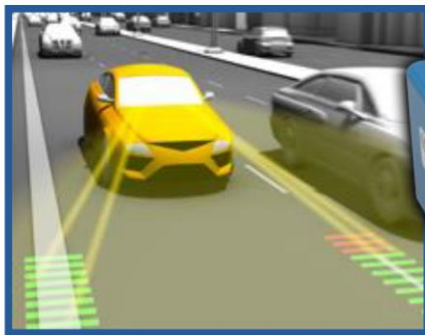


Racelogic ADAS system

User Guide



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Introduction

What is ADAS?

ADAS (Advanced Driver Assistance Systems) is the name given to a group of technologies being implemented by the majority of car manufacturers around the world to improve driver safety and comfort. The Racelogic ADAS system is capable of testing and validating a wide range of these technologies and details of how the Racelogic system can be configured for each application is presented in this document. These technologies include the following:

- Adaptive Cruise Control
- Lane Departure Warning System/Lane Keep Assist
- Autonomous Emergency Braking AEB
- Collision Mitigation System
- Pedestrian Protection System
- Rear Cross Traffic detection
- Automatic Parking
- Blind Spot Detection
- Automatic Main Beam Assist

How do we test ADAS equipped vehicles?

The Racelogic solution utilises 100Hz GPS data loggers (VB3iSL-RTK) to measure relative position from the subject vehicle to lane edges, static points or up to two moving vehicles. Each VB3iSL-RTK unit receives an RTK (real time kinematic) DGPS correction message from a local GPS Base station to gain the positional accuracy required to measure ADAS parameters to 2cm accuracy.

The RTK DGPS correction message can be supplied via a radio link by a locally placed static Base station, or by another VB3iSL-RTK acting as a 'Moving Base'. The configuration of both modes is explained in this manual.

Data output

Each VBOX outputs its data via a CAN bus, so that the Racelogic ADAS solution can be integrated with a 3rd party data acquisition system

CAN Logging

The Racelogic ADAS test solution is also able to log other parameters from the test vehicle, via CAN bus and analogue or digital inputs.

Video

As a further test enhancement/requirement synchronised video can also be recorded by the connection of a Video VBOX system.

All of these aspects are covered in this manual.

The majority of ADAS applications listed above can be tested with near identical Racelogic system configurations. With this in mind the document has been split into the following sections:

1. Single Target Vehicle
2. Single Target Vehicle 'Duplex mode'
3. Multi Vehicle Target
4. Lane Departure Warning
5. Static Point

What will you need?

In order to be able to utilise all features and measure all parameters listed in this manual will require that you have the following firmware versions or later.

VB3i (must be running firmware 1.12b21 or later)

VBOX Manager (must be running firmware 2.25 or later)

VBOX Tools (must be running software or later)

Lane departure Testing:

Down sample software/ VBO file processor

All of the equipment for each vehicle can be connected together and mounted inside the supplied VBOX case, which greatly assists in installation of the equipment in each vehicle and easy movement of the equipment between vehicles.



Figure 1: Racelogic ADAS testing equipment installed in a vehicle

Single Target Vehicle Separation system

This system consists of a VBOX3iSL-RTK in a Target vehicle and a VBOX3iSL-RTK in the Subject vehicle that calculates typical vehicle separation parameters, with respect to the Target vehicle.

This system setup provides a test solution for the following ADAS applications.

- Adaptive Cruise Control
- Autonomous Emergency Braking AEB
- Collision Mitigation System
- Rear Cross Traffic detection
- Blind Spot Detection
- Automatic Main Beam Assist

High accuracy of the vehicle separation calculations is made possible by the use of a Static or Moving Base station.

The following guide is an instruction for a vehicle separation with a Static Base station. See the 'RTK DGPS Configuration' section below for information on system configuration for 'Moving Base' mode.

The Vehicle separation channels are as follows:

- Distance between vehicles (m)
- Angle to remote vehicle (°)
- Lateral Range (m)
- Longitudinal Range (m)
- Lateral relative speed (km/h)
- Longitudinal relative speed (km/h)
- Relative speed (resultant range rate) (km/h)
- Lateral Range – (Target heading) (m)
- Longitudinal Range – (Target heading) (m)
- Time to Collision (s)
- Time to collision2(s) (for decelerating remote vehicle)
- Lateral Difference, (based on track reference markers)
- Separation time (s);
- Remote Speed (km/h)
- Remote Accel (g)
- Link Time
- Subject RTK Status
- Target RTK Status
- Time to Collision_Target (s) (based on heading of the Target vehicle)
- Yaw Diff- between Subject and Target (°)
- Yaw rate –Target vehicle (°/s)

See "Parameter Definitions" for further information.

The Target VBOX (tracked vehicle) will also log the normal GPS data to a .VBO file, so that the files from each VBOX can be compared in the VBOXTools graph screen. This is useful to see the relative positions

Configuration of the VBOX's is done through a VBOX Manager (RLVBFMAN). See later in this manual for further details.

Hardware configuration

Single Vehicle Target testing requires the installation of 2 VBOX ADAS systems, one in the Subject Vehicle and one in the Target Vehicle. The following diagrams show the recommended hardware configuration for each Vehicle. The items greyed out are not essential but many customers may find them beneficial.

Subject Vehicle Configuration

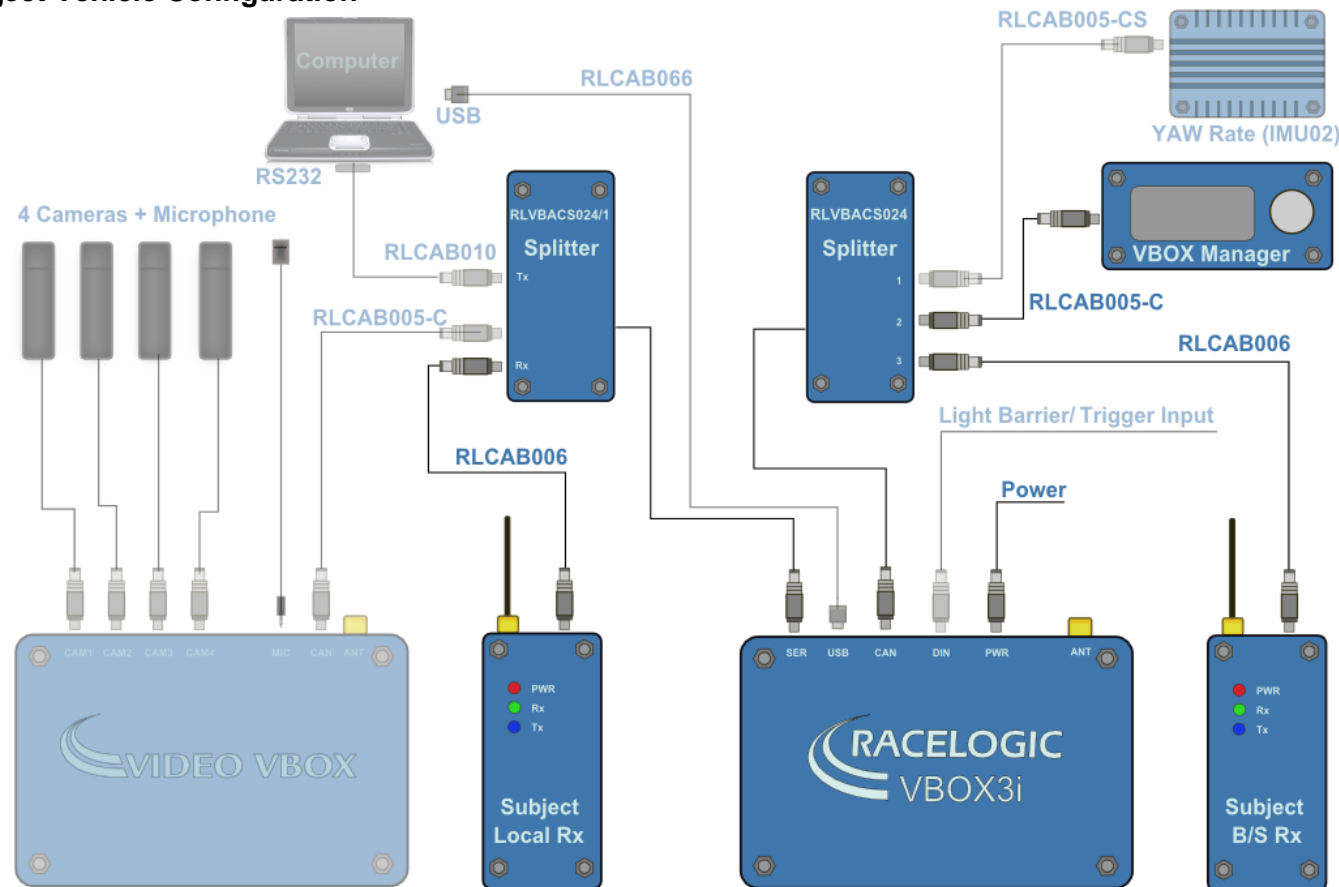


Figure 2: Racelogic ADAS Subject Vehicle hardware configuration

Target Vehicle Configuration

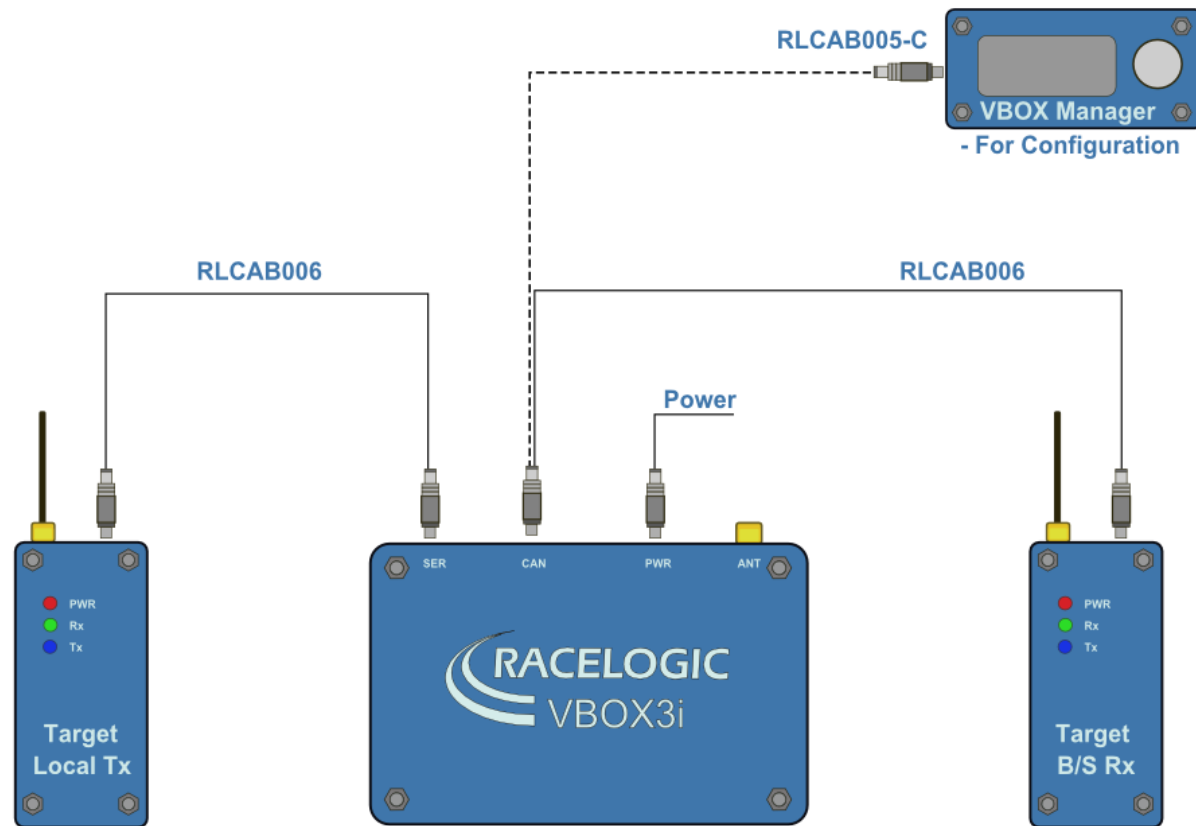


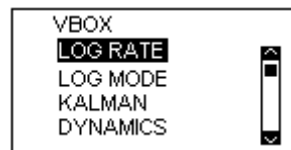
Figure 3: Racelogic ADAS Target Vehicle hardware configuration

Quick Start – VBOX Configuration

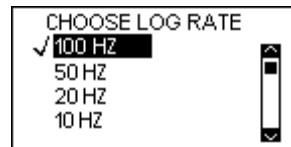
Target Vehicle

This quick start guide assumes the use of a Base station, for a guide to Moving Base configuration please 'RTK configuration' section.

1. Connect the VBOX Manager to the VBOX in the Target Vehicle
2. Enter the setup menu of the VBOX Manager
3. Select the VBOX option



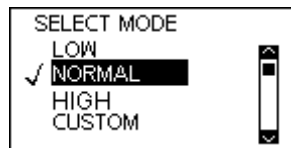
4. Select LOG RATE and set the rate to 100Hz, then select BACK to return to the VBOX setup menu



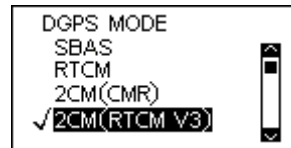
5. Select KALMAN FILTER and ensure none of the options are highlighted, return to the VBOX setup menu



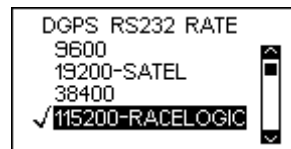
6. Select DYNAMICS and set the dynamic mode to, NORMAL this Dynamics mode is best for ADAS tests, return to the VBOX setup menu



7. Select DGPS and set the DGPS mode to the same 2cm mode that the Base station is set to, return to the VBOX setup menu*
For further info on RTK modes see 'RTK Configuration'

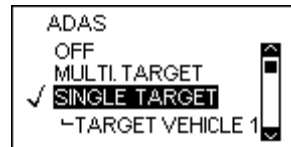


8. Select DGPS RS232 Rate and select the appropriate settings for your radios, return to the VBOX setup menu

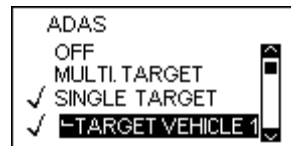


**Note: all Racelogic blue boxed radios
use 115200 b/s
Only the Satel radios use 19200 b/s**

9. Return to the main setup menu and select the ADAS option



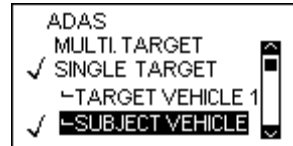
10. Select SINGLE TARGET mode and select TARGET VEHICLE 1, return to the ADAS setup menu



Note , These are settings for a static Base station configuration, please see 'RTK DGPS configuration ' section for details on moving base corrections.

Subject Vehicle

1. Connect the VBOX Manager to the VBOX in the Subject Vehicle
2. Repeat steps 2 – 9 of section 'Target Vehicle'
3. Select SINGLE TARGET mode and select SUBJECT VEHICLE, return to the ADAS setup menu



ADAS Radio Link

1. Ensure the 2.4GHz telemetry modems are connected as shown in Figure 2 and Figure 3.
2. 2.4GHz transmissions are very direct, with a narrow beam width so care needs taking when mounting the antenna; ensure they are:
 - On the highest part of the vehicle roof
 - Away from any nearby obstructions that could cause a potential blockage to the path of the signal
 - Mounted vertically to ensure maximum transmission power in the horizontal plane
 - Mounted at least 50cm away from other Radio antennas



Figure 4: ADAS 2.4GHZ radio mounting



Figure 5: ADAS modem link communications

When the 2.4GHz modems are connected correctly the "SER" light on the SUBJECT VBOX will illuminate, indicating the reception of a serial data stream.

3. To test the stability of the ADAS modem link monitor the “Link Time” channel within VBOX tools. A good link will show a trace incrementing every 10mS with no drops to zero. Figure 6 shows good and poor ADAS modem link quality.

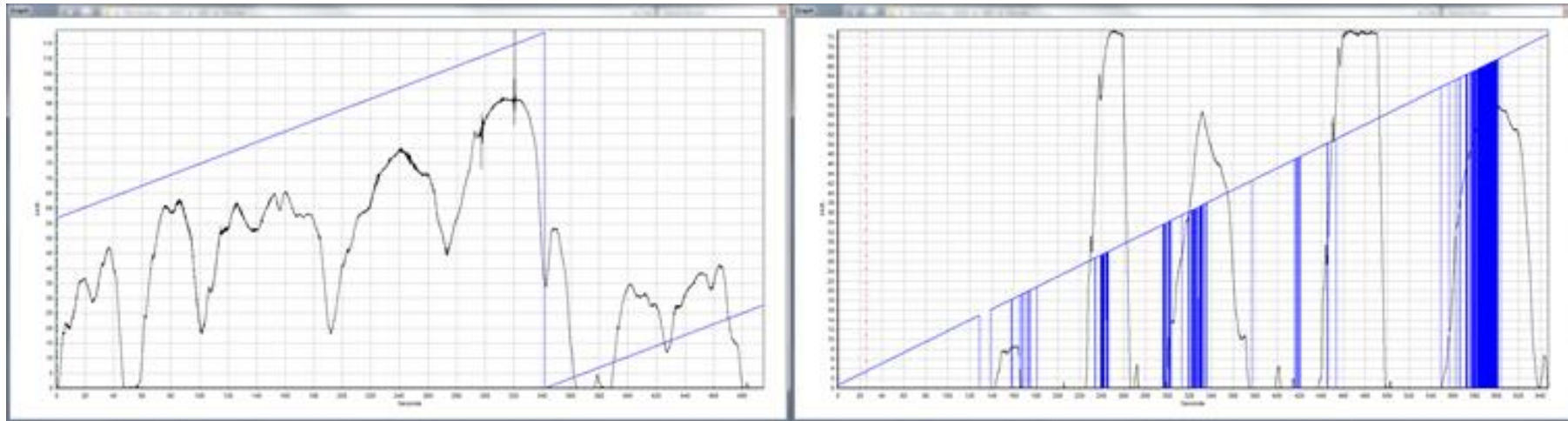


Figure 6: Comparison of good Link Time data (left) with poor Link Time data (right)

The quality of the incrementing link time count is a sign of the quality of the ADAS radio link.

The VBOX will maintain the last known good value of each vehicle separation parameter during a radio link dropout. This makes it possible for the ADAS system to tolerate random and infrequent radio dropouts without adverse effect on the data.

However, if the dropouts look excessive like in the right hand screen shot of Figure 6 then the things to check if the link time is poor are:

- All mounting care listed above has been followed
- Distance between vehicles, the modem link will start to drop around 300m
- No other 2.4 GHz radios that are set to the same Channel are being used in the same area.
- Incorrect radio configuration, please contact your Racelogic dealer for further information

RTK DGPS Configuration

Static Base

Please refer to the 'Base station user guide' for guidance on Base station installation and setup.

DGPS modes

VBOX3i and Base station supports the use of three different RTK DGPS modes; each mode will provide 2cm accurate solution.

Racelogic recommends the use of CMR or RTCMv3 as these modes have less radio bandwidth requirement, which should lead to more reliable RTK lock.

RTK status indication:

1. To confirm the Base station telemetry units have been set up correctly the following should apply:
 - The Tx LED on the Base station telemetry unit should be flashing at 1Hz
 - The Rx LEDs on the Subject and Target Vehicles telemetry units should be flashing at 1Hz
2. Confirm that both VBOX units are now in RTK "Fixed" DGPS status, indicated by either of the following:
 - "DIFF" LED on the VBOX front panel is illuminated green, see Figure 7
 - A VBOX Tools live window set to Solution Type shows "RTK Fixed", see Figure 8

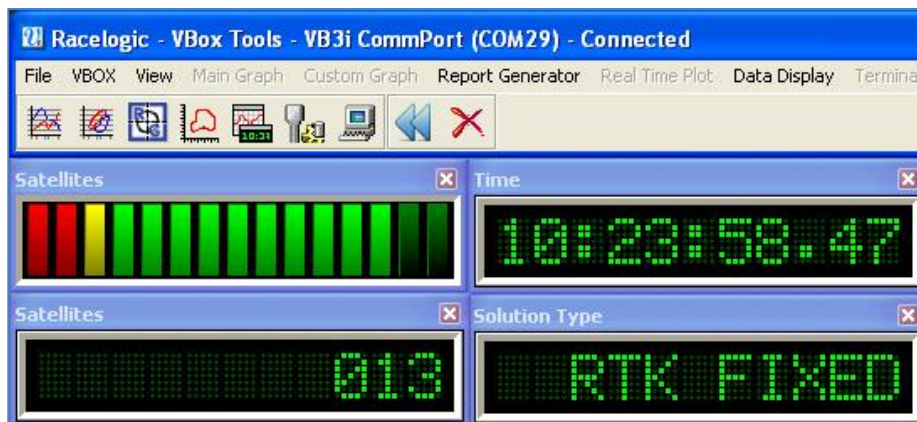


Figure 8: RTK Fixed Solution Type within VBOX Tools



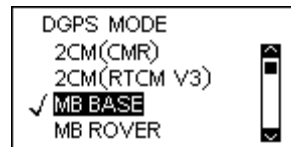
Figure 7: VBOX DGPS status indicator

Moving Base

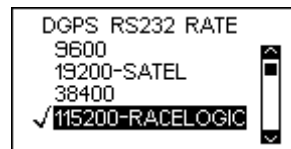
Moving Base solution removes the need for a fixed Base station to obtain accurate GPS position, thereby allowing vehicle separation testing to be carried out in real world environments and without the restrictions of Base station radio range.

To enable moving base mode step 7 and 8 are changed from 'Quick Start' section:

7. Select DGPS and set the DGPS mode to MB BASE, return to the VBOX setup menu

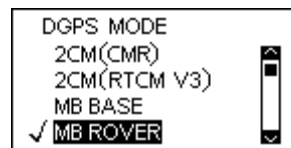


8. Select DGPS RS232 Rate and ensure that 115200 is selected, return to the VBOX setup menu

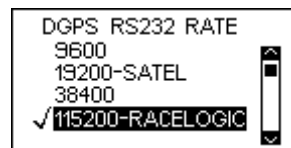


With the Target Vehicle adjust steps 7 and 8 as follows:

7. Select DGPS and set the DGPS mode to MB ROVER, return to the VBOX setup menu



8. Select DGPS RS232 Rate and ensure that 115200 is selected, return to the VBOX setup menu



RTK Status indication

As the Subject vehicle effectively becomes the Base station it will not physically go into an RTK lock, therefore the DIFF LED of the Subject VBOX will **NOT** illuminate.

The DIFF LED of the Target VBOX should gain RTK FIXED status indicated by the DIFF LED illuminating green

Pre-Test Configuration

Antenna Offsets

The vehicle separation firmware measures the straight line distance between the GPS antennas on each vehicle. In order to set a collision point on each vehicle an offset needs to be applied in each VBOX to account for the effective offset of the GPS antenna with respect to contact points. This can be done either manually or automatically:

Auto Offset

Ensure the GPS antennas are placed in the centre line of each vehicle

1. Move the Subject Vehicle behind the Target Vehicle, with the vehicle centres aligned, until the bumpers touch, as shown in Figure 9.

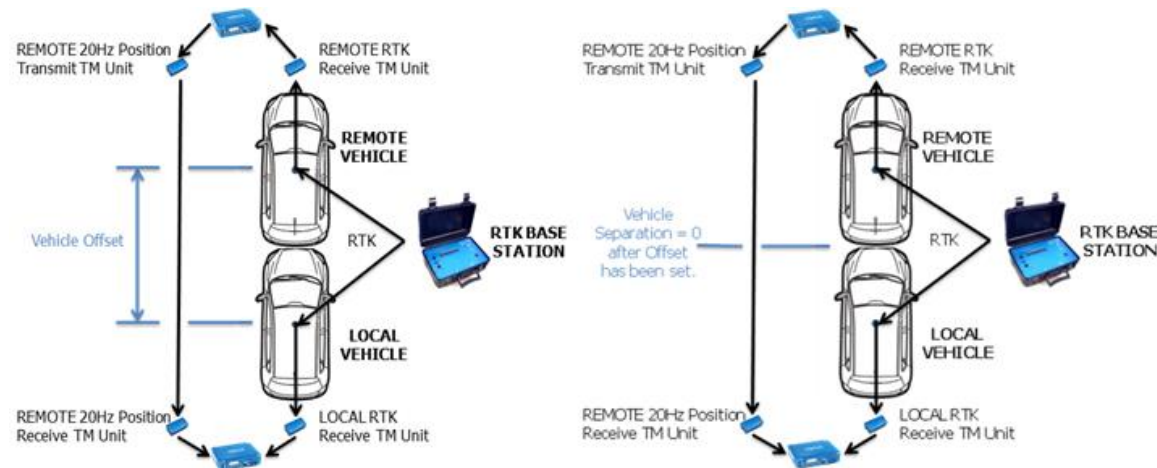
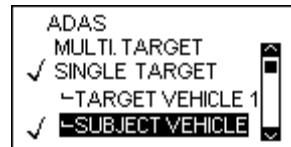


Figure 9: Auto Offset setup

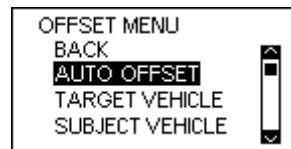
2. Using the VBOX manager, go to the ADAS menu and go to the Single target menu and select Subject Vehicle:



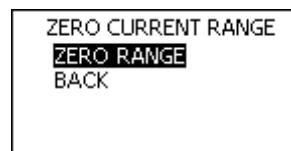
3. Select offset menu



4. Select auto offset



5. Select zero range, this will automatically apply the offsets to both vehicles, if a live data window is open within VBOX Tools the range values will be set to zero.

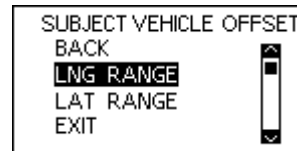


NOTE: The auto offset facility only applies a longitudinal offset so the antennas on each vehicle must be placed accurately on the centre line of the vehicles.

Manual Offset

GPS antenna offsets can be manually entered for both Subject and Target Vehicles. These values are applied through the Subject Vehicle.

1. Carefully measure the longitudinal and lateral distance in meters from the centre of the GPS antenna to the proposed contact point on each vehicle in a 2 dimensional plane (see Figure 10).
2. Repeat steps 2 and 3 from 'Auto Offset' section then select Subject Vehicle from the offset menu



3. Enter the longitudinal and lateral offset as per the conventions shown in Figure 10
4. Repeat the above steps but for the Target Vehicle rather than the Subject Vehicle.

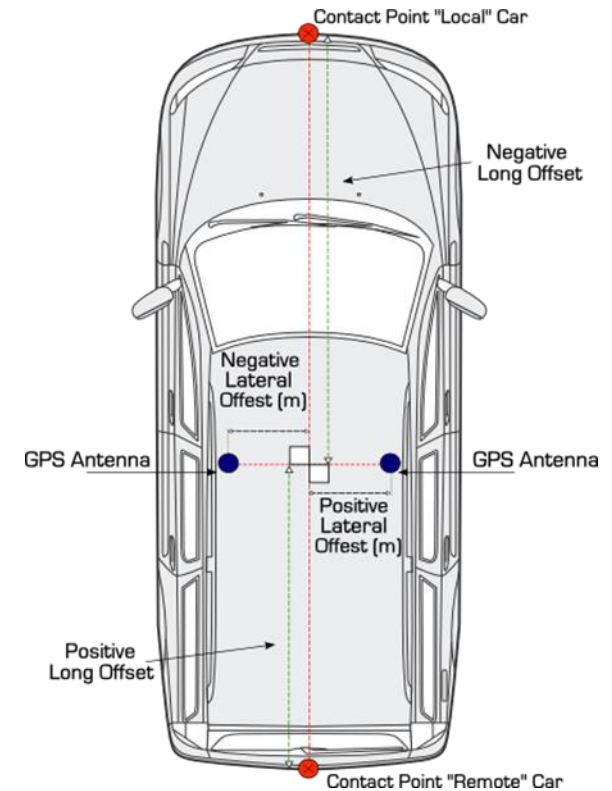
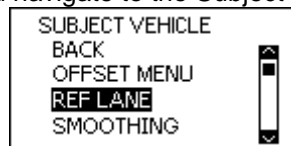


Figure 10: Longitudinal and Lateral offset in 2D plane.

Setting a reference line

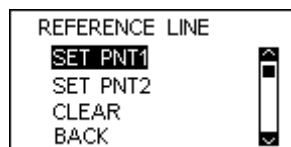
A reference line is used to provide a very stable heading reference for the calculation of a noise free Lateral Difference Channel (LatDif-tg1)
See Figure 17.

1. Under the Single Target option within the ADAS menu navigate to the Subject Vehicle option and select Ref Lane.



2. Move the vehicle to the first nominated point along a straight line that runs perfectly parallel to the test track (a good method for this is to get the outside front and rear tyres perfectly aligned on a marked straight line)

3. Within the Ref Lane Menu select SET PNT 1.



4. Move the vehicle to a distance at least 100m along the straight line, ensuring that the car is re-aligned.

5. Select SET PNT 2.

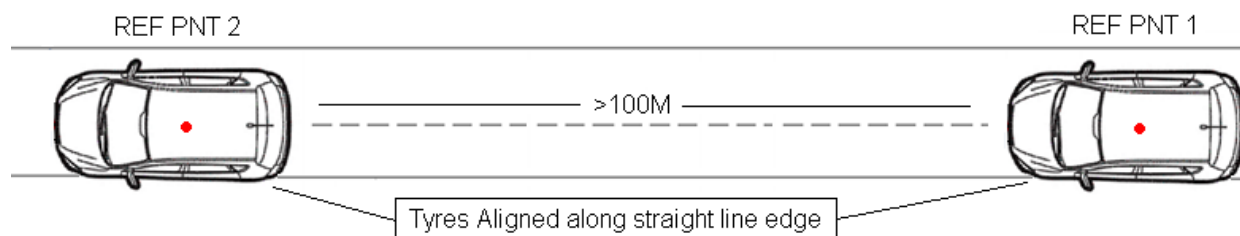
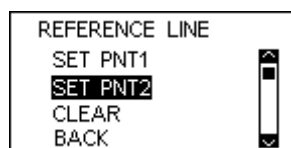


Figure 11: Vehicle alignment for a reference lane

Smoothing

There are two configurable variables linked to heading smoothing; 'Smoothing Distance' and 'Speed Threshold'. Due to the nature of the vehicle separation measurement and calculation process many channels are derived using the heading of the vehicle which can inherently be noisy. To overcome this heading can be smoothed with a dynamic smoothing routine.

Smoothing Distance

The vehicle heading is normally calculated between the current and previous sample. Even with the stability of RTK position GPS position can vary by a few millimetres with respect to the original. When the travelled distance between subsequent samples is short (low speeds) this leads to a potential larger potential error in the calculated heading. See Figure 12

This smoothing routine allows the user to force a 'Smoothing Distance' over which heading is calculated. This is therefore dynamic, resulting in a variable number of samples used to determine the smoothing level on the heading; the lower the speed the more samples that are used. With 100Hz logging and a smoothing distance of 1m at 72kph the heading is calculated over the previous 5 samples whilst at 15kph the heading would be calculated over the previous 26 samples.

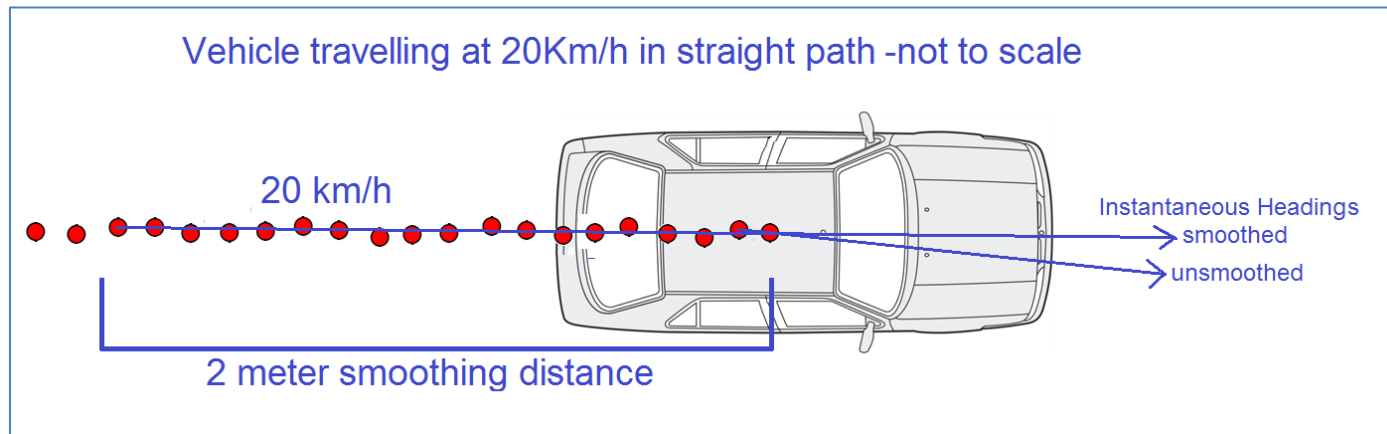


Figure 13: shows the improvement on vehicle heading from using smoothing distance

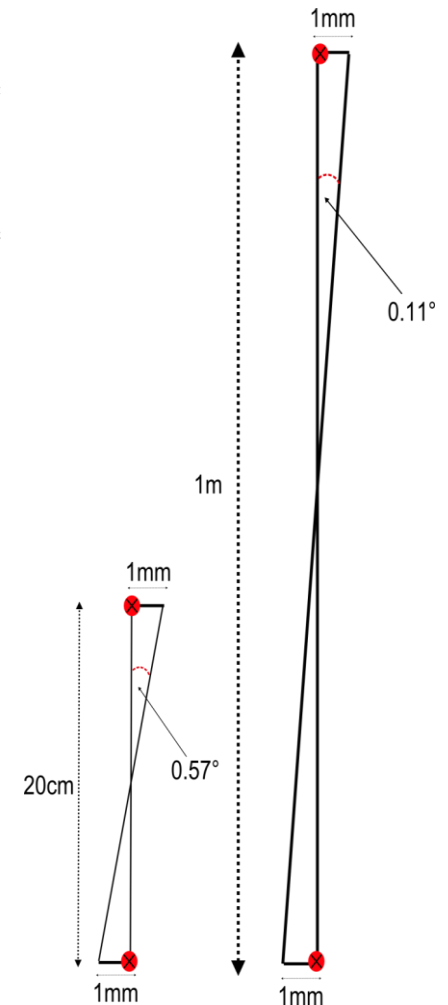
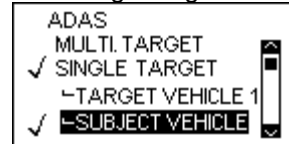


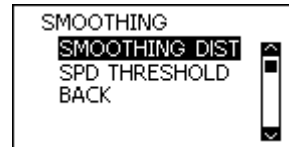
Figure 12: effect of distance on heading calculation

Setting a smoothing distance

- 1) Using the VBOX manager, go to the ADAS menu and go to the Single target menu and select Subject Vehicle:



- 2) Select 'SMOOTHING' from the SUBJECT VEHICLE menu.
- 3) Select 'SMOOTHING DIST' and enter the smoothing option for the Subject Vehicle, from the options between 0.00m and 2.00m.

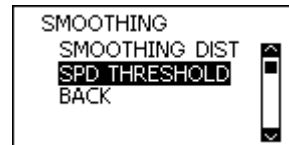


- 4) For typical Vehicle Separation applications we recommend a smoothing distance of 1m

Speed Threshold

Due to the nature of how heading is calculated, even when Smoothing is applied at very low speeds and when the vehicle is stationary the heading channel can become very noisy and unusable, this in turn results in many of the Vehicle Separation channels becoming noisy at low speed and unusable when stationary. This is solved by fixing the heading below a configurable Speed Threshold.

- 1) To set the speed threshold repeat steps 1 and 2 above, then select SPD THRESHOLD and enter the speed threshold option for the Subject Vehicle.



- 2) We recommend a Speed Threshold of 5km/h.

Parameter Definitions

The following table provides a list of channels capable of being calculated in each vehicle. For Single Vehicle Target testing Racelogic refers to each vehicle as the 'Subject Vehicle' or the 'Target Vehicle'. For example, under testing for adaptive cruise control the lead vehicle will be the Target Vehicle, whilst the following vehicle (where the adaptive cruise control is being testing) is referred to as the Subject Vehicle.

Channel name definition. Where the channel name is not obvious, then it is made up of three parts.

LngRsv|tg1

The first part is the parameter type i.e. **LngR** = Longitudinal Range

The second part indicates which vehicle heading is being used in the calculation of this parameter i.e. **sv** = subject vehicle

The last part indicates which vehicle is parameter is being calculated with reference to, i.e. **tg1** = Target Vehicle 1

Channel Name	Channel Description	Units
Range-tg1	Direct Distance between Subject and Target vehicle	Meters
LngRsv-tg1	Longitudinal distance between the Subject and Target Vehicles measured in the direction of the Subject Vehicle heading	Meters
LatRsv-tg1	Lateral distance between the Subject and Target Vehicles measured at right angles to the Subject Vehicle heading	Meters
LatRreftg1	The lateral difference between the two vehicles based on the heading of the test track*	Meters
T2Csv-tg1	Time to Collision with Target Vehicle derived from the LngRsv-tg1 and LngSsv-tg1 channels	Seconds
T2C2sv-tg1	Time to Collision with a decelerating Target Vehicle derived from the LngRsv-tg1, LngSsv-tg1 and Accel-tg1 channels**	Seconds
RelSpd-tg1	The relative speed between the Subject and Target Vehicles	Km/h
LngRtg-tg1	Longitudinal distance between the Subject and Target Vehicles measured in the direction of the Target Vehicle heading	Meters
LatRtg-tg1	Lateral distance between the Subject and Target Vehicles measured at right angles to the Target Vehicle heading	Meters
Angle-tg1	Angle to the Target Vehicle with respect to the heading of the Subject Vehicle	Degrees
Latdif-tg1	The difference between Subject Vehicle and Target Vehicle latitude	Minutes
Lngdif-tg1	The difference between Subject Vehicle and Target Vehicle longitude	Minutes
Spd-tg1	Target Vehicle course over ground speed	Km/h
Accel-tg1	Target Vehicle acceleration calculated from Target Vehicle speed and time	g

Cont'd on next page

Channel Name	Channel Description	Units
LngSsv-tg1	The speed between the Subject and Target Vehicles in the longitudinal direction, with respect to Subject vehicle heading	Km/h
LatSsv-tg1	The speed between the Subject and Target Vehicles in the lateral direction, at right angles to the Subject vehicle heading	Km/h
Status-tg1	The DGPS status of the Target vehicle VBOX	N/A
Status-sv	The DGPS status of the Subject vehicle VBOX	N/A
LkTime-tg1	Rolling time sent over the 2.4Ghz Radio Link, that is used to indicate the quality of the radio link between vehicles ***	N/A
App_Mode	The current operating mode of the Subject VBOX ****	N/A
SepTim-tg1	The time it would take the Subject Vehicle to travel across the Vehicle separation distance at its current speed	Seconds
T2Ctg-tg1	Time to Collision with Target Vehicle, derived from the LngRtg-tg1 and Target vehicle long range speed.	Seconds
Yawdif-tg1	This angle is the difference between subject and target vehicle headings.	Degrees
YawRat-tg1	YAW rate of the Target vehicle, only available when an IMU is connected to the VBOX in the target vehicle	Degrees/Sec

Table 1: Single Vehicle separation channel table

*See Figure 17;

**See section 'Time to Collision';

***See section 'ADAS Radio Link';

****See section 'APP Mode'

A number of the parameters shown in the table above are outlined in schematics over the next few pages in order to give a clear visualisation of how they are calculated.

'LngRsv-tg1', 'LatRsv-tg1'

Longitudinal and Lateral Range with respect to subject vehicle heading

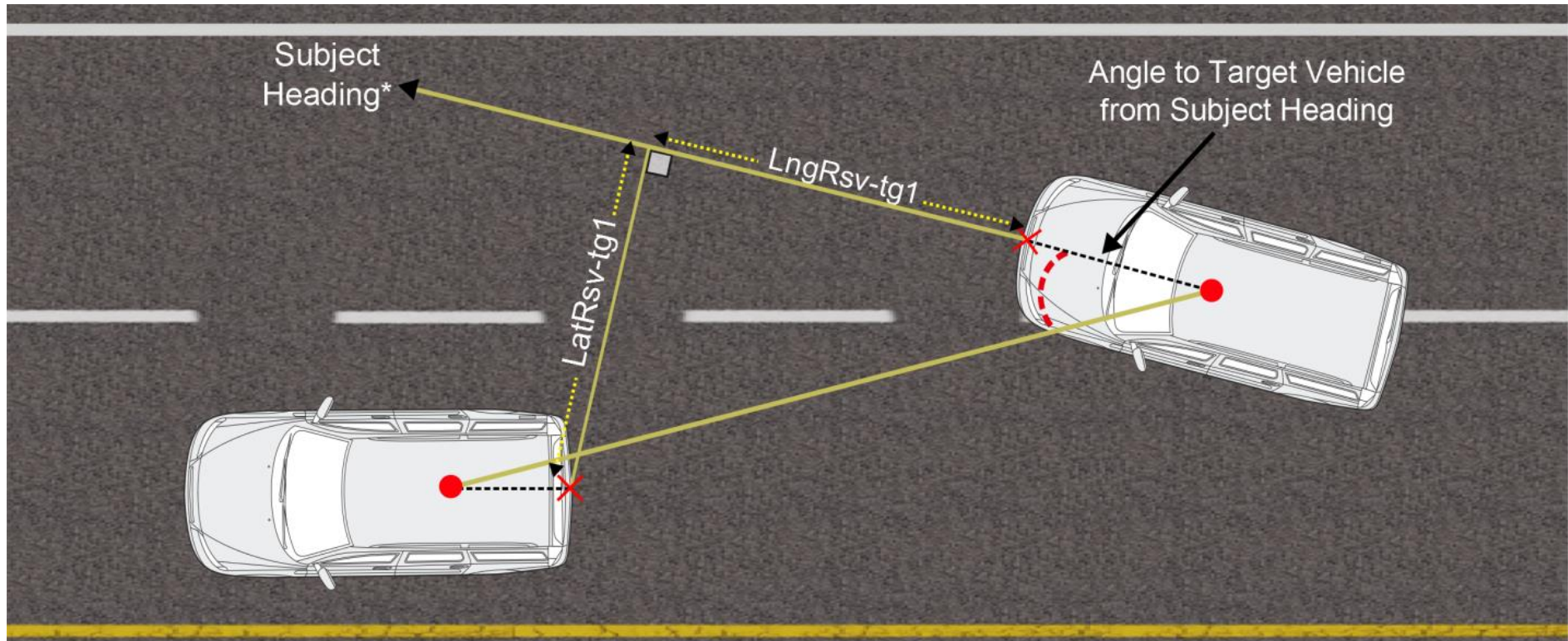


Figure 14: Long Range and Lat Range parameter definition

NOTE: The `LatRsv-tg1` and `LngRsv-tg1` values are calculated from offset points on each respective vehicle. Details of how to apply these offsets is provided in the quick start guide later in this manual (Section 'Pre-test configuration').

'LngRtg-tg1', 'LatRtg-tg1'

Longitudinal and Lateral Range with respect to target vehicle heading

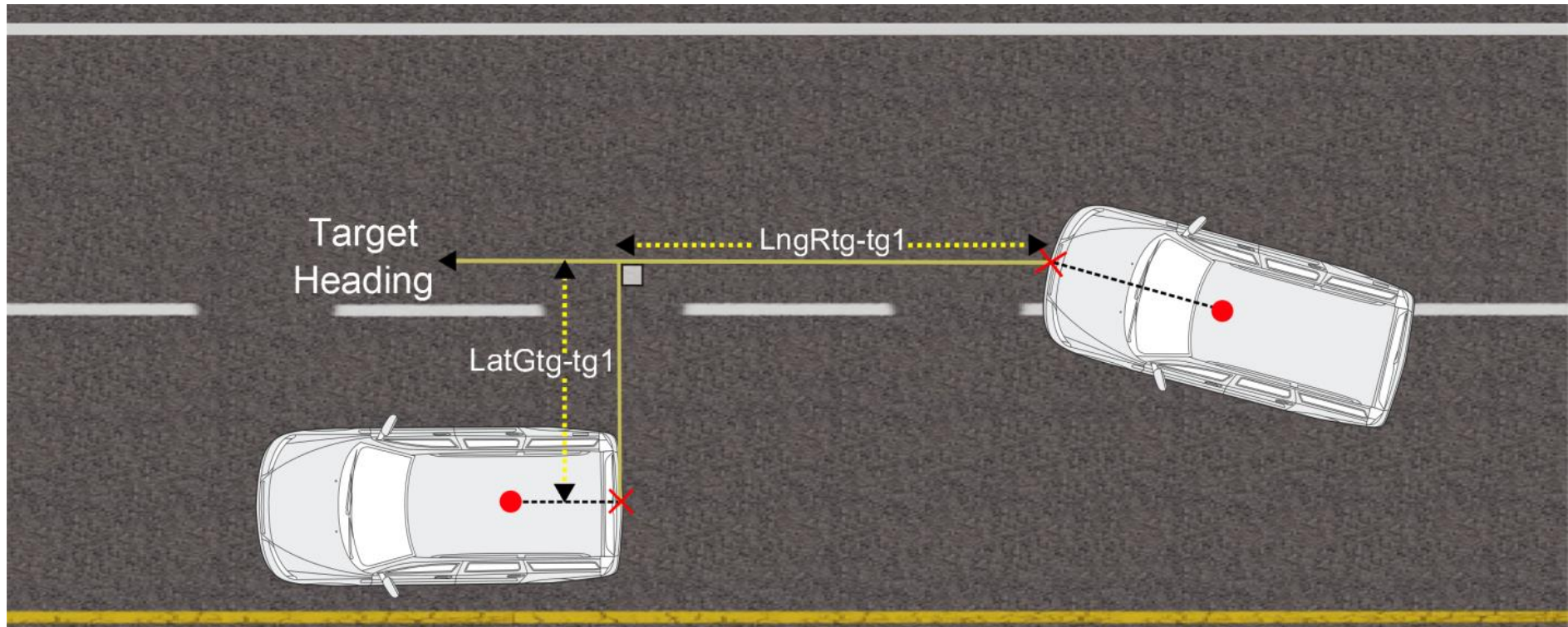


Figure 15: LngRtg-tg1 and LatRtg-tg1 parameter definition

*Target Heading is a standard channel logged in the Target Vehicle, but only used in calculations at the Subject Vehicle

'LatRreftg1'

Lateral difference between two vehicles based on an external reference heading

It is a requirement of the National Highway Traffic Safety Administration "Forward Collision Warning System NCAP Confirmation Test March 2012" confirmation tests that the Subject Vehicle (SV) remains within 0.6m of the centre line of the Target Vehicle (in the standard referred to as Principle Other Vehicle - POV).

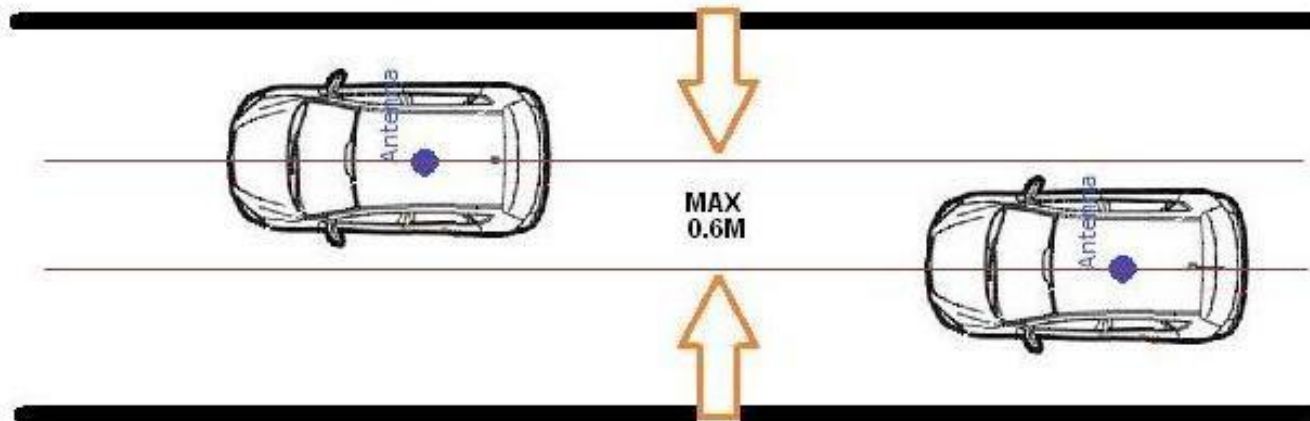


Figure 16: Range calculations using a reference lane for NHTSA FCWS confirmation test

If this Lateral Range channel was based purely on vehicle heading then the resultant value would be extremely susceptible to noise. Small fluctuations in the Subject or Target Vehicle heading will result in fluctuations in Lateral Range greater than the NHTSA standard, the following example demonstrates this principle:

Heading fluctuation of 0.5 deg over a vehicle separation of 100M.

$$\tan 0.5 \times 100 = 0.87M$$

By using a Reference lane heading a very stable Lateral Range channel is generated. Please see section 2.5.4 for details on how to record a reference lane.

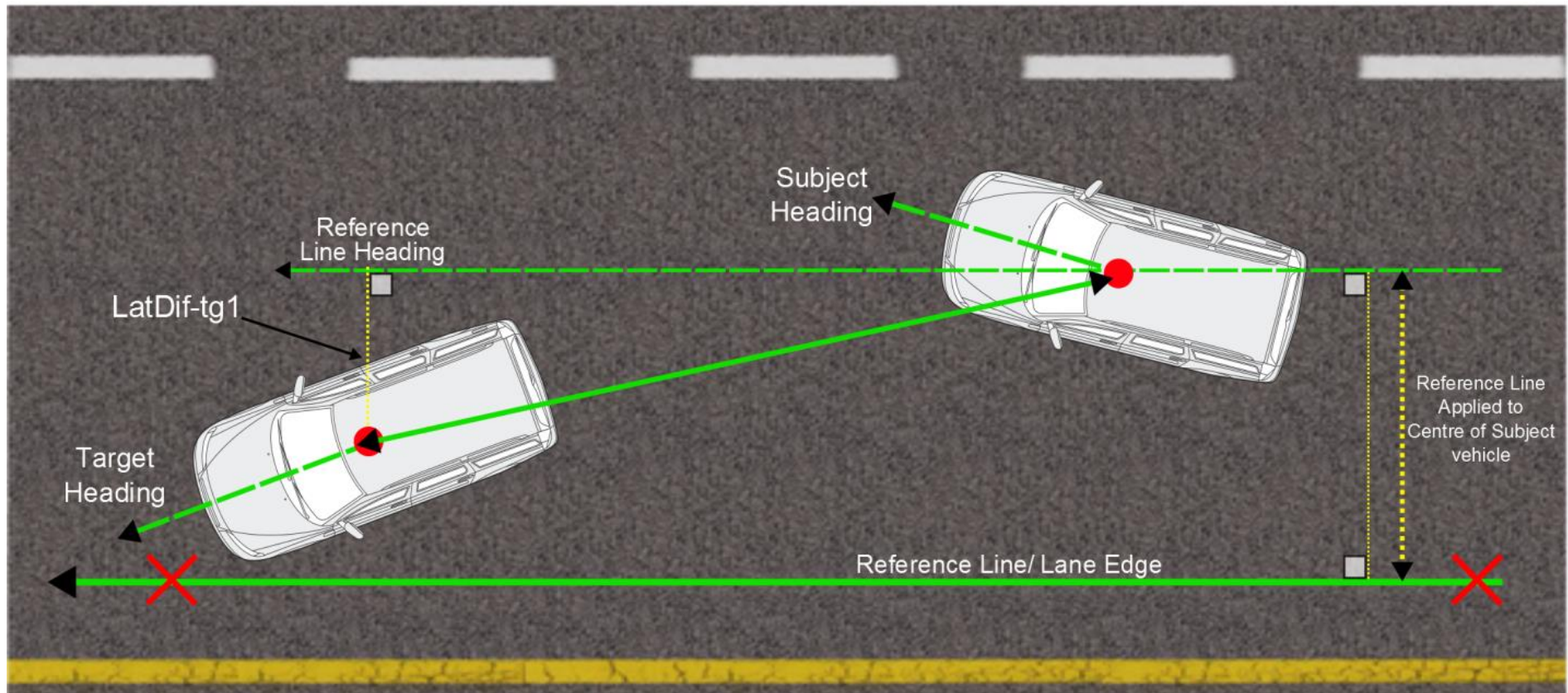


Figure 17: LatDif-tg1 calculations using a heading of a reference lane

Time to Collision

T2Csv-tg1

Time to collision based on Longitudinal Range from subject vehicle to Target vehicle based on subject vehicle heading and Longitudinal Speed.

$$T2Csv-tg1 = \frac{LngRsv-tg1}{LngSsv-tg1(\frac{m}{s})}$$

T2C2sv-tg1

Time to collision taking into account a decelerating target vehicle

NHTSA provide the following equation to account for a decelerating target vehicle in test 2 of their FCWS NCAP confirmation test.

$$T2C2sv-tg1 = \frac{-(V_{pov}-V_{sv}) + \sqrt{(V_{pov}-V_{sv})^2 - 2 \times a_{pov} \times S_{sv}}}{a_{pov}}$$

V_{pov} = Velocity of Principle Other Vehicle (Target Speed)

V_{cv} = Velocity of Subject Vehicle (Speed)

a_{pov} = Acceleration of Principle Other Vehicle (Target Accel)

S_{sv} = Longitudinal distance from Subject Vehicle to Target Vehicle (LngRange)

T2Ctg-tg1

Time to collision based on Longitudinal Range from subject vehicle to Target vehicle based on target vehicle heading and Target vehicle longitudinal Speed.

$$T2Ctg-tg1 = \frac{LngRtg-tg1}{LngStg-tg1(\frac{m}{s})}$$

Link Time 'LkTime-tg1'

This channel is a time based incremental value based on Target Vehicle UTC time. A good link will show a trace incrementing ever 10mS with no drops to zero. Once this value reaches 65535 it is reset to zero.

Link Time is a good indicator of ADAS radio link quality, If this incremental count drops out and falls to zero then it is a likely indication that the ADAS radio link has intermittently failed.

The VBOX ADAS system will suffer occasional single sample drops outs, which are acceptable but larger periods of time with full or intermittent drop outs are an indicator of a Radio problem that needs addressing.

See also section Radio Link

Separation Time; SepTim-tg1

For Adaptive Cruise control testing; time it would take the Subject Vehicle to travel across the Vehicle separation distance at its current speed

$$\text{SepTim-tg1} = \frac{\text{LngRtg-tg1}}{\text{Speed}(\frac{m}{s})}$$

App Mode

This channel indicates the current operating mode of the VBOX

App_Mode Value	Description
1	Normal
2	Target
4	Subject
8	Static
10	Lane Departure – Lane 1
0x50	Lane Departure – Lane 2
0x90	Lane Departure – Lane 3

Table 2: App_Mode definitions

Single Target 'Duplex mode'

In this mode all of the Vehicle Separation parameters are also calculated at the Target vehicle. This is facilitated by creating a 'Duplex' ADAS radio link between the Subject and Target Vehicle.

This is **NOT** possible in 'Multi Target' mode

The channels calculated in the Target vehicle are the same as the channels calculated by the VBOX in the Subject vehicle. They are not new channels calculated in opposite respect; Target to Subject.

Duplex Mode Benefits

- All vehicle separation channels can be viewed live by the driver of the Target Vehicle.
- A Throttle and Braking robot can be connected to the Target VBOX CAN Bus so that the separation and speed of the Target vehicle can be controlled more consistently.
- The logging of the Target vehicle VBOX can be automatically synchronised to the Subject vehicle logging.

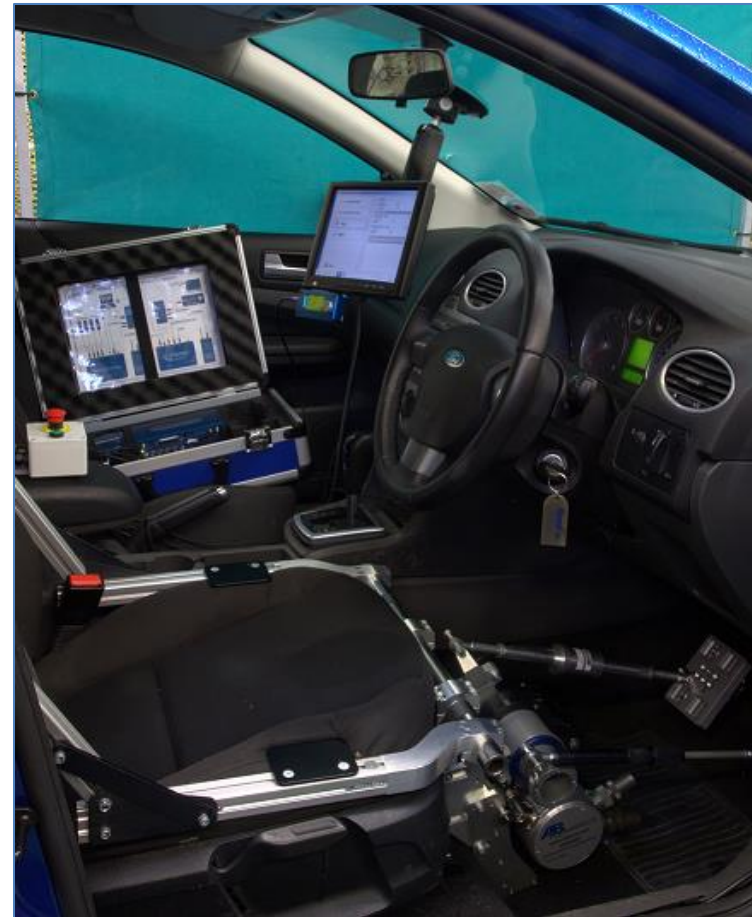


Figure 18: Throttle and Brake robot

Hardware configuration

The hardware at the Subject vehicle should be connected as per Figure 2, except from the following important change.

The ADAS link radio needs to be unplugged from the 'RX' socket and plugged into the unlabelled socket on the RLVBACS024/1 splitter. See Figure 19
This will allow a full Duplex link to exist between the Subject and Target VBOX's.

You should now see that the RX and TX lights of both ADAS radios will now be flashing.

Pre-Test Configuration

The Duplex Radio link allows any configurations that are set in the Subject VBOX to be instantly communicated to the Target VBOX, so that both boxes produce the same values for all Veh Sep parameters.

On power up and during the first communication between each VBOX there will also be a synchronisation of configurations between each VBOX.

Logging

It is possible to synchronise the logging of both VBOX's in this Duplex mode.

To make this possible:

- Set the logging mode in both VBOX's to 'Log Continuously'
- Connect the VBOX manager to the Subject vehicle VBOX.
- Then use the VBOX manager to start and stop the file logging.

The logging of data at the Target vehicle will stop and start in synch with the VBOX manager control.

Note: if you stop the logging with the 'LOG' button on the Target VBOX then you will overwrite this auto-logging control.

Moving Base

It is possible to use Moving Base mode when in Duplex mode. However the extra amount of 2.4GHz radio in close proximity can degrade the ADAS radio link, which can result in more dropouts and reduced range.

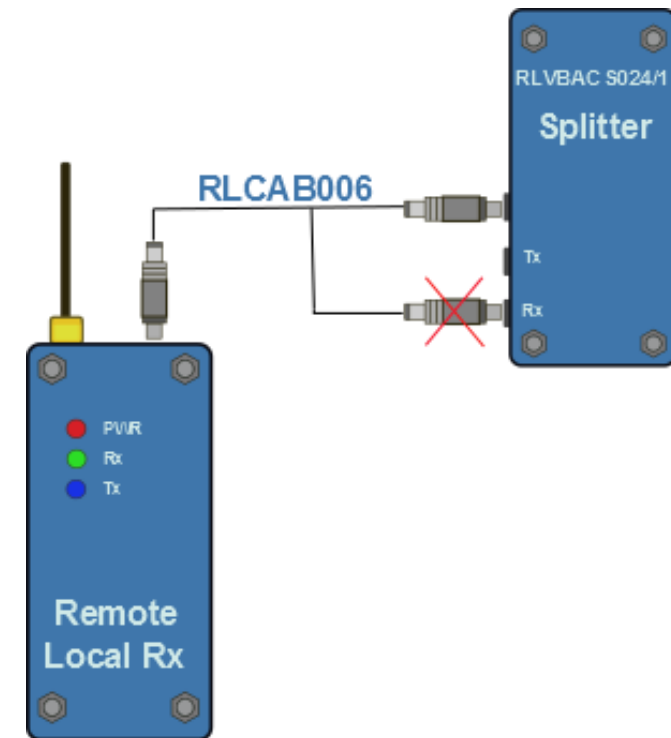


Figure 19: Duplex ADAS radio connection

Target Vehicle Channels

The vehicle separation channels calculated at the Target vehicle are essentially exactly the same as the channels calculated at the subject vehicle except for the channels highlighted in the table below.

Channel Name	Channel Description	Units
Range-tg1	Direct Distance between Subject and Target vehicle	Meters
LngRsv-tg1	Longitudinal distance between the Subject and Target Vehicles measured in the direction of the Subject Vehicle heading	Meters
LatRsv-tg1	Lateral distance between the Subject and Target Vehicles measured at right angles to the Subject Vehicle heading	Meters
LatRreftg1	The lateral difference between the two vehicles based on the heading of the test track*	Meters
T2Csv-tg1	Time to Collision with Target Vehicle derived from the LngRsv-tg1 and LngSsv-tg1 channels	Seconds
T2C2sv-tg1	Time to Collision with a decelerating Target Vehicle derived from the LngRsv-tg1, LngSsv-tg1 and Accel-tg1 channels**	Seconds
RelSpd-tg1	The relative speed between the Subject and Target Vehicles	Km/h
LngRtg-tg1	Longitudinal distance between the Subject and Target Vehicles measured in the direction of the Target Vehicle heading	Meters
LatRtg-tg1	Lateral distance between the Subject and Target Vehicles measured at right angles to the Target Vehicle heading	Meters
Angle-tg1	Angle to the Target Vehicle with respect to the heading of the Subject Vehicle	Degrees
Latdif-tg1	The difference between Subject Vehicle and Target Vehicle latitude	Minutes
Lngdif-tg1	The difference between Subject Vehicle and Target Vehicle longitude	Minutes
Spd-sv	Subject Vehicle course over ground speed	Km/h
Accel-tg1	Target Vehicle acceleration calculated from Target Vehicle speed and time	g
LngSsv-tg1	The speed between the Subject and Target Vehicles in the longitudinal direction, with respect to Subject vehicle heading	Km/h
LatSsv-tg1	The speed between the Subject and Target Vehicles in the lateral direction, at right angles to the Subject vehicle heading	Km/h
Status-tg1	The DGPS status of the Target vehicle VBOX	N/A
Status-sv	The DGPS status of the Subject vehicle VBOX	N/A
LkTime-sv	Rolling time sent over the 2.4Ghz Radio Link, that is used to indicate the quality of the radio link between vehicles ***	N/A
App_Mode	The current operating mode of the Subject VBOX ****	N/A
SepTim-tg1	The time it would take the Subject Vehicle to travel across the Vehicle separation distance at its current speed	Seconds
T2Ctg-tg1	Time to Collision with Target Vehicle, derived from the LngRtg-tg1 and Target vehicle long range speed.	Seconds
Yawdiff-tg1	This angle is the difference between subject and target1 vehicle headings.	Degrees
YawRat-sv	YAW rate of the Target1 vehicle, only available when an IMU is connected to the VBOX in the target vehicle	Degrees/Sec

*See Figure 17;

**See section 'Time to Collision';

***See section 'ADAS Radio Link';

****See section 'APP Mode'

Multiple Vehicle Targets

This mode facilitates the ability for vehicle separation parameters to be calculated at the Subject vehicle with respect to two Target vehicles. This system consists of a VBOX3iSL-RTK in each Target vehicle and a VBOX3iSL-RTK in the Subject vehicle.

NOTE: it is not possible to operate in Duplex mode with multiple Target vehicles.

Hardware configuration

Subject Vehicle Configuration

The equipment is required to be setup in the Subject vehicle exactly as described in 'Single target mode' shown in Figure 2,

Target Vehicle Configuration

The equipment in each Target vehicle should be setup as shown in Figure 3

ADAS link radios

You must use Radio modems programmed with different configuration scripts, for multiple Target mode, it is not possible to use the normal ADAS link radios.

The Radios at each Target VBOX need to set to 'server' mode and paired to the singular ADAS radio at the Subject vehicle. And the Radio at the Subject vehicle needs to set to 'client' and 'broadcast' mode.

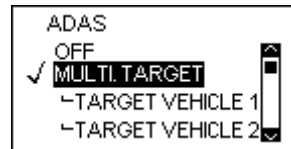
Please consult Racelogic or your local Racelogic distributor for further configuration instruction.

Quick Start – VBOX Configuration

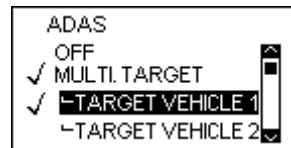
Target Vehicle 1

Follow steps 1-8 of 'Single Target mode' 'Quick start guide'

9. Return to the main setup menu and select the ADAS option



10. Select MULTI TARGET mode and select TARGET VEHICLE 1, return to the ADAS setup menu



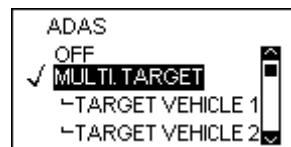
Target Vehicle 2

Repeat steps 1 to 8 of 'Single Target mode' 'Quick start guide'

Select MULTI TARGET mode and select TARGET VEHICLE 2, return to the ADAS setup menu

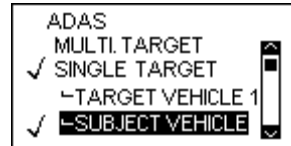


9. Return to the main setup menu and select the ADAS option



Subject Vehicle

1. Connect the VBOX Manager to the VBOX in the Subject Vehicle
2. Repeat steps 2 – 9 of 'Single Target mode' 'Quick start guide'
3. Select SINGLE TARGET mode and select SUBJECT VEHICLE, return to the ADAS setup menu



Multi Target RTK DGPS Configuration

Static Base

The configuration of each VBOX in the Multiple Target system for use with a static Base station is the same as described in the Single Target Base station Configuration section.

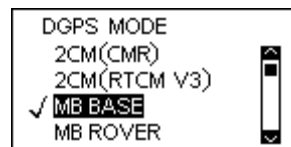
Moving Base

Moving Base solution removes the need for a fixed Base station to obtain accurate GPS position, thereby allowing vehicle separation testing to be carried out in real world environments and without the restrictions of Base station radio range.

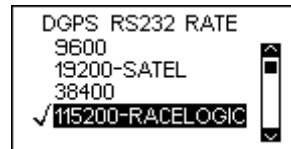
To enable moving base mode step 7 and 8 are changed from Single Target 'Quick Start' section:

Subject Vehicle

7. Select DGPS and set the DGPS mode to MB BASE, return to the VBOX setup menu

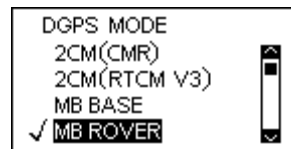


8. Select DGPS RS232 Rate and ensure that 115200 is selected, return to the VBOX setup menu

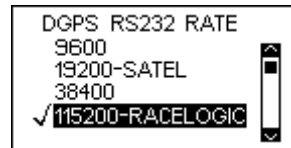


With the VBOX's in the Target Vehicles adjust steps 7 and 8 as follows:

7. Select DGPS and set the DGPS mode to MB ROVER, return to the VBOX setup menu



8. Select DGPS RS232 Rate and ensure that 115200 is selected, return to the VBOX setup menu



RTK Status indication

As the Subject vehicle effectively becomes the Base station it will not physically go into an RTK lock, therefore the DIFF LED of the Subject VBOX will **NOT** illuminate.

The DIFF LED of the Target VBOX's should gain RTK FIXED status indicated by the DIFF LED illuminating green

Pre-Test Configuration

Antenna Offsets

The vehicle separation system measures the straight line distance between the GPS antennas on each vehicle. A vehicle separation offset needs to be applied to account for the effective offset of the GPS antenna with respect to contact points on the vehicles.

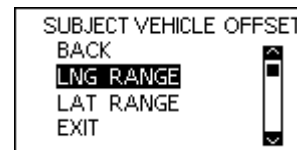
Auto Offset

It is not possible to use the Auto offset facility in Multi Target mode.

Manual Offset

GPS antenna offsets can be manually entered for the Subject and both Target Vehicles. These values are applied through the Subject Vehicle.

1. Carefully measure the longitudinal and lateral distance from the centre of the GPS antenna to the proposed contact point on each vehicle in a 2 dimensional plane, see Figure 20.
2. Repeat steps 2 and 3 from Single Target 'Auto Offset' section then select Subject Vehicle from the offset menu



3. Enter the longitudinal and lateral offset as per the conventions shown in Figure 20.
4. Repeat the above steps for each of the Target Vehicles.

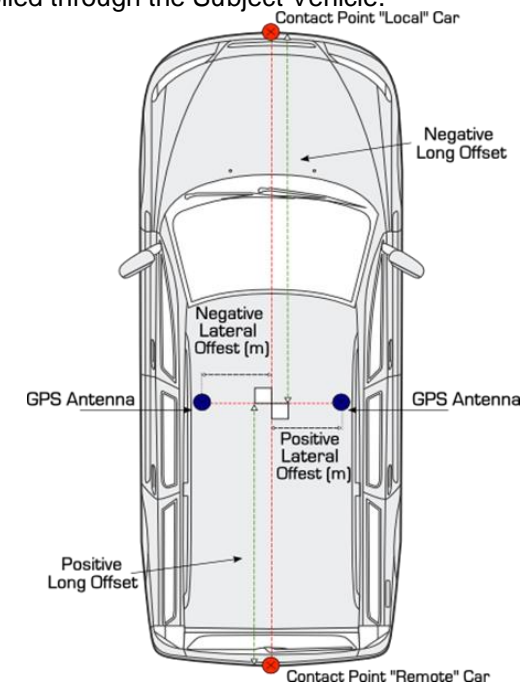


Figure 20: Longitudinal and Lateral offset in 2D plane.

Setting a reference line

A reference line is set in the same way as outlined in the 'Single Target Vehicle' section of this manual.

Smoothing Levels

The smoothing levels are set in the same way as outlined in the 'Single Target Vehicle' section of this manual.

Parameter Definitions

The channels recorded by the Racelogic ADAS solution when configured in multiple vehicle mode are very similar to the channels available with single vehicle mode. In multi –target mode channel naming now changes such to indicate channels calculated with respect to, Target Vehicle 1 and Target Vehicle 2. As there are now three vehicles involved with this testing the number of channels increases at the Subject Vehicle, this is reflected in the table below: Channels based on Target 1 vehicle are the same as the channels description table Table 1
New Target 2 vehicle separation channels calculated at the Subject vehicle are shown below in Table 3

Channel Name	Channel Description	Units
Range-tg2	Distance between the Subject Vehicle and Target Vehicle 2	Meters
LngRsv-tg2	Longitudinal distance between the Subject and Target Vehicle 2 measured in the direction of the Subject Vehicle heading	Meters
LatRsv-tg2	Lateral distance between the Subject and Target Vehicle 2 measured at right angles to the Subject Vehicle heading	Meters
LatRleftg2	The lateral difference between the Subject Vehicle and Target Vehicle 2 based on the heading of the test track*	Meters
T2Csv-tg2	The time before impact on Target Vehicle 2 derived from the LngRsv-tg2 and LngSsv-tg2 channels	Seconds
T2C2sv-tg2	The time before impact on Target Vehicle 2 derived from the LngRsv-tg2, LngSsv-tg2 and Accel-tg2 channels #	Seconds
RelSpd-tg2	The relative speed between the Subject Vehicle and Target Vehicle 2	Km/h
LngRtg-tg2	Longitudinal distance between the Subject and Target Vehicle 2 measured in the direction of Target Vehicle 2 heading	Meters
LatRtg-tg2	Lateral distance between the Subject and Target Vehicle 2 measured at right angles to Target Vehicle 2 heading	Meters
Angle-tg2	The angle of Target Vehicle 2 in relation to the heading of the Subject Vehicle	Degrees
Latdif-tg2	The difference between the Subject Vehicle and Target Vehicle 2 latitude	Minutes
Lngdif-tg2	The difference between the Subject Vehicle and Target Vehicle 2 longitude	Minutes
Spd-tg2	Target Vehicle 2 course over ground speed	Km/h
Accel-tg2	Target Vehicle 2 acceleration calculated from Target Vehicle 2 speed and time	g
LngSsv-tg2	The speed between the Subject and Target Vehicle 2 in the longitudinal direction, in the direction of the Subject heading	Km/h
LatSsv-tg2	The speed between the Subject and Target Vehicle 2 in the lateral direction, at right angles to the Subject heading	Km/h
Status-tg2	The DGPS status of the VBOX within Target Vehicle 2	N/A
Status-sv	The DGPS status of the VBOX within the Subject Vehicle	N/A

LkTime-tg2	Time based channel for showing quality of radio link between the Subject Vehicle and Target Vehicle 2 \$	N/A
App_Mode	The current operating mode of the Subject VBOX ^	N/A
SepTim-tg2	The time it would take the Subject Vehicle to travel across the vehicle separation distance at its current speed	Seconds
T2Ctg-tg2	The time before impact on Target Vehicle 2 derived from the LngRtg-tg2 and LngSpdtg-tg2 channels	Seconds
Yawdif-tg2	This angle is the difference between subject and target2 vehicle headings.	Degrees
YawRat-tg2	YAW rate of the Target2 vehicle, only available when an IMU is connected to the VBOX in the target vehicle	Degrees/s

Table 3: Multi Vehicle separation channel table - Subject Vehicle

*See Figure 17;

**See section 'Time to Collision';

***See section 'ADAS Radio Link';

****See section 'APP Mode'

Lane Departure Warning

The Racelogic Lane Departure system allows for accurate measurement of range and speed with respect to a defined lane edge; ideal for testing vehicle Lane Departure Warning Systems. Combining the VB3iSL-RTK with the Video VBOX and vehicle CAN data provides a complete vehicle testing package.

Lane Departure Warning testing consists of two stages,

1. Lane Survey; During this stage line edges can be surveyed in two ways:
 - Straight Line edges, surveyed by marking 2-8 points along the straight line edge.
 - Curved Line edges, surveyed using the Lane Survey trolley (RLACS173-XXX*) to provide an accurate survey of the lane under test. (*XXX denotes the type radio frequency – please refer to your local distributor for further information)
2. Measurement Tests; in this stage the surveyed line edges are loaded into the test VBOX to act as a measurement reference. Then the Lane Departure test can be conducted with the VBOX measuring all of the parameters listed below with respect to the surveyed lane edge.

Measured parameters

The following table provides a list of channels capable of being logged in the Subject Vehicle during a lane departure warning system test.

Channel Name	Channel Description	Units
Range_Lt	Perpendicular range to the reference lane from the left hand offset	Meters
LatSpd_Lt	Lateral speed of the vehicle towards the reference lane from the left hand offset	Km/h
TTC_Lt	Time to cross the reference lane calculated from the Range_Lt and LatSpd_Lt	Seconds
Range_Rt	Perpendicular range to the reference lane from the right hand offset	Meters
LatSp_Rt	Lateral speed of the vehicle towards the reference lane from the right hand offset	Km/h
TTC_Rt	Time to cross the reference lane calculated from the Range_Rt and LatSpd_Rt	Seconds
Angle	The Angle between the vehicle heading and the tangent of the reference lane at the point where range is calculated	Degrees
Status		

Table 4: Lane departure warning system channel table

Additional parameters

The VBOX retains all of its normal functionality so it is possible for it to also log data from external CAN busses, Analogue and Digital sensors.

Vehicle Lane Departure warning can be captured using one of these input modes and compared to the Lane Departure parameters measured by the VBOX. A Video VBOX can also be connected for added synchronised Video logging.

Hardware Configuration

Lane Survey Configuration

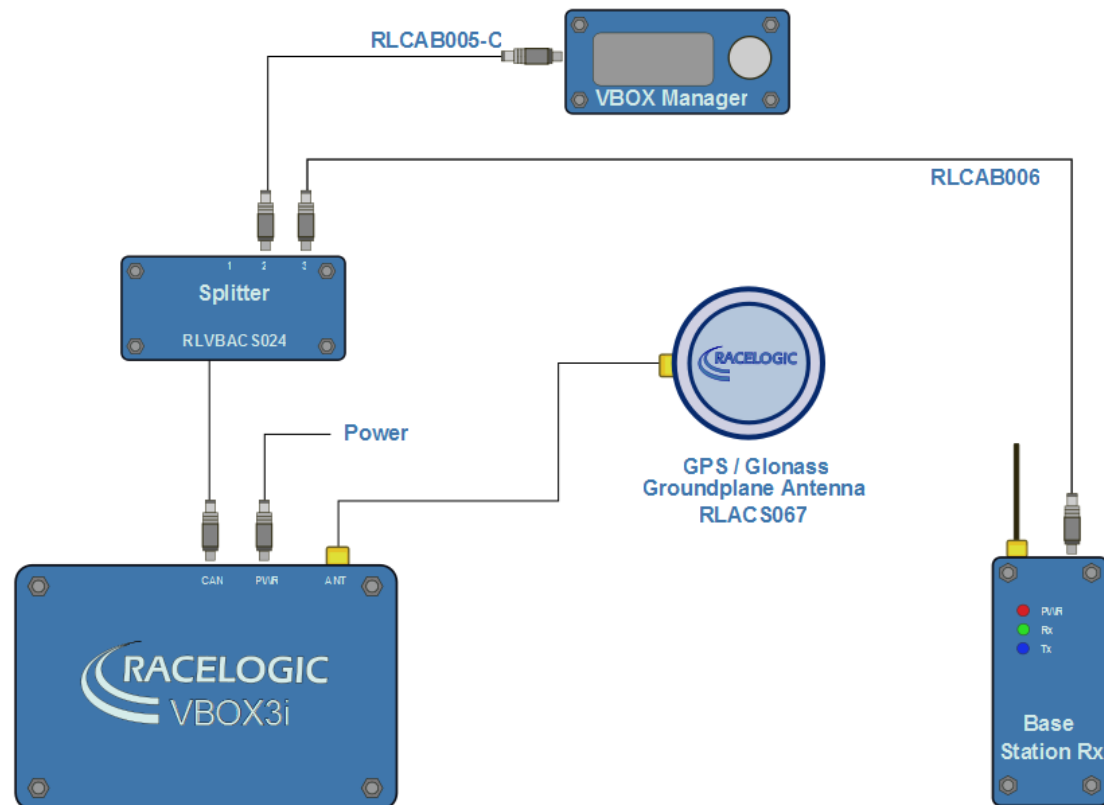


Figure 21: Lane Survey Hardware configuration

Lane Departure Warning Test Schematic

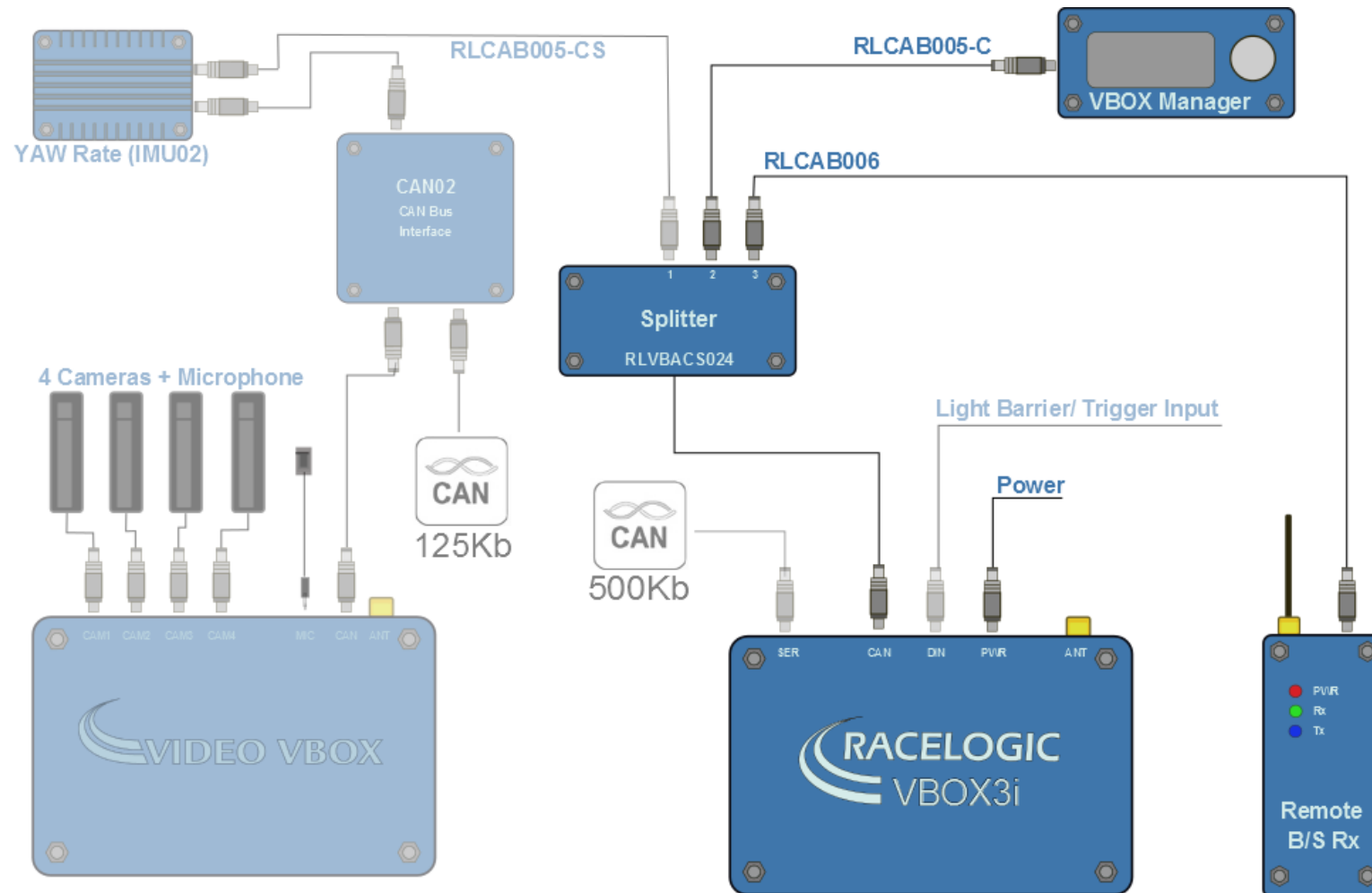


Figure 22: Lane Departure Warning Test hardware configuration

Quick Start – VBOX Configuration

Base station

A static Base station must be used for the VBOX to gain the RTK 2cm positional accuracy. This is required for the lane survey as well as during testing. Moving Base cannot be used because a static Base station is the only way to create a reference to a static location, which then allows measurement to other static objects like lane edges.

See the Base station user guide for Base station installation guide.

Important Note: The Base station GPS antenna must be in exactly the same location for lane survey and for subsequent testing. It is also good practice to save the location into the Base station memory.

The VBOX front panel will indicate the required RTK Fixed status, with the illumination in green of the diff light.

A VBOX Tools live window set to Solution Type shows “RTK Fixed”.

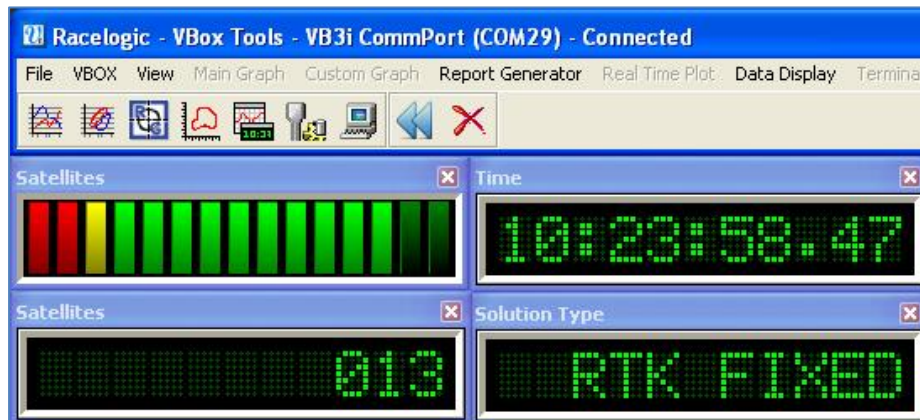


Figure 24: RTK Fixed Solution status shown in VBOXTools



Figure 23: VBOX DGPS status indicator

Process summary

Using the Racelogic ADAS systems there are two setup methods dependant on the straightness of the test lane edge. The following schematic shows the options for determining Lane Departure Warning parameters.

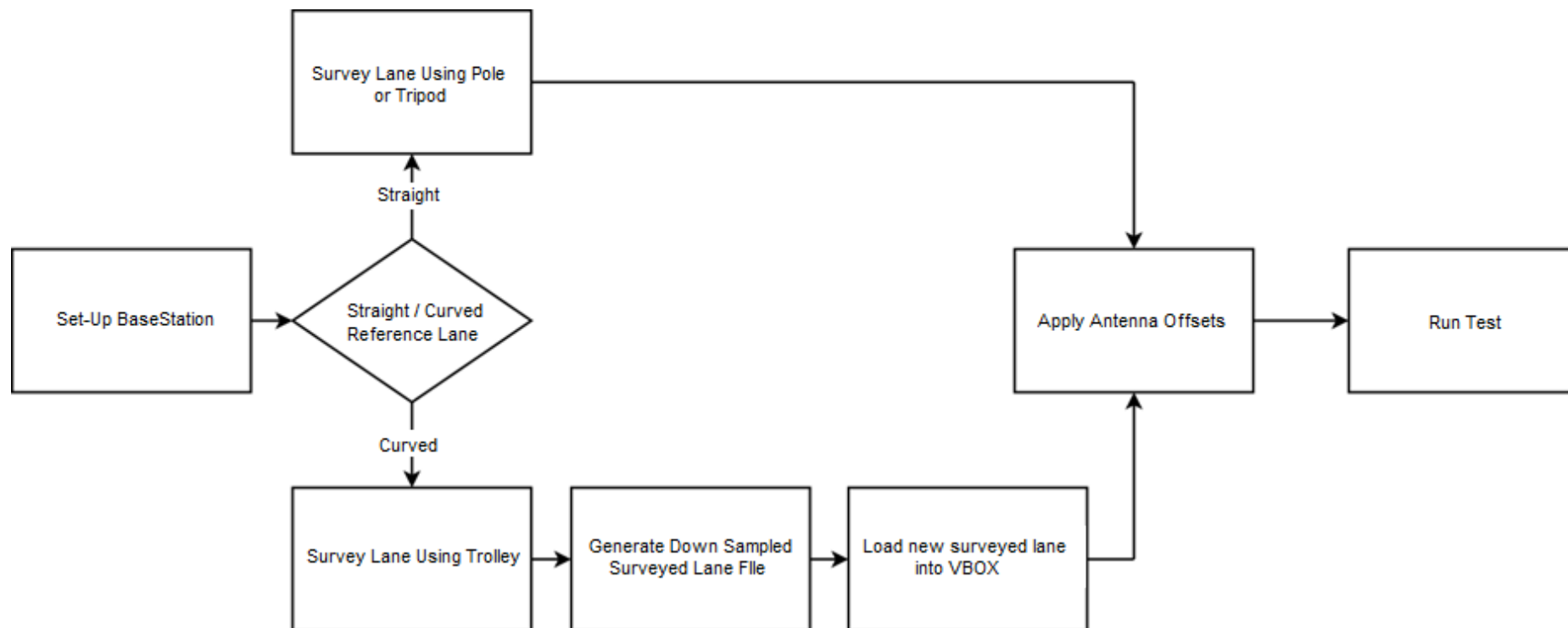
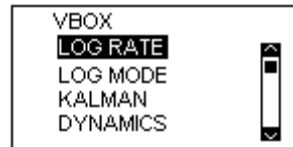


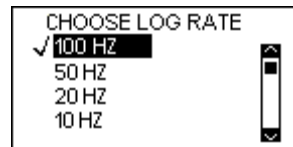
Figure 25: Road map for determining Lane Departure Warning parameters

Hardware Configuration – Lane Survey

1. Connect the VBOX equipment as shown in Figure 21 with the GPS antenna mounted on top of a survey pole (RLACS168)
2. Enter the setup menu of the VBOX Manager
3. Select the VBOX option



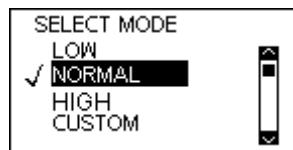
4. Select LOG RATE and set the rate to 100Hz, then select BACK to return to the VBOX setup menu



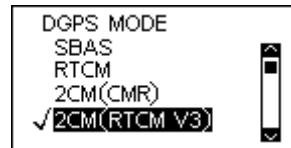
5. Select KALMAN FILTER and ensure none of the options are highlighted, return to the VBOX setup menu



6. Select DYNAMICS and set the dynamic mode to NORMAL, return to the VBOX setup menu



7. Select DGPS and set the DGPS mode to 2cm (or the best available DGPS setting for the VBOX in use), return to the VBOX setup menu



8. Select DGPS RS232 Rate and select the appropriate setting for your radios, return to the VBOX setup menu



Note: all Racelogic blue boxed radios use 115200 b/s
Only the Satel radios use 19200 b/s

Lane Survey

Within the Racelogic ADAS firmware there are two ways for surveying a lane. If the test is intended for straight lanes only then a simple point-to-point lane (utilising up to 8 points along the lane) can be surveyed using a VBOX 3iSL-RTK and a survey pole as described in 'Straight Line' section below.

If the test lane is not straight enough to be represented by 8 points then an alternative method can be used to obtain the reference lane data. This method requires the use of a Survey Trolley (RLACS173-XXX where XXX represents the frequency of the Base station). When using the Survey Trolley data is recorded at 10Hz and provides a more accurate representation of a lane on a curved road. Please see the Survey Trolley instruction manual for instructions on how to assemble the equipment.

Multiple lanes

It is possible to load three surveyed lanes into the VBOX which can then be individually selected via the VBOX manager. It is **NOT** possible for the VBOX to make measurements to more than 1 lane edge at a time.

For 2cm positional accuracy during the Lane Departure Warning Test an RTK BaseStation is required.

Straight Line

- 1) Connect the system as described in Figure 21
- 2) Place the Vehicle near to the edge of the first lane that you plan to survey.
- 3) Place the GPS antenna connected to the vehicle system onto the supplied Tripod or a suitable Survey pole.
- 4) Place the supplied tripod over the Lane edge and use a Plumb line hanging from underneath the GPS antenna to ensure that the GPS antenna is directly over the road side edge of the lane edge.
- 5) Mark this point on the Ground with paint or Sticky tape, as you will need to come back to it if you wish to Auto set the Antenna offsets.



Figure 27: Marking the first lane point

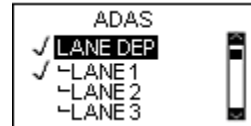


Figure 26: Lane marking with a survey pole



Figure 28: Lane survey with a tripod

- 6) On the VBOX manager go to the Lane Departure menu options and select LANE 1
- 7) Then click on the "SET LANE" option.



- 8) Highlight and select the "SET PNT 1" option to mark this first point.



- 9) Move the Tripod and vehicle to the another position point on the line preferably >50m (further apart is better) from the start position and click "SET PNT 2"

If you believe that the painted Lane edge has been painted perfectly then you can use just two points to describe the line. Go to point 11

If you believe that the line does have some acceptable fluctuations but you want to survey these as best as possible, then you can set more than two points to accurately map the line. Go to point "10"

- 10) Move the Tripod and vehicle to the another position point on the line preferably >50m from the last position and enter this position as the next point, e.g "SET PNT 3"
- 11) After setting the last point click on "BACK" to return to the main menu.

Repeat this procedure for any other test lines that you have up to a maximum of 3 lines.

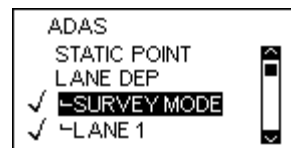
Curved Line

- 1) Assemble the Survey Trolley and mount the VBOX, radio modem, ACS112L Li-Ion battery and VBOX manager into the surveying back pack.



Figure 29: Survey equipment installed in back pack

- 2) Select SURVEY MODE



- 3) Exit the ADAS menu and return to the File Manage home screen. This presents a new display designed for controlling the survey mode function

```
START FILENAME SETUP
SPD  : 000.00 KM/H
SATS : 00
RTK  : NO SOLUTION
```

- 4) When the VBOX achieves RTK lock you can start to survey the lane
- 5) Place the centre line of the Survey Trolley over the lane edge to be surveyed and select 'START' on the VBOX manager to start the logging before moving.



Figure 30: Lane survey trolley

- 6) When the lane surveying is completed stop the logging and revert the VBOX back to standard operating mode by de-selecting SURVEY MODE enabled in step 2
- 7) Remove the CF card from the VBOX and download the recorded reference lane .vbo file from the VBOX onto a PC.
- 8) Then run the Racelogic 'VBC File Generator' software



Figure 31: Racelogic Downsample Software ***PLACE HOLDING IMAGE***

- 9) Load the reference lane file into the 'VBC File Generator' software. The software will show a representation of the surveyed lane edge so that you can be sure that you have loaded the correct file.

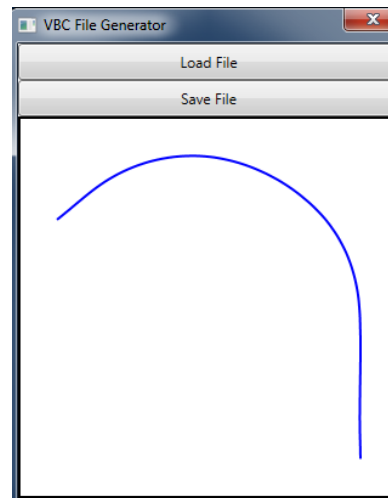
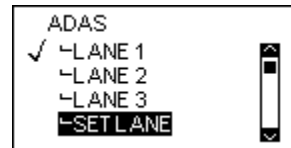
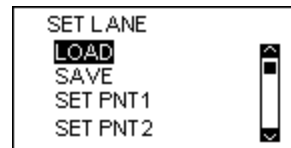


Figure 32: Reference lane loaded into Racelogic Downsample software

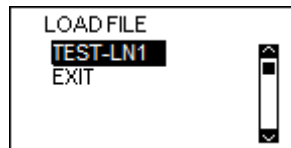
- 10) Click 'Save File' and name and place the new .vbc file onto the Compact Flash card.
- 11) Place the Compact Flash card back into the VB3iSL-RTK module.
- 12) Enter the LANE DEPARTURE option within ADAS configuration on the VBOX File Manager.
- 13) Select the appropriate lane number and select SET LANE



- 14) Select the LOAD option



- 15) The VBOX will browse the CF card for .vbc files, select the appropriate .vbc file for the reference lane in question



The lane is now loaded into the VBOX and is ready to be used to generate live Lane Departure values.

Pre-Test Configuration

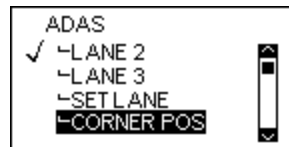
Corner Position

In accordance with the NHTSA “Lane Departure Warning System NCAP Confirmation Test December 2008, “Lane departure is said to occur when any part of the two dimensional polygon used to represent the test vehicle breaches the in board lane line edge. In the Case of tests performed in this procedure, the outside front corner of the polygon will cross the line edge first”.

“The corners of the polygon are defined by the lateral and longitudinal locations where the plane of the outside edge of each tire makes contact with the road. This plane is defined by running a perpendicular line from the outer most edge of the tire to the ground.”
The following provides a guide to setting the two front left and right measurement positions.

Automatic Corner Position –Only applicable to straight line edges

- 1) Within the LANE DEPARTURE option of the VBOX Manager select CORNER POSITION



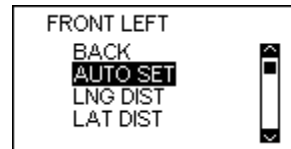
- 2) With the front left corner of the vehicle placed over the initial reference point of Lane 1 select SET FL POS



Figure 33: Positioning Front Left corner of the vehicle on the test lane



- 3) To automatically set the corner position select AUTO SET

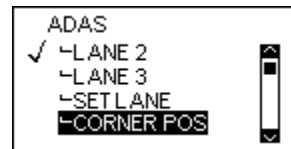


- 4) Repeat this process with the vehicles front right corner over the initial reference point and select SET FR POSITION

Manual Corner Position

When using the down sampled survey lane as a reference lane it is not possible to use the auto corner position function within the VBOX File Manager. In this instance it is necessary to manually enter the offsets into the VBOX File Manager.

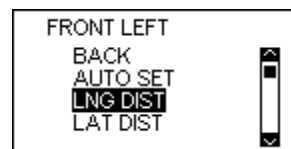
- 1) Within the LANE DEPARTURE option of the VBOX Manager select CORNER POS



- 2) Select SET FL POS



- 3) To manually set the corner position select LNG DIST



- 4) Enter the LNG DIST value is accordance with the following orientation:

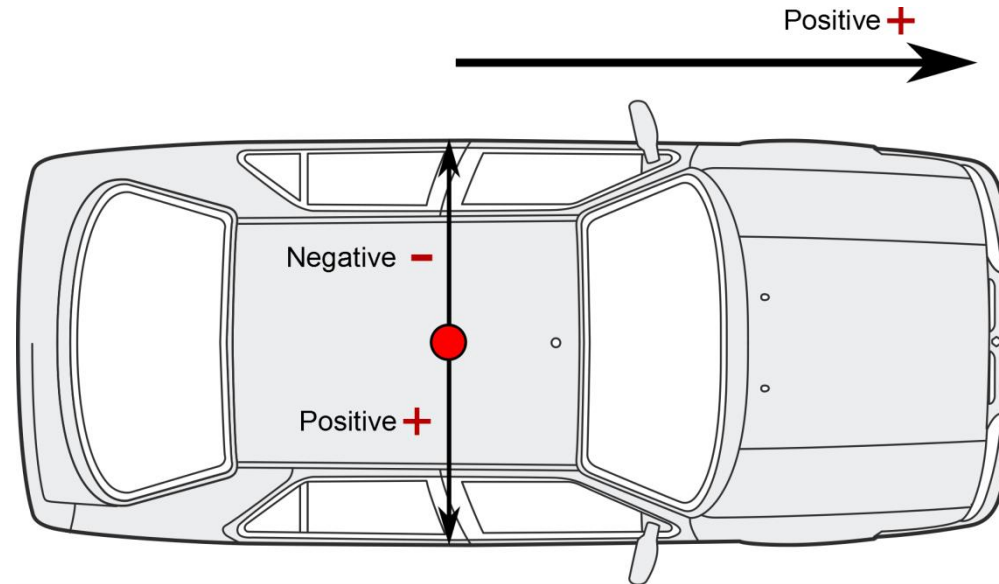


Figure 34: Manual corner position signage

NOTE: The corner position must be in-front of the GPS antenna, i.e. a positive longitude.

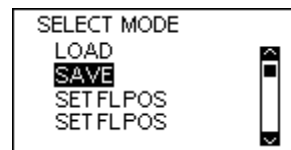
- 5) Repeat step 4 but for the LAT DIST.

Saving and Loading Corner Positions

Once corner positions have been set in the VBOX File Manager they can be saved as a .vbc file and recalled later for repeatability.

NOTE: For corner positions to be recalled accurately the GPS antenna location on the car and the location of the Base station GPS antenna must be identical as when the data was recorded.

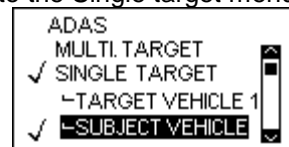
- 1) Within the CORNER POS option of the ADAS menu select SAVE



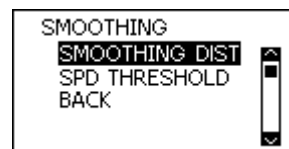
- 2) Within the SAVE menu select the appropriate file name. This will be saved onto the CF card as a .vbc file.
- 3) To load a .vbc file containing offset data select the LOAD option for the CORNER POS menu. This will present a list of saved .vbc files containing corner position offsets. Selecting the appropriate file loads these values into the VB3iSL-RTK firmware and allows for range values to be calculated to these corner positions.

Setting a smoothing distance

- 5) Using the VBOX manager, go to the ADAS menu and go to the Single target menu and select Subject Vehicle:



- 6) Select 'SMOOTHING' from the SUBJECT VEHICLE menu.
- 7) Select 'SMOOTHING DIST' and enter the smoothing option for the Subject Vehicle, from the options between 0.00m and 2.00m.

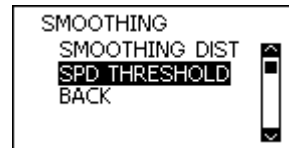


- 8) For typical Vehicle Separation applications we recommend a smoothing distance of 1m

Speed Threshold

Due to the nature of how heading is calculated, even when Smoothing is applied at very low speeds and when the vehicle is stationary the heading channel can become very noisy and unusable, this in turn results in many of the Vehicle Separation channels becoming noisy at low speed and unusable when stationary. This is solved by fixing the heading below a configurable Speed Threshold.

- 3) To set the speed threshold repeat steps 1 and 2 above, then select SPD THRESHOLD and enter the speed threshold option for the Subject Vehicle.



- 4) We recommend a Speed Threshold of 5km/h.

There are two configurable variables linked to heading smoothing; 'Smoothing Distance' and 'Speed Threshold'. Due to the nature of the vehicle separation measurement and calculation process many channels are derived using the heading of the vehicle which can be noisy. To overcome this heading can be smoothed with a dynamic smoothing routine.

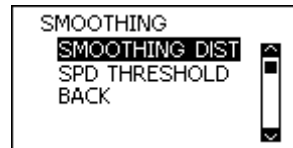
Under the LANE DEP option within the ADAS menu select SMOOTHING



Smoothing Distance

The smoothing routine is calculated between the current and previous samples. The previous sample to be used is determined using a Smoothing Distance, this results in a variable number of samples used to determine the smoothing level on the heading; the lower the speed the more samples that are used. With 100Hz logging and a smoothing distance of 1.1m at 80kph the heading is calculated over the previous 5 samples whilst at 15kph the heading is calculated over the previous 26 samples.

- 1) To set the smoothing distance select 'SMOOTHING DIST' from the SMOOTHING menu on the VBOX manager.

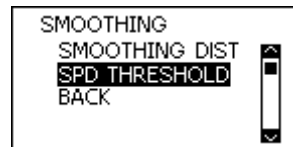


- 2) From the options select the smoothing distance between 0.00m and 2.00m. **A smoothing distance of 2.00m is recommended**, due to the low dynamic nature of Lane Departure testing

Speed Threshold

Due to the large number of sample in a small distance when travelling at low speed the heading channel can become very noisy, this in turn results in many of the Vehicle Separation channels becoming noisy at low speed. When the speed threshold is set to a certain speed the heading is locked when the vehicle travels under that speed.

- 1) To set the speed threshold repeat select 'SPD THRESHOLD' from the SMOOTHING menu on the VBOX manager and enter the speed threshold Value. **5km/h is the suggested value.**



Parameter Definitions

Range_Lt Calculation

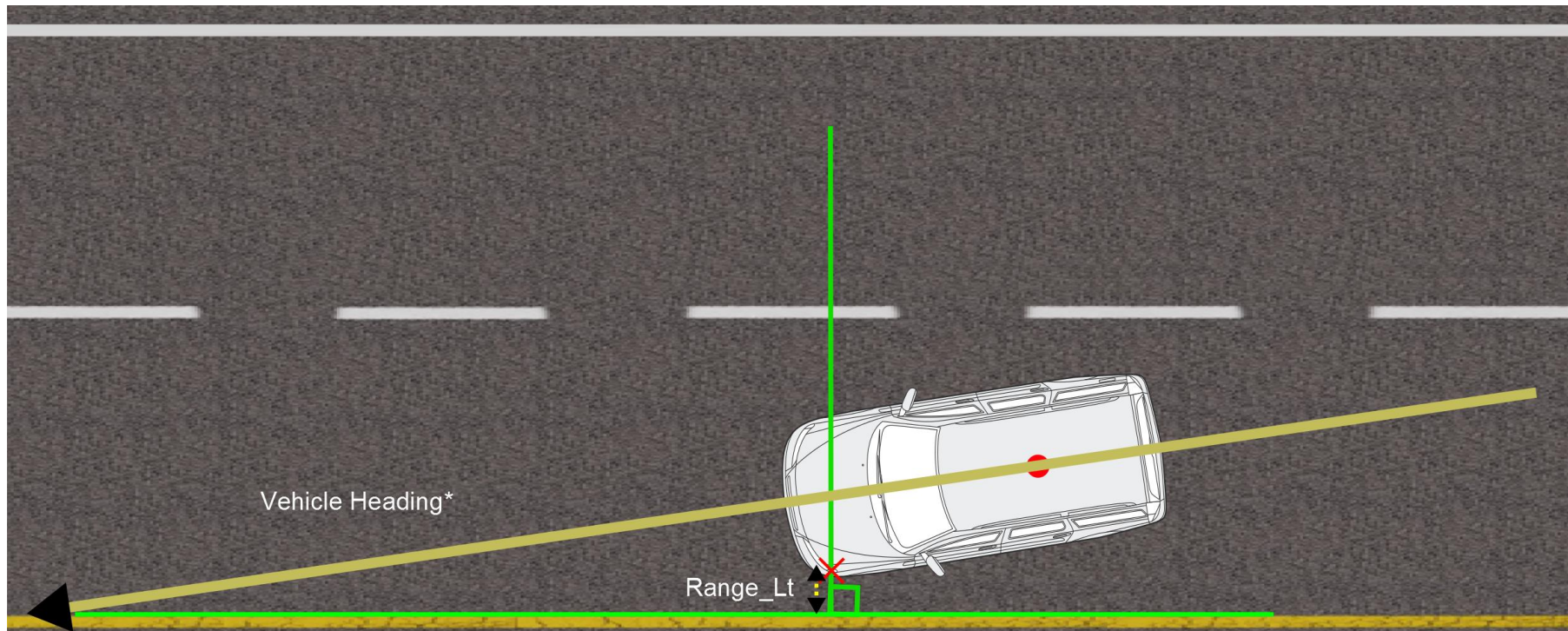


Figure 35: Range_Lt parameter calculation

The value for Range_Lt is the shortest perpendicular distance between the offset and the surveyed lane.

LatSpd-Lt;

Lateral speed of the left hand offset point with respect to the marked lane edge.

$$\text{LatSpd-Lt} = V_{\text{fwd}} * \sin(\alpha)$$

V_{fwd} = GPS velocity (course over ground)

α = Lane edge Heading – Heading at Vehicle offset point.

Range_Rt Calculation

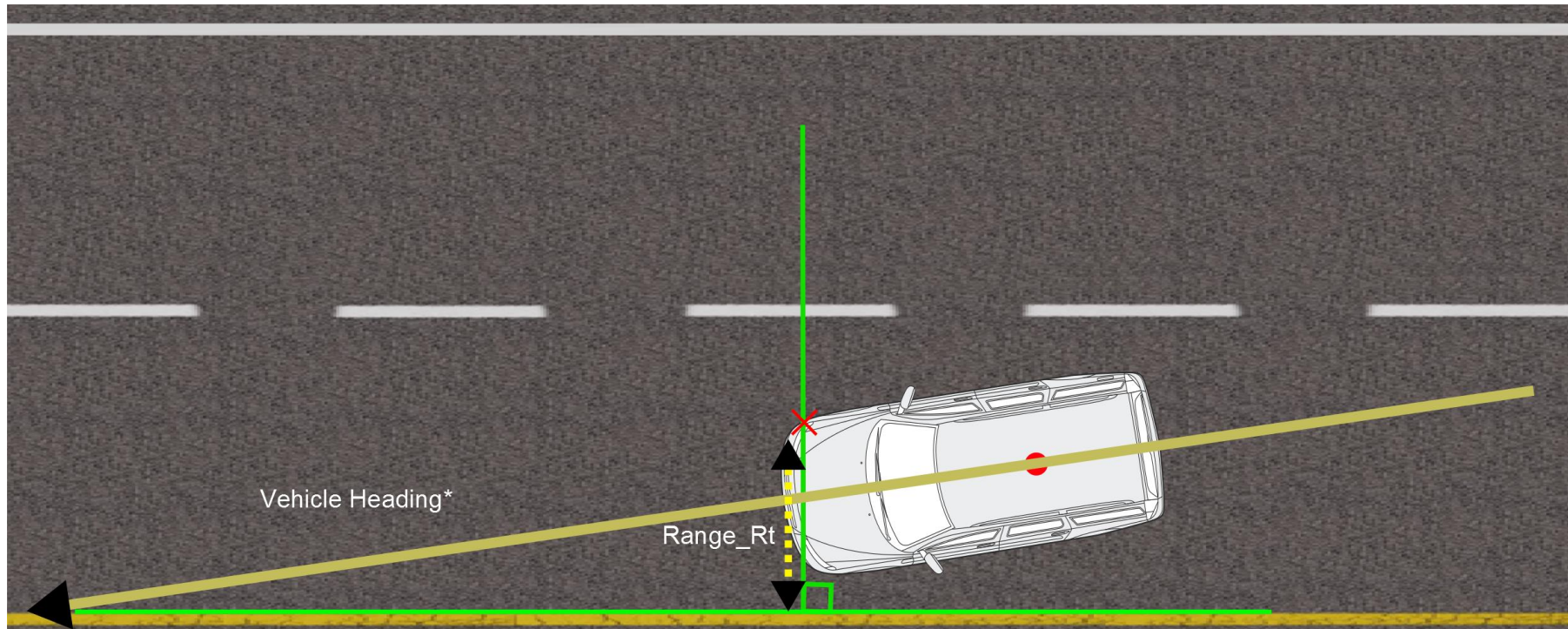


Figure 36: Range_Rt parameter calculation

The value for Range_Rt is the shortest perpendicular distance between the offset and the surveyed lane.

LatSpd-Rt;

Lateral speed of the right hand offset point with respect to the marked lane edge.

$$\text{LatSpd-Rt} = V_{\text{fwd}} * \sin(\alpha)$$

V_{fwd} = GPS velocity (course over ground)

α = Lane edge Heading – Heading at Vehicle offset point.

Angle Calculation

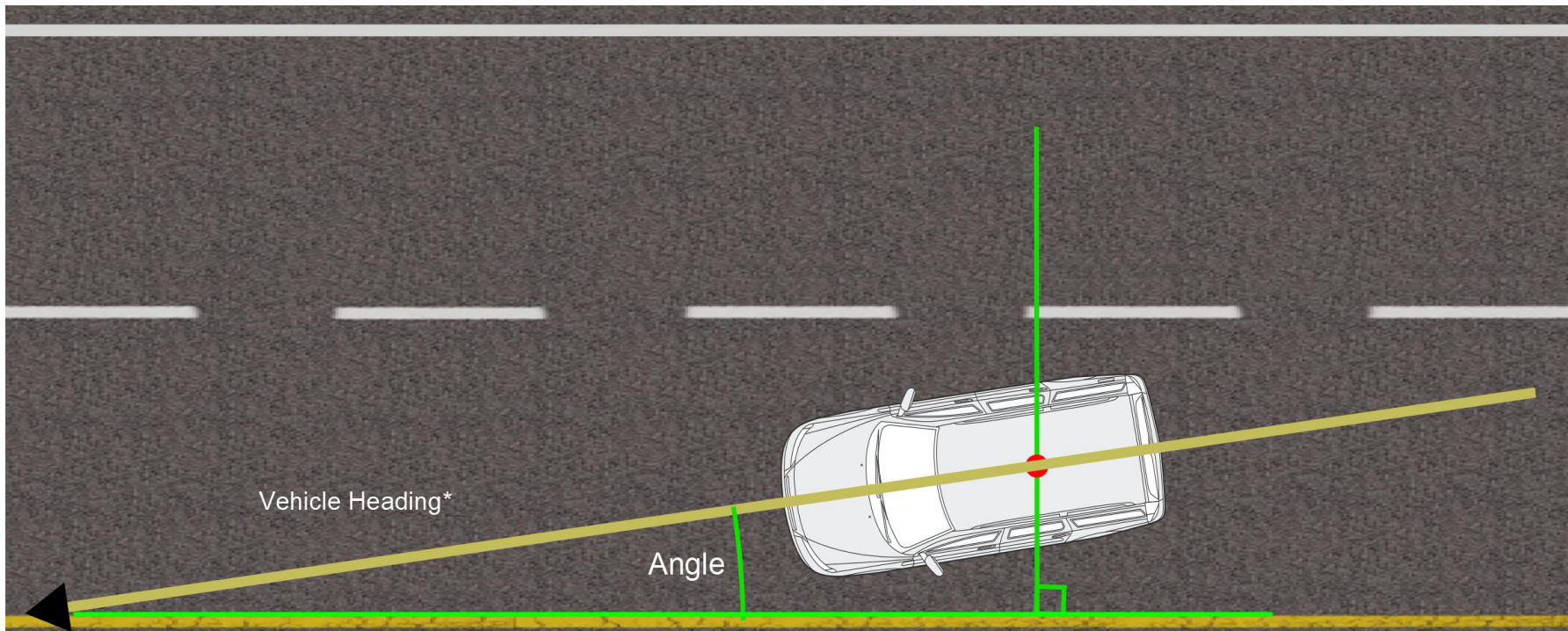


Figure 37: Angle parameter calculation

The value of Angle is the angle between the vehicle heading and the tangent of the surveyed lane at the shortest perpendicular distance to the GPS antenna.

TTC-Lt; TTC-Rt

Time to cross the reference lane calculated from the Left and Right offset point ranges and Lateral speeds.

e.g. $TTC-Lt = Range_Lt \text{ (meters)} / Lat \text{ Spd_Lt (m/s)}$

Lane Departure Calculations around a Curve

When testing a Lane Departure Warning System around a curved lane the VBOX firmware takes measurements from the corner position to the nearest perpendicular tangent line to the curved lane edge, as shown in Figure 38

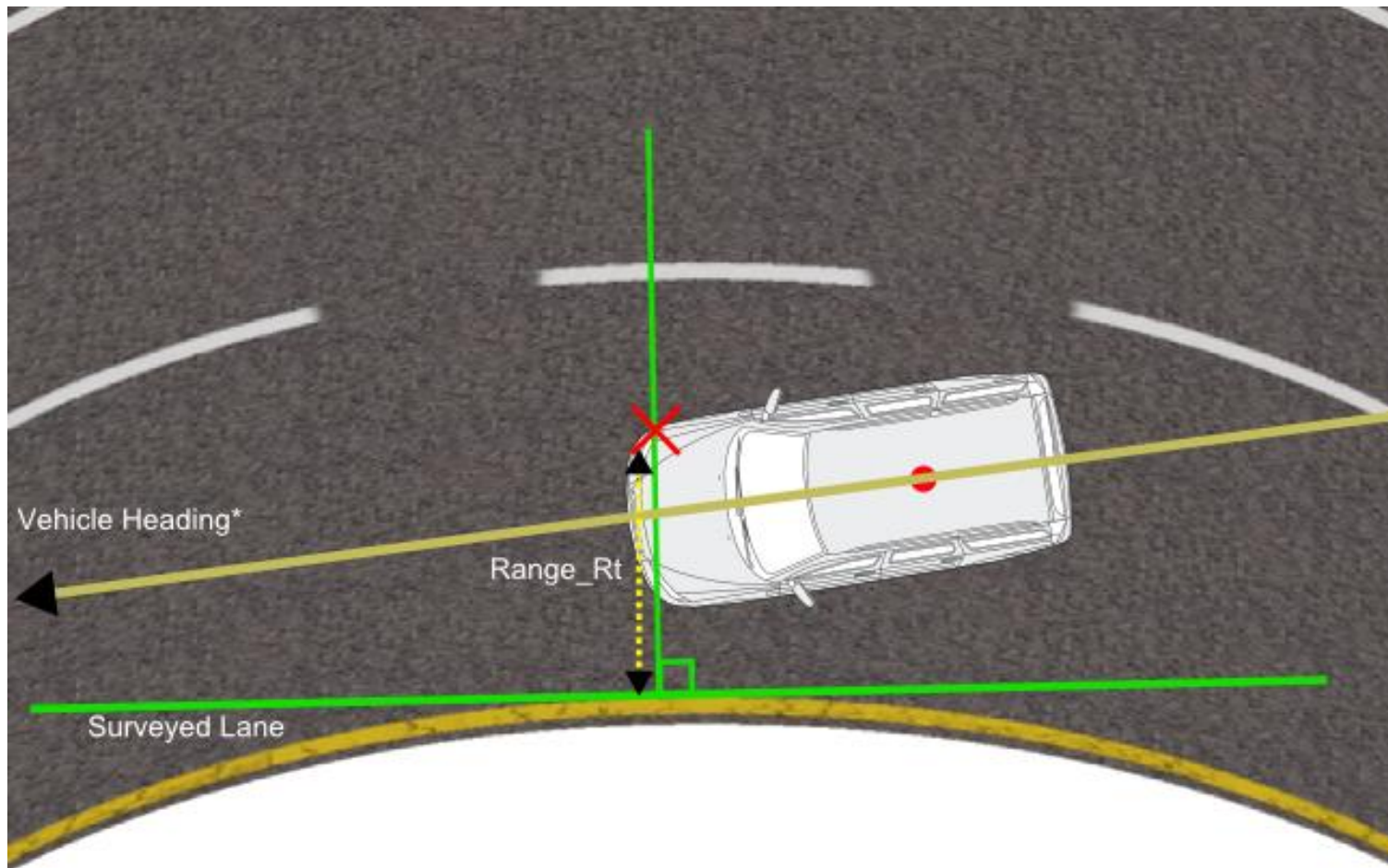


Figure 38: Determining Range from a Curved Lane

Static Point

The Static Point feature of the VB3iSL-RTK firmware allows the user to set any arbitrary target point as the static reference point for all positional calculations. This facility can be used when a dummy pedestrian or static vehicle is the test target.

This also requires the use of a static Racelogic Base station to ensure position accuracies of up to 2cm.

The following table provides a list of channels capable of being logged in the Subject Vehicle during the static point tests.

Channel Name	Channel Description	Units
Range-tg1	Distance between Subject Vehicle and Static Point	Meters
LngRsv-tg1	Longitudinal distance between the Subject Vehicle and Static Point measured in the direction of the Subject Vehicle	Meters
LatRsv-tg1	Lateral distance between the Subject Vehicle and Static Point measured at right angles to the Subject Vehicle	Meters
LatRreftg1	The lateral difference between the two Vehicles based on the heading of the test track*	Meters
T2Csv-tg1	The time before impact on the Static Point derived from the LngRsv-tg1 and LngSpd -tg1 channels	Seconds
T2C2sv-tg1	The time before impact on the Target Vehicle derived from the LngRsv-tg1, LngSpd-tg1 and Accel-tg1 channels #	Seconds
RelSpd-tg1	The relative speed between the Subject Vehicle and Static Point	Km/h
LngRtg-tg1	Longitudinal distance between the Subject Vehicle and Static Point measured in the direction of the Target Vehicle	Meters
LatRtg-tg1	Lateral distance between the Subject Vehicle and Static Point measured at right angles to the Target Vehicle	Meters
Angle-tg1	The angle of the Static Point in relation to the heading of the Subject Vehicle	Degrees
Latdif-tg1	The difference between Subject Vehicle and Static Point latitude	Minutes
Lngdif-tg1	The difference between Subject Vehicle and Static Point longitude	Minutes
Spd-tg1	Target Vehicle course over ground speed	Km/h
Accel-tg1	Target Vehicle acceleration calculated from Target Vehicle speed and time	g
LngSsv-tg1	Speed between the Subject Vehicle and Static Point in the longitudinal direction, in the direction of the Subject Vehicle	Km/h
LatSsv-tg1	Speed between the Subject Vehicle and Static Point in the lateral direction, at right angles to the Subject Vehicle	Km/h
Status-tg1	The DGPS status of the VBOX within the Target Vehicle	N/A
Status-sv	The DGPS status of the VBOX within the Subject Vehicle	N/A
LkTime-tg1	Time based channel for showing quality of radio link between Vehicles \$	N/A
App_Mode	The current operating mode of the Subject VBOX	N/A
SepTim-tg1	The time it would take the Subject Vehicle to travel across the Vehicle separation distance at its current speed	Seconds
T2Ctg-tg1	The time before impact on the Static Point derived from the LngRange_T and LngSpeed_T channels	Seconds
Yawdif-tg1		Degrees
YawRat-tg1		Degrees/second

Table 5: Static Point channel table

NOTE: Table 5 contains channels highlighted in grey, these are legacy channels held over from single vehicle target mode and are not used in Static Point testing. These are present to ensure the continuity of the Racelogic Report Generator application which uses channel ordering as its sort function.

During the configuration of Static Point mode a Heading Reference is generated, this enables the VB3iSL-RTK to provide stable and accurate ADAS parameters. The configuration of the Heading Reference is covered in section 'Setting a Static Point' below.

Hardware Configuration

The following diagram shows the hardware configuration required for Static Point testing. The items greyed out are not essential to run this test but many customers will find them a useful addition.

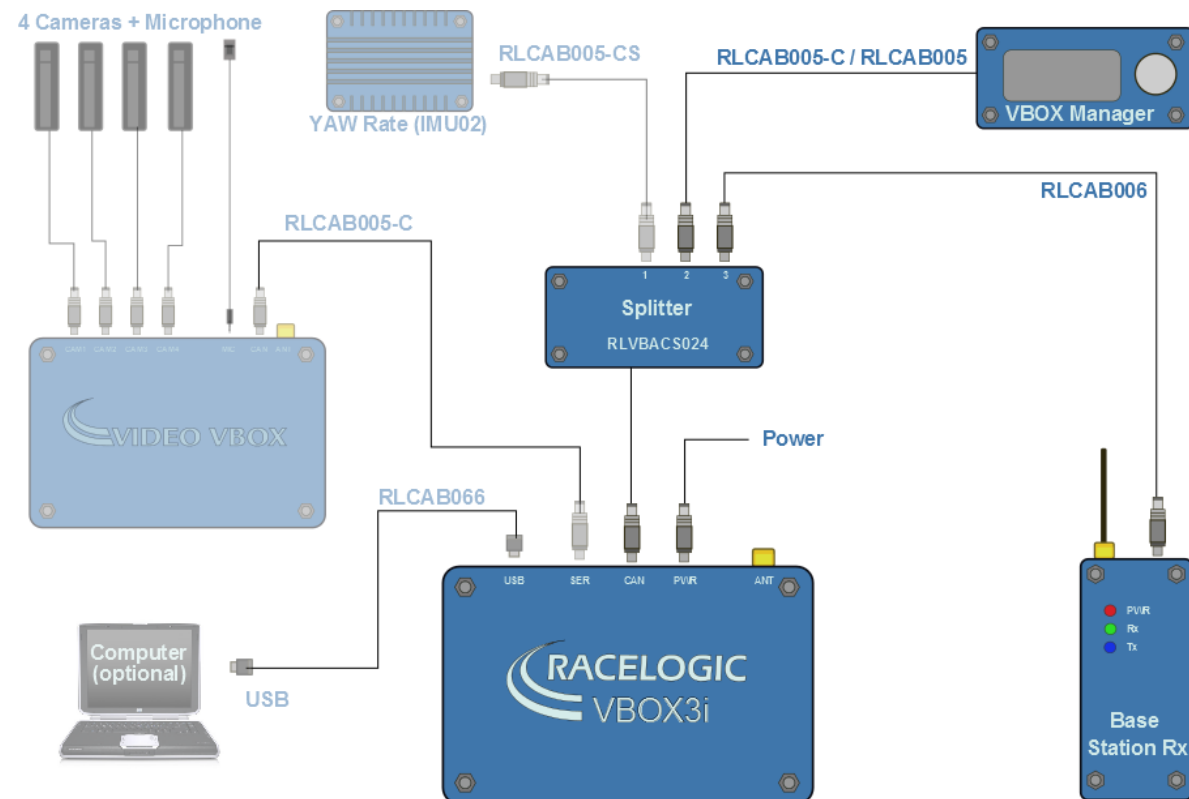
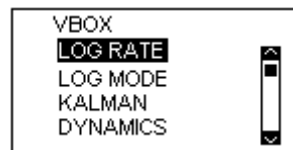


Figure 39: Static Point Subject Vehicle Hardware Configuration

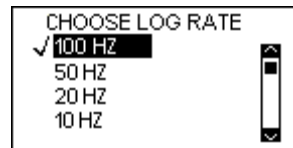
Quick Start – VBOX Configuration

Subject Vehicle

- 1) Connect the VBOX Manager to the VBOX in the Subject Vehicle
- 2) Enter the setup menu of the VBOX Manager
- 3) Select the VBOX option



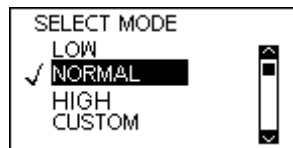
- 4) Select LOG RATE and set the rate to 100Hz, then select BACK to return to the VBOX setup menu



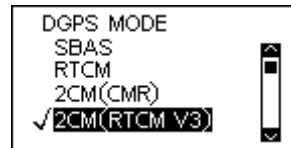
- 5) Select KALMAN FILTER and ensure none of the options are highlighted, return to the VBOX setup menu



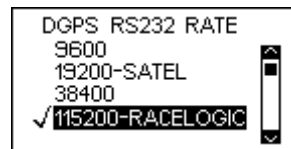
- 6) Select DYNAMICS and set the dynamic mode to NORMAL, return to the VBOX setup menu



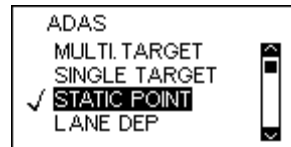
- 7) Select DGPS and set the DGPS mode to 2cm (or the best available DGPS setting for the VBOX in use), return to the VBOX setup menu



- 8) Select DGPS RS232 Rate and select the appropriate settings for your radios, return to the VBOX setup menu



- 9) Return to the main setup menu and select the ADAS option



Base station

A static Base station must be used for the VBOX to gain the RTK 2cm positional accuracy. Moving Base cannot be used because a static Base station is the only way to create a reference to a fixed point like a nominated static point.

See the Base station user guide for Base station installation guide.

Important Note: The Base station GPS antenna must be in exactly the same location for marking the static point and for subsequent testing. It is also good practice to save the location into the Base station memory.

The VBOX front panel will indicate the required RTK Fixed status, with the illumination in green of the diff light.



Figure 40: VBOX DGPS status indicator

Pre-test Configuration

Setting the 'Static Point'

- 1) Position the vehicle touching the desired location of the Static Point.
- 2) Within the STATIC POINT menu select the SET option. This sets the location of the Static Point.



- 3) Once the Static Point has been set drive the vehicle away in a straight line along the test track to a distance of over 100m. Select SET HEADING REF.

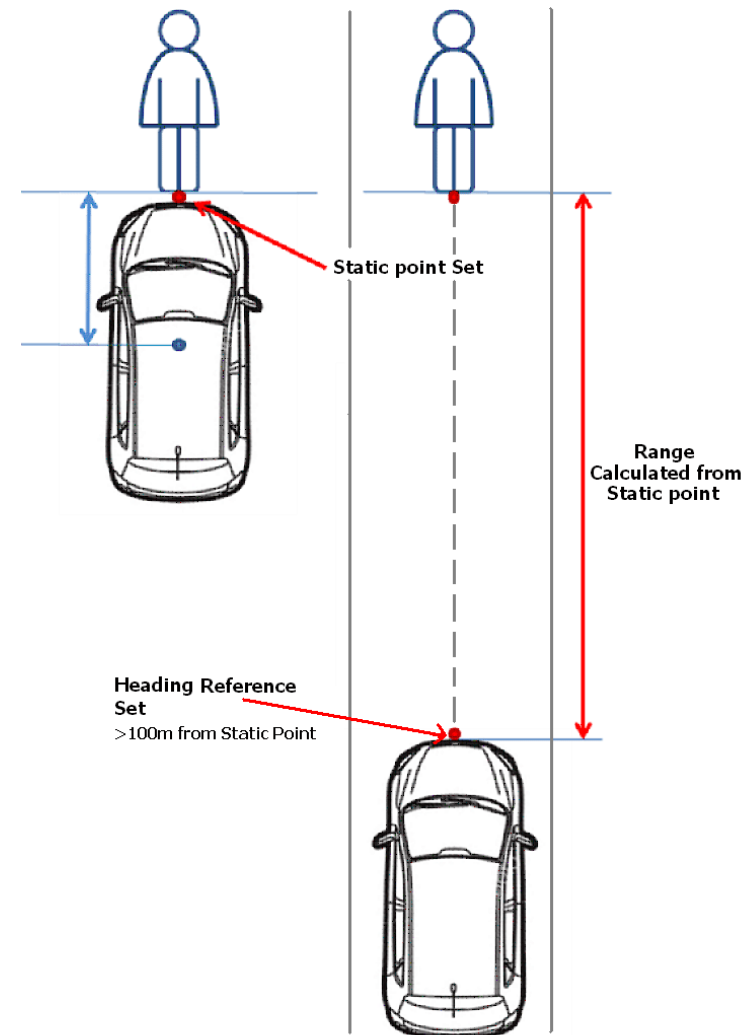


Figure 41: Static Point Heading Reference Configuration

Smoothing Levels

There are two configurable variables linked to heading smoothing; 'Smoothing Distance' and 'Speed Threshold'. Due to the nature of the vehicle separation measurement and calculation process many channel are derived using the heading of the vehicle which can be noisy. To overcome this the heading can be smoothed with a dynamic smoothing routine.

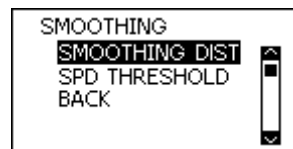
Under the LANE DEP option within the ADAS menu select SMOOTHING



Smoothing Distance

The smoothing routine is calculated between the current and previous samples. The previous sample to be used is determined using a Smoothing Distance, this results in a variable number of samples used to determine the smoothing level on the heading; the lower the speed the more samples that are used. With 100Hz logging and a smoothing distance of 1.1m at 80kph the heading is calculated over the previous 5 samples whilst at 15kph the heading is calculated over the previous 26 samples.

- 1) To set the smoothing distance select 'SMOOTHING DIST' from the SMOOTHING menu on the VBOX manager.

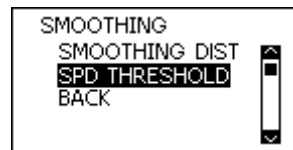


- 2) From the options select the smoothing distance between 0.00m and 2.00m. **A smoothing distance of 1.00m is recommended.**

Speed Threshold

Due to the large number of sample in a small distance when travelling at low speed the heading channel can become very noisy, this in turn results in many of the Vehicle Separation channels becoming noisy at low speed. When the speed threshold is set to a certain speed the heading is locked when the vehicle travels under that speed.

- 1) To set the speed threshold repeat select 'SPD THRESHOLD' from the SMOOTHING menu on the VBOX manager and enter the speed threshold Value. **5km/h is the suggested value.**



Parameter Definitions

LngRsv-tg1 and LatRsv-tg1 Calculations

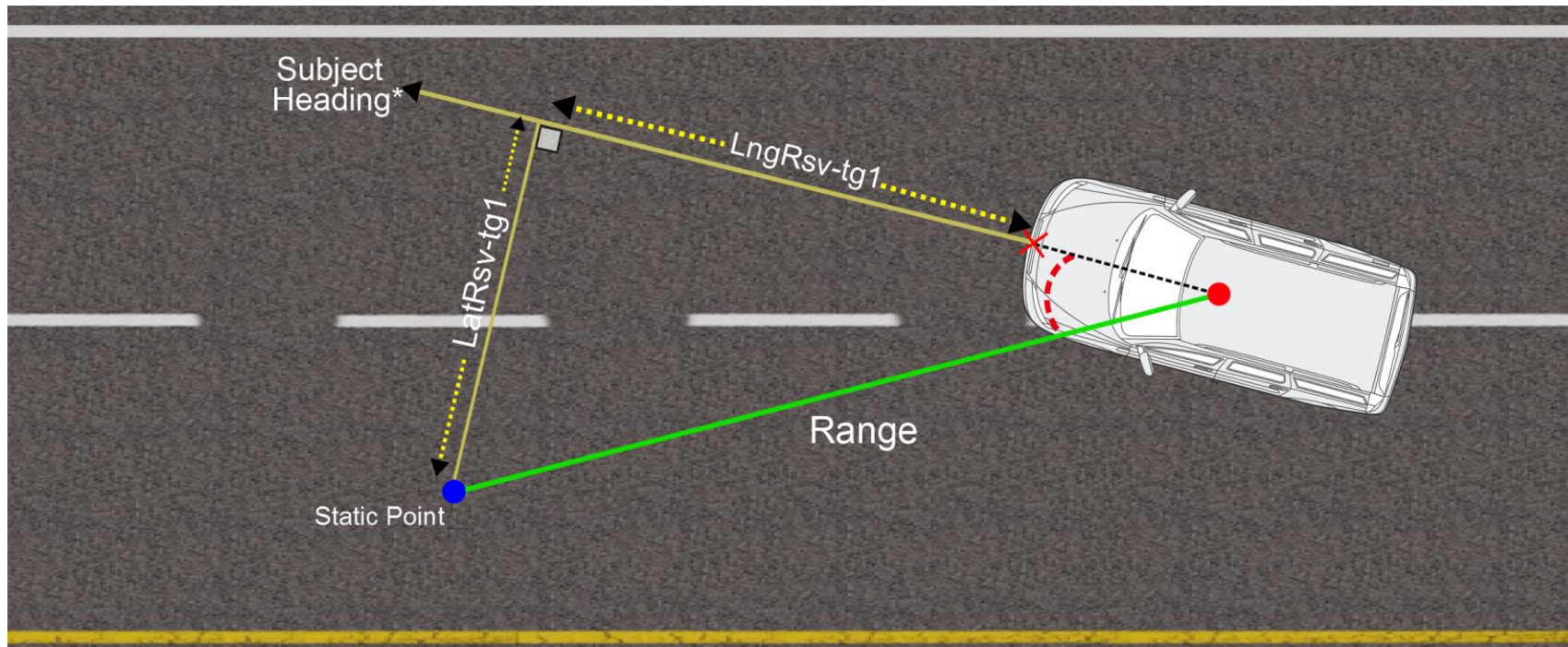


Figure 42: LngRsv-tg1 and LatRsv-tg1 calculations using the Subject Vehicle Heading

LngRtg-tg1 and LatRtg-tg1 Calculations

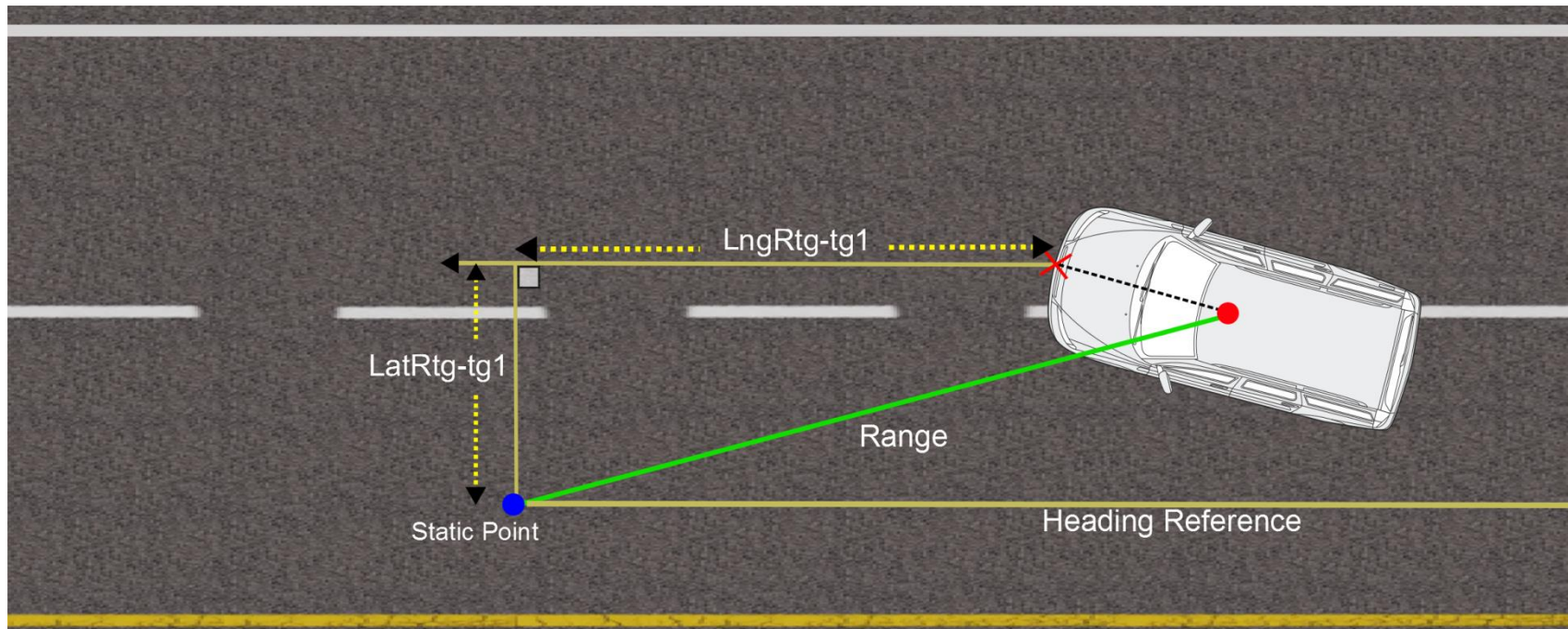


Figure 43: LngRtg-tg1 and LatRtg-tg1 calculations using the Heading Reference

CAN data output

It is possible to output the VBOX ADAS channels to a 3rd party data logger on the VBOX 'VCI' CAN port, which is as default assigned to the 'SER' connector. If the 3rd party logger has a 9 way D-sub connector then a RLCAB019L cable should provide the required interface.

Note that when this CAN port is outputting CAN that the VBOX cannot log CAN signals via this port.

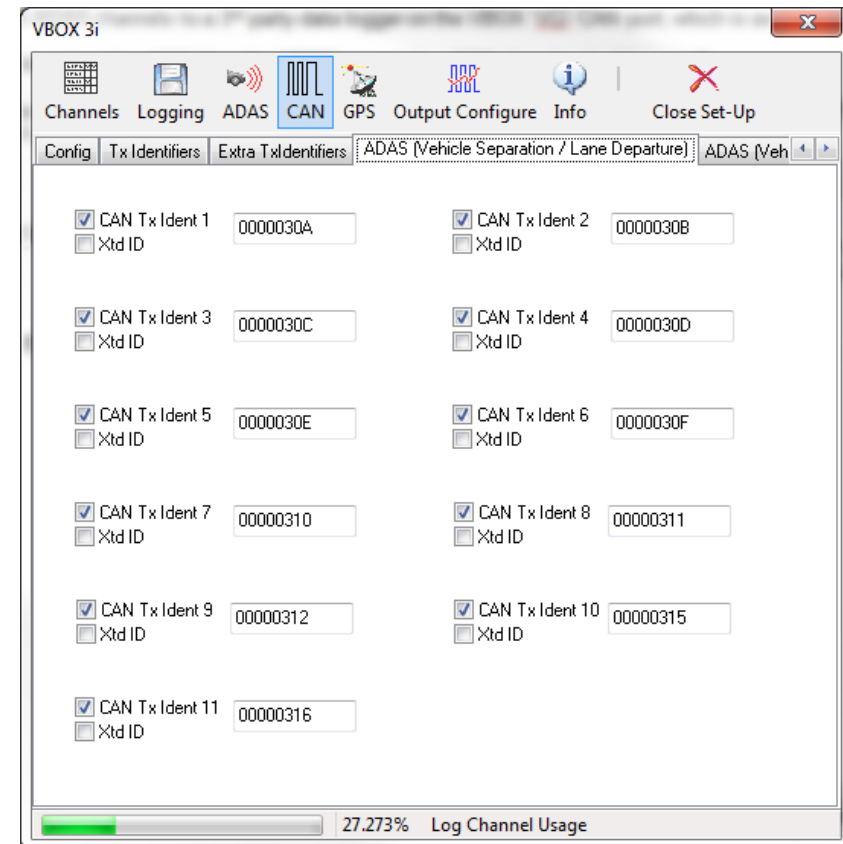
All standard and ADAS parameters are output in a set format, which is outlined in the 'CAN Bus data format' section below.

It is possible to change the ID of each output CAN message, via the CAN page of VBOXTOOLS - VBOX setup.

CAN signal latency

The VBOX in vehicle separation ADAS mode will have the following CAN output timings.

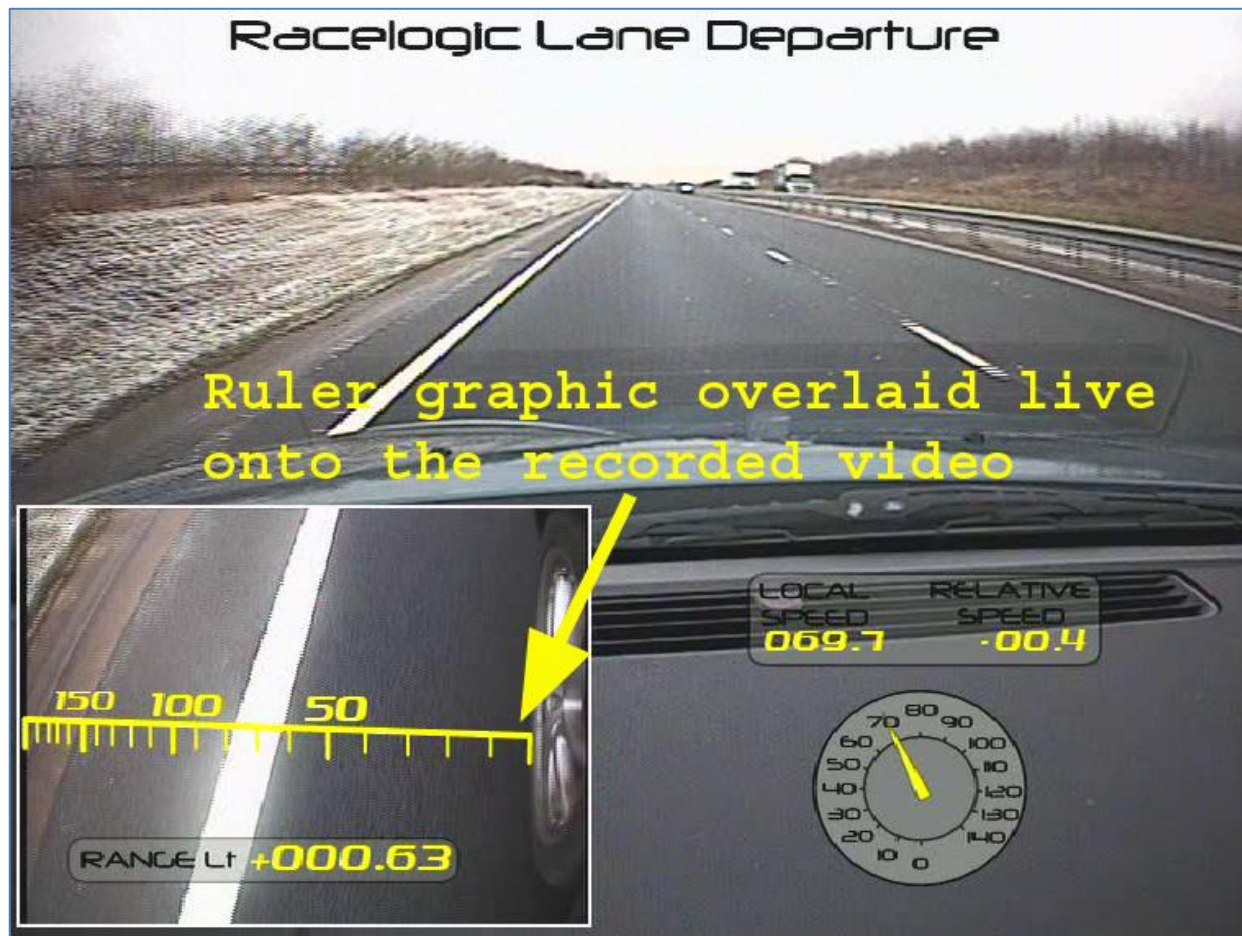
- 37.8-39.3mS delay from 'ground truth' to the leading edge of the associated CAN message
- VBOX output CAN message is 5mS in length at 500kb/s.



Video VBOX

The addition of the Video VBOX to the VB3i ADAS system adds synchronised video logging with the added benefit of overlaid data at static images. Video is often required to be recorded as part of regulation requirements.

For Lane departure the ability to add static images offers the ability to visually gauge wheel to lane edge distances.



Video VBOX connectivity

There are a number of ways to connect the Video VBOX to the ADAS system, depending on whether you are trying to log vehicle CAN on the VBOX system and how many Vehicle CAN busses you need to log data from.

As a guide please find below a number of example connection schematics for most eventualities

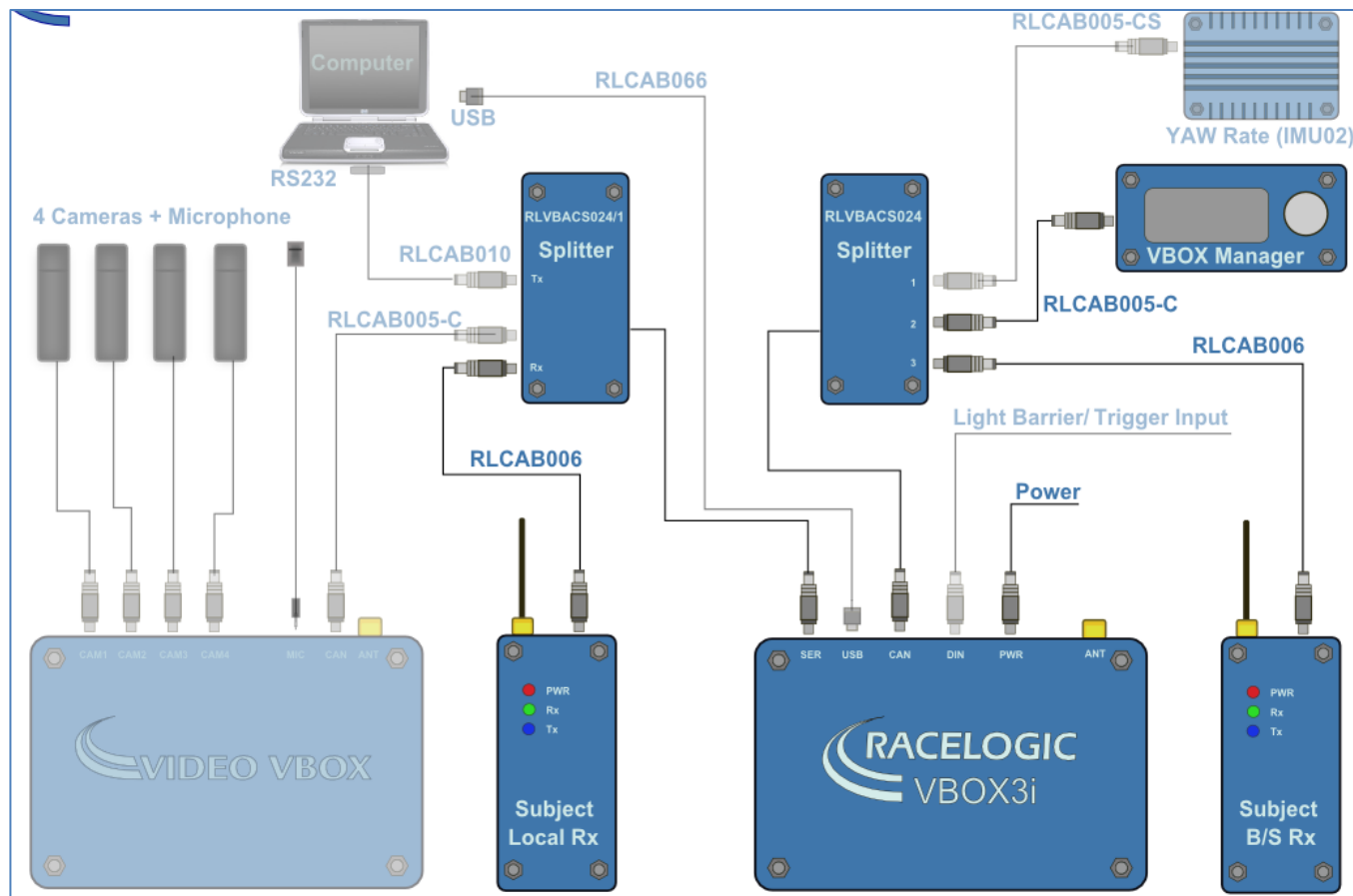


Figure 44: FCWS system with Video and no CAN

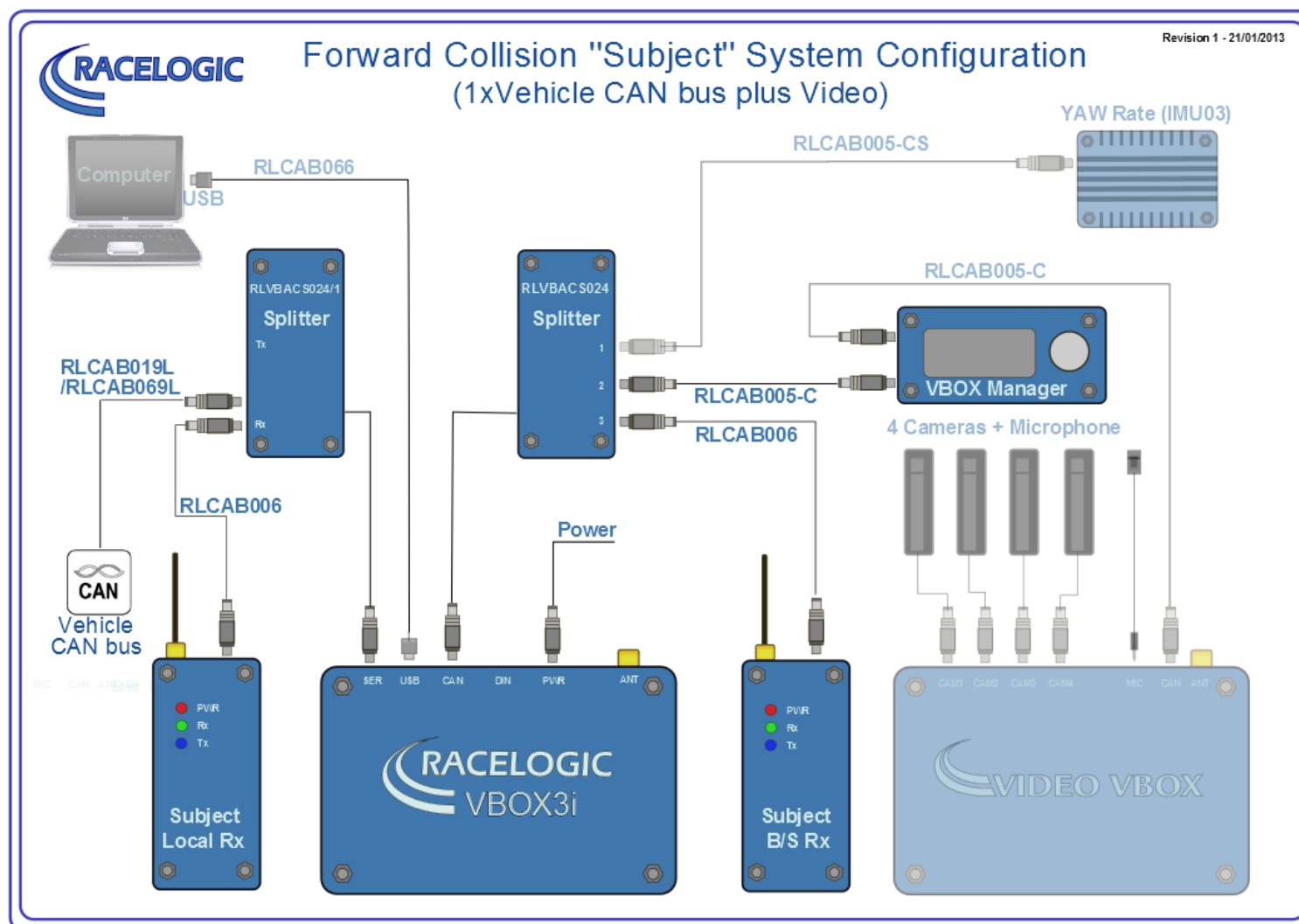


Figure 45: FCWS with Video and 1 CAN bus

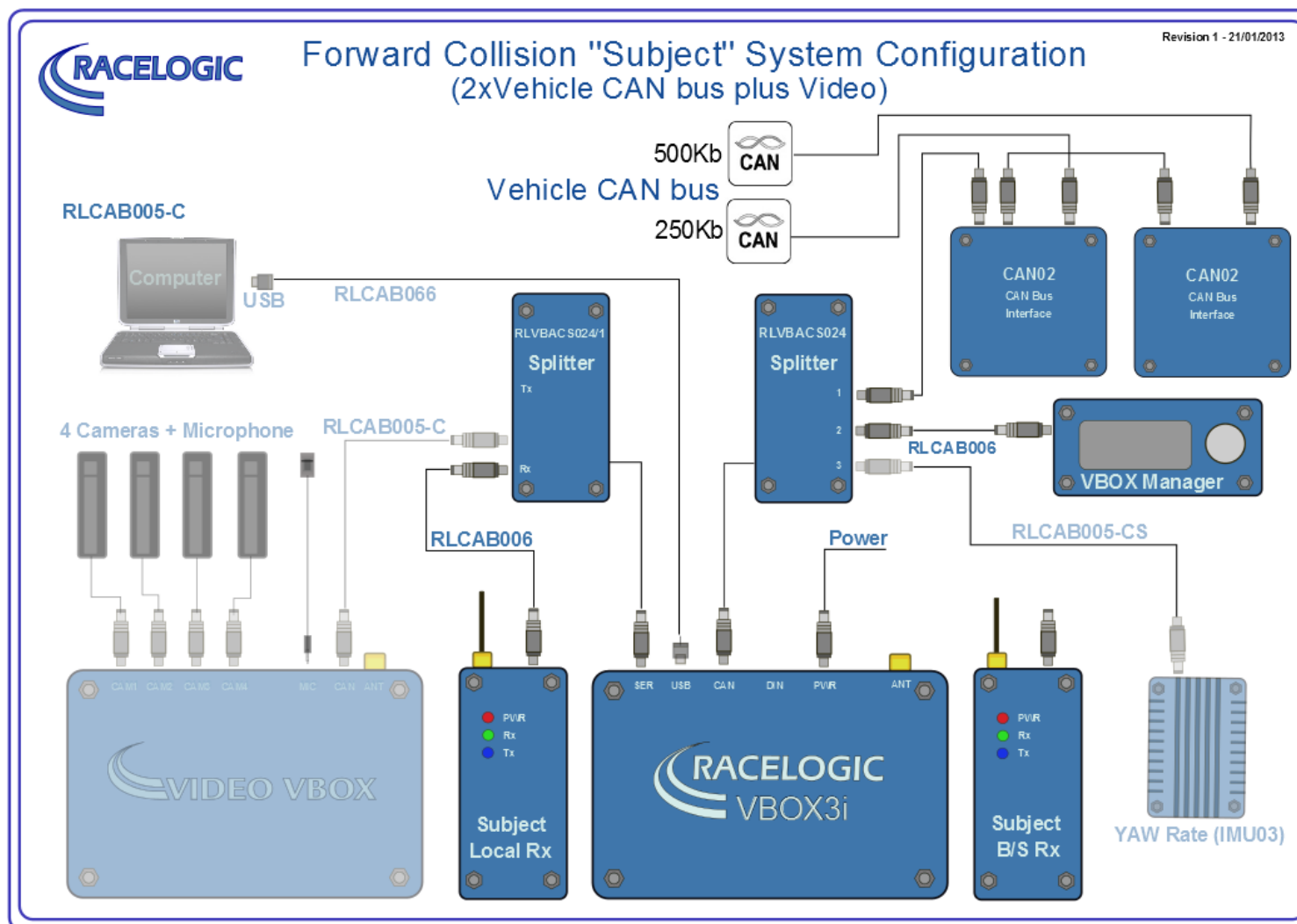


Figure 46: FCWS with video and 2 CAN bus

CAN Bus data format – standard data

Listed below are the standard CAN messages that are transmitted from the VB3iSL-RTK in any mode of operation. The ID's of the CAN messages can be configured through VBOX Tools software if required.

All channels shown in **Blue** are channels available when Twin antenna mode is enabled.

All CAN id's highlighted in yellow are not subject to an additional 3 sample delay that is present when any Vehicle separation ADAS mode is enabled.

Format	Motorola							
ID**	Data Bytes							
	1	2	3	4	5	6	7	8
0x301	(1) Sats in view		(2) Time since midnight UTC		(3) Position – Latitude MMMM.MMMMM			
0x302	(4) Position – Longitude MMMMM.MMMMM				(5) Velocity. (Knots)		(6) Heading. (Degrees)	
0x303	(7) Altitude. WGS 84. (Metres)			(8) Vertical velocity. (M/S)		Unused	(9) Status	(10) Status
0x304	(11) Distance. (Meters)				(12) Longitudinal Accel. (G)		(13) Lateral Accel. (G)	
0x305	(14) Distance travelled since VBOX reset				(15) Trigger time		(16) Trigger Velocity	
0x306	(17) Velocity Quality			(18) True Heading (Degrees)	(19) Slip Angle (degrees)		(20) Pitch Angle (Degrees)	
0x307	(21) Lateral Velocity (Knots)			(22) Yaw Rate (Degrees/S)	(23) Roll Angle (degrees)		(24) Longitudinal Velocity (Knots)	
0x308	(25) Position latitude.							(26) Status
0x309	(27) Position longitude						(28) Velocity. (Knots)	
0x313	(29) Slip_FL			(30) Slip_FR		(31) Slip_RL	(32) Slip_RR	
0x314	(33) Slip_COG			(34) Time since midnight UTC		(35) True Heading2 (Degrees)		

*Default Identifiers. The identifier values can be changed using the configuration software.

- (1) If Satellites in view < 3 then only Identifier 0x301 transmitted and bytes 2 to 8 are set to 0x00.
- (2) Time since midnight. This is a count of 10mS intervals since midnight UTC. (5383690 = 53836.90 seconds since midnight or 14 hours, 57 minutes and 16.90 seconds)
- (3) Position, Latitude * 100,000 (311924579 = 51 Degrees, 59.24579 Minutes North). This is a true 32bit signed integer, North being positive.
- (4) Position, Longitude * 100,000 (11882246 = 1 Degrees, 58.82246 Minutes West). This is a true 32bit signed integer, West being positive.
- (5) Velocity, 0.01 knots per bit.
- (6) Heading, 0.01° per bit.
- (7) Altitude, 0.01 meters per bit, signed.
- (8) Vertical Velocity, 0.01 m/s per bit, signed.
- (9) Status. 8 bit unsigned char. Bit 0=VBOX Lite, Bit 1=Open or Closed CAN Bus (1=open), 2=VBOX3
- (10) Status is an 8 bit unsigned char. Bit 0 is always set, Bit 3=brake test started, Bit 4 = Brake trigger active, Bit 5 = DGPS active

- (11) Distance, 0.000078125 meters per bit, unsigned. Corrected to trigger point.
- (12) Longitudinal Acceleration, 0.01G per bit, signed.
- (13) Lateral Acceleration, 0.01G per bit, signed.
- (14) Distance travelled in meters since VBOX reset.
- (15) Time from last brake trigger event. 0.01 Seconds per bit.
- (16) Velocity at brake trigger point in Knots.
- (17) Velocity Quality, 0.01 km/h per bit.
- (18) True Heading of vehicle, 16-bit unsigned integer * 100.
- (19) Slip Angle, 16-bit signed integer * 100.
- (20) Pitch Angle, 16-bit signed integer * 100.
- (21) Lateral Velocity, 16-bit signed integer * 100.
- (22) YAW rate, 16-bit signed integer*100.
- (23) Roll Angle, 16-bit signed integer * 100.
- (24) Longitudinal Velocity, 16-bit signed integer * 100.
- (25) Position, Latitude 48bit signed integer, Latitude * 10,000,000 (minutes). North being positive.
- (26) Bit 0 = Kalman filter status
- (27) Position, Longitude 48bit signed integer, Longitude * 10,000,000 (minutes). East being positive.
- (28) Velocity, 0.01 knots per bit (not delayed when ADAS enabled)
- (29) Slip Angle Front Left, 16-bit signed integer * 100.
- (30) Slip Angle Front Right, 16-bit signed integer * 100.
- (31) Slip Angle Rear Left, 16-bit signed integer * 100.
- (32) Slip Angle Rear Right, 16-bit signed integer * 100.
- (33) Slip Angle C of G, 16-bit signed integer * 100.
- (34) Time since midnight. This is a count of 10mS intervals since midnight UTC. (5383690 = 53836.90 seconds since midnight or 14 hours, 57 minutes and 16.90 seconds) (not delayed when ADAS enabled)
- (35) True Heading2 16-bit signed integer*100, (not delayed when ADAS enabled)

The VBOX CAN database is available in Vector Database (DBC File) format on request from Racelogic

CAN Bus data format – vehicle separation data Target 1

Below is the tabular list of additional ADAS CAN messages that are present at the Subject VBOX vci output CAN port, when Single target/Multiple Target veh sep or Static point mode is used. The ID's of the CAN messages can be configured through VBOX Tools software if required.

Format	Motorola							
ID**	Data Bytes							
	1	2	3	4	5	6	7	8
0x30A	(1) Range-tg1 (meters)				(2) RelSpd-tg1 (km/h)			
0x30B	(3) LngRsv-tg1 (meters)				(4) LatRsv-tg1 (meters)			
0x30C	(5) LngSsv-tg1 (km/h)				(6) LatSsv-tg1 (km/h)			
0x30D	(7) Angle-tg1 (deg)				(8) Status-tg1	(9) LkTime-tg1		
0x30E	(10) LngRtg-tg1 (metres)				(11) LatRtg-tg1 (metres)			
0x30F	(12) T2Csv-tg1				(10) Status-sv	(14) App Mode	(15) Yawdif-tg1	
0x310	(16) Spd-tg1				(17) T2C2sv-tg1			
0x311	(18) LatRref-tg1				(19) Accel-tg1			
0x312	(20) SepTim-tg1				(21) T2Ctg-tg1			

*Update rate depends on GPS update rate. 10ms Update rate shown corresponds to 100Hz GPS setting.

**Default Identifiers. The identifier values can be changed using the configuration software.

- (1) Vehicle Separation (meters), 32 Bit IEEE Float
- (2) Relative Speed (km/h), 32 Bit IEEE Float
- (3) Longitudinal Range; wrt subject heading (meters), 32 Bit IEEE Float
- (4) Lateral Range; wrt subject heading (meters), 32 Bit IEEE Float
- (5) Longitudinal Speed; wrt subject heading (meters), 32 Bit IEEE Float
- (6) Lateral Speed; wrt subject heading (meters), 32 Bit IEEE Float
- (7) Separation Angle (degrees), 32 Bit IEEE Float
- (8) Target RTK status 8 bit unsigned integer, 0=No solution, 1= Stand alone, 2= Code differential, 3=RTK Float, 4=RTK Fixed
- (9) Link Time 24 bit unsigned integer, count of 10ms counts since midnight.
- (10) Lateral Range; wrt Target heading (metres), 32 Bit IEEE Float
- (11) Longitudinal Range; wrt Target heading (metres), 32 Bit IEEE Float
- (12) Time to collision; wrt subject heading (seconds), 32 Bit IEEE Float
- (13) Local Status, 8 bit unsigned integer, 0=No solution, 1= Stand alone, 2= Code differential, 3=RTK Float, 4=RTK Fixed
- (14) Application Mode, unsigned integer. 0x01=Normal, 0x02= Remote, 0x04= Local, 0x08=Static, 0x10=Lane Dep - Lane1, 0x50=Lane Dep - Lane2, 0x90=Lane Dep - Lane3
- (15) YAW diff, difference between subject and target1 vehicle headings, 16 bit signed integer *100

- (16) Target Vehicle Speed (km/h), 32 Bit IEEE Float
- (17) Time to Collision 2; (seconds), 32 Bit IEEE Float
- (18) Lateral Diff (meters), 32 Bit IEEE Float
- (19) Target vehicle Acceleration (g), 32 Bit IEEE Float
- (20) Separation Time (seconds), 32 Bit IEEE Float
- (21) Time to Collision Target; wrt target heading (seconds), 32 Bit IEEE Float

CAN Bus data format – vehicle separation data Target 2

Below is the tabular list of additional ADAS CAN messages that are present at the Subject VBOX vci output CAN port, when 'multiple target' mode is used. The ID's of the CAN messages can be configured through VBOX Tools software if required.

Format	Motorola							
ID**	Data Bytes							
	1	2	3	4	5	6	7	8
0x317	(1) Range-tg2 (meters)				(2) RelSpd-tg2 (km/h)			
0x318	(3) LngRsv-tg2 (meters)				(4) LatRsv-tg2 (meters)			
0x319	(5) LngSsv-tg2 (km/h)				(6) LatSsv-tg2 (km/h)			
0x31A	(7) Angle-tg2 (deg)				(8) Status-tg2	(9) LkTime-tg2		
0x31B	(10) LngRtg-tg2 (metres)				(11) LatRtg-tg2 (metres)			
0x31C	(12) T2Csv-tg2				(10) Status-sv	(14) App Mode	(15) Yawdif-tg2	
0x31D	(15) Spd-tg2				(16) T2C2sv-tg2			
0x31E	(17) LatRref-tg2				(18) Accel-tg2			
0x31F	(19) SepTim-tg2				(20) T2Ctg-tg2			

*Update rate depends on GPS update rate. 10ms Update rate shown corresponds to 100Hz GPS setting.

**Default Identifiers. The identifier values can be changed using the configuration software.

- (1) Vehicle Separation (meters), 32 Bit IEEE Float
- (2) Relative Speed (km/h), 32 Bit IEEE Float
- (3) Longitudinal Range; wrt subject heading (meters), 32 Bit IEEE Float
- (4) Lateral Range; wrt subject heading (meters), 32 Bit IEEE Float
- (5) Longitudinal Speed; wrt subject heading (meters), 32 Bit IEEE Float
- (6) Lateral Speed; wrt subject heading (meters), 32 Bit IEEE Float
- (7) Separation Angle (degrees), 32 Bit IEEE Float
- (8) Target RTK status 8 bit unsigned integer, 0=No solution, 1= Stand alone, 2= Code differential, 3=RTK Float, 4=RTK Fixed
- (9) Link Time 24 bit unsigned integer, count of 10ms counts since midnight.

-
- (10) Lateral Range; wrt Target heading (metres), 32 Bit IEEE Float
 - (11) Longitudinal Range; wrt Target heading (metres), 32 Bit IEEE Float
 - (12) Time to collision; wrt subject heading (seconds), 32 Bit IEEE Float
 - (13) Local Status, 8 bit unsigned integer, 0=No solution, 1= Stand alone, 2= Code differential, 3=RTK Float, 4=RTK Fixed
 - (14) Application Mode, unsigned integer. 0x01=Normal, 0x02= Remote, 0x04= Local, 0x08=Static, 0x10=Lane Dep - Lane1,
0x50=Lane Dep - Lane2, 0x90=Lane Dep - Lane3
 - (15) YAW diff, difference between subject and target2 vehicle headings, 16 bit signed integer *100
 - (16) Target Vehicle Speed (km/h), 32 Bit IEEE Float
 - (17) Time to Collision 2; (seconds), 32 Bit IEEE Float
 - (18) Lateral Diff (meters), 32 Bit IEEE Float
 - (19) Target vehicle Acceleration (g), 32 Bit IEEE Float
 - (20) Separation Time (seconds), 32 Bit IEEE Float
 - (21) Time to Collision Target; wrt target heading (seconds), 32 Bit IEEE Float

CAN Bus data format – lane departure data

The standard VBOX CAN output is extended with additional identifiers containing vehicle separation data when the VBOX is set to 'Lane Departure' mode. The ID's of the CAN messages can be configured through VBOX Tools software if required.

Format	Motorola							
ID*	Data Bytes							
	1	2	3	4	5	6	7	8
0x30A	(1) Range-Lt (meters)				(2) Range-Rt (meters)			
0x30B	(3) LatSpd-Lt (km/h)				(4) Status			
0x30C	(5) TTC-Lt (sec)				(6) LatSpd-Rt (km/h)			
0x30D	(7) TTC-Rt (sec)				(8) Angle (deg)			

*Default Identifiers. The identifier values can be changed using the configuration software.

- (1) Lateral Distance to Line from vehicle left point (meters), 32 Bit IEEE Float
- (2) Lateral Distance to Line from vehicle right point (meters), 32 Bit IEEE Float
- (3) Lateral speed toward line wrt to vehicle left point (km/h), 32 Bit IEEE Float
- (4) Status, 32 Bit IEEE Float, 0=No solution, 1= Stand alone, 2= Code differential, 3=RTK Float, 4=RTK Fixed
- (5) Time To Line cross, wrt to vehicle left point, (seconds), 32 Bit IEEE Float
- (6) Lateral speed toward line wrt to vehicle right point (km/h), 32 Bit IEEE Float
- (7) Time To Line cross, wrt to vehicle right point, (seconds), 32 Bit IEEE Float
- (8) Angle (deg), 32 Bit IEEE Float

The VBOX CAN database (in either metric or imperial units) is available in Vector Database (DBC File) format on request from Racelogic

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Revision	Date	Description	Author
1	01/12/06	First release	AM
2	14/08/08	Addition of VBOX manager set up and Static Point description. Modification of diagrams.	AM
3	10/03/09	Included diagrams of parameter calculation from remote and local vehicles	AM
4	13/03/09	Updated document to add VB3i comments	AM
5	7/12/09	Addition of new ADAS functions, including lane departure	KB
6	2/2/10	Amendment to CAN output format table to include Local RTK status	KB
7	18/4/11	Update to 100Hz operation	KB
8	8/9/11	Addition of new features, smoothing, heading lock, lat diff channel and separation time	KB
9	28/11/11	Addition of new Time to collision_remote channel	KB
10	10/01/12	Corrections made to Lane Departure CAN bus data format	SN
11	9/2/12	Amendment to Parameter definition pictures.	KB
12	5/4/13	Addition of multiple target mode and duplex, plus Lane departure on curved lanes	KB
13	4/6/13	Corrections made to ADAS CAN bus data format	RO
14	27/11/13	Addition of Twin antenna channels and Yaw dif to CAN output format table.	KB