or decimal) and $PSXN,23 are laid out exactly as the vessel's (sections 8.2 and 8.3) but carry the ROV's heading, roll and pitch.

```
$HEHDT,45.31,T*2C
$HEROT,-0.1,A*07
:000000  0000F 0062 -0185
$PSXN,23,0.62,-1.85,45.31,-0.00*03
```

8.7 ROV: position

String	Talker	Contains
GGA	GP	The ROV's latitude and longitude. The height field holds minus the ROV depth, as USBL systems usually send it.
GLL	GP	The ROV's latitude and longitude.

String	Talker	Contains
$PTNL,PJK	—	Grid position: time, date, northing, N, easting, E, quality, satellites, DOP and height (minus the ROV depth), in metres on the UTM zone shown on the ROV tab.

```
$GPGGA,143201.23,5708.596666,N,00204.330512,W,1,14,0.8,-79.80,M,50.00,M,,*6F
$GPGLL,5708.596666,N,00204.330512,W,143201.23,A,A*79
$PTNL,PJK,143201.23,101526,+6333717.007,N,+556145.595,E,1,14,0.8,EHT-79.800,M*78
```

Tip

If your navigation system expects easting and northing in a different layout, build it with a Custom string (section 9), for example ROV,{rov_easting:.2f},{rov_northing:.2f}.

8.8 ROV: Doppler (DVL) & altitude

String	Talker	Contains
PD6	—	A common DVL text output, sent as a block of lines (below).
VBW	VD	Bottom-track speed along (+ forward) and across (+ starboard) the ROV, in knots. The status is V while bottom lock is lost.
DBT	SD	The ROV's altitude above the seabed, sent as DBT as many altimeters do.

A PD6 block, with one line each for: attitude (:SA); time, salinity, temperature, depth and speed of sound (:TS); water track (:WI :WS :WE :WD, sent as invalid as when tracking the seabed); bottom-track velocity in mm/s in instrument (:BI), ROV (:BS) and earth (:BE) axes; and distance made good east, north and up, altitude and time since the last good reading (:BD). Each line gets the chosen line ending.

```
:SA, -1.85, +0.62, 45.31
:TS,26101514320123,35.0, +6.5,  79.8,1500.0,  0
:WI,-32768,-32768,-32768,-32768,V
:WS,-32768,-32768,-32768,V
:WE,-32768,-32768,-32768,V
:WD,        +0.00,        +0.00,        +0.00,  0.00,  0.00
:BI,    -8, +2062,   +12,    +1,A
:BS,    -8, +2062,   +12,A
:BE, +1459, +1458,   +12,A
:BD,      +123.45,      +123.40,        +0.20,   9.92,  0.00
```

While bottom lock is lost, the :BI, :BS and :BE velocities are sent as -32768 with status V and the last value of :BD counts the seconds since lock was lost.

```
$VDVBW,4.01,-0.02,A,4.01,-0.02,A*51
$SDDBT,32.5,f,9.92,M,5.4,F*01
```

9 Custom strings

The **Custom string** row (at the bottom of the list) sends a string you design yourself, using values from the simulation. Type the layout in the **Template** box, putting each value's name in curly brackets:

```
$XXDEP,{time},{depth:.2f},M
```

This sends, for example:

```
$XXDEP,143201.23,85.21,M*3A
```

Tick **Add NMEA checksum** to have the checksum worked out and added to strings that start with $ (it isn't added if your template already contains a *).

Name	Value
{time} {date}	UTC time (hhmmss.ss) and date (ddmmyy)
{lat} {lon}	Vessel latitude and longitude in decimal degrees
{lat_nmea} {lon_nmea}	Vessel position in NMEA form, e.g. 5708.610000,N
{easting} {northing}	Vessel UTM easting and northing (m)
{heading} {speed} {cog} {rot}	Heading, speed (knots), course over ground, rate of turn
{roll} {pitch} {heave}	Vessel roll and pitch (°) and heave (m)
{depth} {temp} {alt}	Water depth, water temperature, antenna height
{count}	How many times this string has been sent
{rov_easting} {rov_northing}	ROV UTM easting and northing (m)
{rov_lat} {rov_lon}	ROV latitude and longitude in decimal degrees
{rov_depth} {rov_altitude}	ROV depth and altitude above the seabed (m)
{rov_heading} {rov_roll} {rov_pitch}	ROV heading, roll and pitch (°)

Numbers can be given a fixed number of decimal places: {depth:.2f} gives two, {heading:.1f} one. Text outside the curly brackets is sent exactly as typed. If a template can't be understood, the string sent says TEMPLATE ERROR.

```
ROV,143201.23,556145.59,6333717.01,79.8,45.3
```

10 Fault injection

Fault injection deliberately spoils some of the strings, to test how the receiving software copes. Each Output tab has its own settings, which can be changed while sending.

Setting	What it does
Bad checksum	This percentage of NMEA strings are sent with a wrong checksum.
Dropped strings	This percentage of strings are not sent at all.
Corrupted character	This percentage of strings have one character replaced with a random symbol (or, for binary strings, one byte replaced with a random value).
Freeze values	Every string keeps sending the same values (including the time), as a sensor that has stopped updating would. Untick to carry on.

Other faults can be simulated from the Vessel and ROV tabs, for example setting the fix quality to No fix, or unticking the ROV's Bottom lock.

11 Projects

A project stores the whole set-up so you can close the program and pick up where you left off, or keep different set-ups for different jobs.

Command	Shortcut	What it does
New project	Ctrl+N	Starts afresh with default vessel, ROV and multibeam settings and one Output tab.
Open project...	Ctrl+O	Opens a saved project, replacing the current set-up.
Open recent		Lists the last 8 projects you saved or opened.
Save project	Ctrl+S	Saves to the current project file. The first time, it asks for a file name.
Save project as...	Ctrl+Shift+S	Saves to a new file name.
Exit		Closes the program.

Project files have the extension **.stringgen**, the same as before the program was renamed. They are plain text, so they can be copied to another PC or e-mailed like any other file.

- **Saved:** all Vessel, ROV and Multibeam settings; every Output tab with its name, destination, ticked strings, talker IDs, rates, custom template and fault settings; the window size and which tab was showing.
- **Not saved:** whether outputs or the multibeam were running, and the coverage map. After opening a project, press START on the outputs you need.
- If a saved COM port isn't plugged in when you open the project, its name is kept; plug in the adapter and press Refresh if needed.
- If you have unsaved changes when you start a new project, open another one or close the program, you are asked whether to save them first.

12 Testing with String Format Manager

The Survey Simulator and String Format Manager (formerly The Stringinator) are designed to work together: The Survey Simulator plays the part of the survey equipment and String Format Manager receives, displays, converts and logs the data.

12.1 On one PC, using UDP

1. In The Survey Simulator, Output 1 sends to 127.0.0.1 port 5000 by default. Tick the strings you want and press **START**.
2. In String Format Manager, set an input's **Source** to UDP, port 5000, and press **Connect**.
3. Use String Format Manager's line filter to pick each string, for example a Viewer input with **Starts with** $GPGGA and **Field #** 3-6 for the position, and another with $HEHDT and field 2 for the heading.
4. Compare the values with The Survey Simulator's live readouts.

12.2 Using serial ports

Connect two COM ports with a null-modem cable (or use virtual serial port pair software), send from one port in The Survey Simulator and connect String Format Manager to the other, with the same baud rate and line settings on both.

12.3 EM3000 binary

Tick EM3000 in an Output tab of its own, and set String Format Manager's input **Format** to **EM3000 binary**. String Format Manager decodes the packets to text; roll, pitch, heave and heading are fields 3 to 6 with a comma separator.

13 Trial and licence

The program runs as a free 48-hour trial with everything working. The bar under the title shows how long is left:

The trial bar.

After that it needs a Survey Software Utilities licence key: click **Enter licence key…**, paste the key from the email and click **Activate**. One key unlocks every Survey Software Utilities program 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.

> **Note**
> If you already had a licence or trial for The Stringinator Generator, it carries over to The Survey Simulator.

14 Troubleshooting

Problem	What to check
Serial port error when pressing START	The port is used by another program or another Output tab, the adapter has been unplugged or the COM number has changed. Press Refresh and check Windows Device Manager.
“Port in use” message	Another Output tab is already sending to that COM port. Stop it there, or choose a different port.
The receiving equipment gets nothing	Check the right strings are ticked, the status line says RUNNING, the baud rate and line settings match the equipment, and the cable (a null-modem cable may be needed).
Garbled characters at the receiver	The baud rate, data bits, parity or stop bits don't match.
Strings arrive late or the rate is lower than set	Too much data for the baud rate. Raise the baud rate, lower the rates, or spread the strings over more Output tabs (see the appendix).
Nothing arrives over UDP	Check the IP address and port match the receiving program, and that Windows Firewall allows Data-Test-Centre.exe.
Strings show TEMPLATE ERROR	The custom template has a mistake, such as an unmatched { or a number format on a text value.
Values never change	Freeze values is ticked, or (for depth and motion) the amplitude or variation is 0.
The acquisition software gets no multibeam data	Check Start pinging has been pressed, Send BTH0 packets is ticked, the address and Base port match the software, and Windows Firewall allows the program.
The multibeam seabed looks tilted or wavy in the acquisition software	The motion strings aren't reaching it, or the roll, pitch or heave conventions or the offsets don't match the Multibeam tab's Mounting settings.
Gaps across the coverage map	The vessel or ROV is moving too far between pings. Slow it down or raise the Max ping rate.
Position or heading jumps	The vessel or ROV was put back to its start (Back to start), or a new project was opened.

Appendix: quick reference

How much fits down a serial line

Each character takes about 10 bits (8 data bits plus start and stop bits), so a serial line carries about one tenth of its baud rate in characters per second. Add up each string's length (including the line ending) times its rate, and keep well below the line's capacity.

Baud	Characters per second	For example
4800	480	GGA + RMC + VTG at 1 Hz (about 230 a second)
9600	960	the above plus HDT at 10 Hz (about 420 a second)
19200	1,920	EM3000 at 100 Hz (1,000 bytes a second)
38400	3,840	TSS1 at 100 Hz (about 2,700 a second)
115200	11,520	Many strings at high rates

Default talker IDs and rates

String	Talker	Rate (Hz)	String	Talker	Rate (Hz)
GGA	GP	1	DPT	SD	2
RMC	GP	1	MTW	YX	1
VTG	GP	1	VBW	VD	2
GLL	GP	1	VHW	VW	2
ZDA	GP	1	HDT (ROV)	HE	10
GST	GP	1	THS (ROV)	HE	10
HDT	HE	10	ROT (ROV)	HE	5
THS	HE	10	TSS1 (ROV)	—	20
HDG	HC	5	TSS1 decimal (ROV)	—	20
ROT	HE	5	$PSXN,23 (ROV)	—	10
TSS1	—	20	GGA (ROV)	GP	1
TSS1 decimal	—	20	GLL (ROV)	GP	1
EM3000	—	50	$PTNL,PJK (ROV)	—	1
$PSXN,23	—	20	PD6 (ROV)	—	5
$PSXN,20	—	1	VBW (ROV)	VD	5
$PASHR	—	10	DBT (ROV)	SD	5
DBT	SD	2			