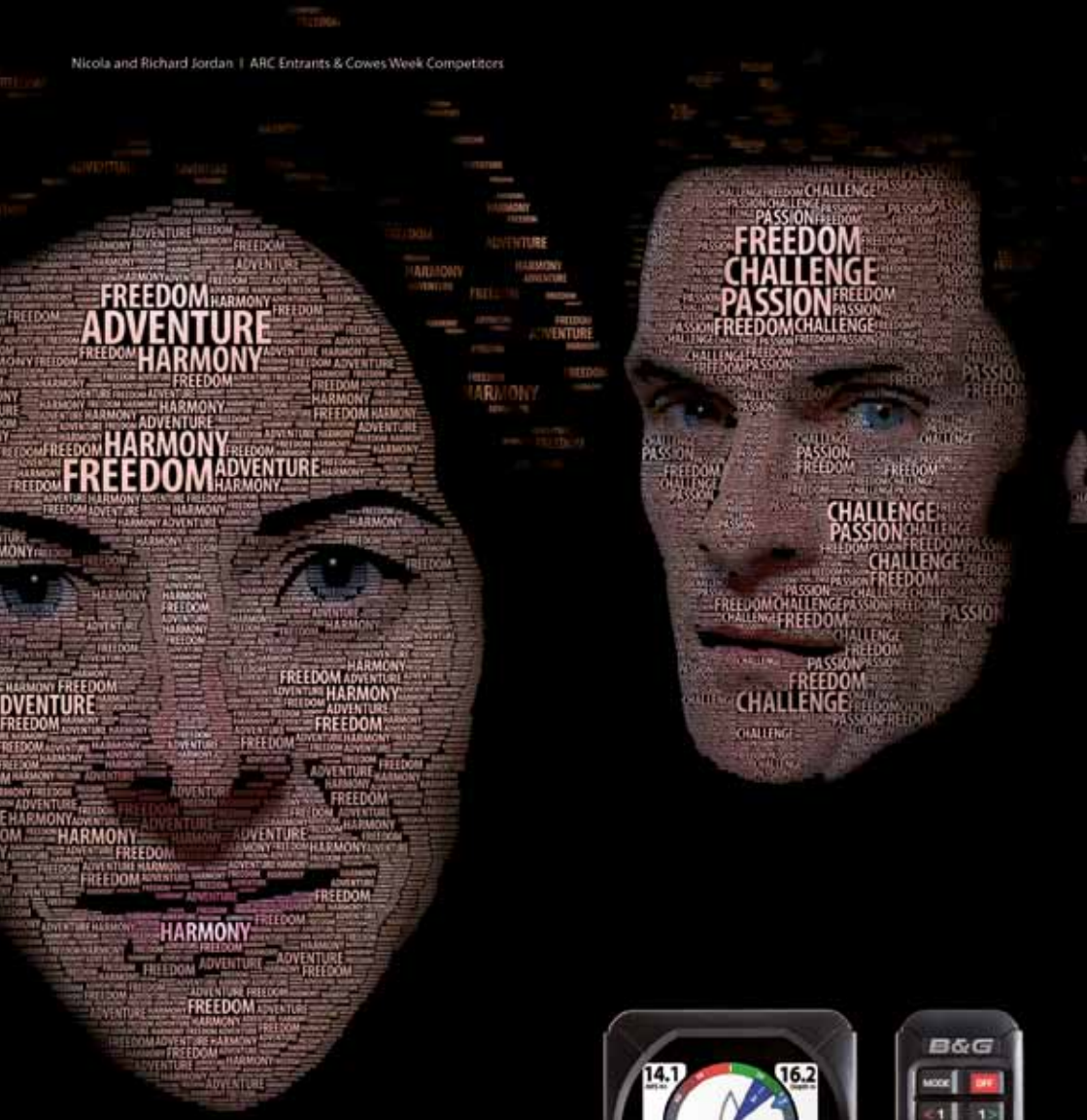
B&G

Essential Guide to Sailing Instruments

TRITON

www.bandg.com

Nicola and Richard Jordan | ARC Entrants & Cowes Week Competitors



YOUR STANDARDS ARE OUR STANDARDS

The New Triton system. Now everyone can enjoy the benefits of superior technology.

Driven by our race heritage, we understand what you need to get the most from your boat. Our large 4.1" bonded high-contrast screen sets the new standard for visibility. It's also very easy to use. Every piece of information you need can be read at a glance, so you can stay focused on what you love best - sailing.

For more information visit www.bandg.com

B&G

Sailing Instruments

Why do I need an Essential Guide?

The Essential Guide to Sailing with Instruments aims to inform newcomers to the marine electronics world, as well as helping to refresh the memories of seasoned sailors, when it comes to the basics of sailing instruments.

Why use instruments for sailing?

If you have spent time sailing dinghies or small day boats, you will have become accustomed to assessing wind speed and direction without using instruments. The absence of electronics onboard these smaller boats mean that all data calculation must be done in the sailor's head.

When it comes to larger boats you have the ability to use electronic aids in addition to your natural senses. Instruments allow us to gain a better understanding of how the conditions are affecting the boat.

With an increasing amount of traffic on the water and cruising yachts taking to more exotic locations, previously only explored by their Superyacht counterparts, it is more important than ever to know what you are facing out on the water. Having accurate instrumentation is one of your most important lines of defence against the unexpected, not to mention keeping you on course to reach your destination safely and by the best possible route.

Sailing instruments do not replace a sailor's natural senses, they help enhance and validate them. It is impossible to know your exact heading without a compass, or the wind speed without an anemometer.

It is essential that instrumentation should be durable, highly visible and have an easy to use interface and menu - after all the last thing you want is to be distracted from sailing to fathom out what your electronics are telling you. Look for bright, clear displays that can be seen from all angles and work just as well in high light levels.

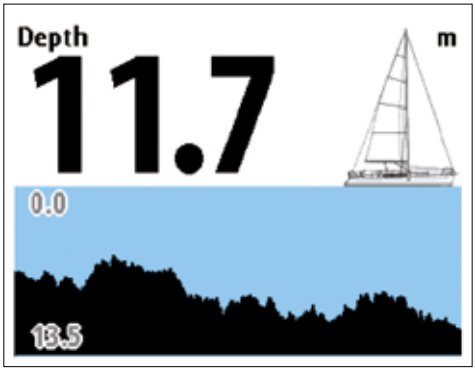
Another factor to consider is compatibility – it's no good having a high tech chart plotter if it won't display information from your Wind system and give you the information you need most.

Sailing instruments from B&G such as Triton feature incredibly clear and bright displays, and offer unsurpassed visibility from all angles - even in the worst conditions or brightest sunlight.

So what are the Basics?

Depth

The most important piece of information you need to consider when sailing is depth. If you run aground, then knowing that you are 250 metres from the layline or that you should be attaining a VMG of 5.3kts is pretty irrelevant, so a good depth sounder should be one of your first considerations on a sail boat.



Depth sounders are very reliable and rarely give false readings, however, given their importance to the safety of the boat and crew, it is sensible to give them a quick "sanity check" every now and then.

Important things to take note of are:

- Is the depth reading changing?
- Does the depth reading look accurate?

It is important to note that in water deeper than 100m a standard depth sensor will usually stop finding the bottom. Most people simply change their instrument display to a different page long before this point.

Depth sounders have a secondary navigational application, they can be used to warn of inaccurate positioning from a GPS unit. If your chartplotter spot-sounding shows that you should be in 30m of water, but your depth sensor says you are in 10m then you should be on high alert – either you have a 20m tidal range, the chart is inaccurate or the GPS position is inaccurate, any of which should be cause for concern!

Modern GPS units can be incredibly accurate, but they aren't infallible – as some sailors have found to their cost. The "disclaimer" warnings that all devices show in the modern age are there for a reason and it is not just to cover liability of the manufacturer. *Over*-reliance on navigational aids is not good practice and can land you in serious difficulties – your eyes and common sense are the most important navigational tools you will ever have.

Heading

So you know how deep the water is – now you need to know where you are heading. Whether we are using Heading as a reference for the wind direction, or for dead reckoning our way across a channel, bay or merely in an area of low visibility, it is a crucial tool. At its very simplest if you sail South in the morning, then get shrouded in fog, you know that home is to the North and can navigate with this basic information.

Boat Speed (Log)

If you know your heading, the boat's speed and a time reference, you can use dead reckoning to calculate your position quite accurately. This is the method, along with celestial navigation, by which early ocean travellers found their routes.

The *Speed Log* is now generally referred to as *Boat Speed,* with the word Log now being used for miles travelled (like odometers in cars). Accurate boat speed is, and has always been, key to accurate navigation and performance measurement.

True Wind

True Wind is the wind experienced by a person or object when stationary relative to the surface of the water.

High quality sensors will provide you with accurate information.

Apparent Wind

Apparent Wind is the wind experienced by a person or object whilst in motion, if you are stood still on a windless day, you will feel no breeze. If however you then get on a bike and ride, you will feel wind rushing past you – this is the effect of Apparent Wind.

The Apparent Wind is not only different in speed to the True Wind, the angle will also be different.

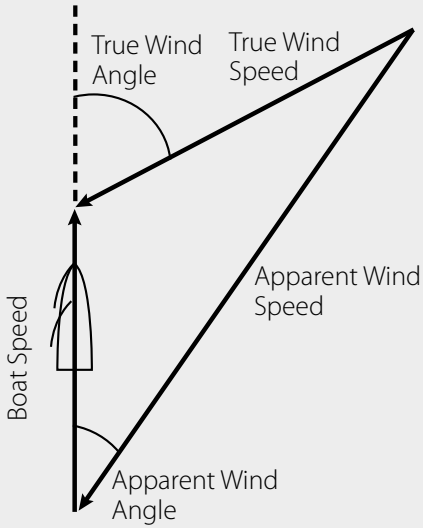
Wind

What's so important about wind information?

Every sailor needs to know which way the wind is blowing from in order to make even the most simple manoeuvres and route calculations. The wind can make a difference between a great journey and a terrible one.

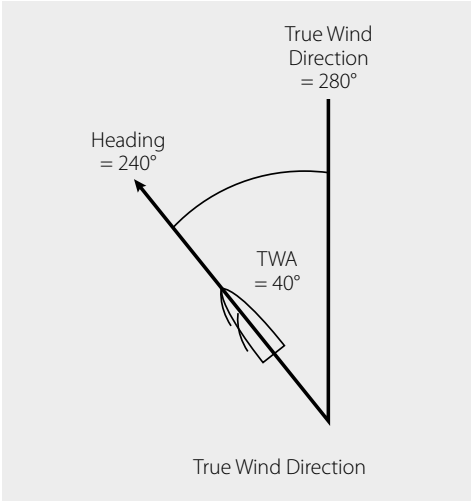
The Wind Triangle

The derivation of wind direction is best described by the "Wind Triangle" which shows the relationship between boat speed, the Apparent Wind (the wind you feel while sailing along), the True Wind (the wind relative to the water surface) and the compass heading of the boat.



True Wind Direction

True Wind Direction is the compass direction of the wind, relative to the water. It is measured from the boat, which may be pointing in any direction and, hopefully, sailing along at reasonable speed. So in order to get an accurate reading, the wind direction must be calculated from multiple sensor inputs, rather than just from an individual sensor.



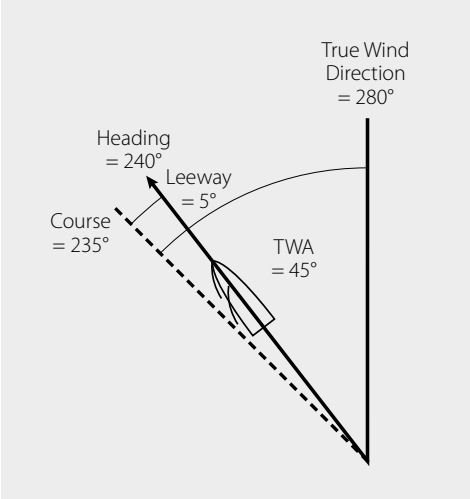
In simple terms: True Wind = Boat Speed + Apparent Wind

Angles vs. Directions

An important distinction when considering instruments, and sailing generally, is that a value that is relative to the boat is normally referred to as an Angle (e.g. Apparent Wind Angle is 35 degrees starboard of the bow).

A value that is relative to an external point such as the water or a point on the Earth is a Direction (e.g. True Wind Direction is 315 degrees magnetic).

It is, unfortunately, common to see True Wind Angle referred to as True Wind Direction – even by some instrument manufacturers who should know better. Some have even been known to refer to "Apparent Wind Direction", you should always be sure of the difference between angles and direction when using your instruments.



Advanced Wind, using Course

Advanced wind calculations

Using Heading data and True Wind Angle to calculate True Wind Direction is normally an accurate enough assumption to be able to monitor wind shifts, but this doesn't take into account how the boat is travelling through the water.

When heeled over and sailing upwind, the effect of leeway (the amount the boat is slipping sideways) will come into play to some degree. Adding the leeway angle that you are achieving to the vessel Heading gives you the Course. Advanced instrument systems will calculate wind with Course rather than Heading..

Course is the direction that you are travelling through the water. This **should not** be confused with COG, which is Course Over the Ground.

Why can't I use SOG and COG for calculating True Wind?

If you substitute SOG (Speed Over Ground) and COG for Boat speed and Heading in the calculation of True Wind Direction, you are negating the fact that when sailing on waters with tides or currents you are, in effect, travelling on a 'moving carpet'.

Clearly if you were to take the sails down and stop the boat you may still be moving over the ground because of the tide but you would be stationary relative to the water! This is where the distinction between True Wind and Ground Wind comes into play.

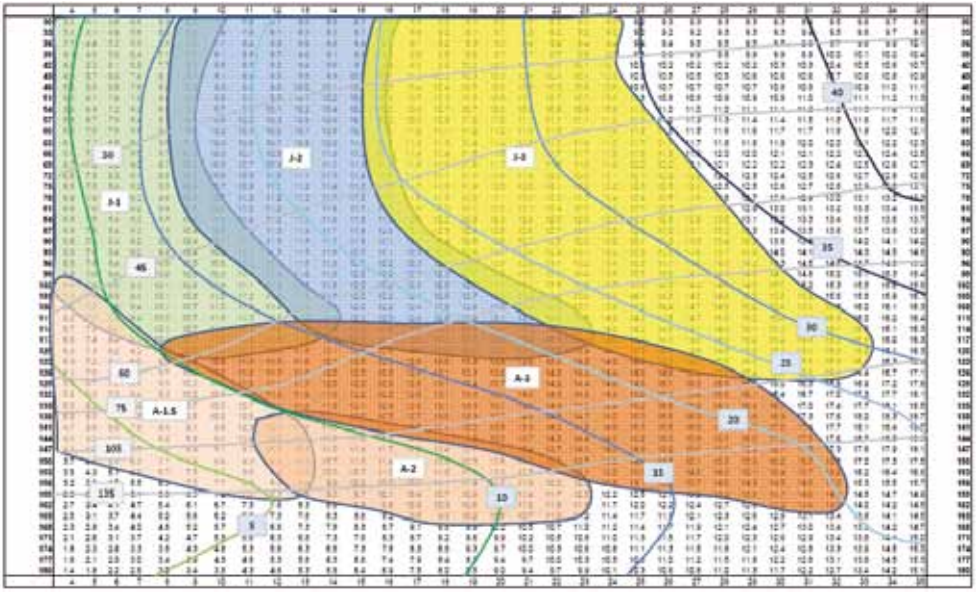
The wind speed and direction when measured relative to a fixed point on the ground is given the term Ground Wind, while the wind speed and direction measured relative to the water is given the term True Wind.

When sailing, you are more interested in the affect the wind has on the boat rather than measurements from a purely meteorological point of view, so True Wind is the preferred choice. Racing navigators constantly convert between True Wind and ground wind to determine the accuracy of weather forecasts which use Ground Wind.

If you have a large difference between the speed of the boat and the speed of the tide (tide rate) then it is possible to use SOG without many issues (e.g. a maxi-multihull travelling at 40kt in 1kt tide is not hugely interested in the tide rate effects), however if you are sailing a more normal boat (say 8kt in 1kt tide) then you should stick with boat speed (speed through the water) so that you have a clear understanding of the effect of tide on your boat.

The units of Wind Speed in instrument systems are usually measured in knots (usually abbreviated kt or kn). However sometimes it is useful to display wind speeds in Beaufort Scale numbers – this allows "at a glance" checking, sometimes preferred by those who cruise and aren't too interested in the difference between 18 and 19 knots.

Racers should use knots exclusively and get a feel for the wind speeds at which their choice of sails work best. It is common to have a simple sail selection chart on the boat, with a look-up table showing each sail against True Wind Speed and True Wind Angle.

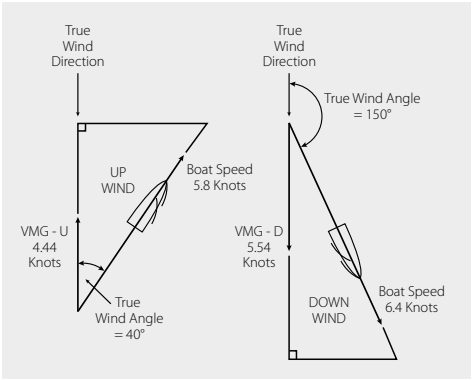


Sail Chart. A look-up table showing the working range of each sail - identified by coloured areas.

VMG

What is VMG?

Velocity Made Good (VMG) is the component of the boat speed in the direction of the wind – if you motor dead upwind then Boat Speed equals VMG, if you are on a beam reach then VMG is zero.



VMG and the vicious circle

Don't steer to VMG! If you head-up then you will notice the VMG will increase in the short term, but the boat will then slow and the VMG will be lower than before, you may then be tempted to head-up further – because it worked last time – and again a short term increase will be followed by a long term reduction in VMG.

In order to compensate for this loss in speed you might bear away – but then the VMG gets instantly worse! This is caused by the fact that yachts are relatively heavy and carry a significant amount of momentum, it is not an error in the instrument system. The Golden Rule is to never attempt to steer to VMG.

It is always sensible to check your VMG calculation – by definition VMG should be zero on a 90 degree (TWA) reach, if it isn't check your instruments.

Isn't VMG my speed towards a waypoint?

VMG has been used by the powerboat fraternity* to refer to the speed component towards a waypoint, however this is resisted by true sailors! We call the speed towards a waypoint VMC (Velocity Made Good on Course), which is very useful on longer legs of a course (tens of miles or more), but generally not used on short legs.

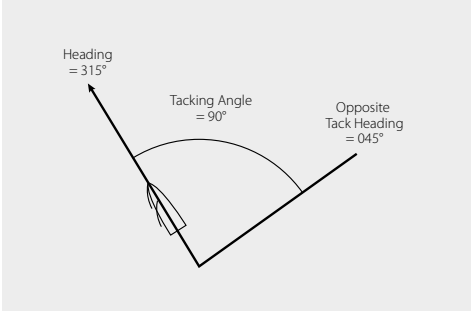
*To be fair to our powered friends, the original GPS units used to call this "VMG Waypoint", but somewhere along the line it has been shortened to merely "VMG" and now causes wide confusion.

Laylines

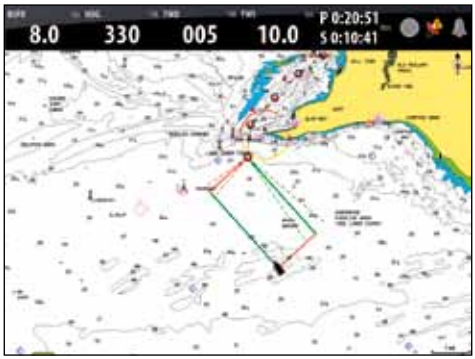
What is crucial about a Layline?

Whether Racing or Cruising, the layline is key information to have when sailing. It helps sailors deduce when they can tack or gybe to make a specific mark, and aids safe clearance of headlands - True Wind Angle is key to having accurate laylines.

At its simplest, the layline can be represented by Opposite Tack Heading, this is simply your current heading plus your tacking angle, giving you a new heading for the other tack – this can be compared to a hand bearing compass reading to see where you would be heading following your tack.



Some chart plotters now overlay laylines onto the navigation chart, so that it is possible to see exactly where the opposite tack is likely to take you in respect to the waypoint, hazards on the chart etc. This is very useful as you can use this tool to keep yourself in favourable tide, away from dangerous areas and to make the best approach to your waypoint.



Laylines calculated from True Wind Angle displayed on a Chartplotter

Tacking Angle

In simplified form, your Tacking angle is equal to double your upwind True Wind Angle (if your True Wind Angle = 45, your tacking angle is 90), however on simpler instrument systems that don't factor leeway into the calculation this will always be *slightly* incorrect, as the boat will slip sideways a small amount while sailing.

Course Over Ground (COG) is a valuable tool here – once you have tacked for a waypoint compare COG and Bearing To Waypoint (BTW) to see if you are gaining or losing ground to windward. If they are equal then you are following a course directly to the mark.

Don't try to pinch excessively to make a waypoint, the boat will slow and leeway will increase – making the situation worse. This will be shown on the instruments by a reduction in VMG. It is almost always better to admit that you won't make a waypoint early, sail at your normal angles and make one or two additional tacks.

Tides

So what about tide?

Tide is usually displayed on instrument systems as Set and Rate, however to calculate tide we need the input of a geographical location/positioning device – such as a GPS.

Tide is calculated by looking at the difference between where a GPS says we are actually going (relative to the ground) and where the instruments believe we are going (relative to the water - without any tidal assumptions).

Why Rate not Drift?

A common mistake (even for the experts!) is to refer to the tide speed as *drift,* when the correct term is *rate.*

Drift is the distance something travels on the tide over a given time. However as both terms are commonly interchanged there is usually no confusion if you get the wrong one.

Tide Set is the direction that the tide is flowing **to.** It is important to note the difference between a northerly tide set and a northerly wind direction. A northerly wind means that the wind is blowing **from** the north, whereas a northerly tide set means the tide is flowing **to** the north.

Understanding and being aware of the effect of tide is crucial to a safe passage.

- The effect of tide on the boat means that there will be a difference when comparing Heading and COG, Boat Speed and SOG. Tide set and rate can be calculated by the difference between these values.
- The effect of tide on the water can result in smooth or rough water depending on the True Wind Direction. For example Wind against tide produces large waves, making entering some ports dangerous if not impossible!
- The effect of tide on the (True) Wind – True Wind is reduced if the tide is taking us downwind, but increased if the tide is pushing us up into the wind.

Weather

Using the Weather Forecast

Every sailor will have experience of weather forecasts that don't reflect the on-water situation, using instruments to check the forecast can help ensure that you are prepared for all conditions.

Weather data on a B&G Zeus chartplotter

Barometric Pressure sensors and air temperature sensors – used alongside your wind instruments - can give a good indication of the accuracy of a weather forecast. Yacht Clubs often have wind instruments displayed in the club house- take note of these to compare them to predicted forecasts – do the instruments agree with the weatherman?

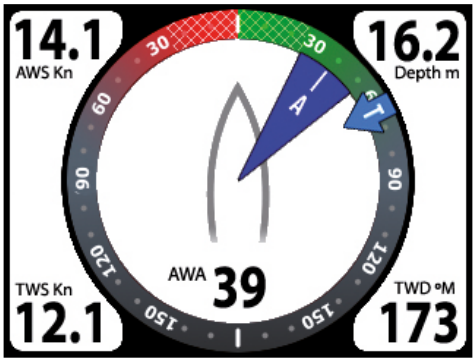
You can compare your observations of the wind speed, direction and air pressure to determine if a forecast area of low pressure is approaching quicker/slower/to the north/to the south of what has been forecast.

Displaying Data

With all this data readily available, it can sometimes be a little overwhelming. Different pieces of data gain and lose significance throughout a sailing passage.

For example depth will be less significant when halfway across the English Channel compared to entering a harbour on a falling tide. It may be necessary to configure a display with multiple pages allowing you to quickly and easily change page to keep a high level of awareness of the relevant information.

Dedicated instrument displays such as Triton come with up to eight data pages which gives you the option of customising pages to suit your needs. In addition some instruments will swap pages automatically if desired. A simple user interface will allow quick selection relevant data.



How do displays derive the data I see?

Instrument systems display 2 types of data. Measured functions consist of (Apparent) Wind Speed and Angle, Boat Speed, Heading and Depth. (Depth is the exception because apart from applying an offset, it is not used in any other calculations.)

Wind Speed and Angle are measured at the top of the mast with a masthead unit comprising a wind vane and cups. The angle that the wind vane is pointing is measured and displayed as the Apparent Wind Angle and is relative to the centre line of the boat. Apparent Wind Speed is measured in knots by calculating how fast the wind cups are rotating.

Boat speed is normally measured with a paddlewheel that is installed through the hull of the vessel. The flow of the water against the blades causes it to rotate – the speed of the rotations are equivalent to the speed through the water or Boat Speed.

Depth is measured with another sensor (sometimes combined into the same through-hull fitting as the boat speed sensor) that emits pulses of sound at a high frequency. The sensor listens for the return echo from the seabed and, similar to radar, the distance can be calculated by measuring the time taken between sending and receiving the pulse.

Advanced Systems

More advanced instrument systems make use of additional sensors and techniques to gain a higher level of accuracy in the calculation of True Wind.

Motion Correction

Heel and Trim angles can be factored into the wind angle measurements, along with the rolling and pitching motion of the boat, allowing us to compensate for induced motion at the top of the mast as the wind sensor is thrown around with the motion of the boat.

True Wind Corrections

More advanced calibrations like True Wind Correction Tables allow the Wind angle to be adjusted manually for the deflection effect that the sail plan has on the wind immediately before it hits the boat, similar to the way a container ship pushes a bow wave ahead of it.

Performance Wind Filter

Performance Wind Filtering comprising advanced filtering methods can be used to achieve a True Wind Direction that is statistically more accurate, and less susceptible to short term errors, than basic trigonometric calculations.

Polar Tables

Polar tables can be loaded into some systems to enable an automatic look-up of target boat speed and optimum wind angle speed at the present wind speed and angle. This allows the helm to compare the current performance of the yacht with its known, or theoretical, optimum performance.

Tactical Software

For tactical planning, software such as Deckman from B&G allows you to input data to calculate future journeys – GRIB weather files and tidal data can be uploaded into the software for up-to-the-minute calculations of optimum routes. These software packages link directly with the instrument system to enable them to receive current data from the yacht and calculate more advanced features than are normally available in instrument systems.

B&G

www.bandg.com