RACELOGIC VBOX

APPLICATION NOTE:
MARINE APPLICATIONS – Trim, Roll and Leeway.

An Alternative VBOX Application

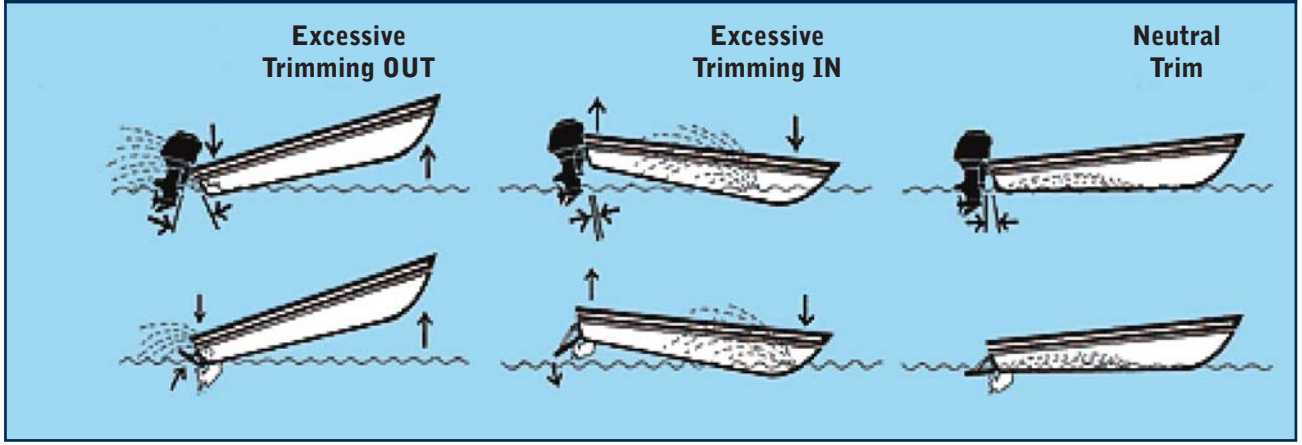
Traditionally, the **VBOX** has been used by automotive markets but the wealth of measurements it offers can equally be applied to non-automotive applications.

RACELOGIC has recently been working in conjunction with luxury yacht manufacturer Fairline, to use the **VBOX** to provide a measurement solution for Trim Angle, Roll Angle and Leeway Angle measurements.

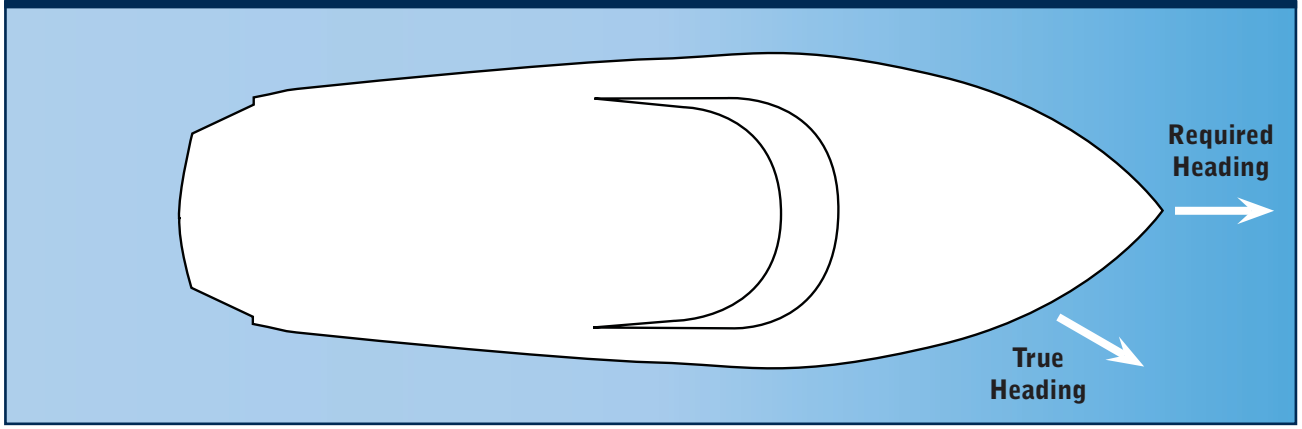
Trim Angle is the marine equivalent of Pitch Angle and is of particular importance to powerboat manufacturers in order to be able to design the hull of the boat to "plane", that is, to allow the boat to go faster by using its speed and hull shape to lift the front part of the hull out of the water. This reduces drag on the vessel, enabling it to cut the cleanest path through the water, which in turn improves the comfort, performance and fuel economy of the vessel.

Leeway Angle is the marine equivalent of Slip Angle and is also important to boat manufacturers, as this is a measure of the boats ability to travel in the intended direction. Water resistance, particularly on rough, open seas and wind effects can cause a vessel whose bow is pointing East to actually travel South-East (for example). Good hull design can counteract these effects and minimize the Leeway Angle.

Examples of Trim Angle effects



Leeway Angle is a function of required heading – true heading



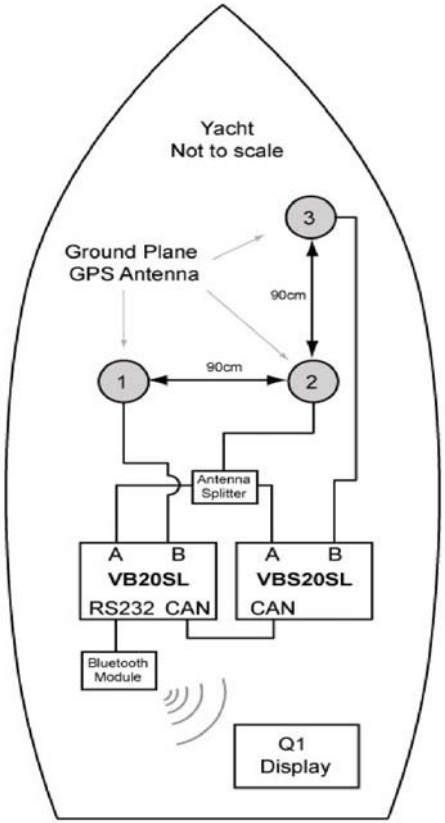
RACELOGIC were asked to demonstrate a suitable system for measuring Trim Angle, Roll Angle and Leeway Angle, which would provide fast and accurate results.

Equipment used:

- VB20SL – **VBOX II SX with Slip Angle**.
- VBS20SL – **VBOX II SX Slip Angle Sensor.**
- 3 x Ground Plane Antennas.
- Q1 Display running **VBOX** Tools software (tablet edition).
- **VBOX** Bluetooth module.
- Antenna Splitter
- Fairline luxury yacht (model confidential).

Execution of test:

The test was set up with the 3 Ground Plane Antennas set-up inside the cabin of the boat.



Block diagram of test set-up

General picture of test set-up

3 x Ground Plane Antennas

Measurement principles:

Antennas 1 and 2 are placed perpendicular to the intended direction of travel of the boat and are used to measure Roll Angle.

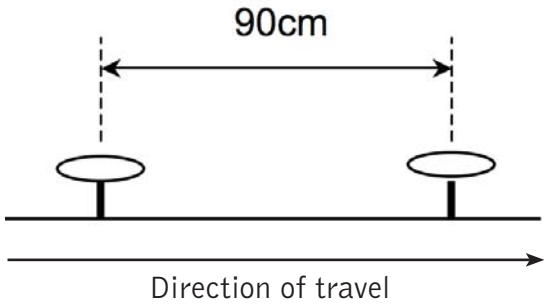
Antennas 2 and 3 are placed parallel to the intended direction of travel of the boat and are used to measure Trim Angle and Leeway Angle

Trim Angle is measured with antennas 2 and 3 by very accurately calculating the relative positions of the primary and secondary antenna using RTK techniques (RTK = Real Time Kinematic). Accuracies of up to 0.1 degrees are achievable by fixing the distance between the antennas, and inputting this into the **VBOX**.

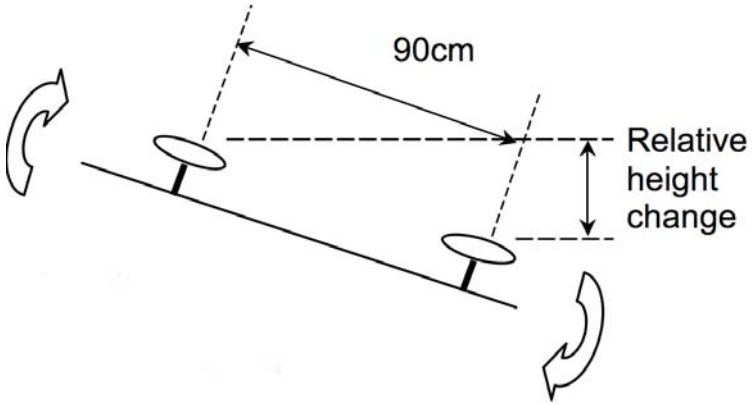
This constrains the RTK positioning routines within the GPS engines and gives a very accurate relative displacement between the primary and secondary antenna, including the relative height between them.

Roll Angle is measured in the same way using antennas 1 and 2 and tilt in the lateral plane.

Antennas on horizontal surface



Longitudinal "tilt" causes change in relative Antenna height



Leeway Angle is measured using antennas 2 and 3. The most important parameter to measure in the quest for Leeway Angle is the direction that the vehicle is pointing. This is measured by measuring the relative position of the primary antenna and the secondary antenna, and using this information to measure the angle between the antennas, relative to true North.

In the 1st picture, the angle between the primary and secondary antennas is required. This is calculated to within an accuracy of 0.1 degrees, (depending on the separation of the antennas).

The second measurement required to measure Leeway Angle is the angle the vehicle is travelling. This is measured by the primary antenna and is the normal GPS "heading" measurement or Course over Ground.

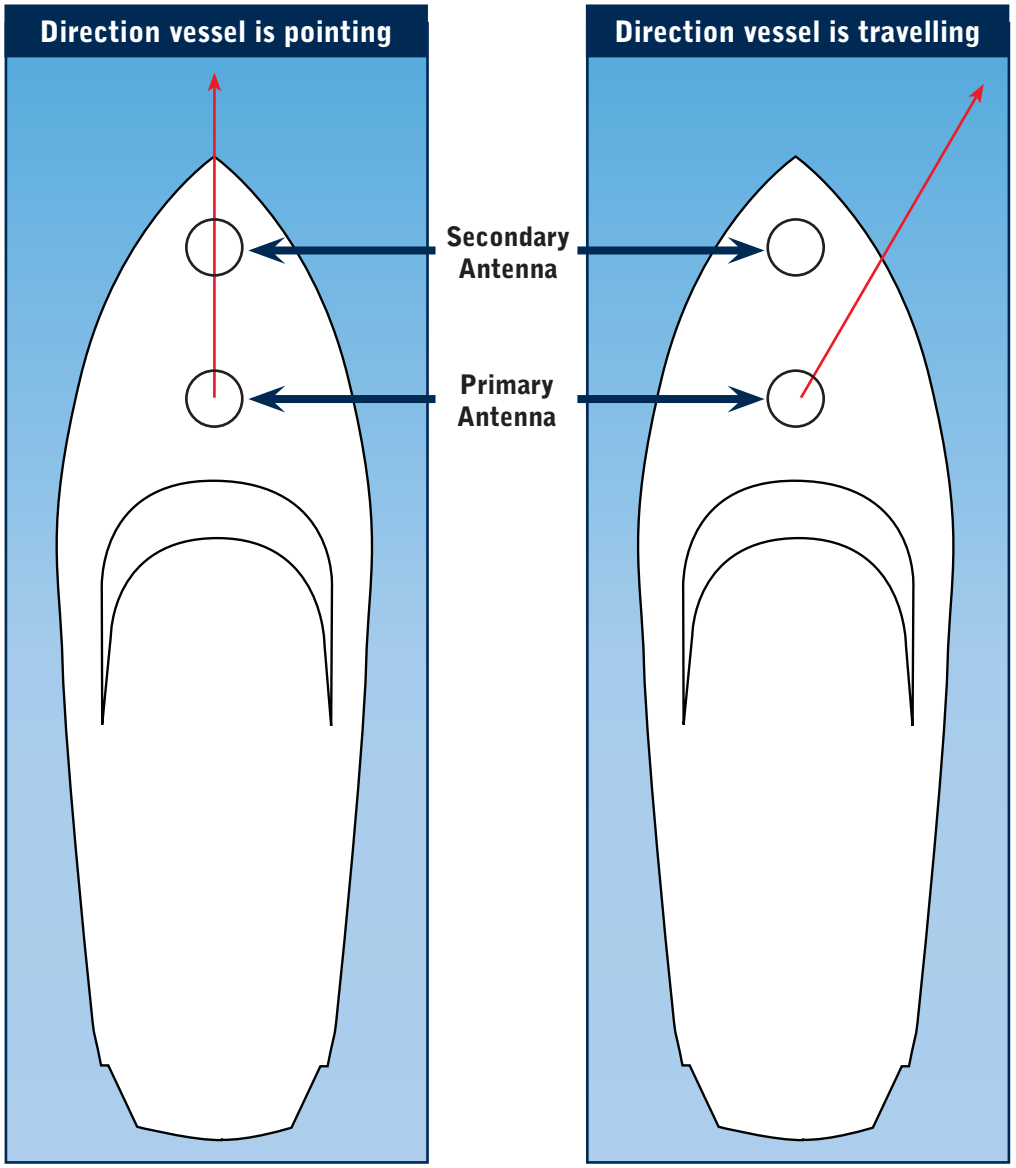
This is calculated from the direction of motion of the primary antenna, and is derived from the primary components of the Doppler velocity (north velocity and east velocity). By subtracting the direction the vehicle is pointing from the direction it is travelling will give you a direct measurement of Leeway Angle.

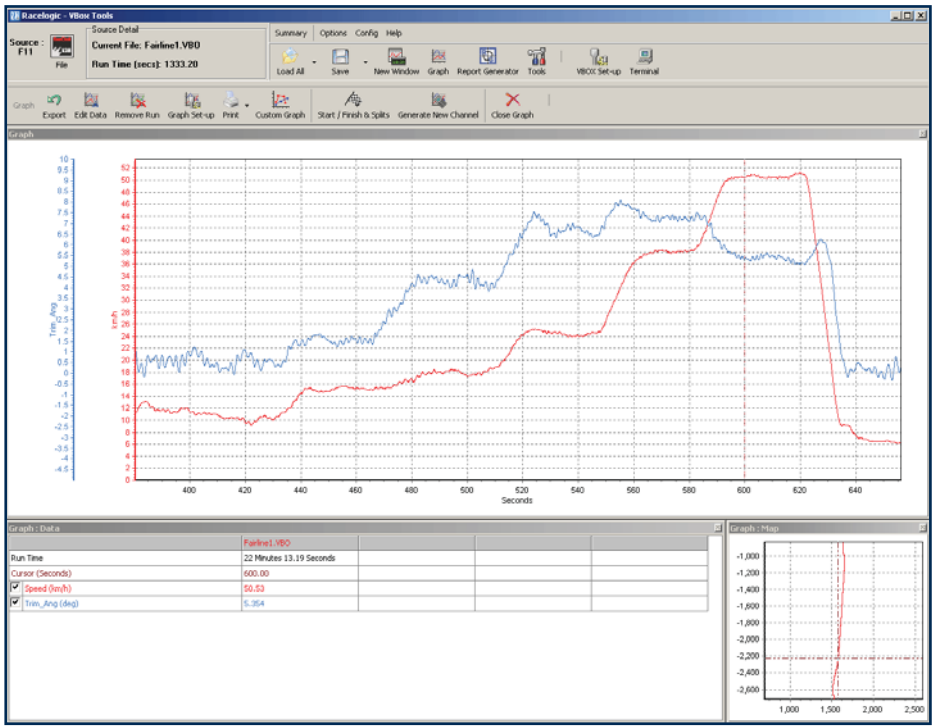
Results:

The main purpose of the test was to record data for Trim Angle and this was recorded successfully at all times.

The system was also able to simultaneously record data for Roll Angle and Leeway Angle. No adjustments to the original set-up were required to record these three parameters.

Please see the next page for results examples.

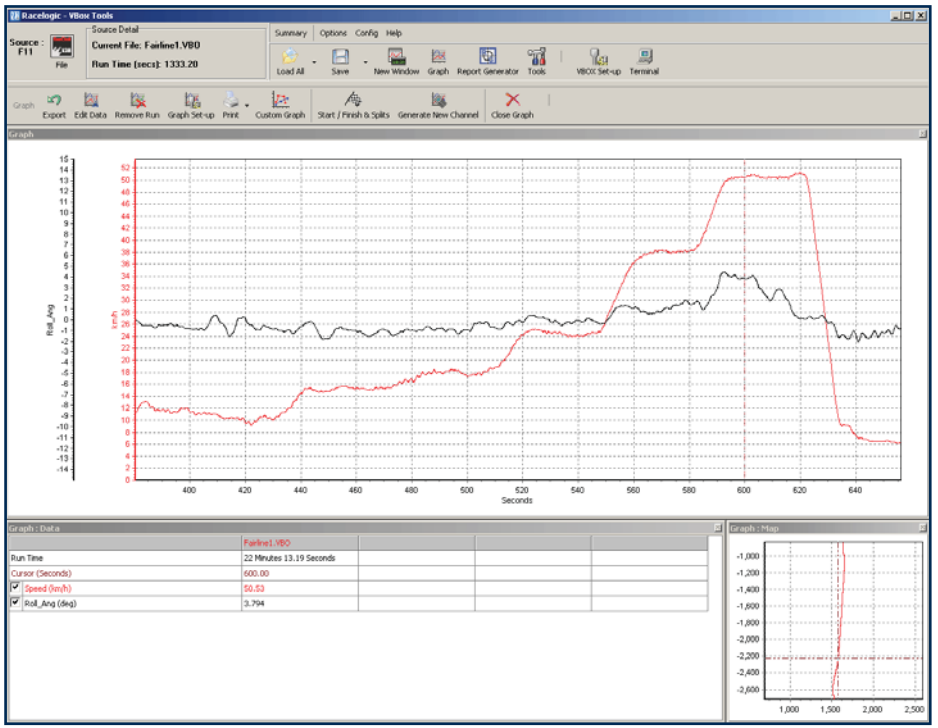




VBOX TOOLS showing Speed and Trim Angle.

The cursor shows that at 600s into the test run,
the recorded Trim Angle was 5.359° at 51.34km/h

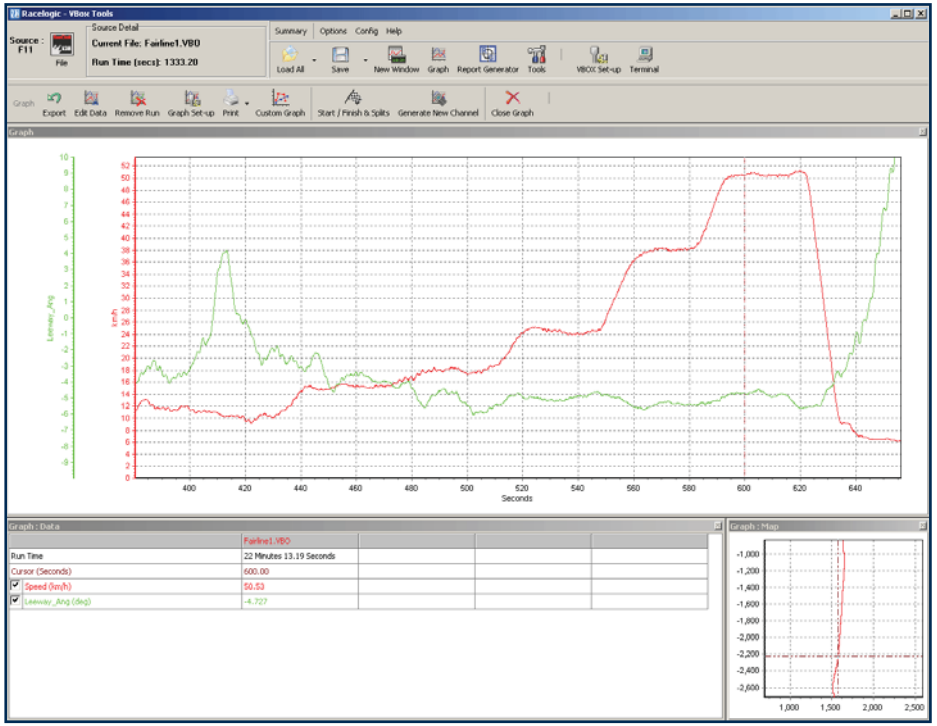
The maximum Trim Angle recorded was 8.25° at 32km/h



VBOX TOOLS showing Speed and Roll Angle.

The cursor shows that at 600s into the test run,
the recorded Roll Angle was 3.792° at 51.34km/h

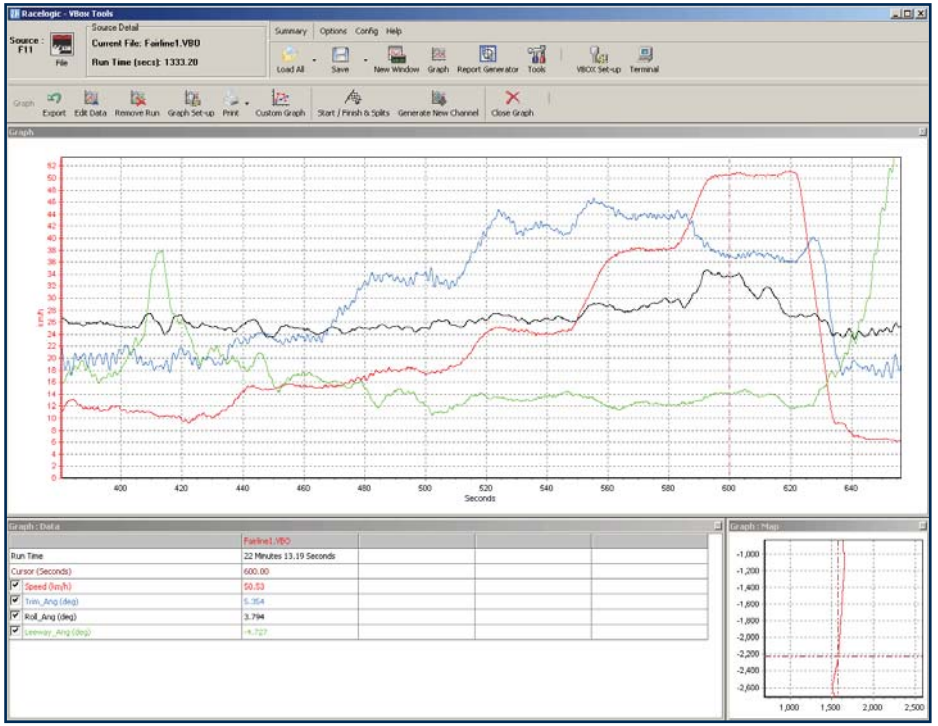
The maximum Roll Angle recorded was 4.5° at 48km/h



VBOX TOOLS showing Leeway Angle.

The cursor shows that at 600s into the test run,
the recorded Leeway Angle was –4.732° at 51.34km/h

The maximum Leeway Angle recorded was +13° at 7.5km/h



VBOX TOOLS showing that all measurements of Trim Angle, Roll Angle and Leeway Angle can be made simultaneously.

The ***RACELOGIC VBOX*** can also be used to measure

Surge:

This is a measure of "sliding" longitudinal motion of a vessel and can be measured using Longitudinal Acceleration.

Longitudinal Motion

Sway:

This is a measure of "sliding", lateral side-to-side motion of a vessel and can be measured using Lateral Acceleration.

Lateral Motion

Heave:

This is a measure of the vertical, up-and-down motion of a vessel and can be measured using Vertical Velocity.

Vertical Motion