Obtaining the Swept Width of Articulated Vehicles

Abstract

Australia has the largest and heaviest road legal vehicles in the world, with some measuring over 50m and weighing in at nearly 200 tonnes. This combination of extreme weight and length requires vehicle designers to adhere to strict legislation to minimise the risk to the drivers of these vehicles and other road users. These standards are set out in the "Performance Based Standards Scheme" set by the National Heavy Vehicle Regulator (NHVR) often references the worldwide standard ISO 14791:2000.

One area of main concern is how closely the path of the rear trailer follows the path of the hauling unit when travelling in both a straight line and around a corner, and so it is these tests that this paper will focus on.

These tests are:

- **C5 – Tracking Ability on a Straight Path**
  The total swept width of the whole vehicle while travelling on a straight path
- **C7 – Low Speed Swept Path**
  The maximum width of the swept path in a prescribed 90˚ low speed turn
- **C8 – Frontal Swing**
  The maximum width of the frontal swing swept path and the maximum difference between the frontal swing out distances of adjacent vehicle units path in a prescribed 90˚ low speed turn
- **C9 – Tail Swing**
  The maximum outward lateral displacement of the outer rearmost point on a vehicle unit during the initial and final stages of a prescribed 90˚ low speed turn
- **C13 – High Speed Transient Offtracking**
  The lateral distance that the last axle on the rearmost trailer tracks outside the path of the steer axle in a sudden evasive manoeuvre

It is possible to complete all of these tests using two VB3iSL-RTK systems, an RTK 2cm BaseStation and the new VBO File Processer Software, more specifically, the Lane Departure plugin.

VBO File Processer – Lane Departure Plugin

The Lane Departure plugin was originally designed for ADAS verification, where by test engineers can determine the left and right lateral ranges to the specified lane boundaries. This is done by first mapping out the lane boundaries before carrying out the driven test. The software then allows the user to add 2D offsets to the left and right of the antenna position, to reference the outermost point of the vehicle. The processed file will then return a range of values such as the lateral range between the right left and right hand side of the vehicle to the lane boundaries, the angle of approach to the lane boundaries and the time it will take to cross the lane boundary, allowing the user to validate the Lane Departure Warning System on the vehicle.

Testing Methodology

Engineers looking to complete these tests can also make use of the Lane Departure Plugin, as these tests all look at the path following capabilities of various parts of the vehicle in relation to the hauling unit. This means that if one VBOX system is placed on the hauling unit, and another on the trailer unit, it is possible to use the hauling unit as the "Lane" and the trailer unit as the "Subject Vehicle" in the Lane Departure plugin and set the offsets to whichever point of the vehicle the test needs to reference. Once processed, this will allow the user to calculate the distance between the hauling unit's path and the trailer unit's path which will then allow the calculation of the total swept width.

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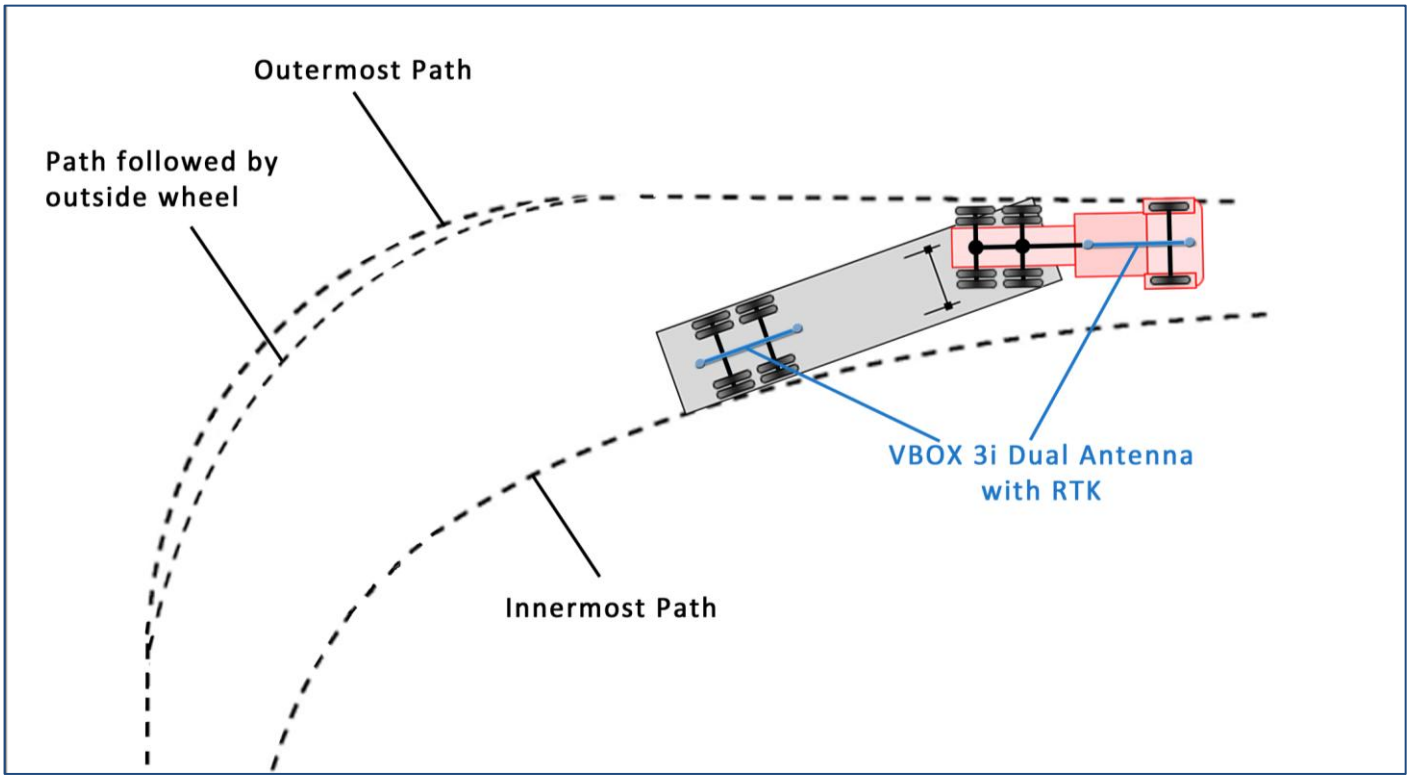

Figure 1: Diagram to show the path taken by an Articulated Vehicle during a turn

Take test C7 as an example. This test requires the vehicle to complete a 90˚ turn at 5km/h to make sure that the trailer does not stray outside of the designated lane and potentially into pedestrians, as shown above.

With two VB3iSL-RTK systems, it is possible to place one antenna point on the hauling unit, and one at the rear of the trailer unit. This configuration alone will give the user a graphical display of the path taken by the two antenna points as seen below.

Here it is clearly possible to see that the rear trailer (red) undercuts the path taken by the hauling unit (blue) during the turn; however it is not enough to ascertain an accurate swept width of the whole vehicle, which is where the VBO File Processer comes in.

First load the VBO file recorded from the trailer unit as the “input file” and the VBO from the Hauling unit as “Lane 1”. If the user has placed the antenna point directly over the points of interest (for this test in a left hand turn, only the front right and rear left paths are needed to calculate the swept width), it is possible to process the file and analyse the output file without any need to input offsets. In this case, the total swept width will be the maximum value of either of the default channels “Range_Lt” or “Range_Rt” in VBOX Tools.

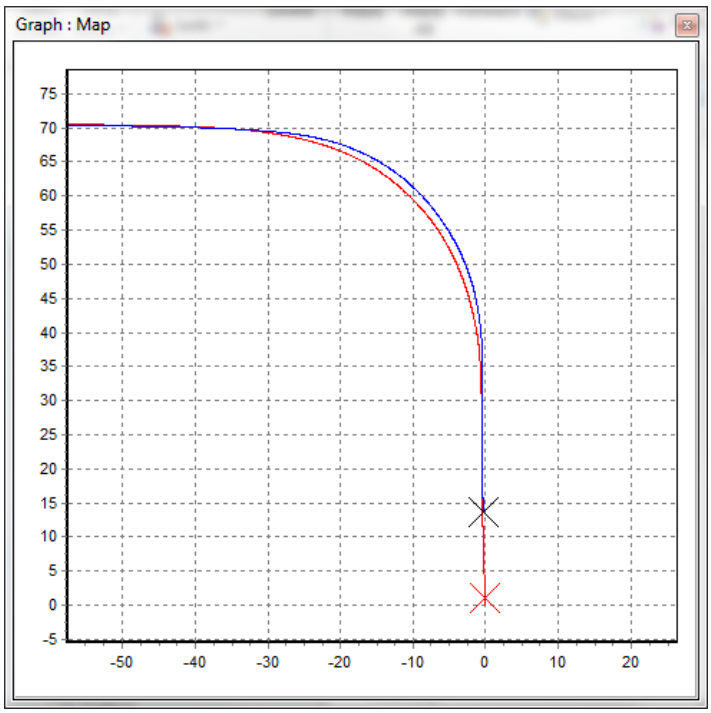

Figure 2: Graph to show the paths taken by the Hauling unit (Blue) and rear trailer (Red)

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If it is not possible to place the antenna over the measurement points, the user will need to enter the left and right offset distances to the rear left and rear right of the trailer unit (as mentioned, only the rear left point is of interest, but it's good practice to enter all offsets in when possible), rename the "Range_Lt" and "Range_Rt" channels to something that will differentiate between the front and rear files (Rear_Lt and Rear_Rt will be used for this example) and then process the file. The user will then need to load the VBO file from the hauling unit as both the input file AND as "Lane 1", and repeat the process (renaming the channels to Front_Lt and Front_Rt).

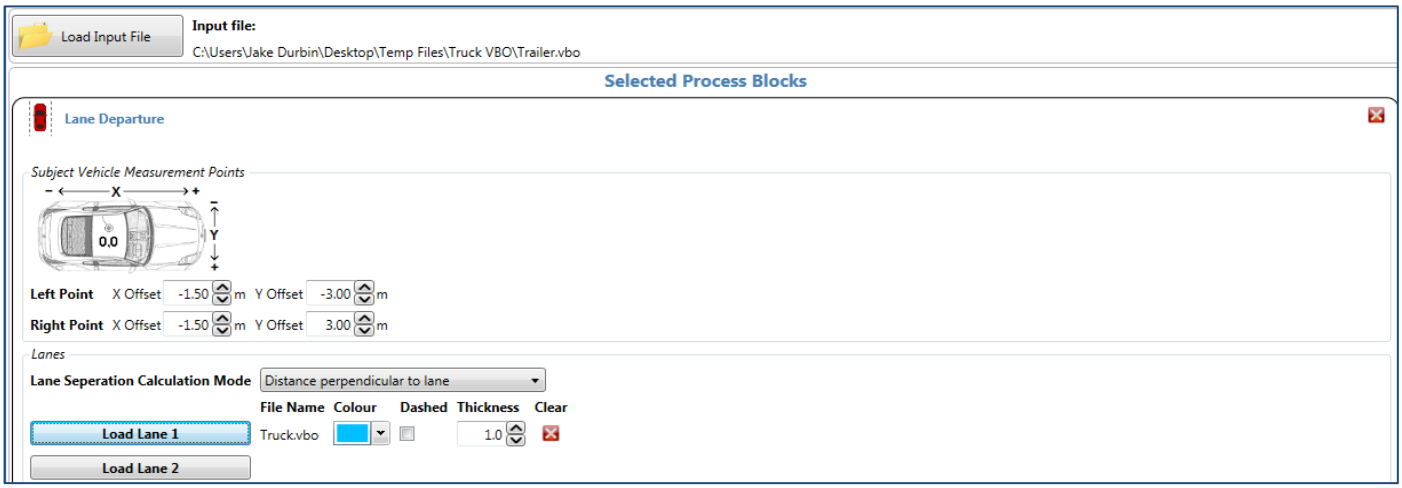

Figure 3: The Lane Departure Plugin screen

Once both files have been processed, it is then possible to use another of the VBO File Processer's process blocks called "File Combination" to combine the two output files that have been created. This will then leave the user with one file with 4 extra channels, Front_Lt, Front_Rt, Rear_Lt and Rear_Rt. These new channels, when opened in VBOX tools, will show the lateral ranges to the reference lane, which in this case is the path taken by the hauling unit's antenna point. Using these channels, it is then possible to generate a maths channel that calculates the difference between, in this case, the front right (Blue) and rear left (red) points and thus, the swept width (Green) in the graph below). To find the total swept width, it is just a case of using the Measure tool across the whole manoeuvre and looking for the maximum value of swept width.

The other tests can be completed using the same process and by referencing different parts of the vehicle, for example, for parts of test C8, it is necessary to look at the path taken by the front outside corner of the trailer unit and so the offset would be need to be entered to that corner, not the rear corners as in test C7).

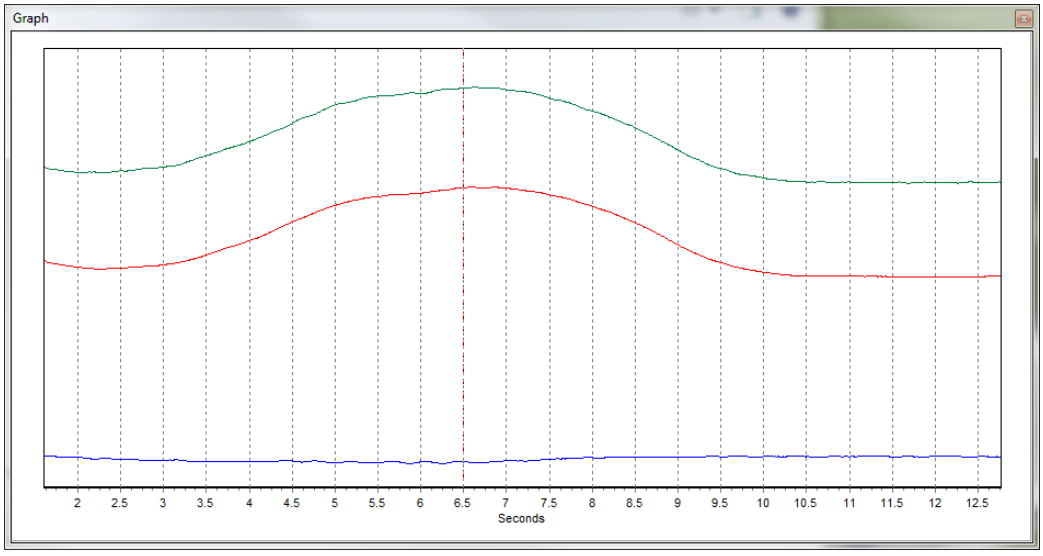

Figure 4: Graph showing the Front_Rt (Red), Rear_Lt (Blue) and Swept Width (Green)