THE SURVEY CALCULATOR

CONVERSIONS · GEODESY · OFFSHORE

User Manual

Positions, UTM, ranges and bearings, offsets, KP,
units, sound velocity, time and a calculator

Version 1.0

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1 Introduction

The Survey Calculator puts the everyday sums and conversions of offshore survey in one place: positions in any format, UTM, ranges and bearings, vessel offsets, KP and DCC, units, sound velocity, depth from pressure, layback, GPS time and a calculator.

There are no Calculate buttons. Every result is worked out again as you type, and every result has a **Copy** button that puts it on the clipboard, ready to paste into another program. Everything you type is remembered for the next time you open the program.

Tab	What it is for
Position	Type or paste a latitude and longitude in any format. The format is detected and the position is shown in every format and in UTM. UTM back to latitude and longitude.
Range & Bearing	Range, bearing and ΔE / ΔN / ΔZ between two grid points; a point from a range and bearing; distance and bearings between two latitudes and longitudes; a position from a bearing and distance.
Offsets & KP	Vessel offsets to grid positions and back; KP and DCC along a route line and back.
Units	Speed (with the Beaufort scale), distance, pressure, angle, volume, mass and temperature.
Ocean	Sound velocity, depth from pressure and back, towfish layback, acoustic travel time and range.
Time	GPS week and seconds to UTC and back, and day of year.
Calculator	A calculator with trigonometry in degrees and a history.

> **Note**
> All positions use the WGS84 datum and UTM projection. If your survey uses another datum (ED50, OSGB36, ETRS89 grids and so on), transform the coordinates in your survey software first, as the difference can be 100 m or more.

2 Getting started

2.1 What you need

- A Windows PC.
- The program file, **SurveyCalculator.exe**. Nothing else needs to be installed.

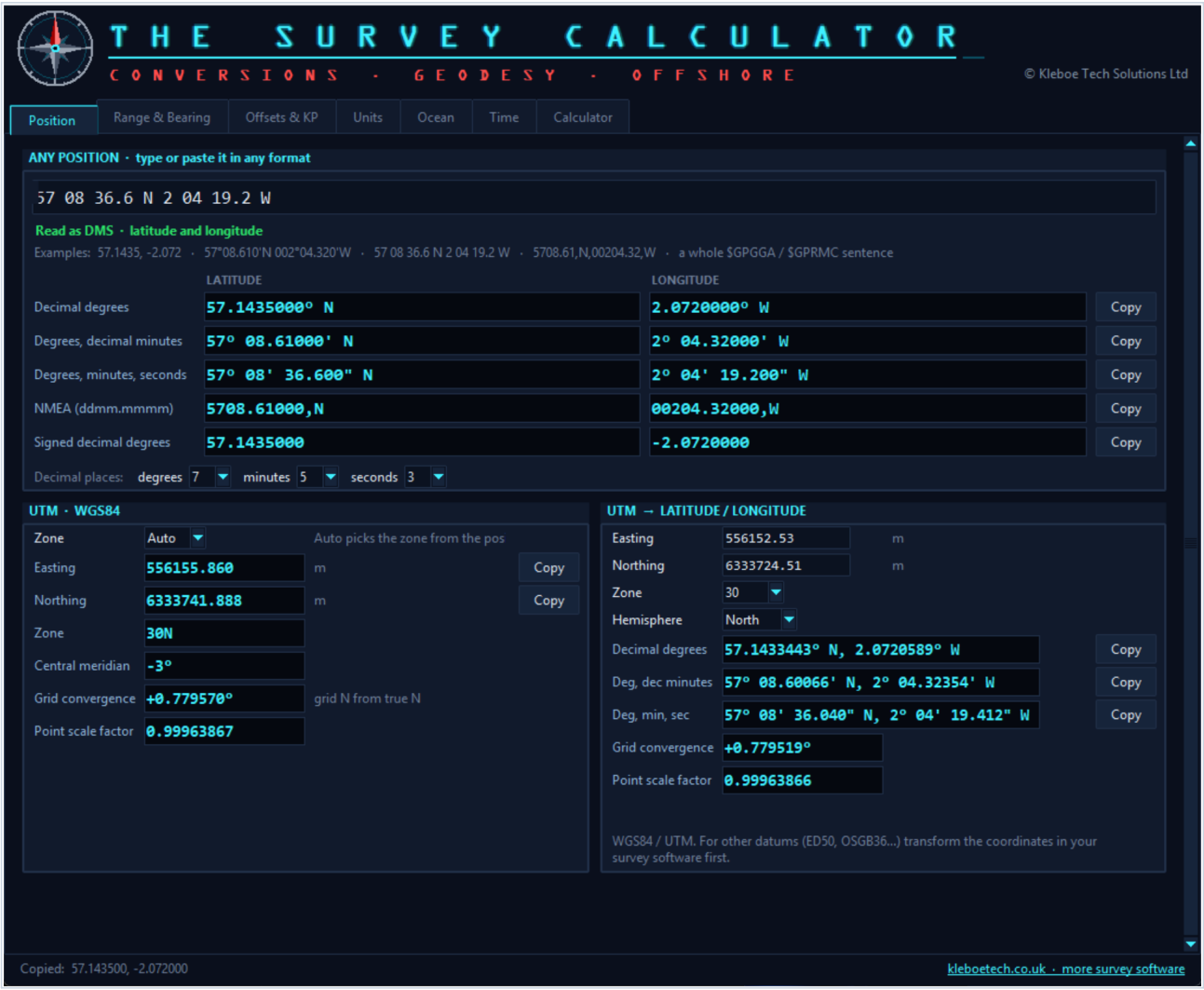
2.2 Installing and starting

Copy **SurveyCalculator.exe** into a folder of your choice and double-click it. There is no installer. A loading screen shows for three seconds while the program opens; click it to skip.

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

> **Note**
> The first time you start the program, Windows may show a **Windows protected your PC** message. Click **More info**, then **Run anyway**.

2.3 The main window



The Survey Calculator, showing the Position tab.

- **Title banner** across the top, with the compass rose.
- **Tabs** for each set of calculations. The program opens on the tab you used last.
- **Input boxes** are where you type. **Result boxes** (cyan text, darker background) can't be typed in, but you can select and copy from them.
- A **red message** under a panel says what is missing or wrong, for example a minute value over 60.
- The **status line** at the bottom confirms what was copied. The right-hand link opens hydrosurveylabs.com for more survey software.

2.4 Typing numbers

- Use a full stop for decimals: 556152.53.
- Bearings and headings can be decimal degrees (45.5) or degrees, minutes and seconds separated by spaces (45 30 00).
- Boxes marked *optional* can be left empty.

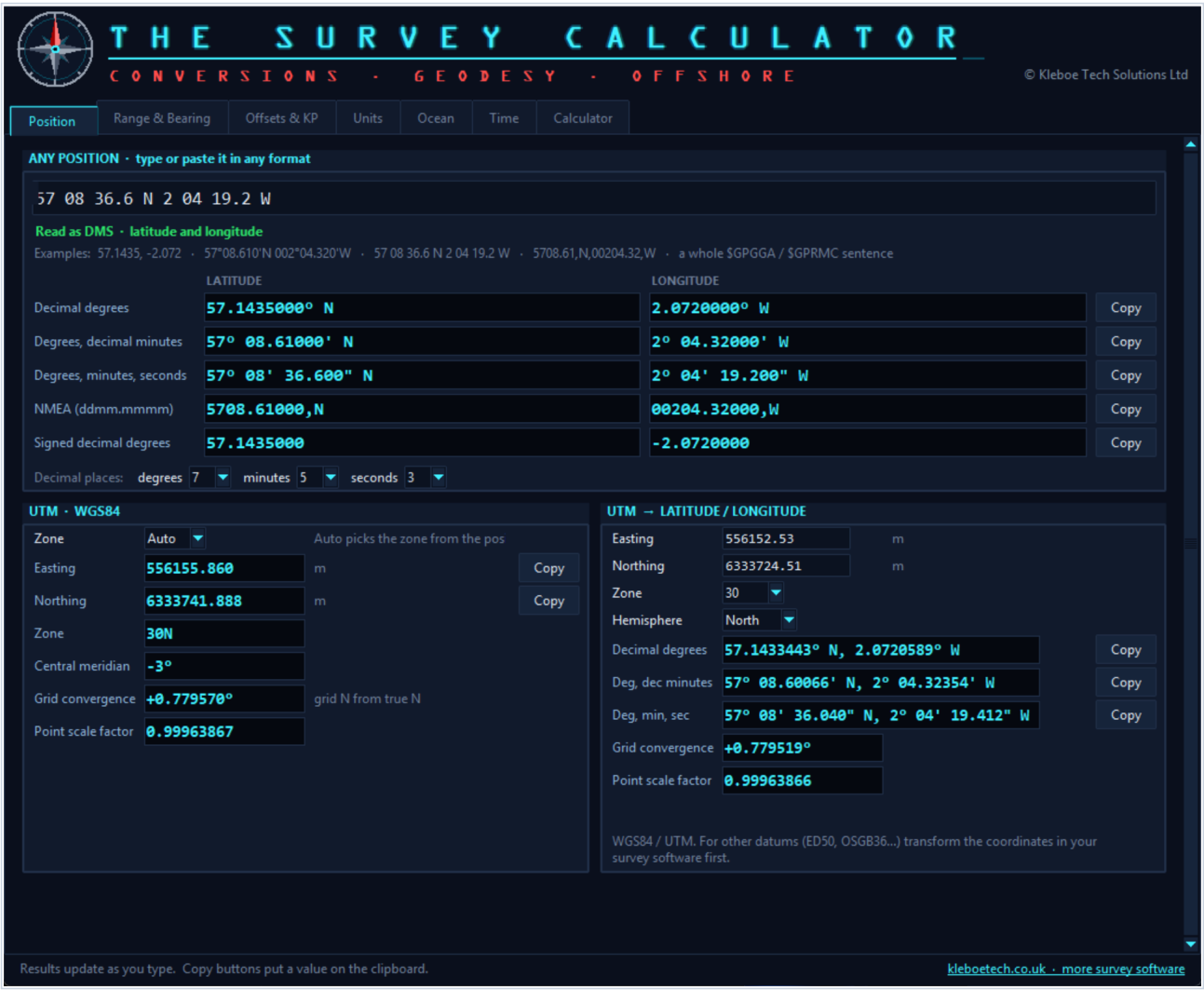
2.5 Closing

When you close the program, everything you typed is saved and HydroSurveyLabs.com is shown for five seconds before it fades away. Click it to close straight away.

The closing screen.

3 Position

Type or paste a position into the box at the top of the Position tab. The line under the box says how it was read, and the table shows the position in every format.



A position typed in degrees, minutes and seconds, shown in every format and in UTM.

3.1 Formats it understands

Format	Examples
Decimal degrees	57.1435, -2.072 · 57.1435N 2.072W · N57.1435 W2.072
Degrees, decimal minutes	57 08.610 N, 2 04.320 W · 57°08.610'N 002°04.320'W
Degrees, minutes, seconds	57 08 36.6 N 2 04 19.2 W · 57°08'36.6"N 2°04'19.2"W
NMEA (ddmm.mmmm)	5708.6100,N,00204.3200,W · 5708.61 N 00204.32 W
NMEA sentence	a whole $GPGGA, $GPRMC, $GPGLL or $GPGNS line, pasted from a log
One coordinate	57 08.61 N · -2 04.32 · 5708.61 · 570836.6

3.2 How a position is read

- A comma (or semicolon, slash or tab) separates the latitude from the longitude.
- Without a comma, the N / S / E / W letters are used to split them. The letters can be before or after the numbers.
- Without commas or letters, the count of numbers decides: two numbers are a decimal pair, four are degrees and minutes, six are degrees, minutes and seconds.
- Within one coordinate, 1 number is decimal degrees, 2 are degrees and decimal minutes and 3 are degrees, minutes and seconds.
- S and W, or a minus sign, make a coordinate negative.
- A number too big to be degrees is read as NMEA packed degrees: 5708.61 is 57° 08.61', and 570836.6 is 57° 08' 36.6".
- If there are no letters, the first coordinate is taken as the latitude, unless it is over 90°, when the two are swapped (and a note says so).
- Symbols such as ° ' " and d / m are ignored, so most copied text works as it is.
- If there are no full stops at all, commas between digits are read as decimal points (57°08,610'N).

> **Tip**
> If two numbers could be either a decimal pair or one coordinate in degrees and minutes (for example 57 08.61), they are read as one coordinate and a note says so. Put a comma between a latitude and longitude to make it clear.

Minutes and seconds must be less than 60, and latitudes can't be over 90°; anything that can't be read gives a red message saying why.

3.3 The results

Each row has a **Copy** button that copies the latitude and longitude together. The **Decimal places** settings below the table choose how many places are shown:

Shown to	About	Shown to	About
0.00001° (5 places)	1 m	0.001' (3 places)	2 m
0.000001° (6 places)	0.1 m	0.0001' (4 places)	0.2 m
0.0000001° (7 places)	1 cm	0.00001' (5 places)	2 cm
0.1" (1 place)	3 m	0.001" (3 places)	3 cm

3.4 UTM

For a latitude and longitude, the UTM panel shows the easting and northing, the zone and its central meridian, the grid convergence and the point scale factor.

- **Zone: Auto** picks the zone from the position, including the special zones around Norway and Svalbard. Choose a zone number to force one, for example to keep a project that crosses a zone boundary in one zone. A note warns

when the position is outside the normal width of the chosen zone.

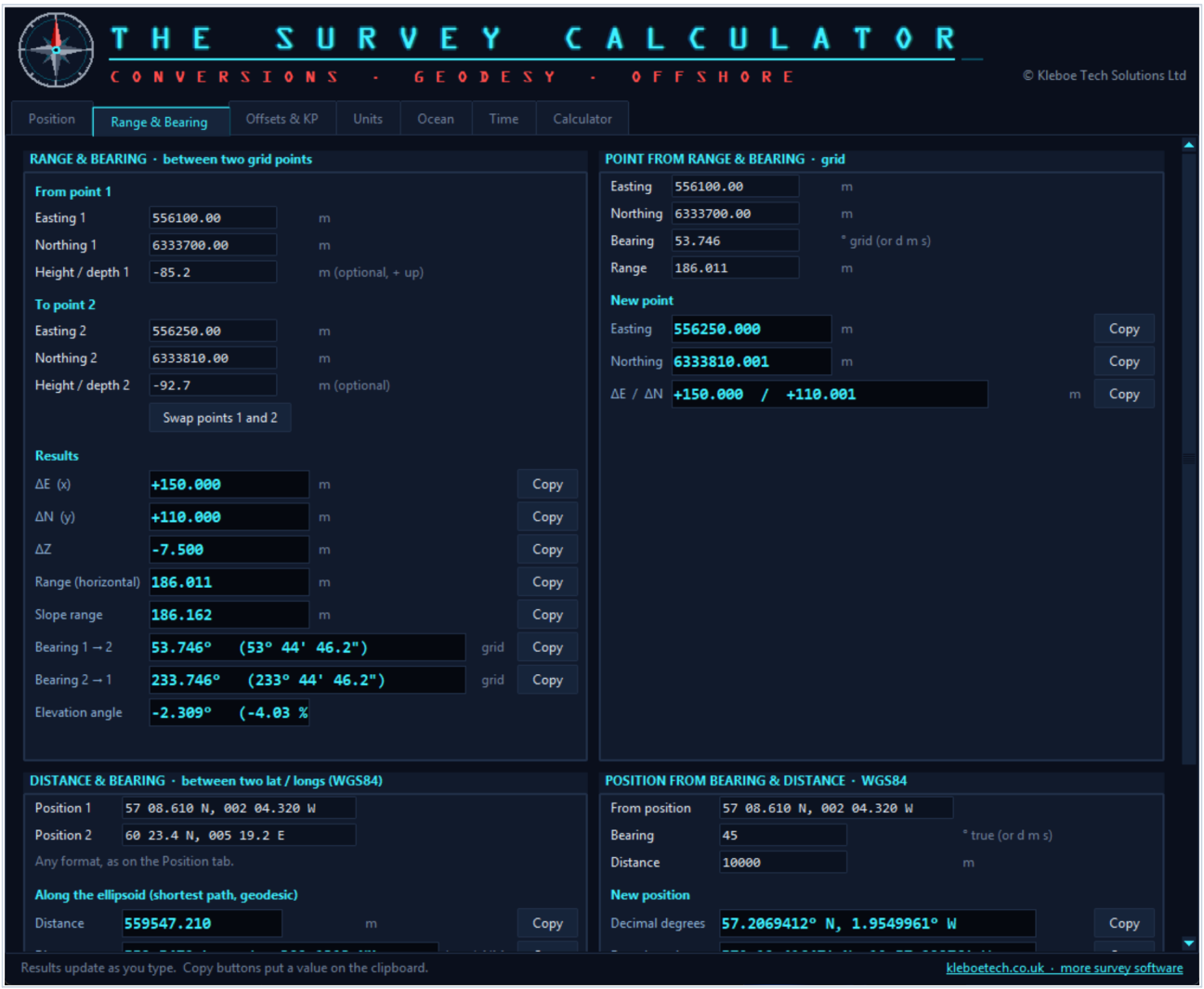
- **Grid convergence** (γ) is the angle between true north and grid north. Grid north is γ clockwise from true north; east of the central meridian in the northern hemisphere γ is positive.
- **Point scale factor** (k) is the ratio of a short grid distance to the same distance on the ellipsoid.

```
grid bearing = true bearing − γ
grid distance = ellipsoid distance × k
```

3.5 UTM to latitude and longitude

Enter an easting, northing, zone and hemisphere to get the latitude and longitude in decimal degrees, degrees and decimal minutes, and degrees, minutes and seconds, with the convergence and scale factor at that point.

4 Range & Bearing



Range and bearing between two grid points (with heights), a point from a range and bearing, and distances between latitudes and longitudes.

4.1 Between two grid points

Enter the easting and northing of two points. If you also enter both heights (positive up, so a depth is negative), the vertical difference, the slope range and the elevation angle are worked out too. **Swap points 1 and 2** exchanges them.

Result	Meaning
ΔE (x), ΔN (y)	Easting and northing of point 2 minus point 1
ΔZ	Height of point 2 minus point 1
Range (horizontal)	$\sqrt{(\Delta E^2 + \Delta N^2)}$
Slope range	$\sqrt{(\text{range}^2 + \Delta Z^2)}$
Bearing 1 → 2	Grid bearing from point 1 to point 2, in degrees and in d m s
Bearing 2 → 1	The reverse bearing (± 180°)
Elevation angle	The angle above (+) or below (–) horizontal, and the gradient in %

4.2 Point from range & bearing

Enter a start point, a grid bearing and a horizontal range to get the easting and northing of the new point, and its ΔE and ΔN from the start.

4.3 Between two latitudes and longitudes

Type each position in any format, as on the Position tab. Two results are given:

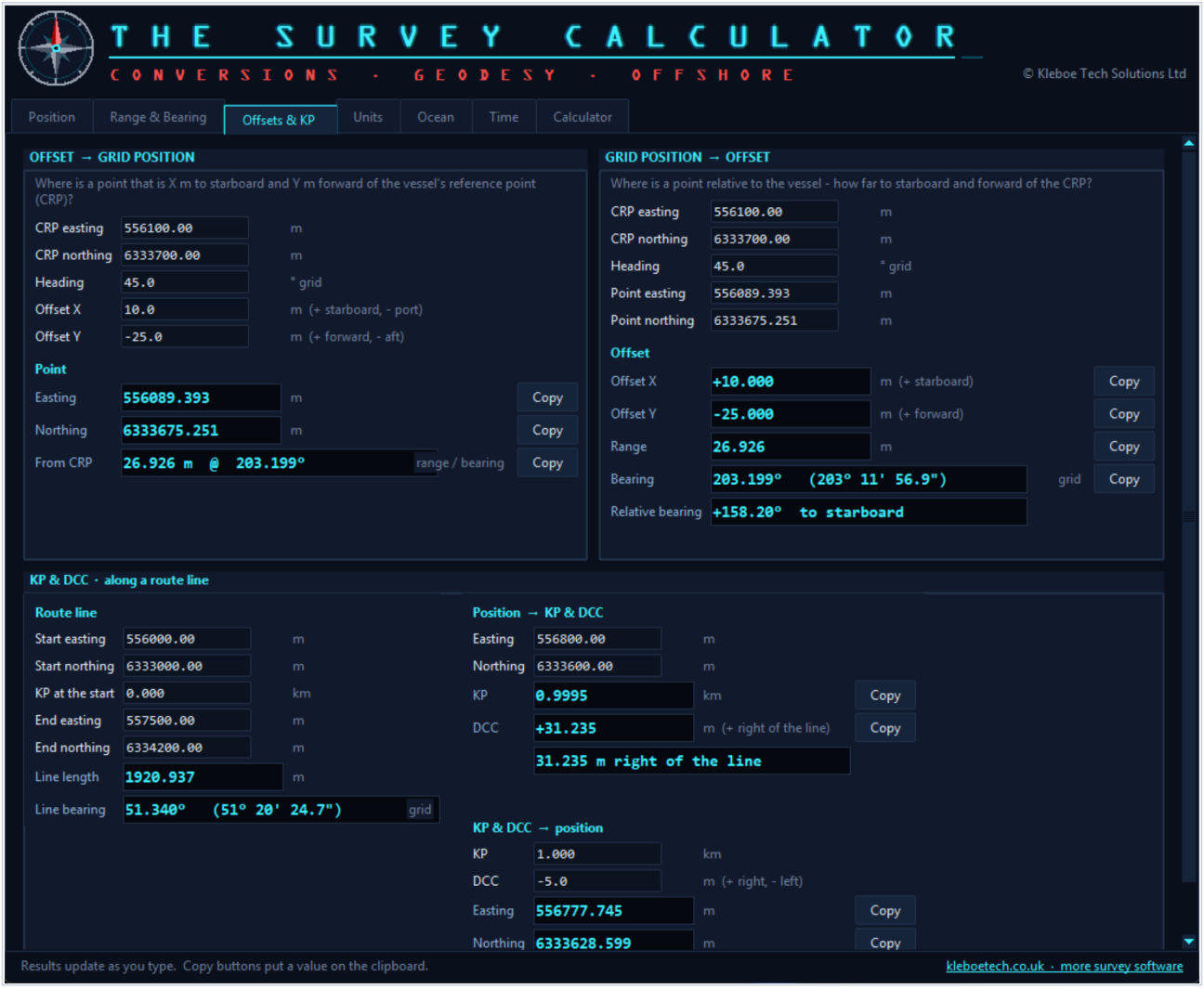
- **Along the ellipsoid**: the shortest distance over the WGS84 ellipsoid (a geodesic, worked out with Vincenty's formulae, to millimetres), with the true bearing at the start and at the end. On a long line the two bearings differ because the shortest path curves.
- **Rhumb line**: the distance and the single true bearing of a line that crosses every meridian at the same angle, the line a vessel steering a constant course follows. It is a little longer than the geodesic.

4.4 Position from bearing & distance

Enter a start position, a true bearing and a distance along the ellipsoid to get the new position, and the bearing at the far end.

> **Note**
> Grid bearings (from eastings and northings) and true bearings (from latitudes and longitudes) differ by the grid convergence. See section 3.4.

5 Offsets & KP



Vessel offsets to grid and back, and KP and DCC along a route line.

5.1 Offset to grid position

Where is a point that is a known distance to starboard and forward of the vessel's reference point (CRP)? Enter the CRP's easting and northing, the vessel's grid heading and the offsets:

- **Offset X**: + to starboard, – to port.
- **Offset Y**: + forward, – aft.

```
E = E0 + X cos H + Y sin H
N = N0 – X sin H + Y cos H
```

The result also shows the range and grid bearing of the point from the CRP.

5.2 Grid position to offset

The reverse: enter the CRP, the heading and the point's easting and northing to get its X and Y offsets, the range and bearing from the CRP and the relative bearing (the angle off the bow, + to starboard, – to port).

> **Tip**
> Use this to check a dimensional-control survey, or to find where an ROV or a target is relative to the vessel.

5.3 KP and DCC

Enter a route line's start and end eastings and northings and the KP at its start (in km). For any position you get:

- **KP**: the distance along the line from its start, in km, plus the start KP.
- **DCC** (distance cross course): the distance off the line in metres, + to the right and – to the left, looking along the line in the direction of increasing KP.
- A note if the point is before the start or past the end of the line.

The panel also shows the line's length and grid bearing.

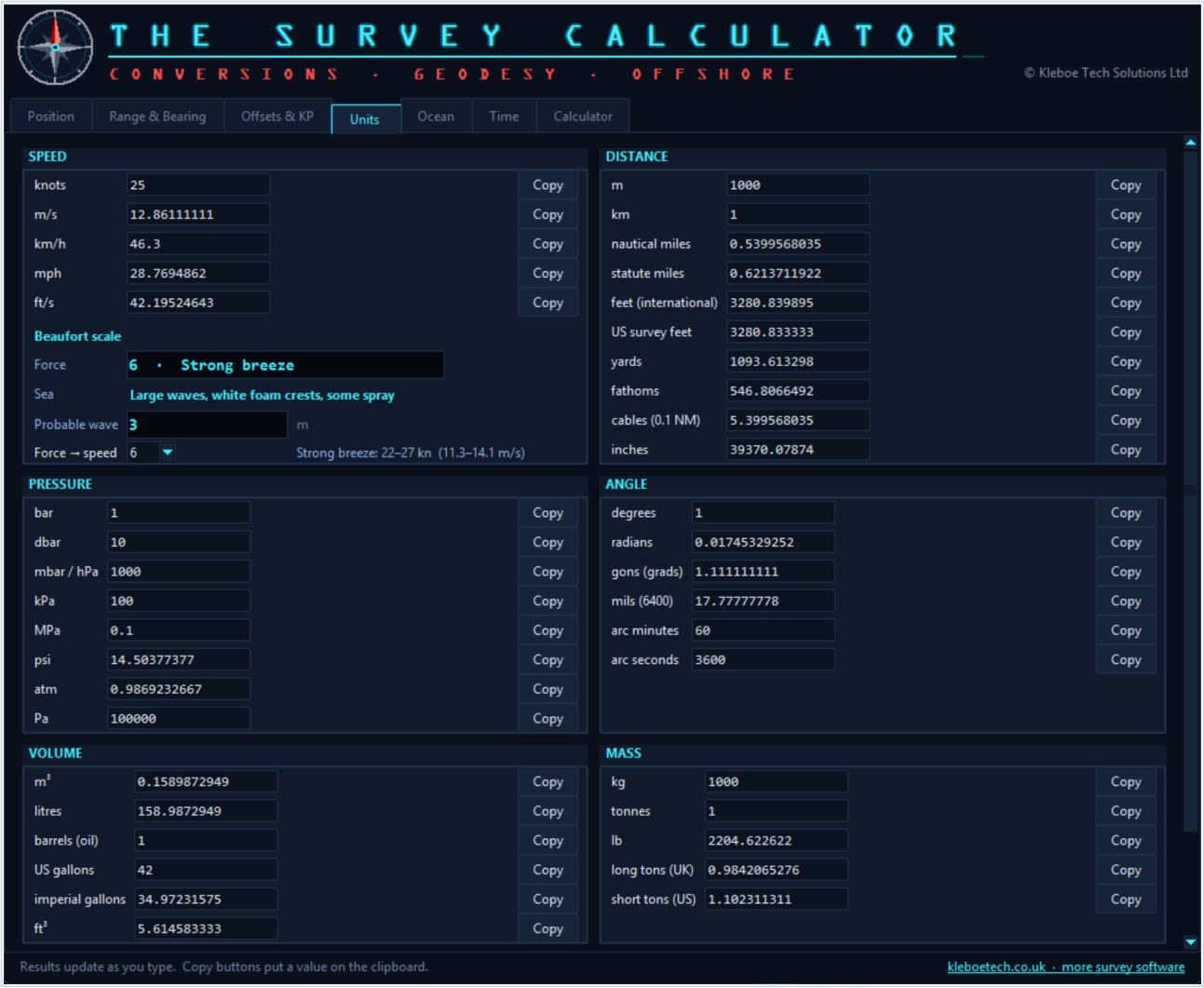
5.4 KP and DCC to position

Enter a KP and DCC to get the easting and northing of that point, using the same route line.

> **Note**
> The KP panels use one straight line. For a route with bends, enter the start and end of the straight section the point is on, with that section's start KP.

6 Units

Type a value in any box of a panel and all the other boxes in that panel convert straight away. Each box has its own **Copy** button.



Unit conversions. Typing 25 knots shows Beaufort force 6.

Panel	Units
Speed	knots, m/s, km/h, mph, ft/s
Distance	m, km, nautical miles (1852 m), statute miles, international feet (0.3048 m), US survey feet (1200/3937 m), yards, fathoms (1.8288 m), cables (185.2 m), inches
Pressure	bar, dbar, mbar / hPa, kPa, MPa, psi, atm, Pa
Angle	degrees, radians, gons (400 to a circle), mils (6400), arc minutes, arc seconds
Volume	m³, litres, oil barrels (158.987 l), US gallons, imperial gallons, ft³
Mass	kg, tonnes, lb, long tons (UK), short tons (US)
Temperature	°C, °F, K

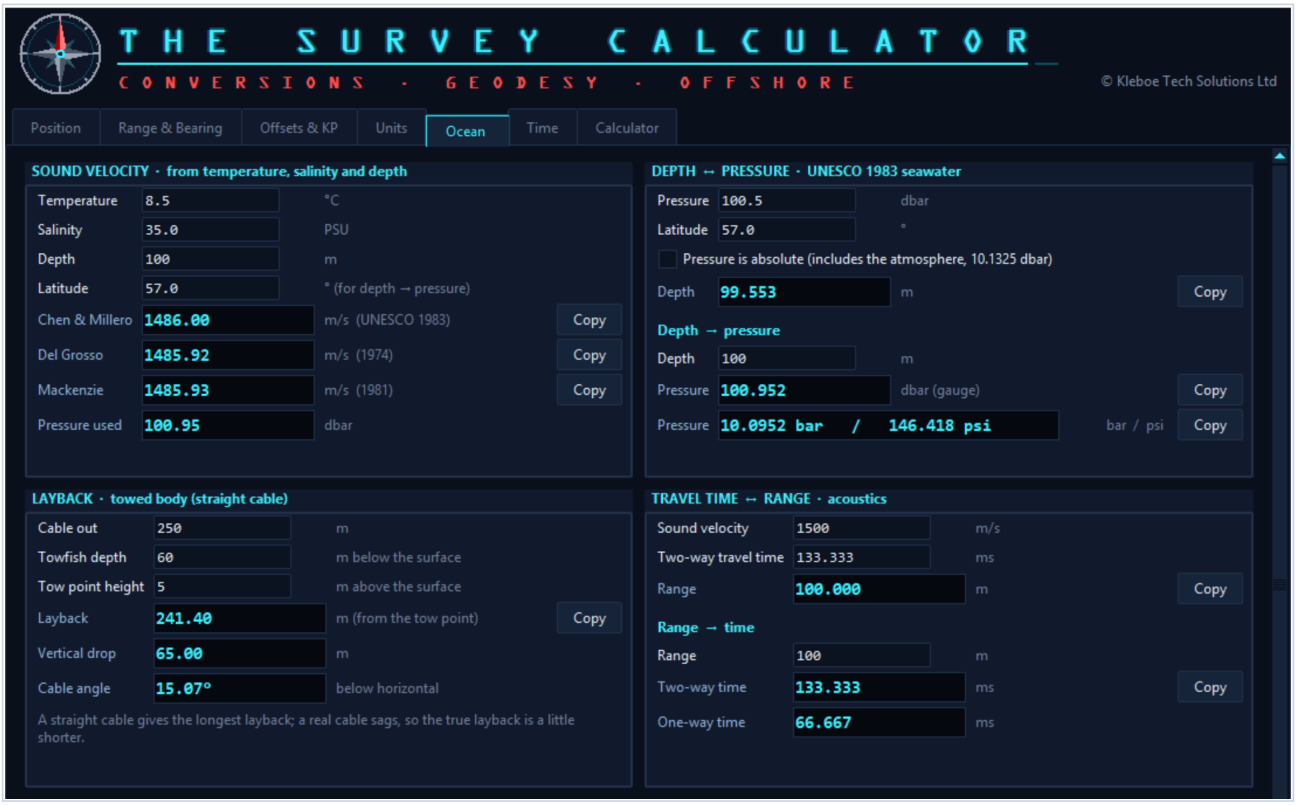
6.1 Beaufort scale

The Speed panel shows the Beaufort force, its name, the sea it raises and the probable wave height for the wind speed typed. **Force → speed** shows the range of wind speeds for any force.

Force	Name	Knots	Sea	Wave (m)
0	Calm	under 1	Sea like a mirror	0
1	Light air	1–3	Ripples, no foam crests	0.1
2	Light breeze	4–6	Small wavelets, crests glassy	0.2

Force	Name	Knots	Sea	Wave (m)
3	Gentle breeze	7–10	Large wavelets, crests begin to break	0.6
4	Moderate breeze	11–16	Small waves, frequent white horses	1
5	Fresh breeze	17–21	Moderate longer waves, many white horses	2
6	Strong breeze	22–27	Large waves, white foam crests, some spray	3
7	Near gale	28–33	Sea heaps up, foam blown in streaks	4
8	Gale	34–40	Moderately high waves, crests break into spindrift	5.5
9	Strong gale	41–47	High waves, dense foam, spray affects visibility	7
10	Storm	48–55	Very high waves, sea looks white	9
11	Violent storm	56–63	Exceptionally high waves	11.5
12	Hurricane	64 +	Air full of foam and spray, sea completely white	14 +

7 Ocean



Sound velocity, depth and pressure, layback, and travel time.

7.1 Sound velocity

Enter the water temperature, salinity and depth (and the latitude, used to turn the depth into pressure). Three standard formulas are given side by side:

Formula	Notes
Chen & Millero (UNESCO 1983)	The international standard, used by most CTD and SV software. Uses pressure.
Del Grosso (1974)	Often preferred in deep water. Uses pressure.
Mackenzie (1981)	A simpler formula from depth. Agrees with the others to within a few tenths of a m/s in normal sea water.

A message warns when the temperature, salinity or depth is outside the range the formulas were made for.

7.2 Depth and pressure

Depth from pressure uses the UNESCO 1983 formula for sea water (Saunders and Fofonoff), which allows for the change of gravity with latitude and depth. Pressure from depth uses the same formula the other way round.

- Pressures are gauge pressures in dbar (0 at the sea surface), as from most CTDs and depth sensors.
- Tick **Pressure is absolute** if the reading includes the atmosphere; 10.1325 dbar is taken off before working out the depth.
- 1 dbar is very close to 1 m of sea water, but not exactly: at 1000 m the difference is about 10 m.

7.3 Layback

For a towed body (side-scan, magnetometer, sub-bottom towfish), enter the cable out, the towfish depth and the height of the tow point above the water. The layback is the horizontal distance from the tow point to the towfish:

```
vertical drop = towfish depth + tow point height
layback = √(cable² − drop²)
```

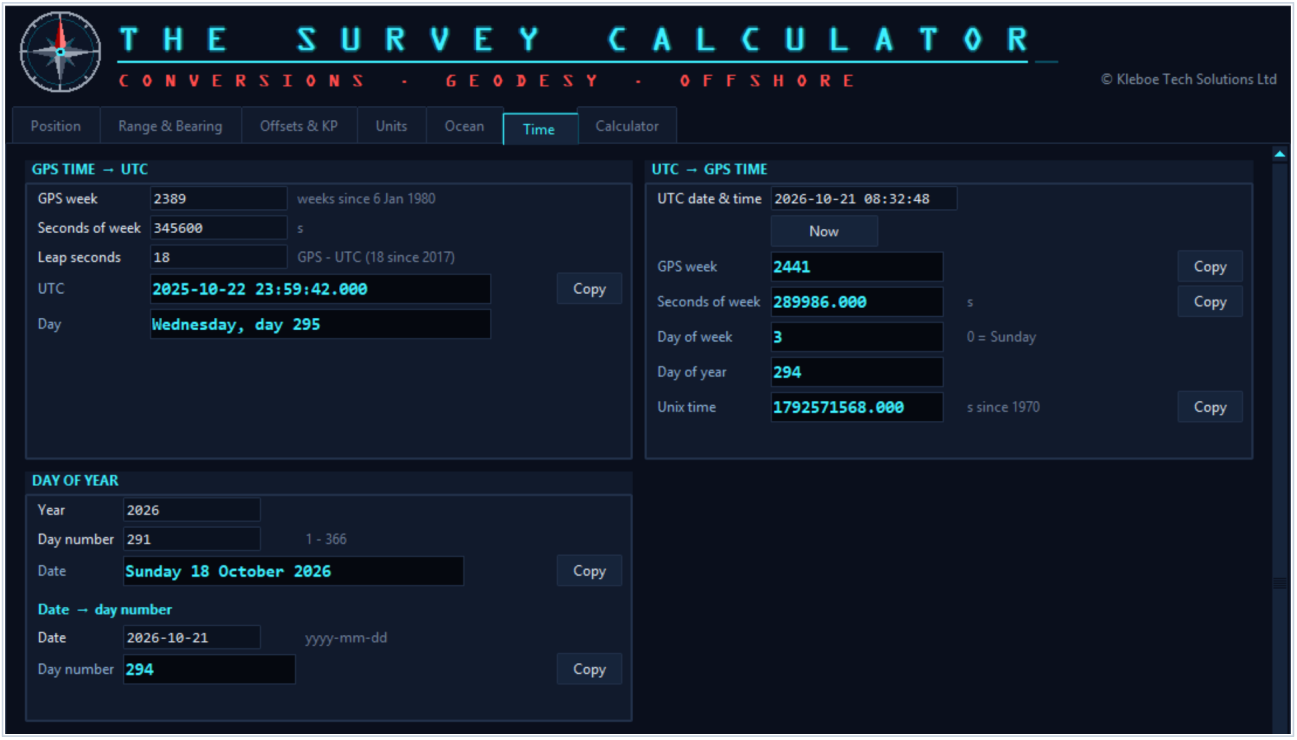
This assumes a straight cable, which gives the longest possible layback. A real cable sags, so the true layback is a little shorter; the cable angle is shown as a guide.

7.4 Travel time and range

```
range = two-way travel time × sound velocity ÷ 2
```

Enter the sound velocity and a two-way travel time in milliseconds to get the range, or a range to get the two-way and one-way times.

8 Time



GPS time, UTC and day of year.

8.1 GPS time and UTC

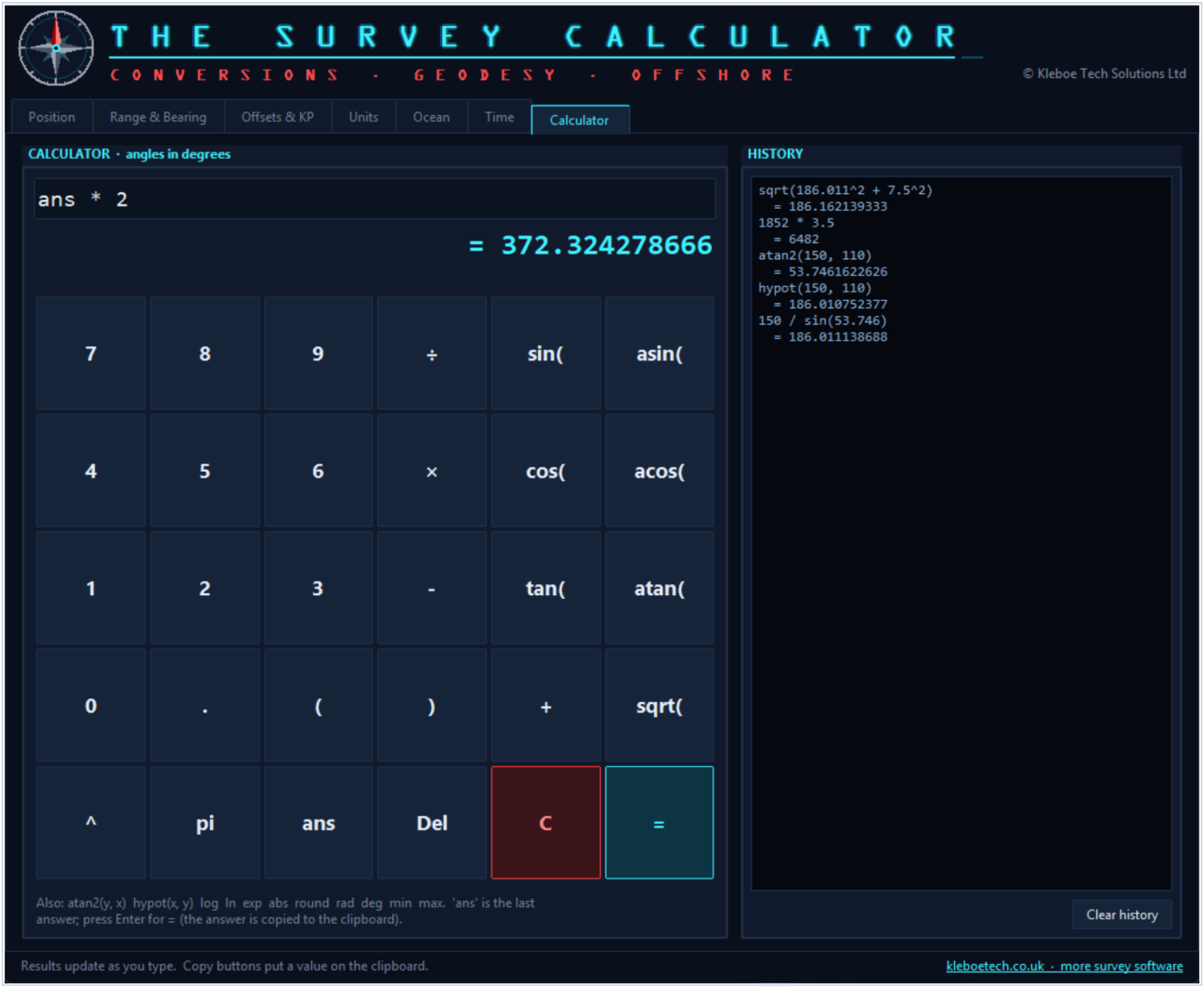
GPS receivers and many survey logs count time in GPS weeks since 6 January 1980 and seconds of the week (from midnight Saturday / Sunday). GPS time does not include leap seconds, so it is ahead of UTC.

- **GPS time** → **UTC**: enter the week and seconds of week to get the UTC date and time.
- **UTC** → **GPS time**: enter a UTC date and time (2026-10-18 14:30:00), or press **Now**, to get the GPS week, seconds of week, day of week (0 = Sunday), day of year and Unix time.
- **Leap seconds** is 18 (GPS – UTC since 1 January 2017). If a new leap second is announced, change this box.

8.2 Day of year

Turn a day number (1 to 366) into a date for any year, or a date into its day number, as used in many log file names and in GNSS data.

9 Calculator



The calculator, with the history of earlier sums.

Type a sum in the box, or use the keys, and press **Enter** or **=**. The answer is shown as you type, added to the history when you press Enter, and copied to the clipboard.

Type	To get
+ - * / ^ ( )	add, subtract, multiply, divide, power, brackets (× and ÷ work too)
sin cos tan	trigonometry, with angles in degrees
asin acos atan atan2(y, x)	inverse trigonometry, answers in degrees
sqrt hypot(x, y)	square root; $\sqrt{(x^2 + y^2)}$
log ln exp	log base 10, natural log, e to the power
abs round floor ceil min max	the usual meanings
rad(x) deg(x)	degrees to radians, radians to degrees
pi e	the constants
ans	the answer to the last sum

Tip

> atan2(ΔE, ΔN) gives a bearing from coordinate differences, for example atan2(150, 110) = 53.746°. Add 360 if the answer is negative.

10 Accuracy and checks

The calculations have been checked against published test values:

Check	Published	The Survey Calculator
Vincenty geodesic test line (Flinders Peak to Buninyong)	54 972.271 m	54 972.271 m
UNESCO sound speed, S 40, T 40 °C, 10 000 dbar	1731.995 m/s	1731.995 m/s
Mackenzie sound speed, T 25 °C, S 35, 1000 m	1550.744 m/s	1550.744 m/s
UNESCO depth, 10 000 dbar at 30°	9712.653 m	9712.653 m
UTM northing on the central meridian at 60° N	6 651 411.19 m	6 651 411.19 m

- UTM uses the Krüger series, accurate to better than a millimetre across the whole zone; UTM to latitude and longitude and back returns the same position.
- Geodesic distances are on the WGS84 ellipsoid, accurate to well under a millimetre. Points almost exactly opposite each other on the Earth can't be worked out and give a message.
- Grid ranges and bearings are plane (grid) values. Over long distances, ground distances differ by the scale factor.

11 Troubleshooting

Problem	What to check
A red message under a panel	It says what is missing or wrong. Fill in the boxes it names, or correct the value.
The position is read the wrong way round	Add N / S / E / W letters, or put the latitude first with a comma between them.
Two numbers are read as one coordinate	Put a comma between the latitude and longitude, or give both decimal points (57.1435, -2.072).
UTM looks a long way out	Check the datum: positions here are WGS84. Check the zone, and the hemisphere for UTM back to latitude and longitude.
Bearings differ from the survey software	Grid and true bearings differ by the grid convergence (section 3.4).
A comma decimal (1,5) isn't accepted	Use a full stop for decimals in number boxes.