VBOX 3i User Manual

- 01 - VB3i Introduction
- 02 - VB3i GPS Antenna Placement
- 03 - VB3i Front Panel
- 04 - VB3i LED Indicators
- 05 - VB3i Logging
- 06 - VB3i Dual Antenna Setup
- 07 - VB3i VBOX Setup
- VB3i VBOX Setup 1 - General
- VB3i VBOX Setup 2 - Channels
- VB3i VBOX Setup 3 - Logging
- VB3i VBOX Setup 4 - GPS
- VB3i VBOX Setup 5 - IMU
- VB3i VBOX Setup 6 - ADAS
- VB3i VBOX Setup 7 - CAN
- VB3i VBOX Setup 8 - Output
- 08 - VB3i CAN
- 09 - VB3i Analogue and Digital I/O
- 10 - VB3i Dynamic Modes
- 11 - VB3i DGPS / RTK
- 12-1 - VB3i IMU Integration
- How to Mount the IMU
- Kalman Filter Calibration
- VB3i V3-V5 Additional IMU04 Channels
- 12-2 - VB3i IMU Integration - Roof Mount
- 13 - VB3i Bluetooth Pairing
- 14 - VB3i Voice Tagging
- 15 - VB3i Technical Properties
- VB3i Analogue Input PIN OUTS
- VB3i CAN Output
- VB3i EC Declaration of Conformity

- VB3i Firmware Upgrade
- VB3i PIN OUTS
- VB3i Technical Specification

01 - VB3i Introduction

Configuration

VBOX 3i can be configured using **VBOX Manager** via a RLCAB005 cable, or can be connected to a computer and configured using **VBOX Tools Setup** or **VBOX Setup** software. You can connect to a computer via Bluetooth, a RLCAB001 cable to the '**SER**' input and the computer's serial port (USB-serial adapter may be required), or via a RLCAB066-2 cable to one of the computer's USB ports.

For ADAS applications, connection between the VB3i and computer should be made via USB or Bluetooth to ensure optimum performance.

Note: VBOX 3i V5 can only be configured by computer using VBOX Setup software.

Power Supply

Included with the VBOX 3i is a cigar lighter power cable, which is the primary source of power input. This is terminated in a 2-way connector and mates with the 2-way 'PWR' socket on the VBOX 3i.

The VBOX 3i can be powered from a wide range of voltage sources. When considering batteries as a power source please note that the minimum operating voltage of the VBOX 3i is 7 V. The maximum operating voltage input must not exceed 30 V DC. Failure to observe this could result in damage to the VBOX.

Note - Using an **External Power Backup** prevents the system shutting down under temporary power loss.

Warning

The VBOX can be connected to other Racelogic input modules including the ADC03, ADC02, TC8, FIM02/3 and multifunction display. Please note that the voltage supply to Racelogic modules connected to the VBOX will be at the same level as the VBOX power input. Therefore when using any of the Racelogic peripherals with VBOX 3i, the input voltage must not exceed 15 V. Failure to observe this could result in damage to the module and possibly the VBOX 3i.

When running the VBOX from a battery pack, the VBOX will sound a warning tone to indicate when the battery voltage

is reaching the minimum operating voltage level. When this tone is heard, the battery pack requires re-charging or replacing.

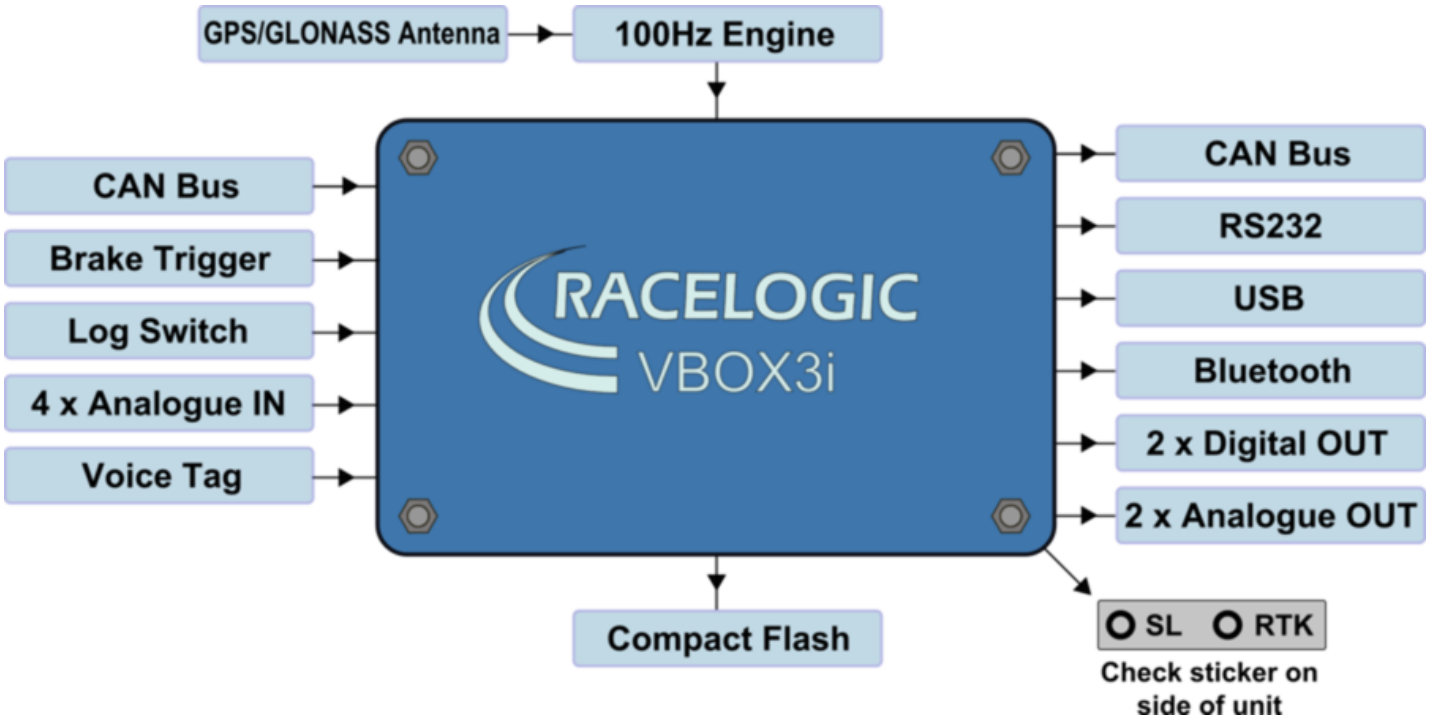
The VBOX 3i has been designed to generate as little heat as possible and it has a wide operating temperature range. However, it is good practice to mount the VBOX 3i in a position where it has sufficient airflow around the case.

You must connect the GPS antenna before connecting power to the VBOX 3i. This is necessary because on power-up the VBOX 3i will look for a connected GPS antenna and automatically adjust its gain for optimum performance.

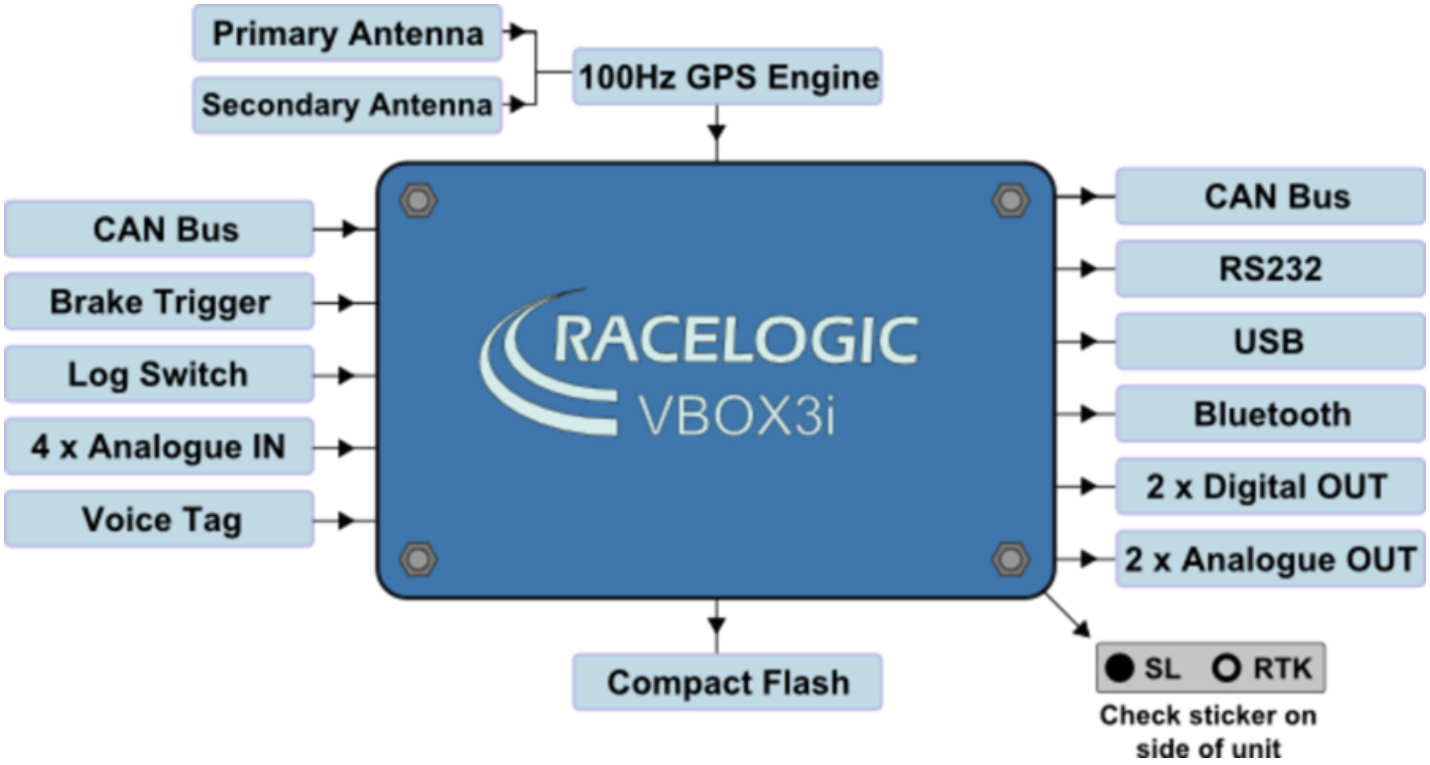
RACELOGIC external modules operate from a 12 V vehicle supply. Therefore, when using external modules, VBOX supply must not exceed 15 V DC.

Inputs/Outputs

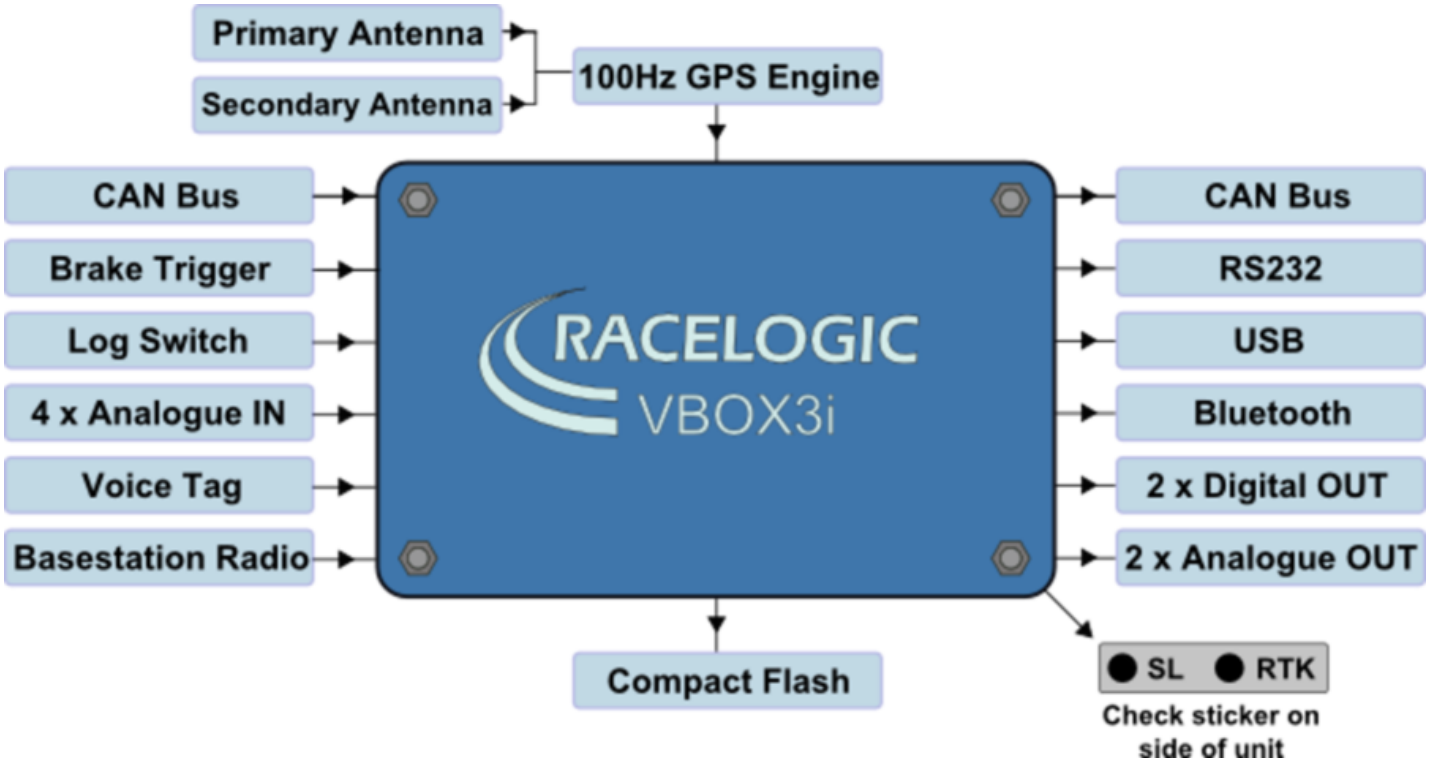
VBOX 3i



VBOX 3i Dual Antenna



VBOX 3i RTK



Inputs

- **100 Hz GPS / GLONASS Engine (Dual antenna systems only)**
  VB3iSLR features a powerful GPS engine embracing twin antennas capable of providing 100Hz signal update rate for all GPS/GLONASS parameters (i.e. velocity, heading & position). Velocity and heading are calculated via Doppler Shift in the GPS carrier signal, providing you with unparalleled data accuracy.
- **GPS/GLONASS Antenna(s) (Dual antenna systems and VBOX 3i V4G only)**
  All standard parameters like time, speed, distance, and position are measured at the primary antenna. The secondary antenna enables logging of additional channels like slip angle, pitch or roll angle (depending on antenna orientation).
- **Base Station Radio Link (RTK systems only)**
  Can be used in conjunction with an **RTK differential Base Station** to obtain centimetre-level positional accuracy.
- **2x CAN Bus**
  Two CAN Bus interfaces are available; a Racelogic CAN bus and a customer VCI bus. The Racelogic CAN bus is designed to interface with Racelogic external modules, such as TC8, FIM03 and IMU04. The customer VCI bus is designed to connect third party CAN devices, to log additional VCI CAN data to the VBOX (i.e. vehicle CAN bus, Steering wheel sensor). Having separate CAN bus connections allows the user to connect to separate CAN data sources without risk of re-broadcast on to customer VCI source. 32 external CAN channels can be logged by the VBOX, of which up to 16 CAN signals can be logged on the VCI customer bus. When logging data from another source, **VBOX Tools** or **VBOX Setup** software can be used load signal data from an industry standard CAN database file (.DBC).
- **Brake Trigger**
  By using a physical pressure switch on the brake pedal, a precise 'start of braking event' can be captured. The brake/event trigger input is oversampled to 25 ns for high distance accuracy.
- **Log Switch**
  A start/stop logging switch allows users to manually choose when they wish to record data.
- **4x Analogue Inputs**
  Each of the four analogue input channels has a dedicated 24 bit analogue converter. Data is recorded from each channel simultaneously to avoid latency between analogue channel data. The name, scale and offset of each analogue input channel can be adjusted using VBOX Tools or VBOX Setup software to allow sensor calibration and therefore logging of data in standard SI units. The analogue input connector also provides two power outputs that may be used for driving sensors. These are in the form of a 5 V DC isolated supply and an output equal to the VBOX power supply voltage. If the VBOX is set to 100 Hz log rate, then the additional option of 500 Hz analogue data sampling will be present and available.
- **Voice Tagging**
  VBOX 3i can record a GPS synchronised WAV audio tag of up to 30 seconds long, captured to a time accuracy of 0.5 sec. The recorded WAV file is then logged to the CF card.
- **Power Supply**
  VBOX 3i can accept a supply voltage between 7 – 30 V DC. Low current consumption results in extended battery life.

Outputs

- **CAN Bus**
  The VCI customer CAN bus can be utilised to output standard VBOX data parameters, plus up to 12 additional data channels from connected external source or internal modules (i.e. ADAS, dual antenna).
  The **baud rate** and CAN id's for these outputs are user configurable.
- **RS232**
  The RS232 connector is used for VBOX configuration and output of real-time GPS data. Provides the facility to connect to a radio telemetry system to offer PC monitoring of test data.
- **USB**
  VBOX 3i USB connector can be used for VBOX configuration and to output real-time data at 100 Hz to a PC.
- **Bluetooth**
  VBOX 3i comes equipped with an internal Bluetooth Radio allowing remote configuration and remote output of real-time GPS data to any Bluetooth capable PC or Data logger. The Bluetooth connection is capable of sending data at the full 100 Hz rate.
- **2x Digital Outputs**
  The first digital output is assigned to 'Speed/Distance' with adjustable 'Pulses per Meter' setting, while the second output is a level switch output enabling users to select any one of the logged channels and assign it a threshold value, e.g. output high (5 V) when speed greater than 20kmh.
- **2x Analogue Outputs**
  Both 16 bit analogue outputs can be configured to output any data channel being logged by the VBOX for use by additional data logging equipment. The voltage output range is from 0 – 5 V DC with a resolution of 76 µV per bit.
- **CF Card**
  Data is logged in a space-delimited text format. Recording time dependent on flash card capacity, log frequency, number of channels and logging conditions. Approximately 29 MB per hour used when logging GPS data at 100 Hz; approx. 182 MB per hour total logging capacity.

  Note: Large VBO files may cause issues when loading into VBOX Tools or VBOX Test Suite, depending on PC specification. The higher the set recording frequency, the larger the logged data file will be.

Technical specifications vary for each VBOX 3i version. Please see the **datasheets** for detailed information.

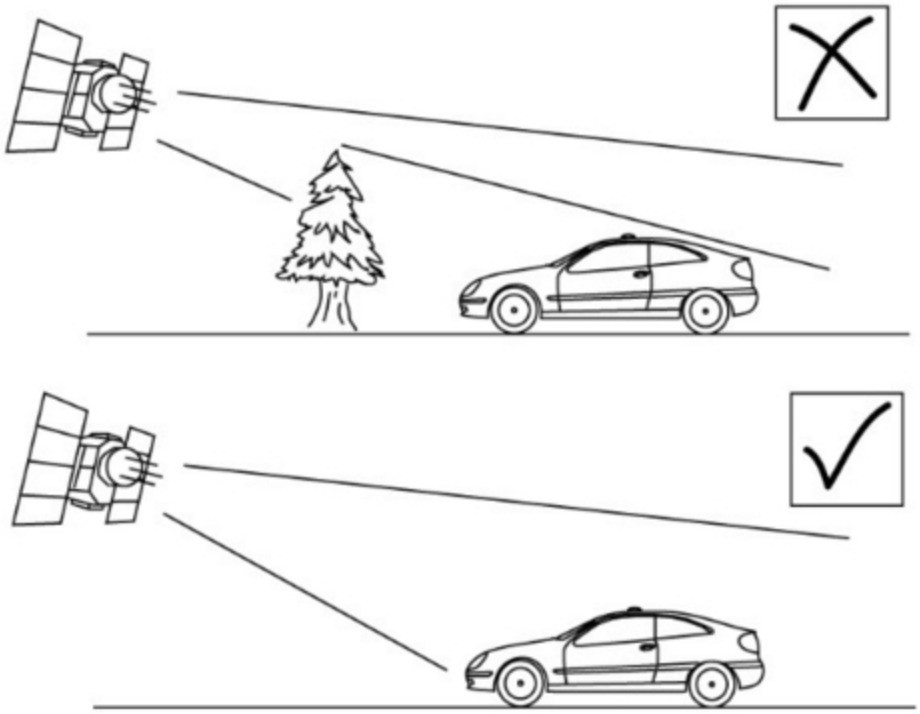
02 - VB3i GPS Antenna Placement

Single Antenna Systems

The GPS antenna supplied with the VBOX is a 5 V active antenna. For the best possible signal quality, it is important to maintain a clean connection between the antenna and the VBOX. Before fixing the antenna to the VBOX, ensure that there are no dust particles in either connector. Replacement antennae are available by contacting your VBOX distributor.

The antenna is a magnetic mounting type for quick and simple mounting to the vehicle roof. For optimum GPS signal reception, make sure that the antenna is fitted to the highest point of the vehicle away from any obstructions that may block satellite reception. The GPS antenna works best with a metal ground plane underneath (a metallic vehicle roof is perfect for this)

Please also note that when using any GPS equipment, a clear sky view is important. Objects in the surrounding area such as tall buildings or trees can block the GPS signal causing a reduction in the number of satellites being tracked, or introducing reflected signals that can decrease the accuracy of the system. Note that clouds and other atmospheric conditions do not affect the VBOX's performance.

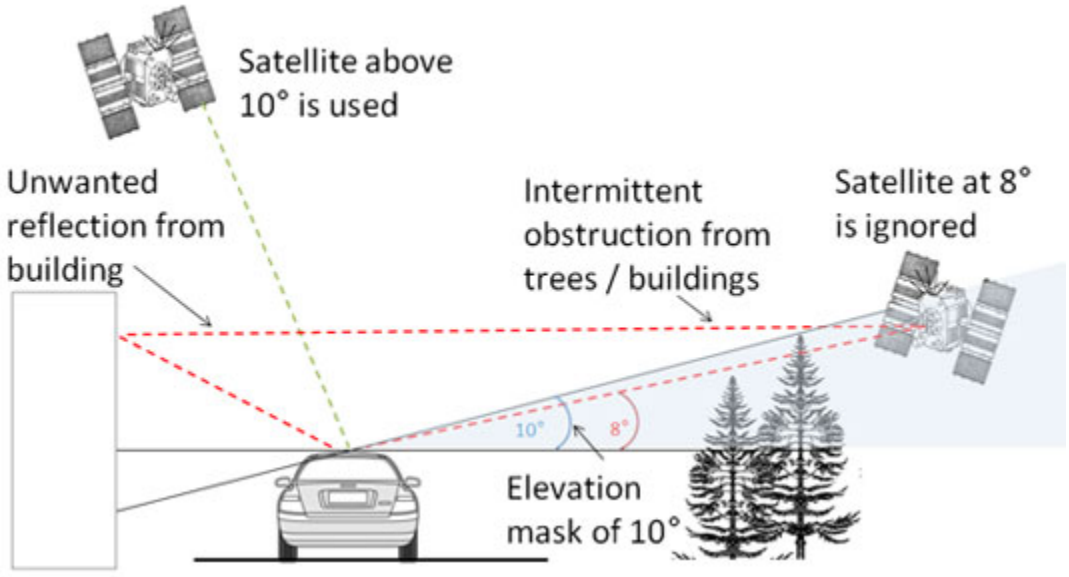


GPS antennas require a ground plane to operate correctly. This helps to reduce unwanted reflections of the GPS signal caused by nearby objects, and usually the metal roof of a vehicle performs this function. However, if a test requires an antenna to be placed either off the vehicle, or on a vehicle that does not have a metallic roof, a special ground plane antenna must be used. This has an internal ground plane and can operate perfectly without the need for mounting on a metal surface. Ground plane antennas are available from your VBOX distributor.

Satellite Elevation Mask

This feature can be used to improve GPS signal quality when nearby obstacles like trees and building are reflecting or temporarily obscuring the signal from satellites at low elevation. Raising the mask will cause the GPS engine to ignore satellites below the mask angle, so must be used carefully as it also reduces the total number of received satellites.

The elevation mask angle can be changed in VBOX Tools Setup, VBOX Setup and by using VBOX Manager.



Dual Antenna Systems

For further info on slip/pitch and slip/roll setups, click here.

When testing using dual antenna mode, the greater the antenna separation, the greater the accuracy of the dual antenna derived data channels.

Slip Angle Accuracy

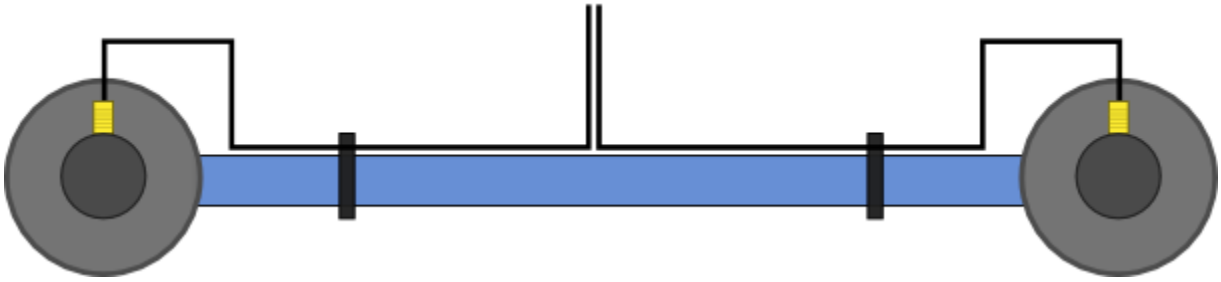
<0.2° rms at 0.5 m antenna separation
<0.1° rms at 1.0 m antenna separation
<0.067° rms at 1.5 m antenna separation
<0.05° rms at 2.0 m antenna separation
<0.04° rms at 2.5 m antenna separation

Pitch/Roll Angle Accuracy

<0.14° rms at 0.5 m antenna separation
<0.07° rms at 1.0 m antenna separation
<0.047° rms at 1.5 m antenna separation
<0.035° rms at 2.0 m antenna separation
<0.028° rms at 2.5 m antenna separation

Some vehicle roofs limit the potential separation value. In this case a roof mount (**RLACS171**) can be utilised to increase separation.

Antennas should be positioned so that the gold antenna connector of primary and secondary antennas (A+B) are **pointing in the same direction**. This matching positioning ensures that the separation measurement is relative.



We recommend you measure separation from outer edge of antenna connector A, to same outer edge of antenna connector B. Note that accurate entry of **antenna separation** is essential for dual antenna operation.

- In pitch alignment, the primary antenna (ANT A) should be placed towards the rear of the vehicle, and the reference antenna (ANT B) placed at the front.
- When in roll alignment, the primary antenna (ANT A) should be placed to the left of the vehicle, and the reference antenna (ANT B) placed to the right.

When mounting the antennas directly to the vehicle roof, ensure that the antenna placement still follows the guidance of the single antenna above (i.e. clear ground-plane, away from obstruction).

The two antennas must be on a similar plane! If there is a degree of separation greater than 10°, the system will not obtain dual antenna lock.

Both antenna cables must be the same length!

Timing is a very important aspect of the dual antenna lock and identical cable lengths will ensure that signal propagation delays do not cause unreliable dual lock.

GPS Coldstart

A GPS coldstart may be required when:

- The GPS engine has locked up.
- VBOX is struggling to acquire satellite lock

A GPS coldstart forces the GPS engine to reset its downloaded almanac of current satellite positions. This can be useful if the VBOX 3i is having trouble locking onto satellites, which typically occurs if the VBOX 3i has not been used for several weeks or if it was last used a long distance (over one thousand miles) away from the current location.

After performing a GPS coldstart leave the VBOX 3i powered up in a static location where the antenna has an unobstructed view of the sky until the ‘GPS’ LED becomes solid green.

Once the VBOX3i has downloaded the new almanac it will reacquire satellites in noisy situations (such as near trees, buildings and under bridges) much quicker. It will also acquire satellite much quicker on power-up.

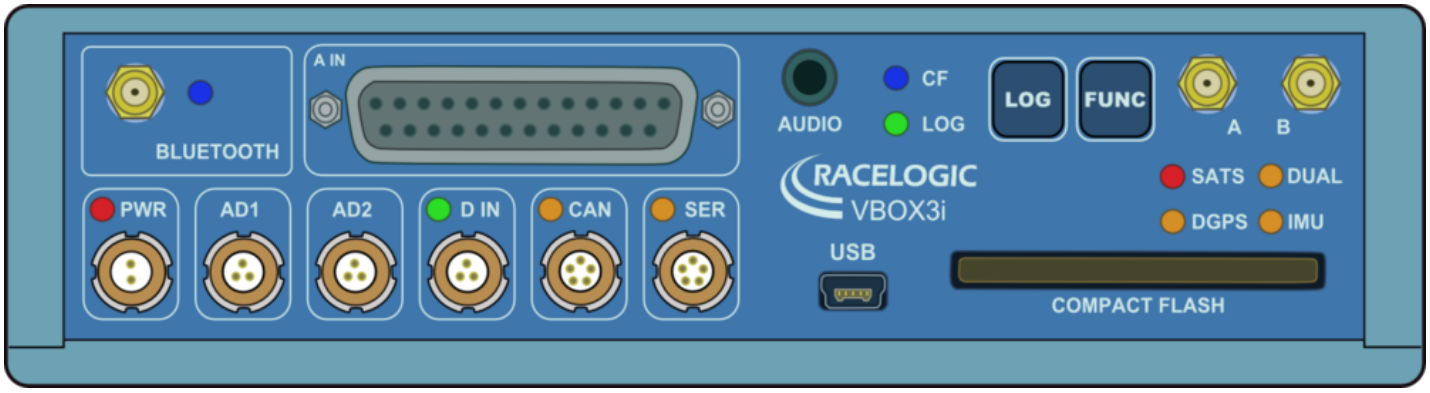
To perform a GPS coldstart on the VBOX3i perform the following actions:

- Press and hold the ‘LOG’ button on the front of the VBOX 3i for five seconds until a long beep is sounded.
- When the button is released the ‘GPS’ LED will start to flash red showing that the coldstart has been performed and the GPS engine is now not locked onto any satellites.
- After approximately 30-45 seconds the ‘GPS’ LED will start to flash green indicating that satellite lock has been achieved and indicating the number of satellites that it is locked onto.

Important notes

When a GPS coldstart is carried out, please note that this reset the DGPS and RTK mode to 'none'. Also, if using a dual antenna system, the VBOX 3iSL will reset dual antenna separation to default settings (1 m).

03 - VB3i Front Panel



Buttons

VBOX 3i has two membrane buttons on the front panel, LOG and FUNC. LOG is used to start and stop logging to the compact flash card, and FUNC is used to switch between two sample rates, 100 Hz and 20 Hz.

LOG

The LOG button will override any of the automatic logging thresholds set in the VBOX. For example, if you have set the VBOX to log all the time, the LOG button will toggle logging on and off. If you have set the VBOX to 'log only when moving' and you are moving, pressing the LOG button will stop the VBOX logging and close the file on the compact flash. Logging will now not continue even if you are moving until the LOG button is pressed again or the compact flash card is removed and reinserted. The VBOX will then continue to log only when moving. Note that if the VBOX is using 'log only when moving' log mode, and the vehicle has been stationary from power-up, the LOG button will not initiate logging. If you want the VBOX to log, you would have to use VBOX Manager, VBOX Tools Setup or VBOX Setup to change the log mode to 'Log Continuous'.

- Every time the logging is toggled with the LOG button, a new file is created.

- When the VBOX is logging, the the green LOG LED will be solid and the blue CF light will flash.

- Do not remove the CF card or power down whilst this LED is flashing. If you need to remove the card or power down whilst the CF light is flashing, then press the LOG button first to stop the VBOX logging. Failure to do so will result in data loss or corruption.

FUNC

Pressing the FUNC button briefly flashes the LED's and beeps to indicate the current sample rate. A slow flash (once per second) on all the LED's indicates 20 Hz, and rapid flashing (5 times a second) indicates a 100 Hz sample rate. A running sequence of lights indicates a sample rate other than 100 Hz or 20 Hz. Pressing and holding the FUNC button for 5 seconds toggles the current sample rate. The sample rate can also be set using VBOX Manager, VBOX Tools Setup or VBOX Setup.

Default setup

The default factory settings are restored to the VBOX by pressing and holding the FUNC and LOG buttons for 5 seconds. This will put the VBOX 3i into the default factory settings; 100 Hz log rate, log continuous mode, Fixed 20 ms CAN delay, Output CAN Tx Identifiers on, Racelogic CAN on the CAN port, customer VCI CAN on the SER port, and only standard GPS channels and brake trigger event time set to log.

VB3i RS232 / CAN Ports

Click here for information on the VB3i RS232 protocol.

VBOX 3i is equipped with 2 CAN Bus interfaces and 2 RS232 serial ports. The primary RS232 port is used for all communication between the VBOX and laptop PC. The primary port is marked SER on the VBOX 3i front panel. The primary RS232 port (SER) is able to transmit live data from the VBOX to the PC for viewing and performing real-time tests. It is important to note however that due to limitations of the PC serial port, live data transfer of all channels is limited to 20 Hz, at 50 Hz only standard GPS channels and Solution Type should be transmitted, and at 100Hz only Sats, Time, Speed, and Trigger Event Time should be transmitted. Logging too many channels at too high a rate is likely to cause drop-outs and loss of data.

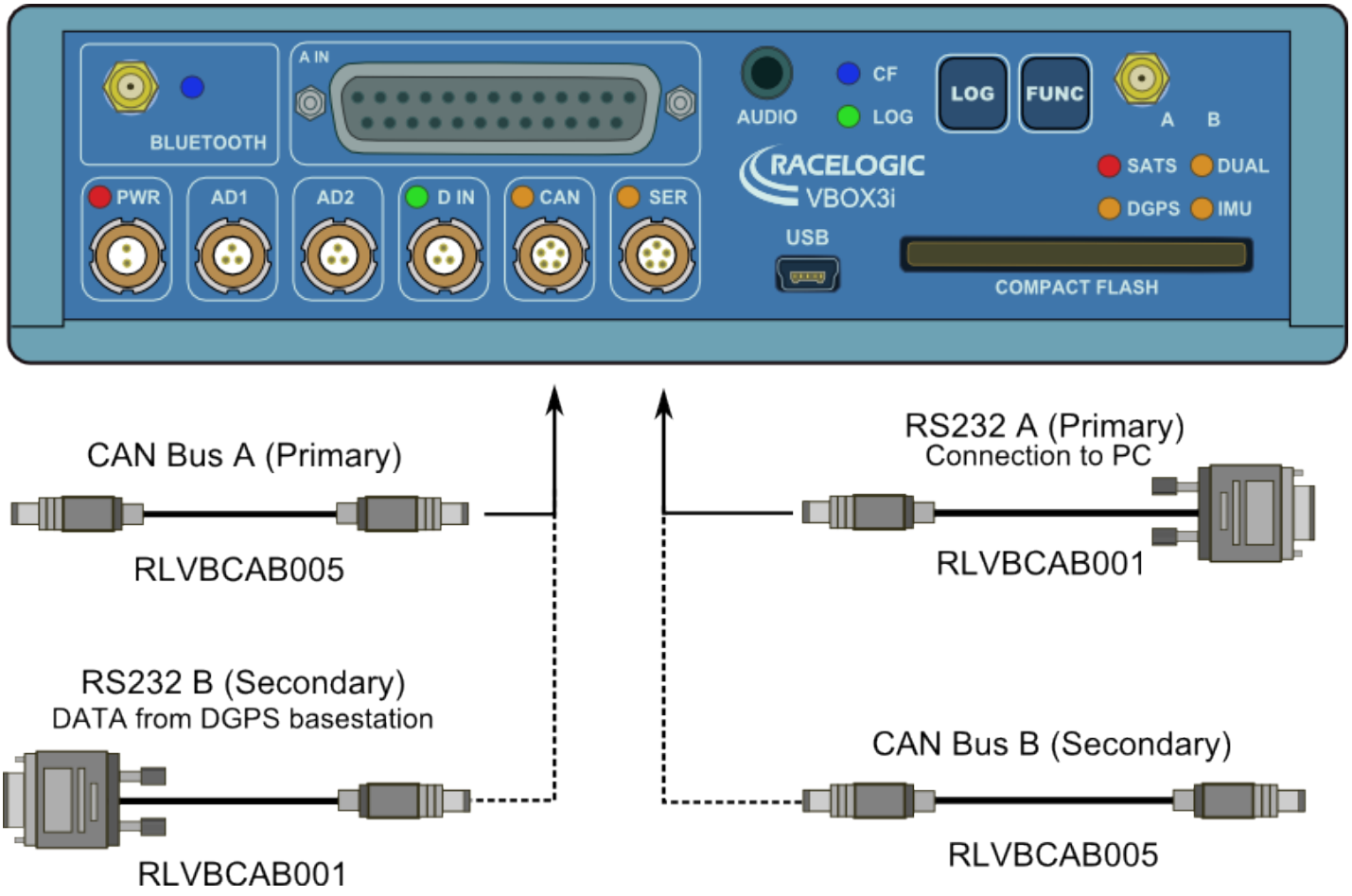
Therefore for maximum accuracy, tests performed at a GPS sample rate above 20 Hz should be logged to compact flash and post processed.

Note that when the VBOX is set to an ADAS mode, RS232 serial transmit from the SER port will be disabled.

The secondary RS232 port is used for connection to a Telemetry Radio module allowing the reception of Differential GPS (DGPS) data for local correction from a Racelogic Local DGPS basestation, or Moving Base solution. The secondary RS232 port is located in the connector marked CAN on the VBOX 3i front panel.

The CAN Bus ports A and B are located in the VBOX 3i connectors “CAN” and “SER” respectively. The function of these ports is configurable by the user, using VBOX Tools Setup or VBOX Setup to toggle the Racelogic Bus profile. The Racelogic CAN bus is used for connected Racelogic modules or displays. The Vehicle CAN bus (VCI) is for use by third party CAN equipment, whether logging to the VBOX, or logging from the VBOX. For dual use of RS232 and CAN from one of the sockets you will require a 5 way Lemo splitter RLVBACS024.

Power supplied to external Racelogic CAN modules through the “CAN” or “SER” cables is at the same voltage as the input power supply. Therefore when using Racelogic external CAN modules (eg; MFD or ADC03), the VBOX 3i supply voltage must not exceed 15 V DC.



USB

The VBOX includes a USB 2.0 connection that can be used for VBOX configuration and the output of real-time serial data at the full 100 Hz data rate.

Before you connect your VBOX to your PC ensure that you have downloaded and installed either VBOX Setup or VBOX Tools software, as this will also put the required USB drivers onto your PC.

The software installation will place the VBOX USB drivers in the following location on your computer. C:\program files\ Racelogic\Drivers.

VB3i drivers can also be downloaded from the Drivers and Utilities section of vboxautomotive.co.uk.

When you connect a powered up VBOX 3i to your PC with the supplied USB lead, your PC will recognise the presence of new hardware and open the typical Windows install window for new hardware. Follow the on screen prompts and point the Windows installation to the location of your drivers.

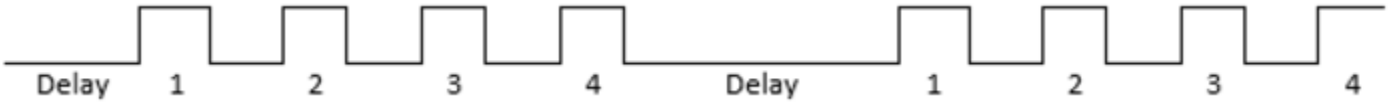
04 - VB3i LED Indicators

SATS

- Flashing **red** indicates no satellites in view
- Flashing **green** sequence indicates the number of GPS satellites currently being tracked. Each flash indicates a satellite with a short pause between each sequence.
- Flashing **orange** sequence indicates the number of GLONASS Satellites currently being tracked. Each flash indicates a satellite with a short pause between each sequence.

Sequence showing 1 Satellite

Sequence showing 4 Satellites



Sequence showing 0 Satellites

Note for VB3i V1 units

When the filter is enabled and the IMU is connected, the **satellite** LED will remain off to act as an indicator for the IMU integration status. Only when the filter is initialised and movement is detected will the SAT LED return to its normal operation.

The user will need to leave 1 minute after powering the VBOX on with the IMU connected before starting to move. This occurs on every power up of the VBOX unit.

DIFF/DGPS

- Off indicates that no DGPS mode is set or is in MB-Base mode.
- Flashing **orange** indicates DGPS is set but not locked (either 2 cm RTK, 40 cm local DGPS, MB-Rover or NTRIP).
- Solid **orange** indicates a 'Float' RTK status (either 2 cm RTK, MB-Rover or NTRIP) or ‘Fixed’ DGPS lock (40 cm local DGPS or SBAS).
- Solid **green** indicates a ‘Fixed’ RTK lock (either 2 cm RTK, MB-Rover or NTRIP).

DUAL (VB3i SL units only)

- Solid **orange** indicates that dual antenna mode is enabled.
- Solid **green** indicates dual antenna lock is fixed.

PWR

- Solid **green** indicates that a suitable power source is connected, unit is fully booted and ready to use.
- Solid **red** indicates that the VBOX is not ready to operate either because it is still booting up, settings are being written to the unit or because there is an error condition.

D IN

- Solid **green** indicates that the brake trigger input has been activated/triggered.

CAN

- Flashing **green** indicates that expected incoming CAN data has been decoded properly and is being logged.
- There is no illumination to indicate that there is incoming Serial traffic through this socket.

SER

- Flashing **yellow** indicates that there is incoming Serial traffic through this socket.
- Flashing **green** indicates that expected incoming CAN data has been decoded properly and is being logged.

BLUETOOTH

- V1 Bluetooth module - Flashing **blue** indicates Bluetooth is waiting for a connection.
  V2 Bluetooth module – Flashing **blue** indicates Bluetooth is initialising coms with a Bluetooth device.
- Solid **blue** indicates the VBOX3i has a Bluetooth connection with another Bluetooth device.

CF

- Flashes **blue** when data is being written to the card.

LOG

- Solid **green** when the VBOX is capturing data to the CF card.
- Flashes **red** indicating current logging rate after 'FUNC' button press, fast for 100 Hz, slow for 20 Hz.

IMU (V2/V3/V4/V5 only)

- Solid **orange** indicates that IMU integration is enabled but no IMU is connected, or, the detected IMU is invalid. When using an IMU04, ensure that it is: connected using an RLCAB119 to the 25-way D connector, is set to Racelogic CAN mode, and is running the **latest release firmware**.
- Flashing **orange** shows IMU is connected and integration initialisation is running. This will not complete until the VB3i has had a satellite lock whilst stationary for 30 seconds.
- Flashing **green** indicates Initialisation complete – movement not yet detected.
- Solid **green** indicates movement detected – IMU integration working OK.

VB3i V1

When IMU Integration is enabled and the IMU is connected, the **satellite** LED will remain off to act as an indicator for the IMU integration status. Only when the filter is initialised and movement is detected will the SAT LED return to its normal operation.

The user will need to leave 1 minute after powering the VBOX on with the IMU connected before starting to move. This occurs on every power up of the VBOX unit.

05 - VB3i Logging

Logging modes

The logging method can be set within **VBOX Tools > VBOX Setup** or **VBOX Setup.** There are three options which operate as described below.

Log continuously

With ‘log continuously’ ticked the VBOX will log data, regardless of movement, whenever powered with media detected.

Log only when moving

With ‘log only when moving’ ticked then the VBOX will only log data to the CF card when it detects speed >0.5 km/h.

Advanced

The advanced logging option on the VBOX 3i allows any of the logged data channels to be used to trigger the logging on the VBOX.

This facility allows a threshold value to be set as either > or < so that the logging will start or stop when a data value is exceeded (or not).

Multiple data channels can be combined in a Boolean ‘OR’ manner to control the logging.

Compact Flash Memory Cards

The VBOX stores logged data onto CF cards. The CF cards available from Racelogic are already optimised for use on the VBOX and as such do not need formatting before use. Should the CF Card need formatting due to card errors it can be done through Windows, as the VBOX supports the following format type:

- FAT
- FAT16
- FAT32

To guarantee compatibility with VBOX 3i, please purchase CF cards direct from Racelogic, via a Racelogic Distributor or contact us to confirm card compatibility.

Notes:

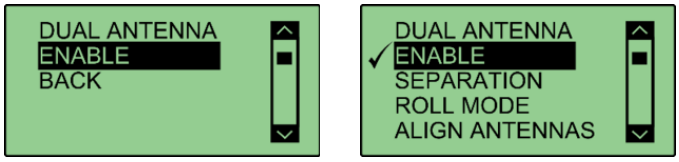
- The VBOX3i only supports CF cards up to a **maximum size of 32 GB** - cards larger than this may not be correctly detected by the VBOX and may fail to capture data.
- UDMA 7 CF cards are not compatible with the VBOX 3i.

06 - VB3i Dual Antenna Setup

VBOX Manager has been developed to control the operating functions of a VB3iSL. This section describes how to setup your vehicle with two antennas.

Menu

Within the Dual Antenna menu, select the enable option in order to see the full dual antenna system menu, with a tick shown next to enable.



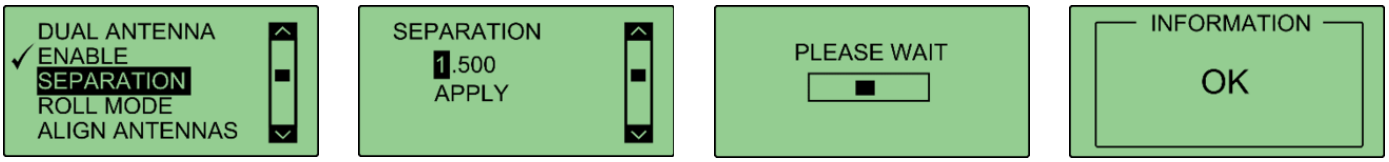
Antenna Separation

The most important factor for dual antenna testing is the correct configuration of the separation distance between the two antenna centre points. This allows the VB3iSL / VBSS100SL to acquire and maintain dual antenna lock. The physical separation distance between the two antennas should be measured as accurately as possible, and entered in to the Separation option of the Dual Antenna menu.

To provide consistent reference, the two antennas should be aligned with the gold antenna connectors pointing in the same direction. This then allows a connector-to-connector physical reference measurement to be made.

When the antennas are setup on an un-even plane, and not perfectly level, the hypotenuse (3D distance) measurement should be used.

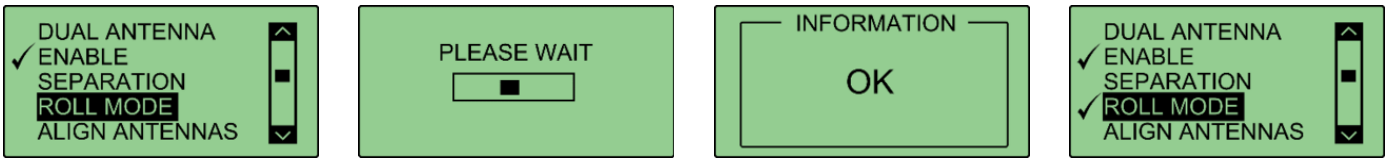
Where possible, antennas should be placed on a level plane. A maximum of 10° different between the primary and secondary antenna is permitted.

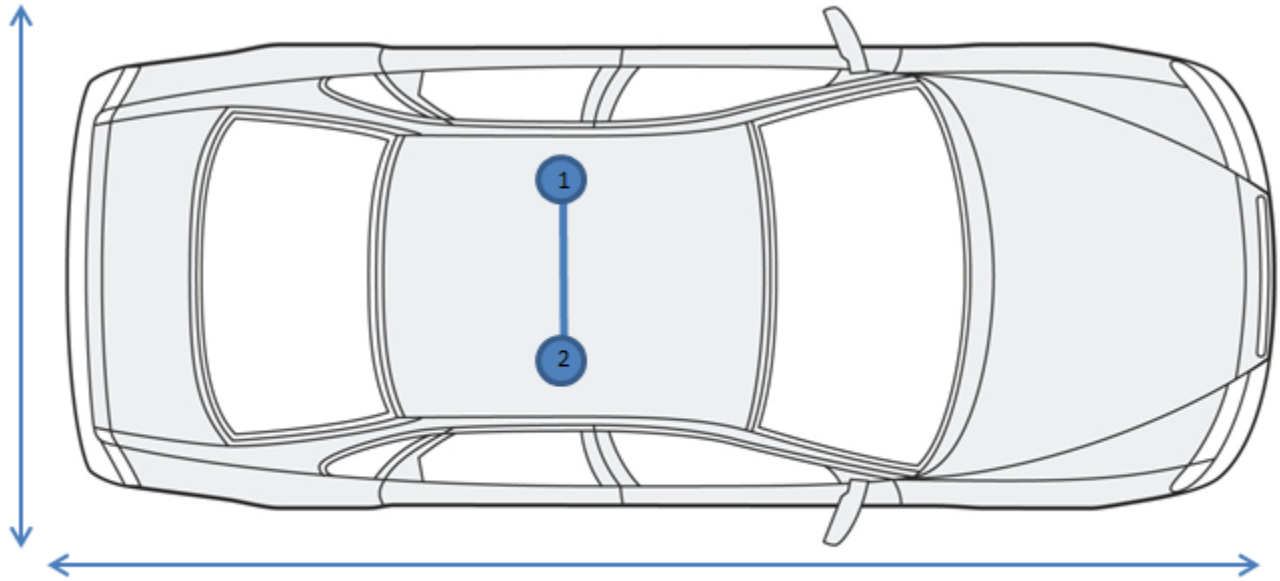


Note: Whenever the physical antenna separation is altered, this should be changed accordingly within VBOX Manager.

Roll Mode (optional)

The VB3iSL / VBSS100SL allows the user to separately test roll and pitch measurements during their testing. By default, the VB3iSL / VBSS100SL will be setup for pitch determination. If the user wishes to setup their antennas across the width of the car to measure roll angle, then the Roll Mode option must be toggled in the Dual Antenna menu. Click this option to toggle between Pitch Mode (no-tick), and Roll Mode (tick).

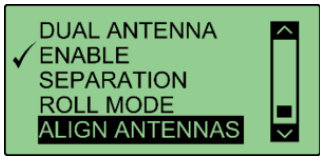


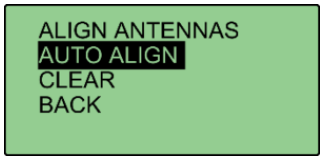


1. Primary Antennae (Port A)
2. Secondary Antennae (Port B)

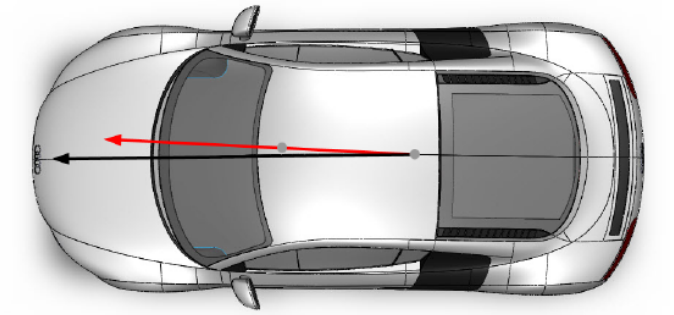
Align Antennas

To measure the slip angle with the most precision, try and get the alignment of the antennas as close as possible to the centreline of the vehicle. Any residual errors in this alignment can be removed using the **AUTO ALIGN** feature available in VBOX Manager.

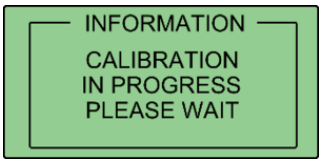


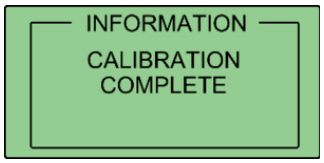


The calibration process requires the driver to drive in a straight line for a short period of time, whilst maintaining a constant speed, greater than 25 km/h.
Note any existing alignment offset from a previous setup should be removed by using the CLEAR function. This should be completed before the AUTO ALIGN.
Note that any camber on the road or a strong side wind will affect this alignment.



The calculated alignment offset will be applied to the determined heading of the secondary antenna (True Heading). The True Heading Offset will be displayed in the header comments section of a recorded .vbo, when viewed in a text editor suite, such as Notepad++.





Selecting the **CLEAR** option will remove any offset applied to the slip channel.

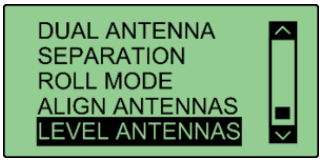
Note: You must have dual antenna lock to be able to perform this calibration.

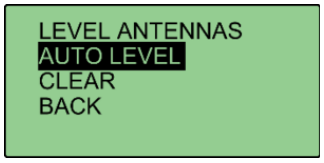
Level Antennas

The Pitch measurement uses the relative height difference between the antennas to calculate the Pitch Angle relative to the ground. If the roof of your vehicle is not perfectly flat in relation to the ground, then this will show up as a Pitch offset. You can automatically remove any offset by performing the **AUTO LEVEL** feature available on VBOX Manager.

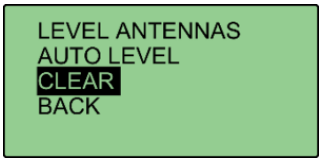
Note that any existing antenna level offset from a previous setup should be removed by using the CLEAR function. This should be completed before the AUTO LEVEL.

It is recommended that you perform the **AUTO LEVEL** on a flat, level section of road.





Selecting the **Clear** option will remove any offset applied to the pitch channel.

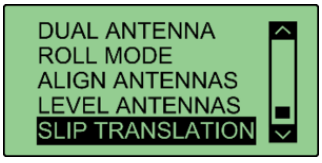


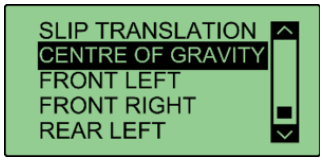
Slip Angle Translation

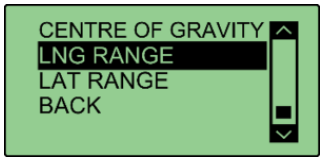
In Dual Antenna mode you may wish to take slip measurements from other locations on the vehicle, for instance the centre of gravity or slip over the wheels. This can be set using the **SLIP TRANSLATION** function in VBOX Manager. The five additional locations are set using longitudinal and lateral offsets from the primary antenna location (antenna 1 in the picture below). Longitudinal translation offsets should be defined as positive when forward of the primary antenna, negative when behind the antenna. Lateral translation offsets should be defined as negative when to the left of the antenna, positive when to the right.

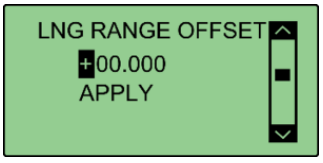
VB3iSL - IMU assistance: When an IMU module is connected to the VB3iSL, the yaw rate channel will be used in the calculated slip channels, as the signal to noise ratio is much lower than the GPS derived yaw rate. Therefore no extra noise is added during the slip translation process.

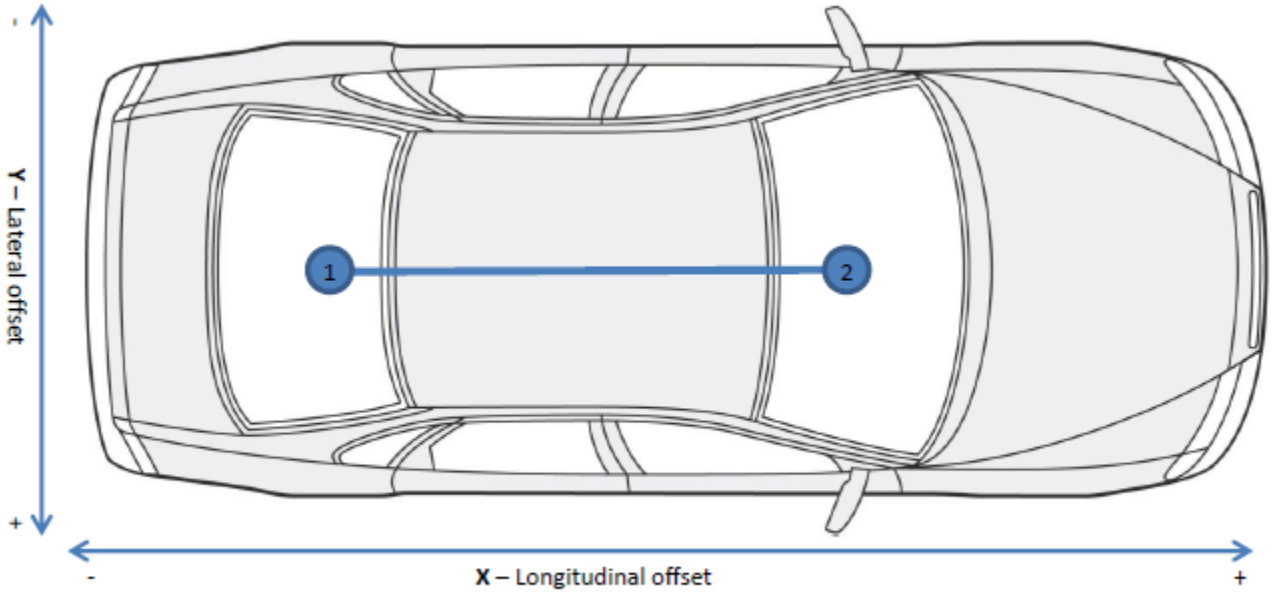
VBSS100SL - Gyro assistance: VBSS100SL has an integrated gyroscope which requires the unit to be mounted flat. The Gyro Yaw Rate will be used in the calculated slip channels as the signal to noise ratio is much lower than the GPS derived yaw rate. Therefore no extra noise is added during the slip translation process.





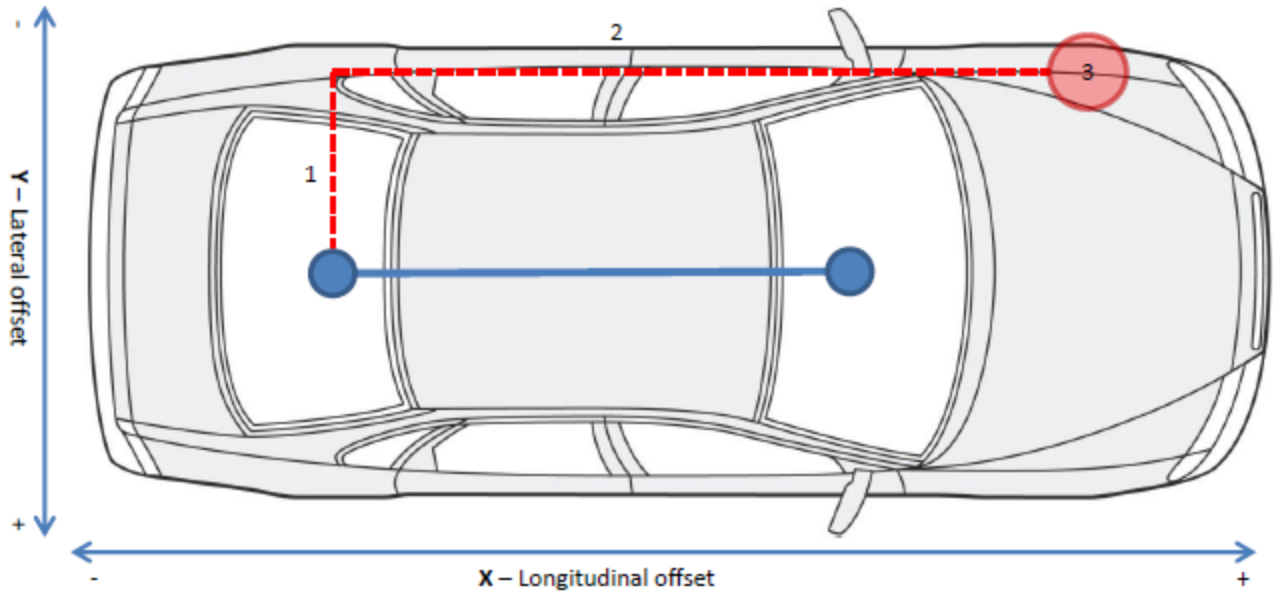






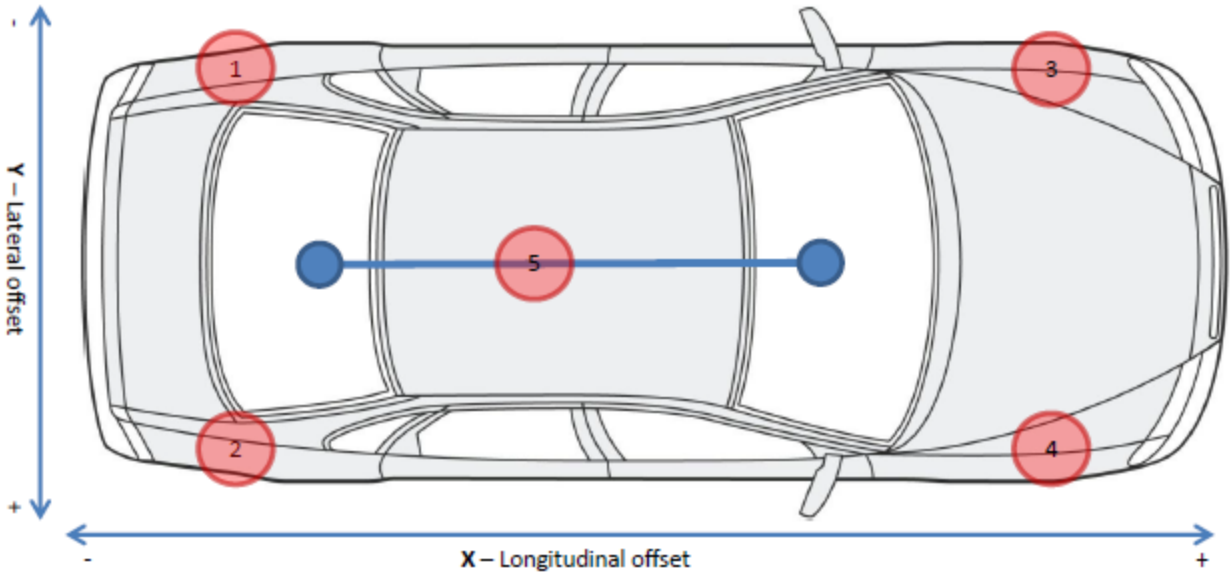
1. Primary Antennae
2. Secondary Antennae

In section 1 on the diagram below there is a lateral offset between the primary antenna and the target area for slip measurement. Same again for section 2, there is a longitudinal offset. These offsets will need to be applied by VBOX Manager (ensure you apply the correct sign when entering the offsets).



1. Lateral offset **Y** (example -0.45m)
2. Longitudinal offset **X** (example +3.50m)
3. FL (Front Left) translated slip position

Each calculated slip point will require two offsets, LAT and LNG (or lateral and longitudinal), for the VBOX to calculate the channels correctly. Note: If the primary antenna moves the offsets will need to be measured again, for example swapping between a pitch and roll setup.



Translated slip points

1. RL (Rear Left)
2. RR (Rear Right)
3. FL (Front Left)
4. FR (Front Right)
5. COG (Centre of gravity)

07 - VB3i VBOX Setup

To configure VB3i, the VBOX needs to be connected to a power source and a PC.

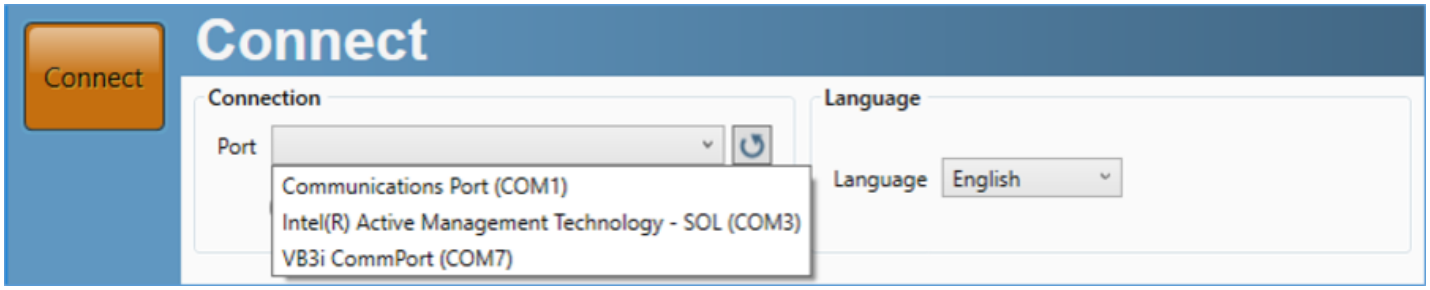
Configuration of VB3i can be performed using VBOX Setup software, which can be downloaded here. You can connect to a computer via Bluetooth, a RLCAB001 cable to the 'SER' input and the computer's serial port (usb-serial adapter may be required), or via a RLCAB066-2 cable to one of the computer's USB ports.

IMPORTANT – Microsoft Windows 7 SP1 or newer is required (must be compatible with .Net Framework 4.7.1)

For ADAS applications, connection between the VB3i and computer should be made via USB or Bluetooth to ensure optimum performance.

Use the drop down list to select the correct COM port that the VB3i is connected to. VBOX Setup automatically connects to the selected device and enters the VB3i setup screen.

Note: An auto detect message may appear if the baud rate has been changed from the default value – select 'Yes' to allow the different baud rates to be scanned.



VB3i VBOX Setup 1 - General

VB3i VBOX Setup 2 - Channels

VB3i VBOX Setup 3 - Logging

VB3i VBOX Setup 4 - GPS

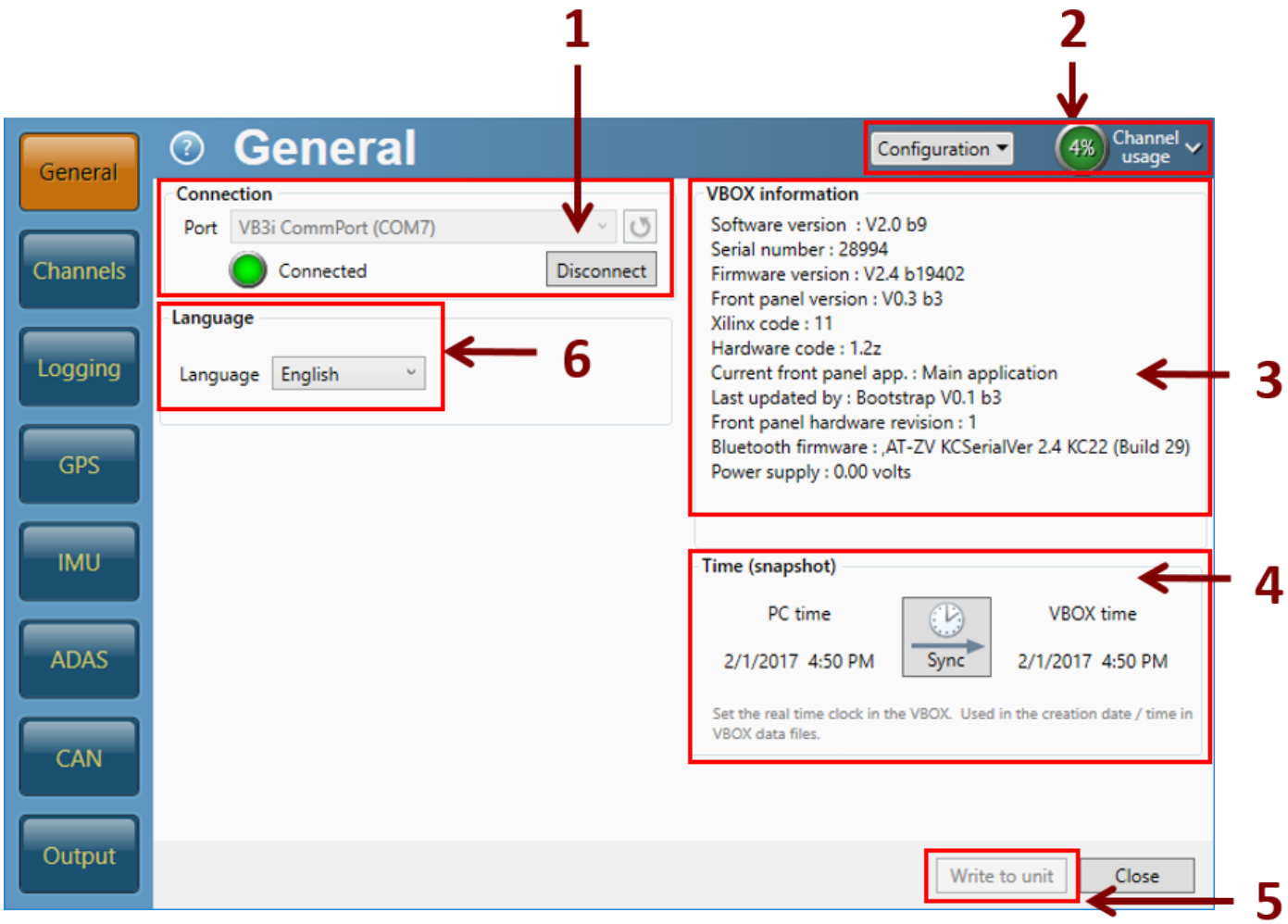
VB3i VBOX Setup 5 - IMU

VB3i VBOX Setup 6 - ADAS

VB3i VBOX Setup 7 - CAN

VB3i VBOX Setup 8 - Output

VB3i VBOX Setup 1 - General

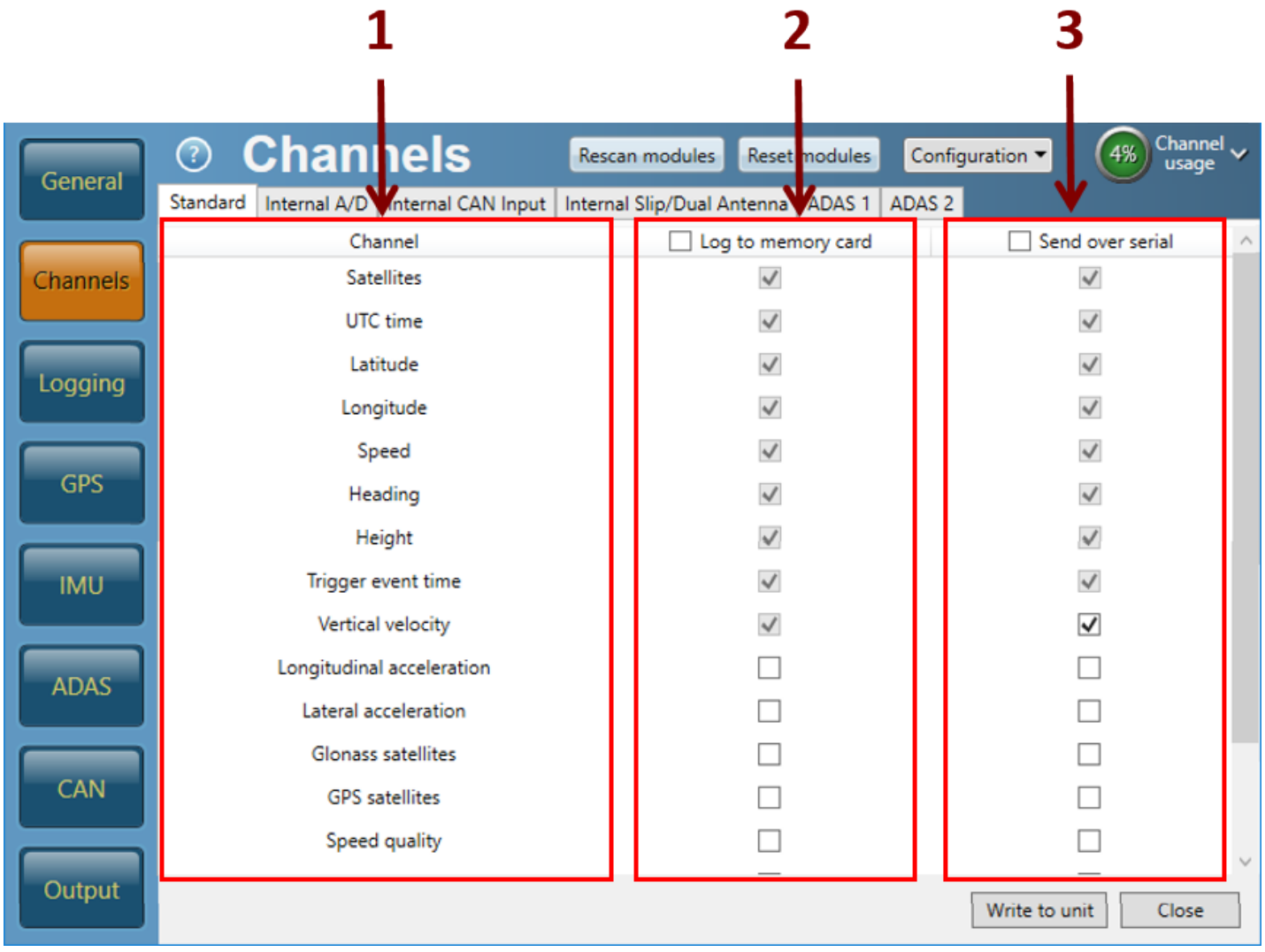


1. **Connection** – Selected com port, refresh and disconnect buttons.
2. **Configuration/ Channel usage** – Load/Save settings from/into an .rcf file, allowing setups to be kept for future use. View log, serial and CAN channel usage.
3. **VBOX Information** – Serial number and installed firmware version of connected unit, software version.
4. **Time (snapshot)** – Syncs the VB3i time to match the PC time, used for the top line of a vbo, to show the time and date when the file was created.
5. **Write to unit** – After making changes to setup, the write to unit button must be selected to upload settings.
6. **Language** – Select an operating language.

VB3i VBOX Setup 2 - Channels

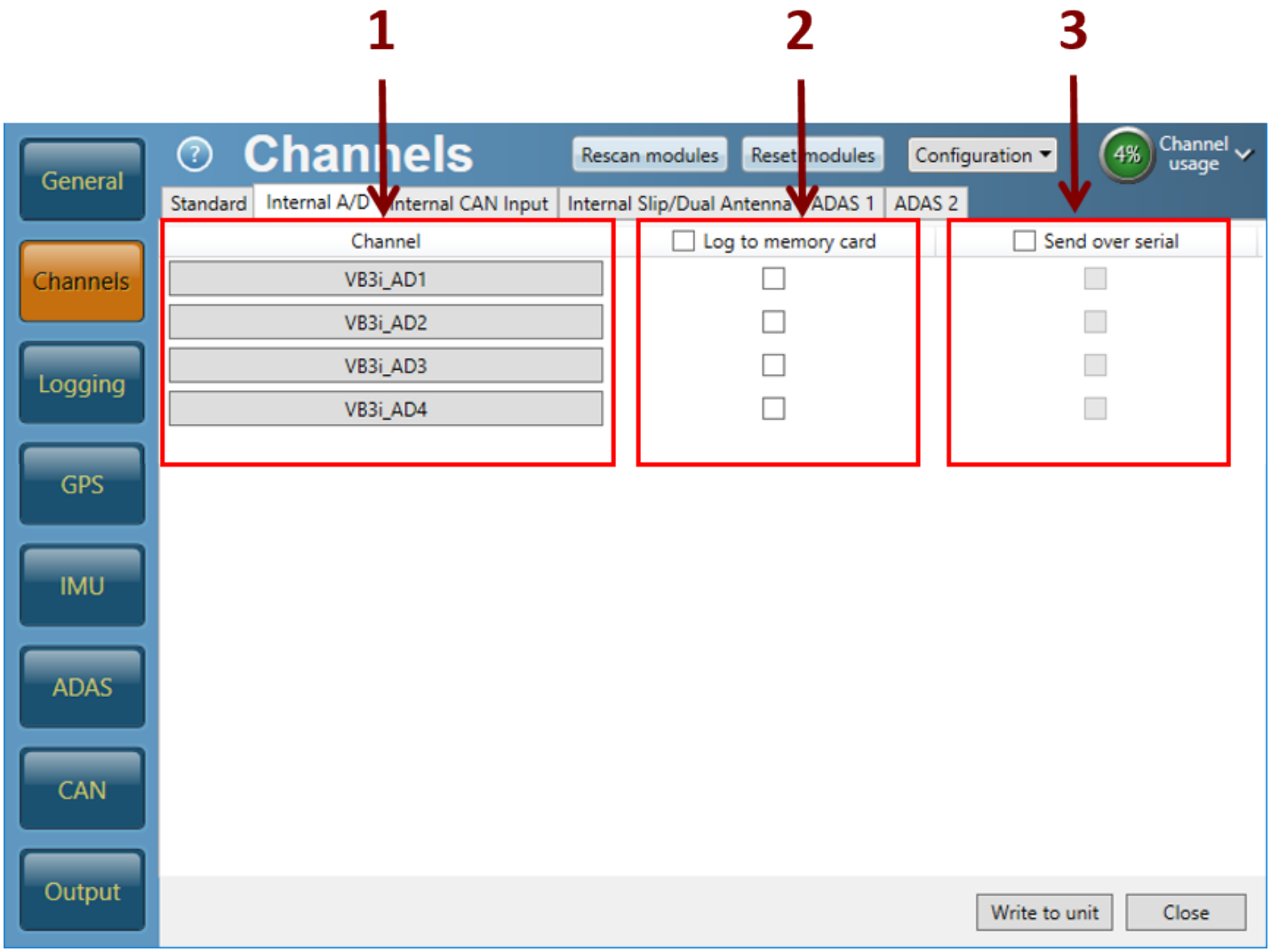
This menu changes depending on what is connected. If a module is connected when VBOX Setup is already running, clicking '**Rescan modules**' performs a rescan and anything new connected will show up (and anything disconnected will disappear).

Standard



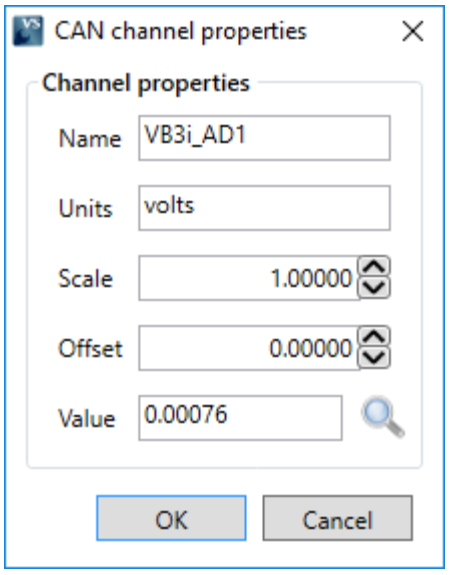
1. **Channel** – List of standard channels logged by VB3i.
2. **Log to memory card** – Select to log channel to memory card.
3. **Send over serial** – Select to send channel over serial.

Internal A/D



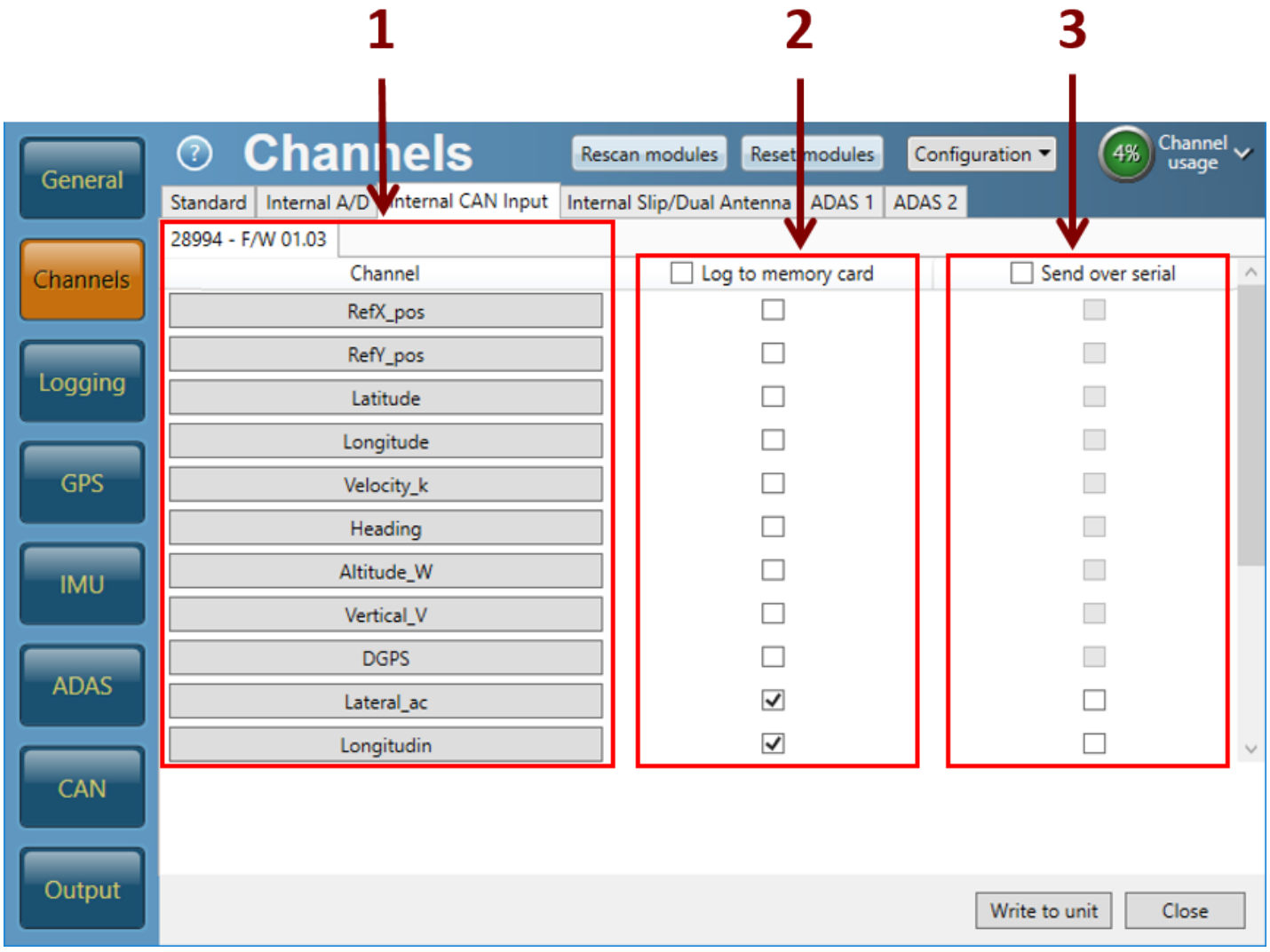
1. **Channel** – List of internal A/D channels logged by VB3i. VB3i has 4 A/D inputs, these are on the 25 way D type connector. Pin outs can be found here.

   Clicking on any channel box will display a live data reading.



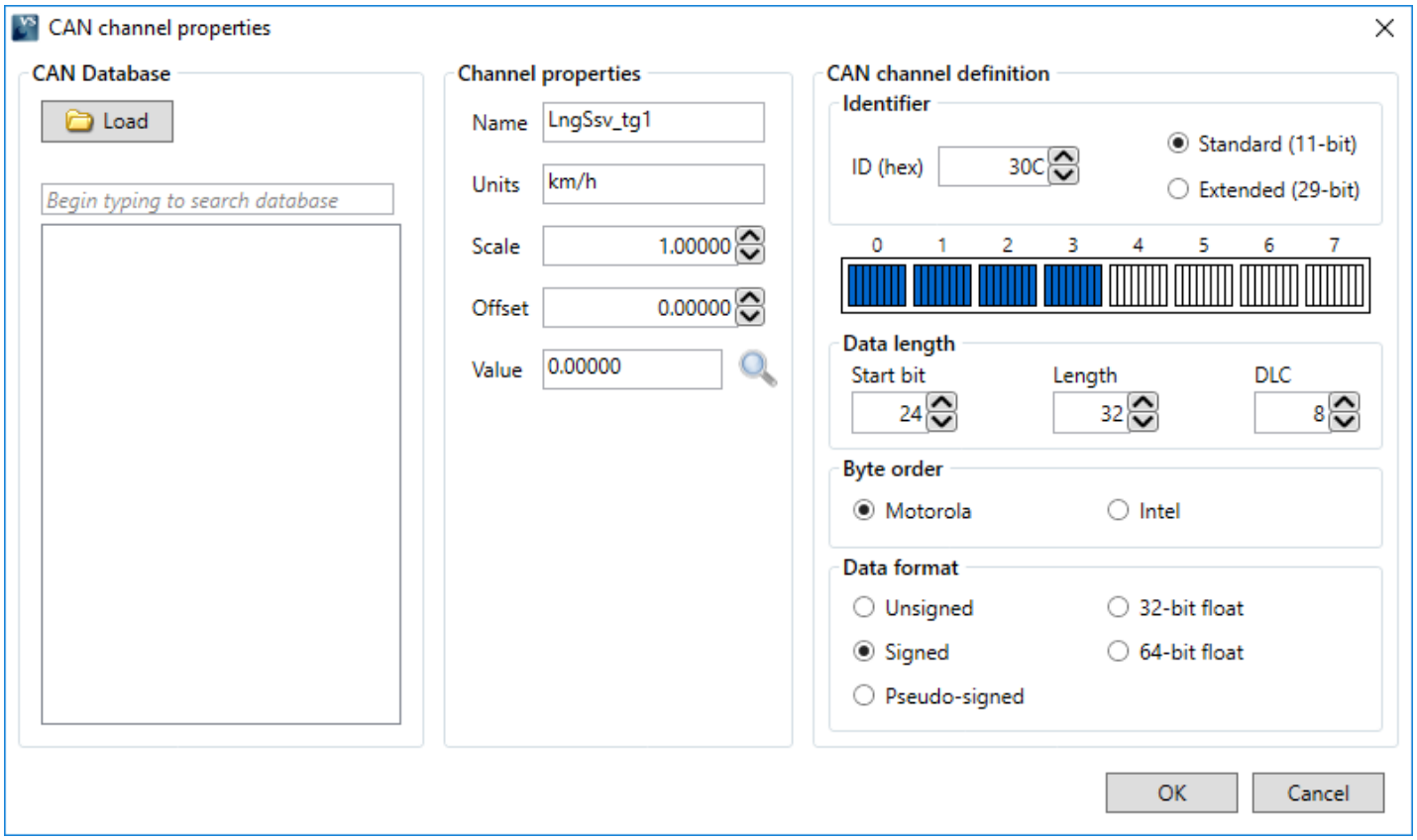
2. **Log to memory card** – Select to log channel to memory card.
3. **Send over serial** – Select to send channel over serial.

Internal CAN Input



1. **Channel** – List of internal CAN input channels logged by VB3i. The serial number and firmware version is shown at the top of the tab.

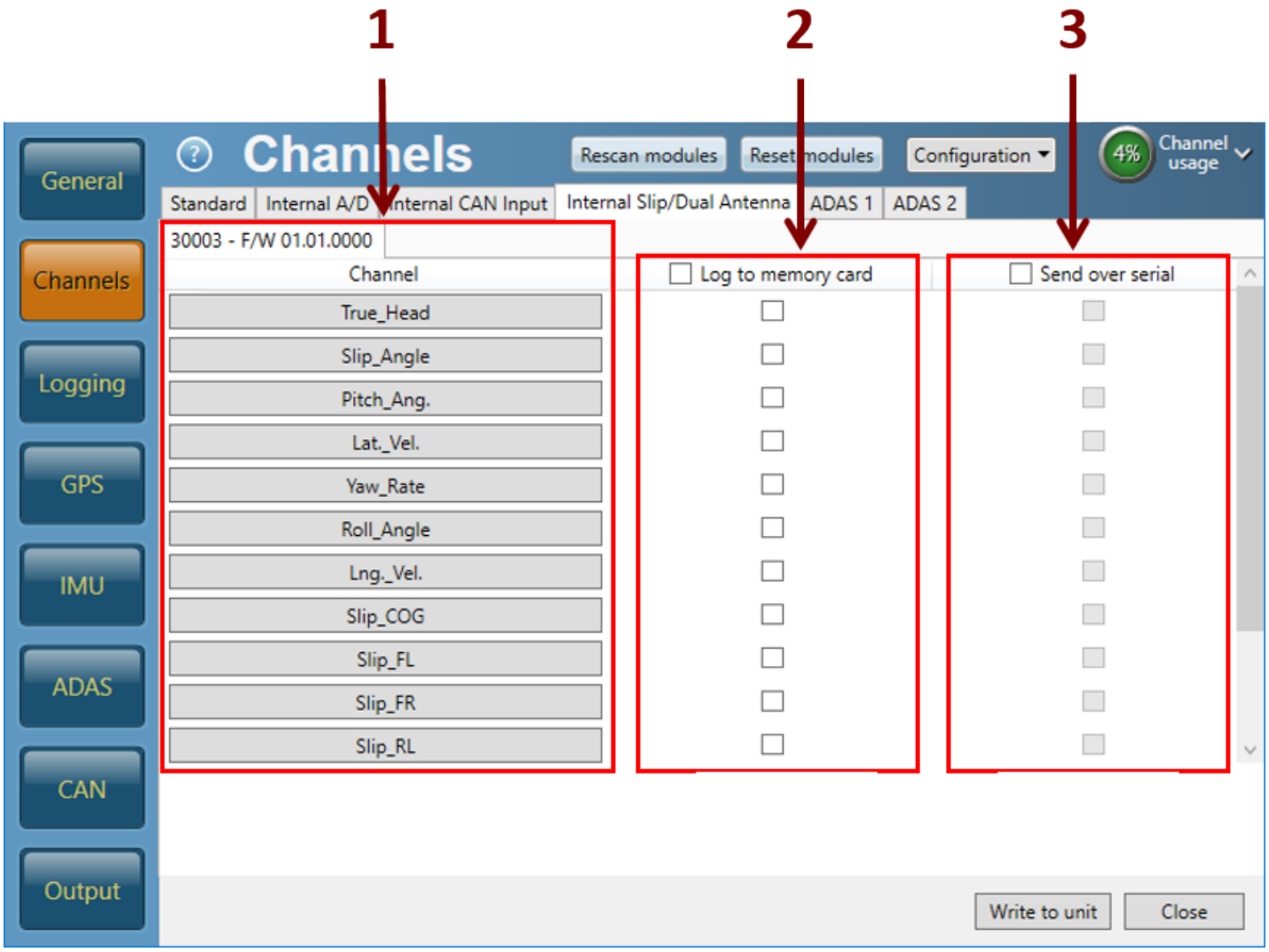
   A maximum of 16 channels are available and are set up by clicking on any channel box. This brings up a new window, where a CAN database file (.dbc/.ref/.vci) can be loaded, or the channel can be manually defined.



2. **Log to memory card** – Select to log channel to memory card.
3. **Send over serial** – Select to send channel over serial.

Internal Slip/Dual Antenna

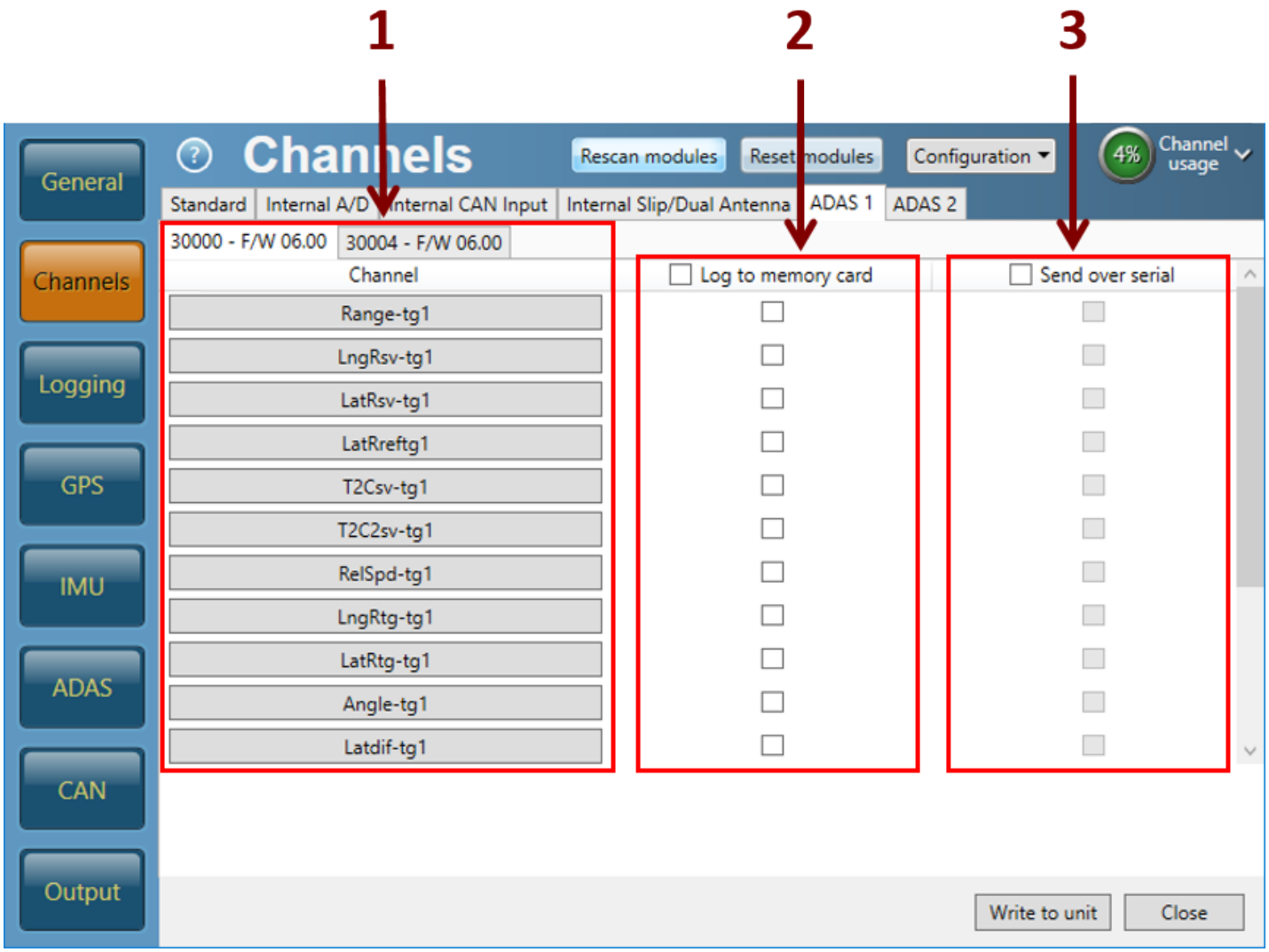
Note: This menu only appears with VBOX 3i Dual Antenna (VB3i SL).



1. **Channel** – List of internal slip/ dual antenna channels logged by VB3i. Clicking on any channel box will display a live data reading.
2. **Log to memory card** – Select to log channel to memory card.
3. **Send over serial** – Select to send channel over serial.

ADAS 1

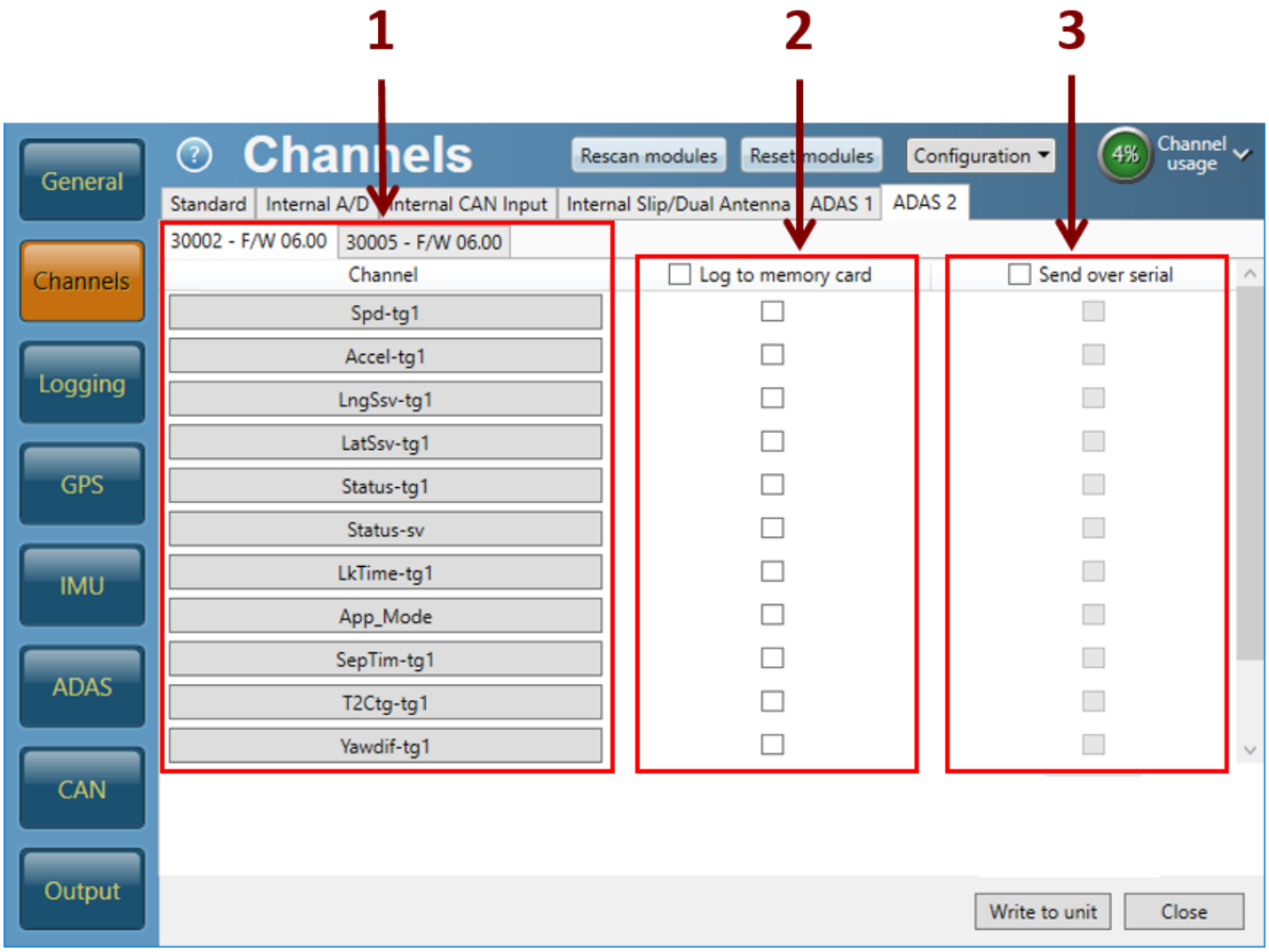
*Note: This menu only appears when an ADAS mode is enabled and will vary dependent on the specific mode (screenshots based on '**Multi** **target**' mode)*



1. **Channel** – List of ADAS 1 channels logged by VB3i. Clicking on any channel box will display a live data reading.
2. **Log to memory card** – Select to log channel to memory card.
3. **Send over serial** – Select to send channel over serial.

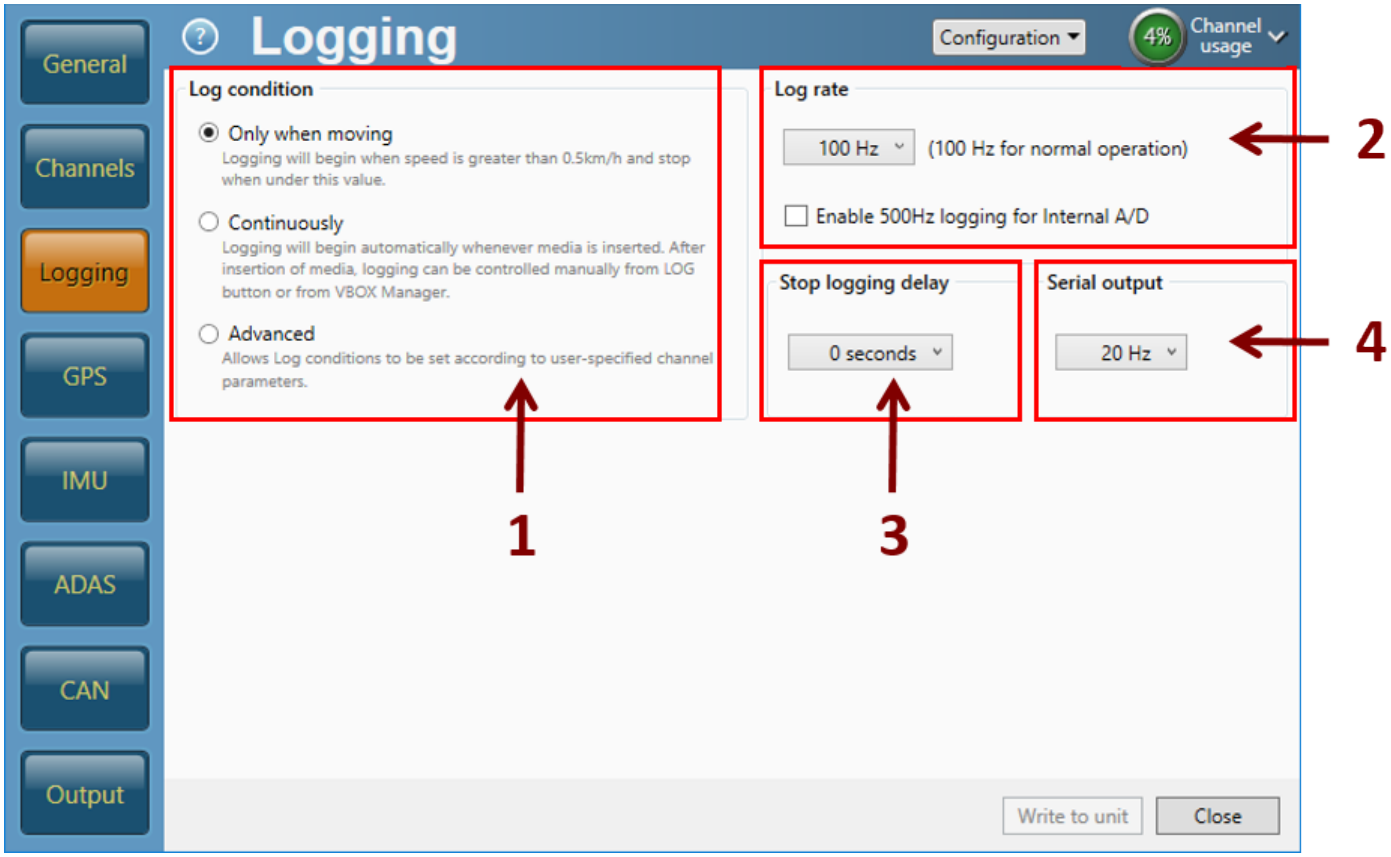
ADAS 2

*Note: This menu only appears when an ADAS mode is enabled and will vary dependent on the specific mode (screenshots based on '**Multi** **target**' mode)*

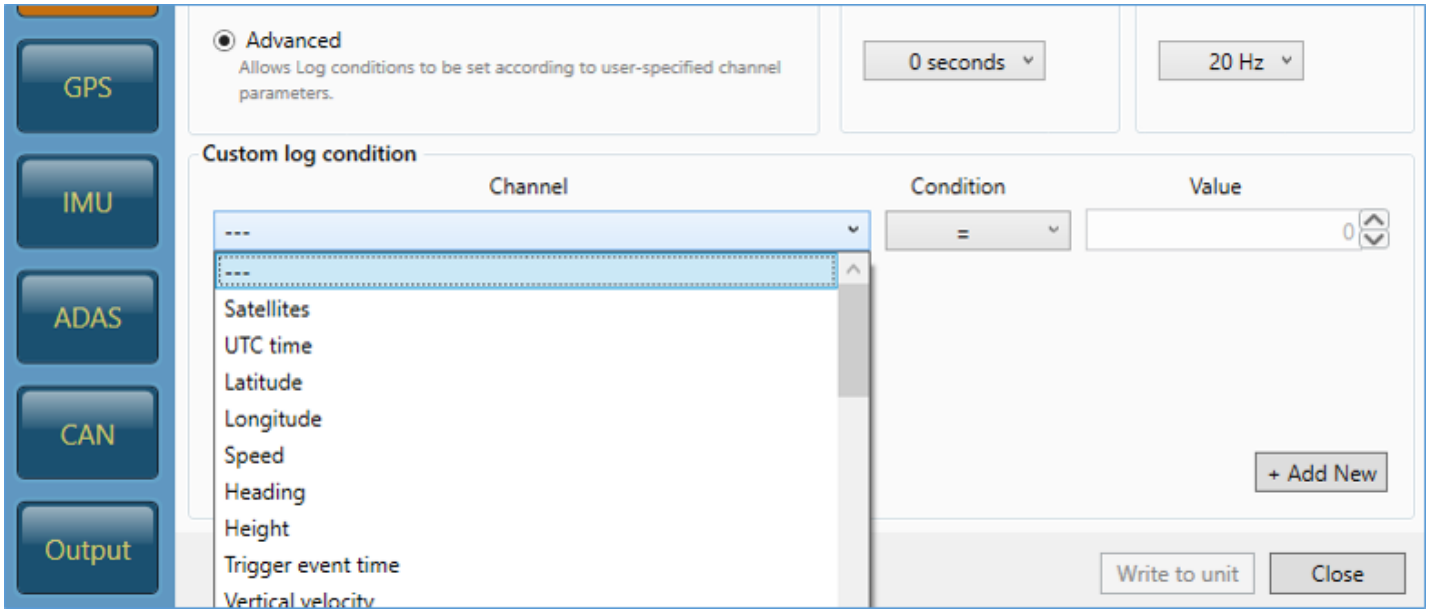


1. **Channel** – List of ADAS 2 channels logged by VB3i. Clicking on any channel box will display a live data reading.
2. **Log to memory card** – Select to log channel to memory card.
3. **Send over serial** – Select to send channel over serial.

VB3i VBOX Setup 3 - Logging



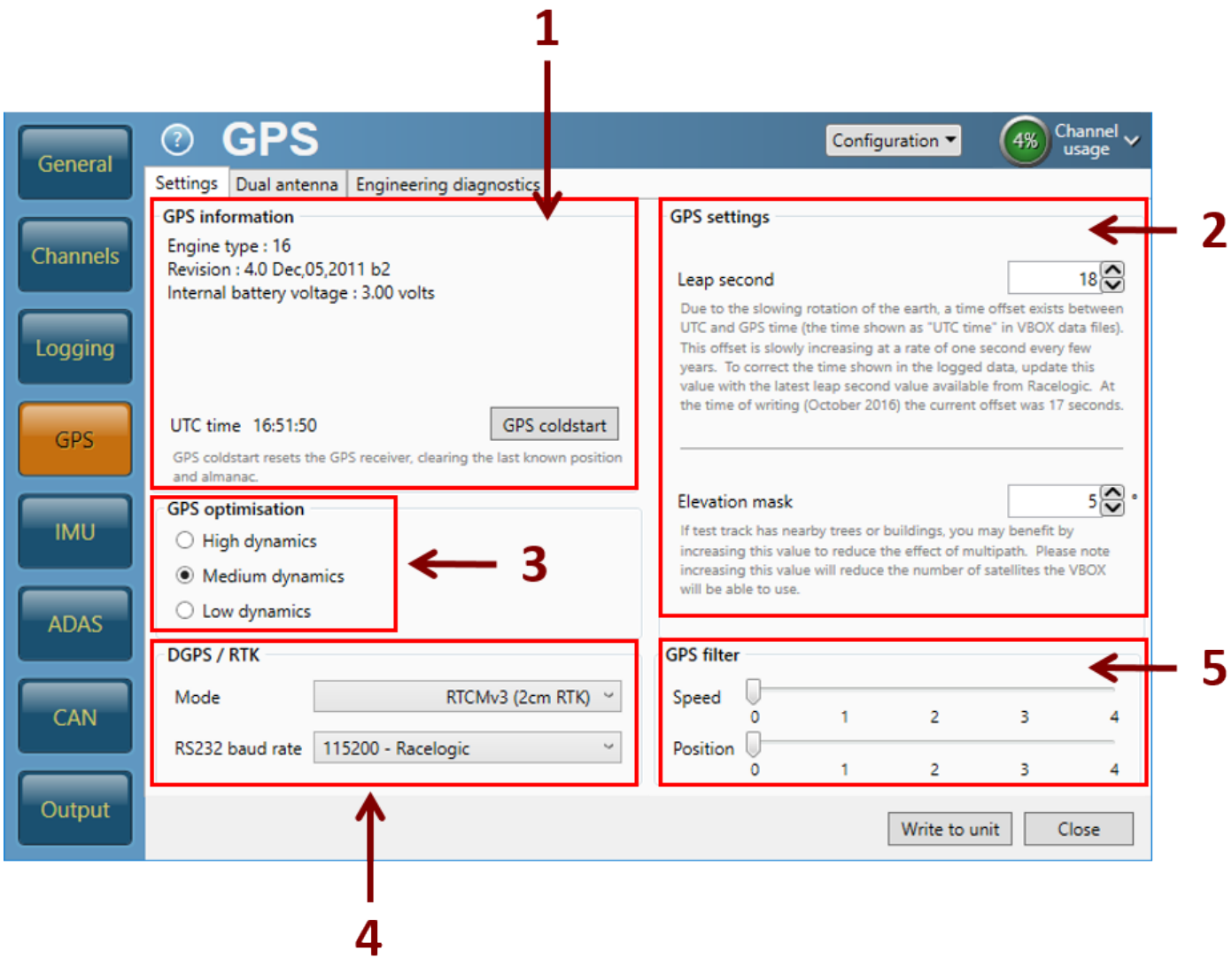
1. **Log condition** – Select whether the VBOX will commence logging when moving or continuously. Selecting '**Advanced**' opens a **'Custom log condition**' option which allows the setting of up to 8 logging conditions.



2. **Log rate** – Choose between 6 log rate options: 1 Hz, 5 Hz, 10 Hz, 20 Hz, 50 Hz and 100 Hz (100 Hz should be used for normal operation). Enable or disable internal analog/ digital inputs 500 Hz logging.
3. **Stop logging delay** – Select the stop logging delay, available between 0-10 seconds.
   Note: Not available if 'Continuously' logging is selected.
4. **Serial output** – Choose between 4 serial output options: 5 Hz, 20 Hz, 50 Hz and 100 Hz.

VB3i VBOX Setup 4 - GPS

Settings



1. **GPS Information** – View information about the GPS receiver, see the UTC time and can perform a GPS coldstart.

2. **GPS Settings** – Set an **elevation mask** if required as well as the leap second value. This was increased to 18 seconds as of December 2016 - for more information on this, **click here.**

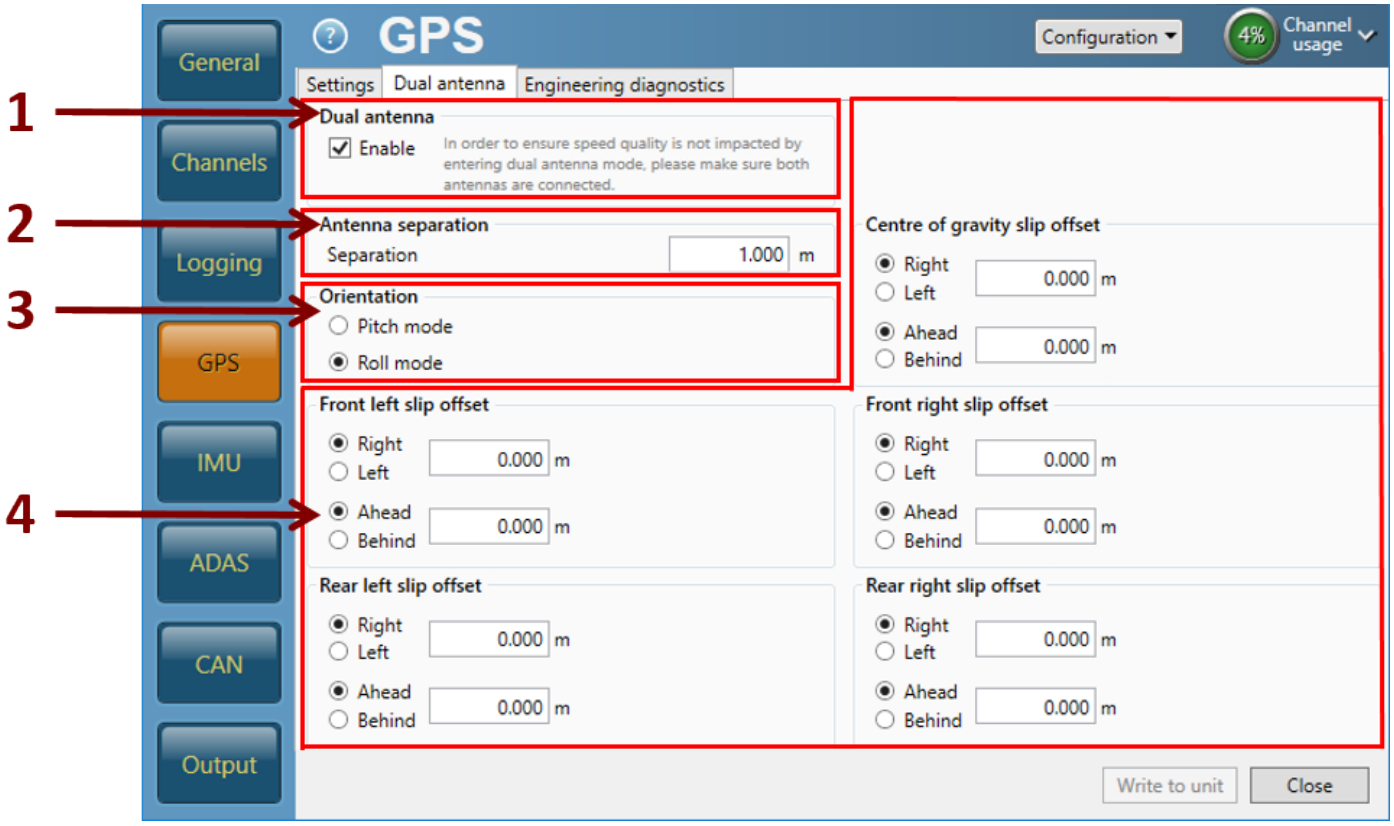
3. **GPS Optimisation** – This option allows you to change the sensitivity of the GPS engine.
   For high dynamic applications such as brake stop testing, this should be set to High.
   For less dynamic applications, such as steady state speed measurement or coast down testing, this can be set to Low.
   The default value of medium dynamics is suitable for all other testing.

4. **DGPS/ RTK** – This gives the option to select whether the VB3i uses differential GPS:
   None: Differential GPS is off.
   CMR (2 cm RTK): 2 cm correction (Trimble standard message type).
   RTCMv3 (2 cm RTK): 2 cm correction (RTCM standard message type) **RECOMMENDED.**
   NTRIP: Internet based subscription service, more information can be found **here**.
   MB-Base: Mode for use in Moving Base ADAS applications.
   MB-Rover: Mode for use in Moving Base ADAS applications.
   RTCM (40 cm): RTCM corrections are received by the VB3i via a Racelogic telemetry module and a locally placed Base station. Contact Racelogic or your local agent for more details.
   SBAS: SBAS differential corrections are received from the nearest Geo-stationary GPS-SBAS satellite.
   RS232 baud rate – Sets the DGPS serial rate. To ensure that the VBOX receives the DGPS correction signal, the correct RS232 rate must be set. All Racelogic blue boxed radios use 115200 kbit/s, Satel grey boxed radios use either 19200 kbit/s or 38400 kbit/s.

5. **GPS filter -** *This option is removed when IMU kalman filter is enabled.*
   Adjust the level of filtering applied to the position and speed data in real time, selectable from 0 to 4. Once the filter is turned on, it remains on until it is manually turned off or a GPS Cold Start is performed, even if the VBOX is disconnected from its power supply.

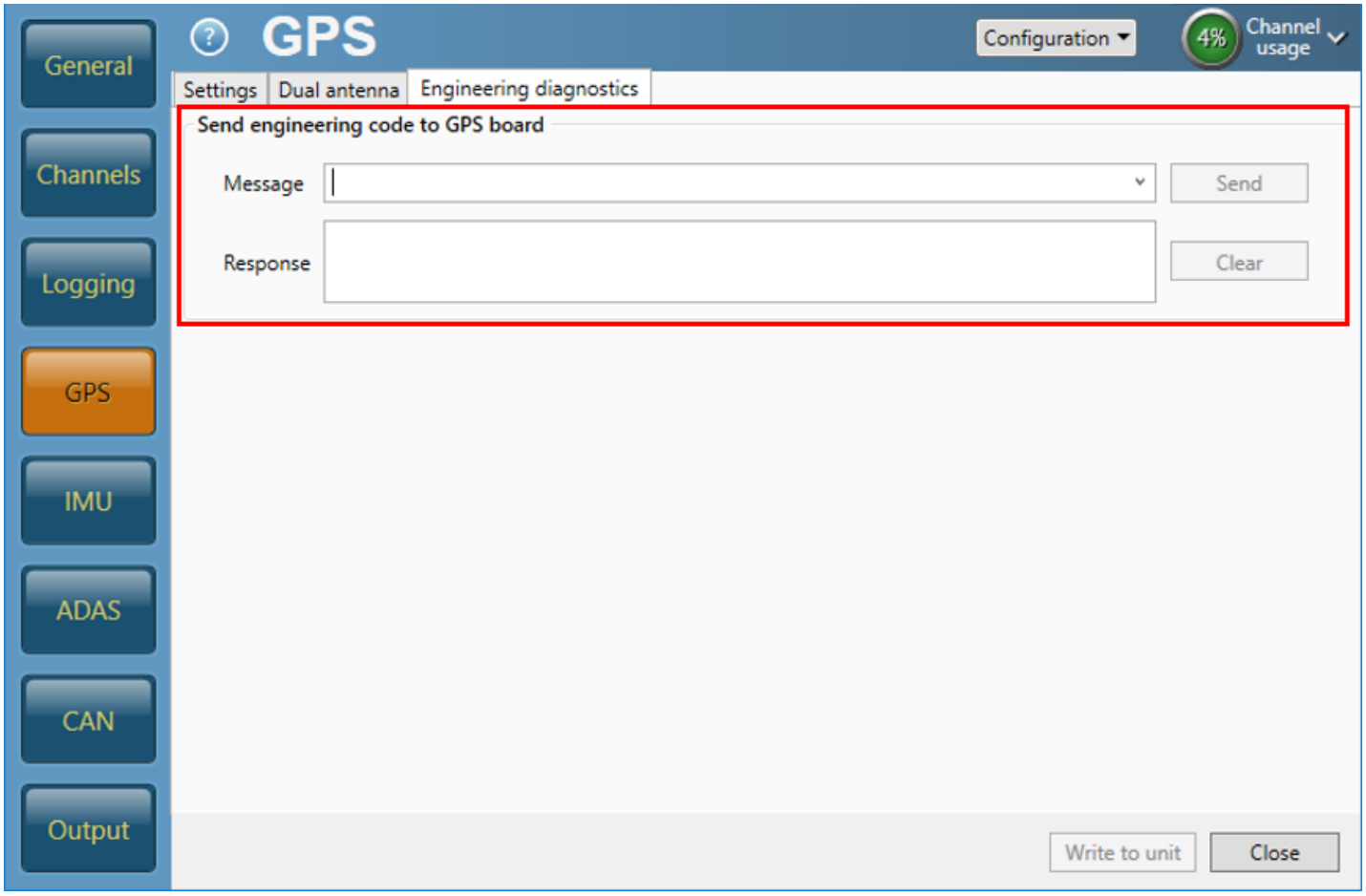
Dual antenna

Note: This menu only appears with VBOX 3i Dual Antenna (VB3i SL).



1. **Dual antenna** – Enable or disable twin antenna mode.
2. **Antenna separation** – Applies an antenna separation distance.
3. **Orientation** – Gives the ability to separately test roll and pitch measurements during testing.
4. **Slip angle settings** – Configure slip translation channel offsets.

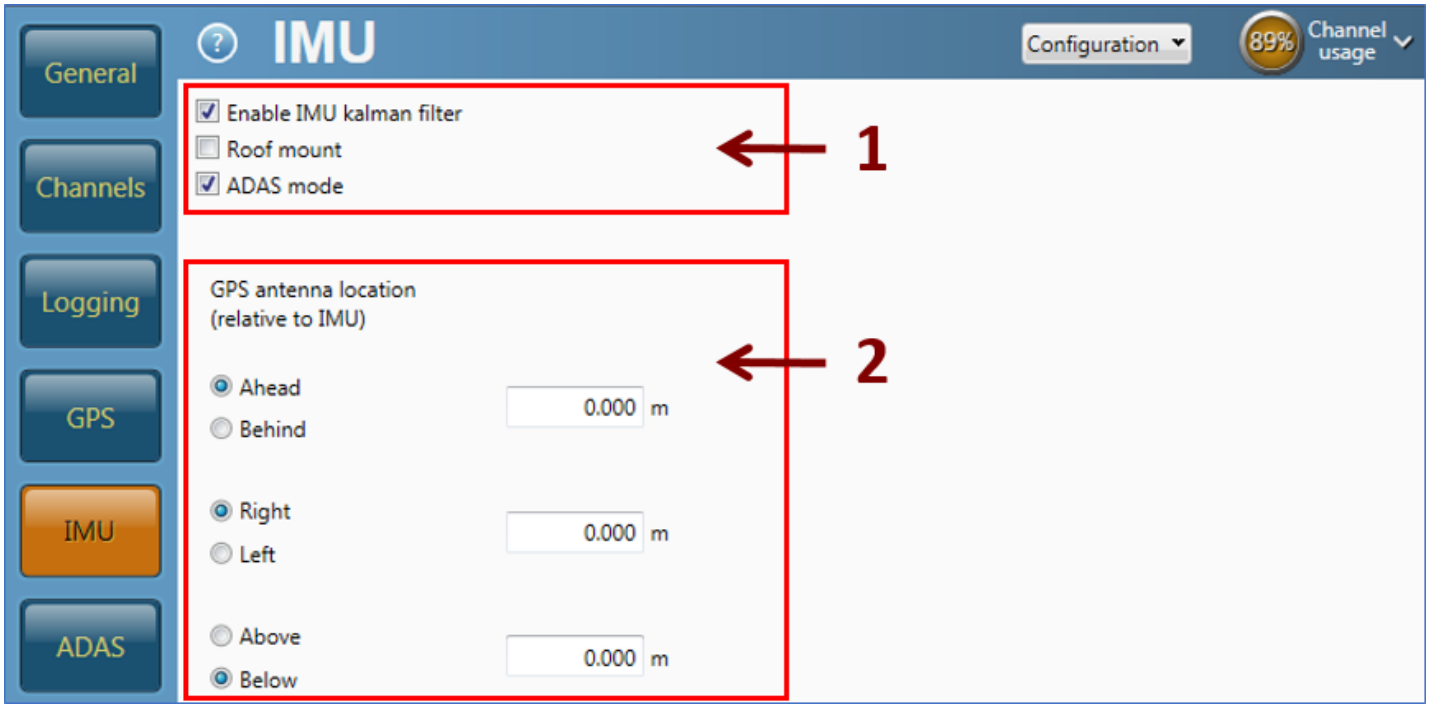
Engineering diagnostics



Send engineering code to GPS board – Used to set non-standard settings in the GPS engine.

Note: Should only be used on advice from a VBOX support technician.

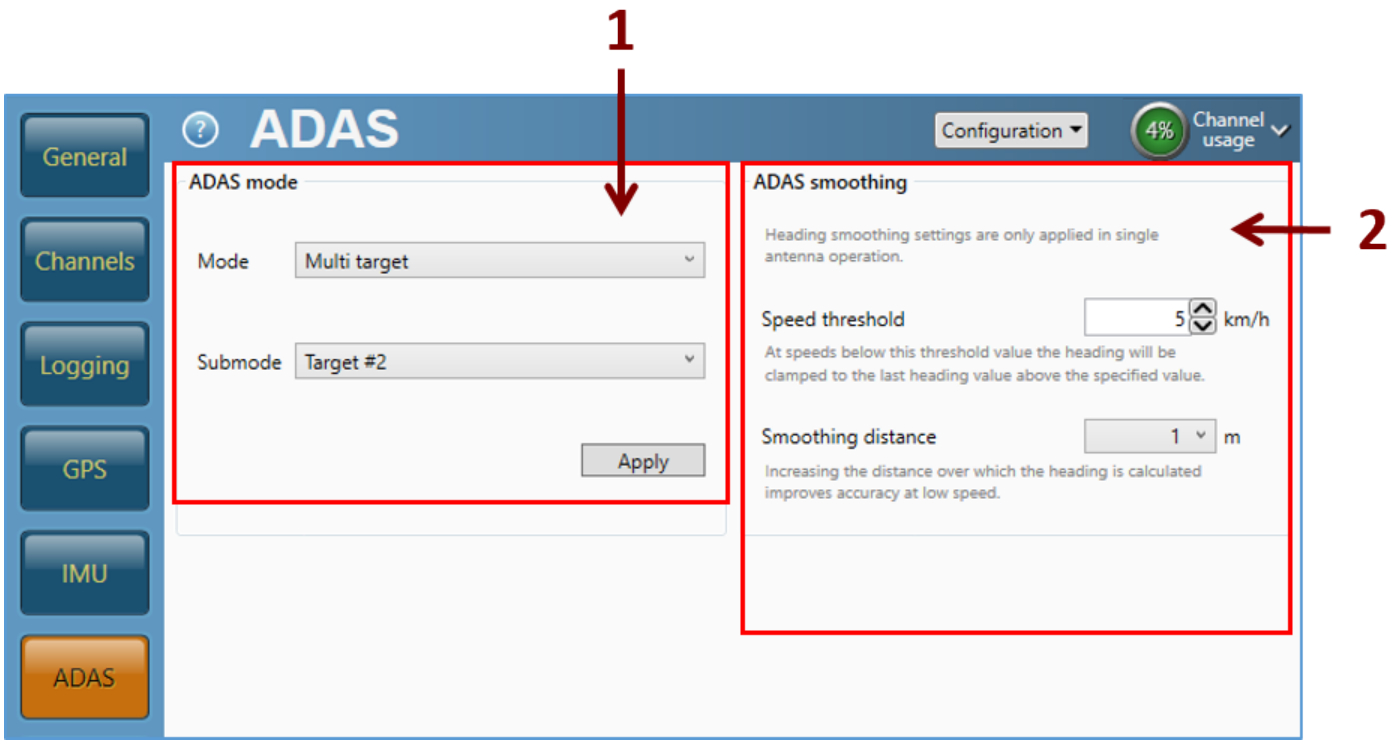
VB3i VBOX Setup 5 - IMU



1. **Enable IMU kalman filter** – Enable or disable IMU integration.
   Roof mount – Selecting will translate the data from the roof to another point on the vehicle.
   ADAS mode – This is selected as default when an ADAS mode is activated within the 'ADAS' menu. It changes the kalman filter mode to low dynamics, deselecting will restore the VB3i to the default high dynamics setting (*only presented when IMU kalman filter is 'Enabled' and an ADAS mode is activated within the 'ADAS' menu).*

2. **IMU offset measurements**
   Note: This option is only presented when IMU integration is 'Enabled'.
   Roof mount not selected: GPS antenna location (relative to IMU) is displayed.
   Roof mount selected: Translate IMU (relative to GPS antenna) is displayed, by default a 1 m Z offset is added, translating the filtered speed down in to the vehicle, towards the centre of gravity.

VB3i VBOX Setup 6 - ADAS

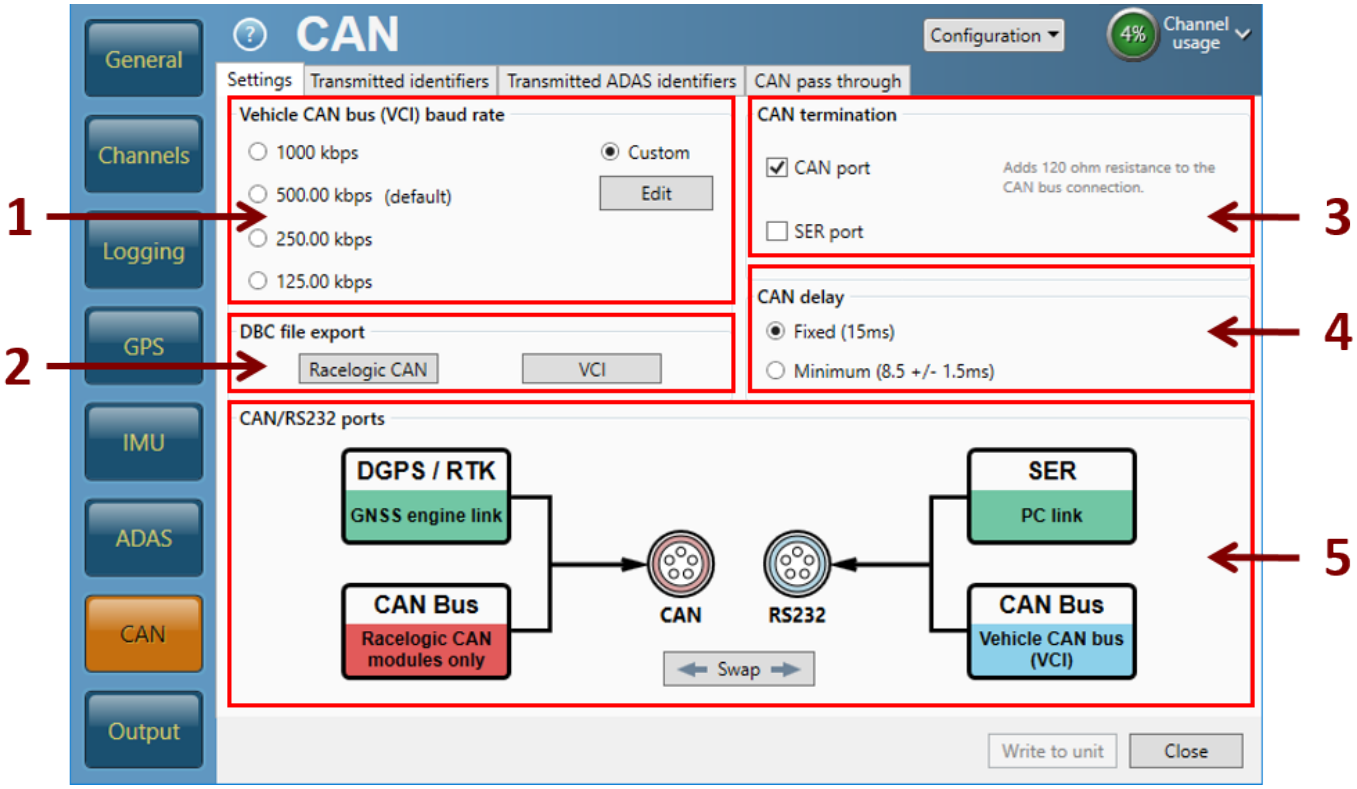


1. **ADAS mode** – This configures the VBOX for use in ADAS applications, more information can be found here.
   Off: ADAS mode is off. Submode is not selectable.
   Multi target: Configures the VBOX for Multi target mode. Subject, Target #1 and Target #2 submodes available.
   Single target: Configures the VBOX for Single target mode. Subject and Target submodes available.
   Lane departure: Configures the VBOX for Lane departure mode. Lane 1, Lane 2 and Lane 3 submodes available.
   Static point: Configures the VBOX for Static point mode. Submode is not selectable.
   Multi static point: Configures the VBOX for Multi static point mode. Submode is not selectable.

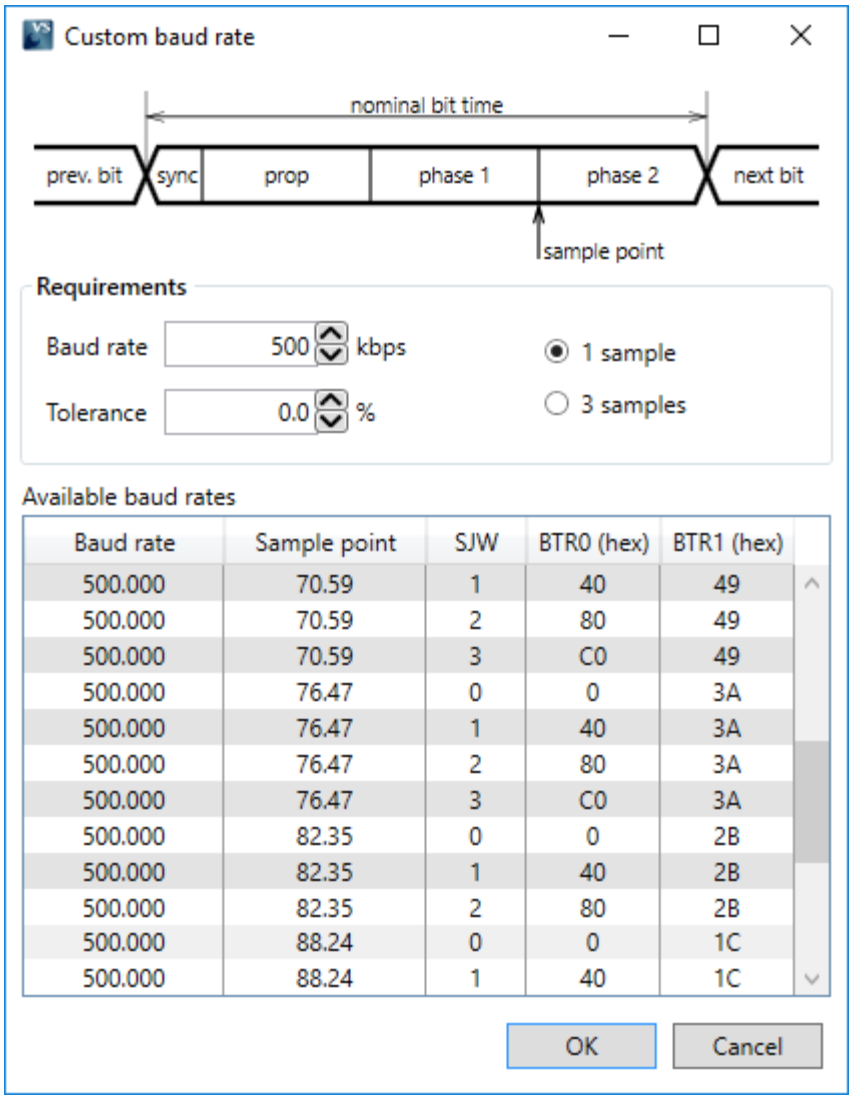
2. **ADAS smoothing** – Set a speed threshold to lock the heading to the last value above the set speed and a smoothing distance over which heading is calculated. The higher the distance the more accurate the value, however it will change slower when the heading changes.
   Note: Smoothing is only applied in single antenna operation.

VB3i VBOX Setup 7 - CAN

Settings

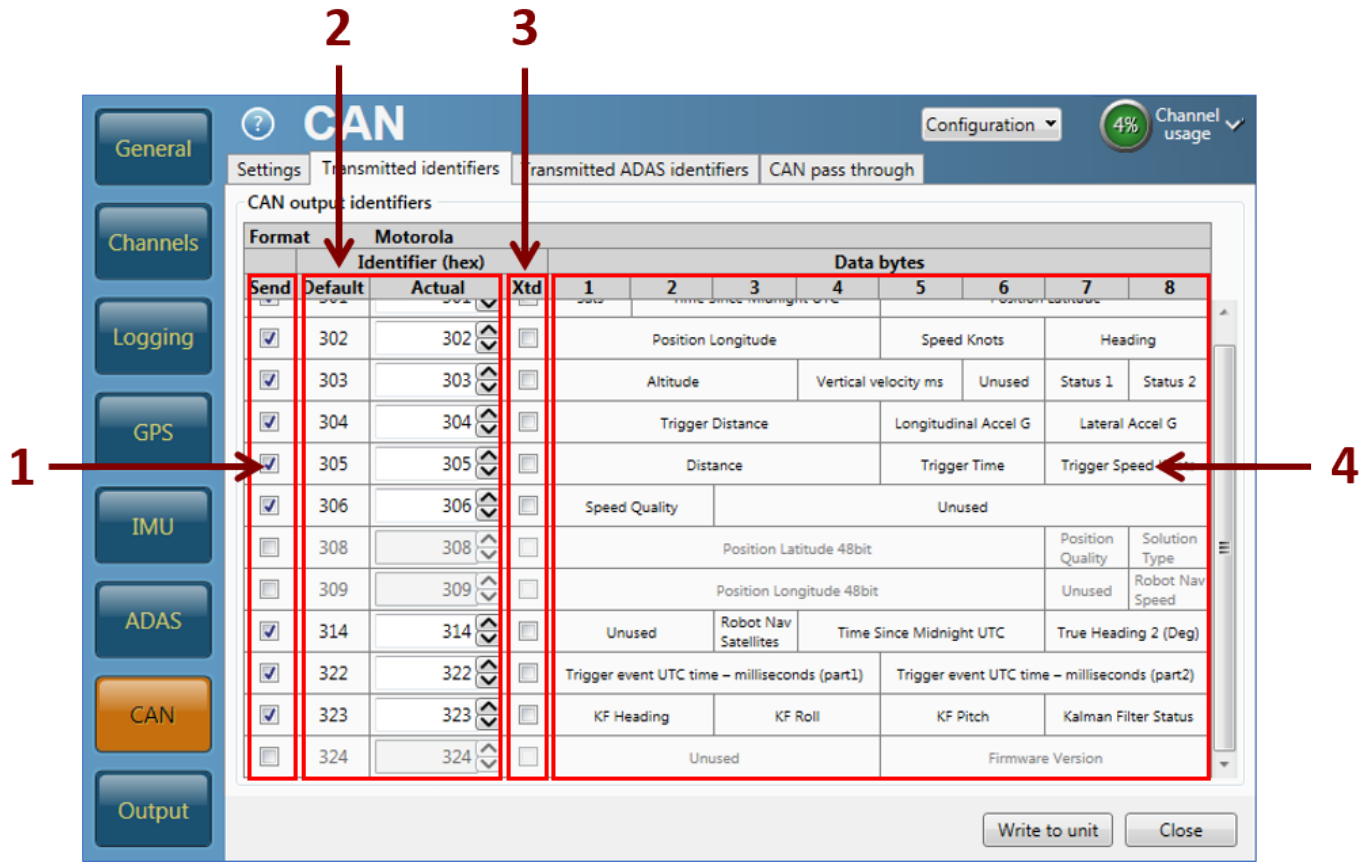


1. **Vehicle CAN bus (VCI) baud rate** – The software has four baud rate input values: 1000 kbit/s, 500 kbit/s (default), 250 kbit/s or 125 kbit/s. A custom option is also available where you can select a specific setting.



2. **DBC file export** – Create a .dbc/ .vci file of the current VB3i channels.
3. **CAN termination** – Select to Enable/ Disable CAN input termination.
4. **CAN Delay** – Select between fixed (default) and minimum CAN delay.
5. **CAN/RS232 ports** – Select which port is used for Racelogic CAN, and which is used for vehicle CAN (VCI). By default, Racelogic is on the CAN port and VCI on RS232.

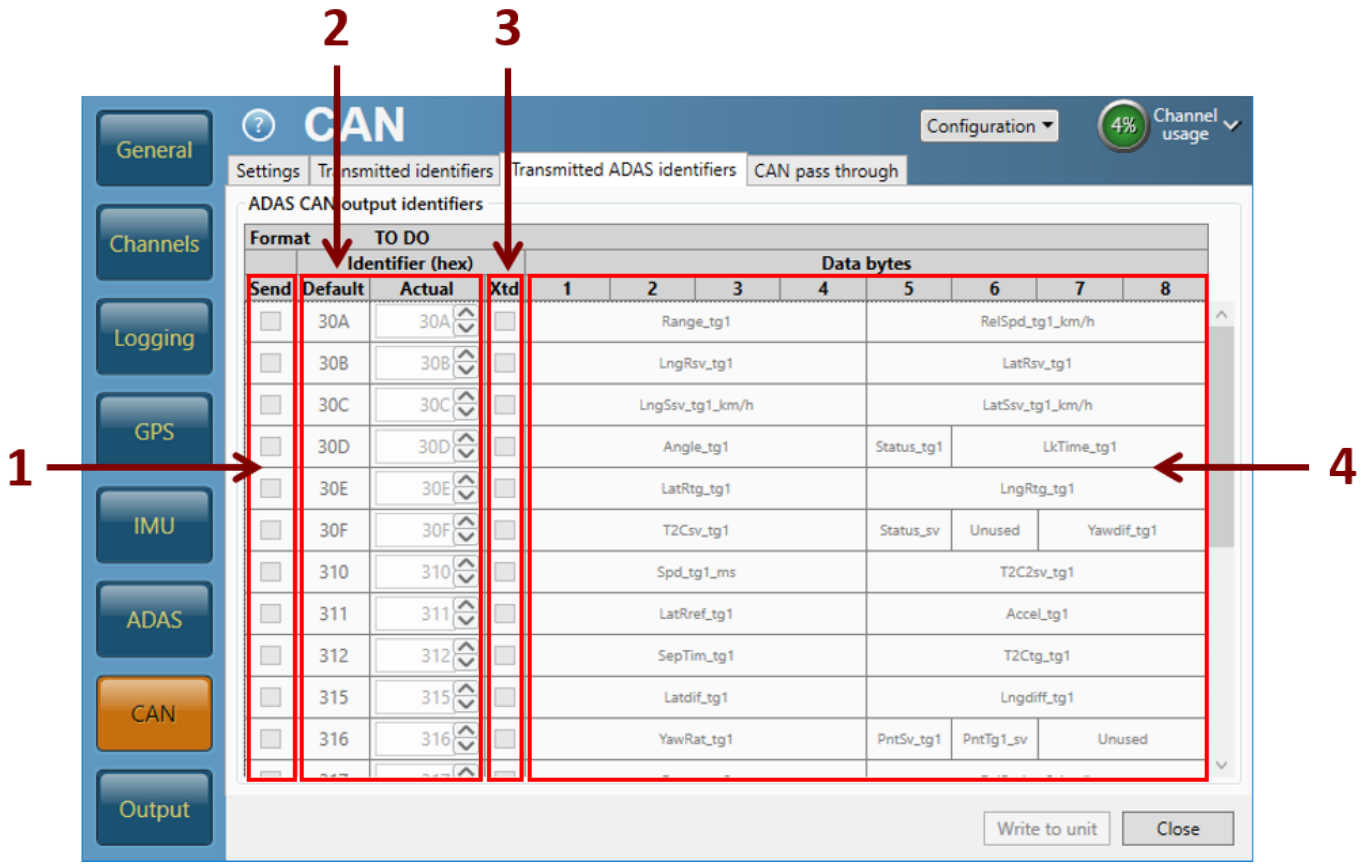
Transmitted identifiers



1. **Send** – To switch a CAN message on/off, tick or un-tick the box for the corresponding message.
2. **Default / Actual ID** – This allows the modification of the CAN IDs transmitted by the VBOX. Default values are the Racelogic standard ID's of 0x301, 0x302 …. 0x307.
3. **Xtd** – To change the identifier format from standard 11 bit to extended 29 bit, tick the '**Xtd**' box in the corresponding column.
4. **Data bytes** – Shows which channels will be sent out in each message.

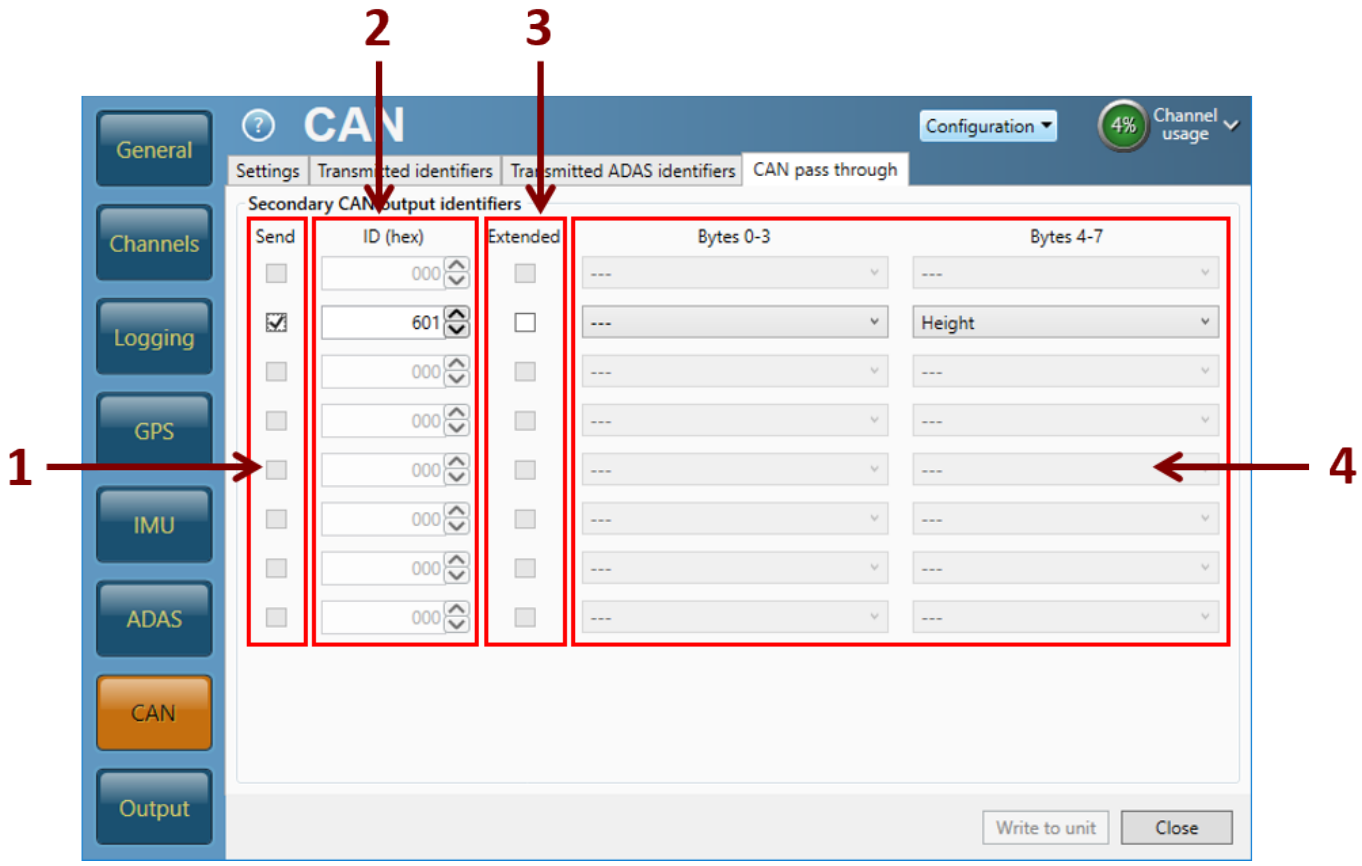
Transmitted ADAS identifiers

Note: This tab is only presented when the ADAS mode is 'Enabled'.

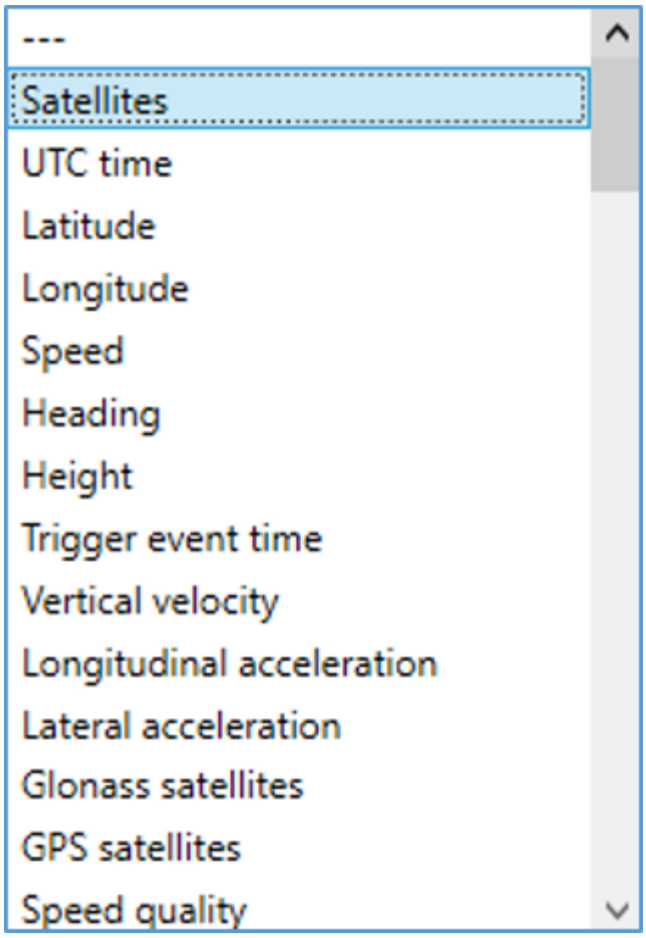


1. **Send** – To switch an ADAS CAN message on/off, tick or un-tick the box for the corresponding message.
2. **Default / Actual ID** – This allows the modification of the ADAS CAN IDs transmitted by the VBOX. Default values are the Racelogic standard ID's of 0x30A, 0x30B …. 0x30F.
3. **Xtd** – To change the identifier format from standard 11 bit to extended 29 bit, tick the **'Xtd'** box in the corresponding column.
4. **Data bytes** – Shows which channels will be sent out in each message.

Can pass through

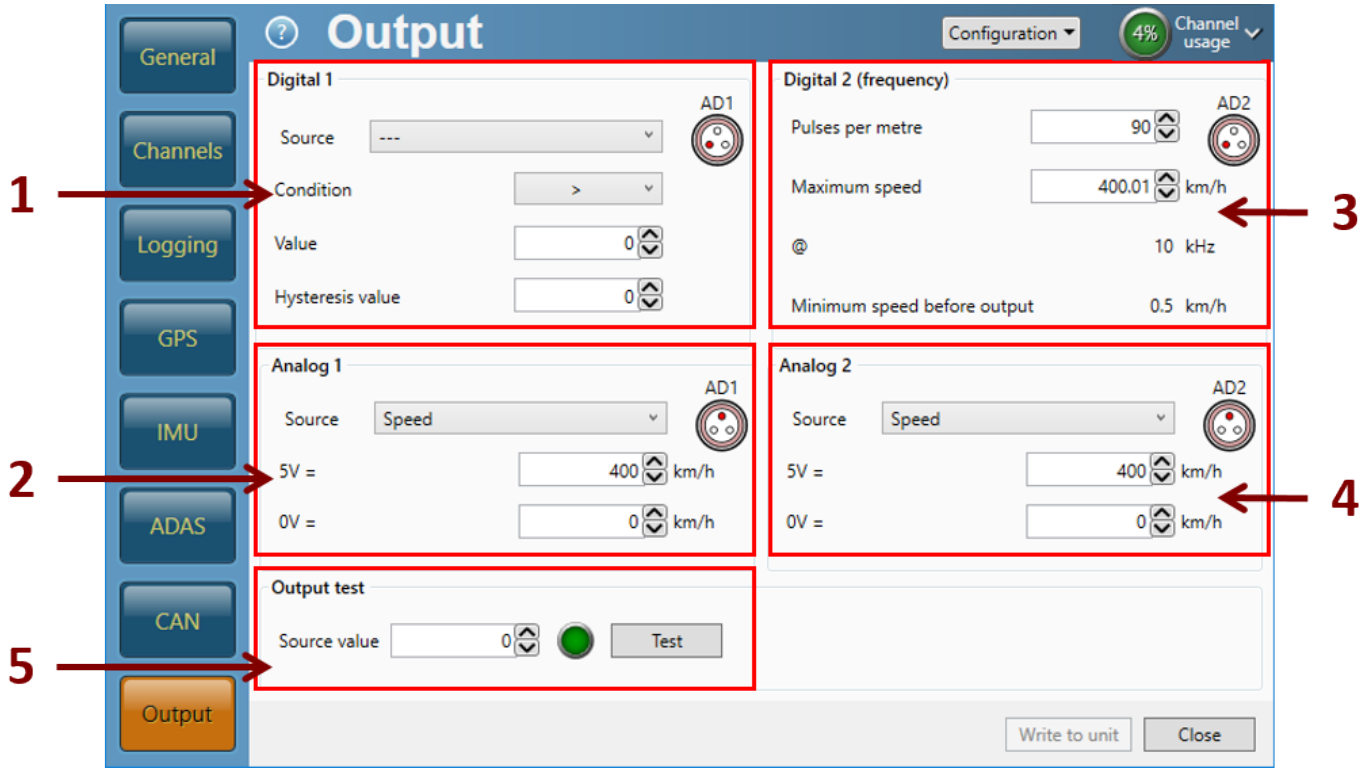


1. **Send** – To switch a CAN message on/off, tick or un-tick the box for the corresponding message.
2. **ID Hex** – Input the required custom CAN ID's transmitted by the VBOX.
3. **Extended** – To change the identifier format from standard 11 bit to extended 29 bit, tick the '**Extended**' box in the corresponding column.
4. **Bytes** – Select which channels are sent out in each message, the 8-byte CAN message can contain any 2 parameters from the drop-down menus.



Satellites
UTC time
Latitude
Longitude
Speed
Heading
Height
Trigger event time
Vertical velocity
Longitudinal acceleration
Lateral acceleration
Glonass satellites
GPS satellites
Speed quality

VB3i VBOX Setup 8 - Output



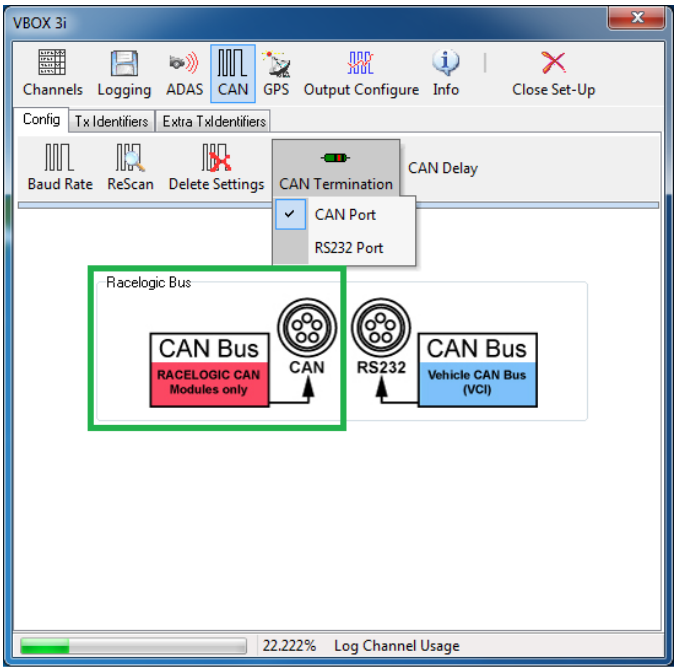
1. **Digital 1** – Configure the digital signal on the AD1 output, select from a range of source channels and enter a condition. Digital 1 is an on/off signal, giving 5 V when the condition is met, and 0 V when it is not.
2. **Analog 1** – Configure the analog signal on the AD1 output, it gives a linear 0-5 V output over a configurable range from any source (standard VB3i channels and A/D inputs).
3. **Digital 2 (frequency)** – Configure the digital signal on the AD2 output, select from a range of source channels and enter a number of pulses per metre and a maximum speed.
4. **Analog 2** – Configure the analog signal on the AD2 output, it gives a linear 0 – 5 V output over a configurable range from any source (standard VB3i channels and A/D inputs).
5. **Output test** – Set a source value and test the output connected to a device.

08 - VB3i CAN

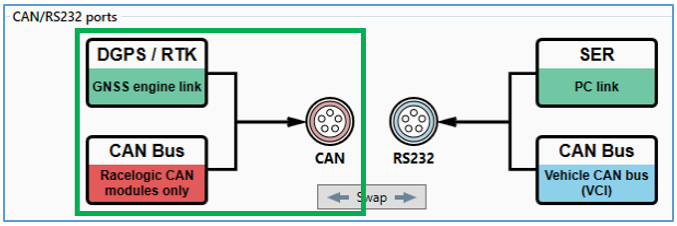
Racelogic CAN bus

The Racelogic CAN bus connection can be used to connect Racelogic modules (i.e. TC8, FIM03 etc), and displays such as VBOX Manager and Multi-Function Display. This port will allow the VBOX 3i to log up to a maximum of 32 Racelogic module channels.

Note: For the Racelogic CAN port we would recommend the CAN termination resistor is on.



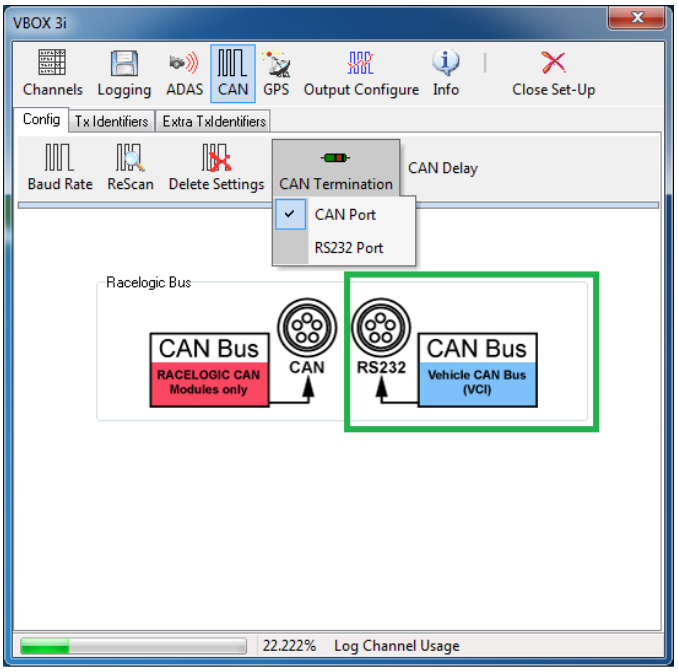
VBOX Tools view



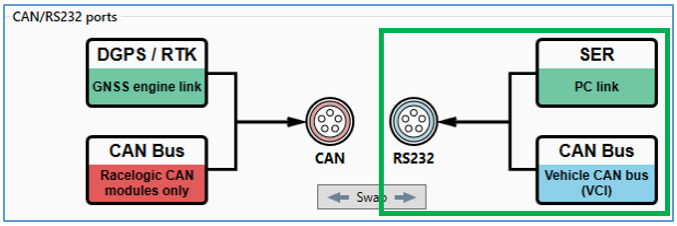
VBOX Setup view

The **Vehicle CAN bus (VCI)** connection can be used to connect to a vehicle CAN or a sensor CAN bus. This port will allow the VBOX3i to log up to a maximum of 16 channels.

Note: For the VCI CAN port we would recommend the CAN termination resistor is off when connected to a vehicles CAN bus.



VBOX Tools view

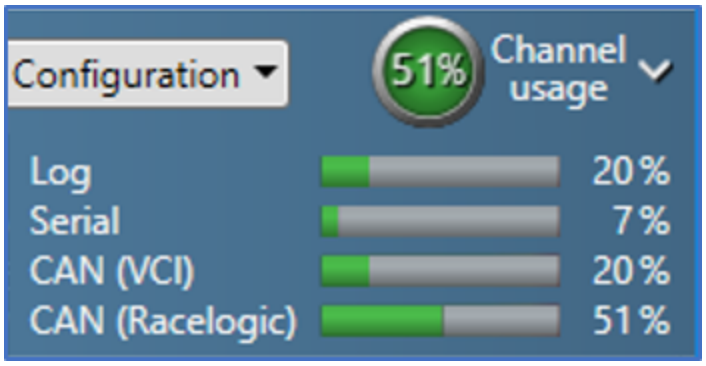


VBOX Setup view

Note: VBOX 3i has an additional channel limit of 64. Additional channels consist of VCI channels (up to 16), RL CAN channels (up to 32) and any other channels that fall outside of the 'standard channel tab' in VBOX Tools Setup. Example this includes AD inputs, IMU KF channels, Twin antennas channels, ADAS channels and so on…

Channel selection is controlled using VBOX Tools Setup or VBOX Setup. Additional channels can be logged by the VBOX 3i up until the point the Log channel usage is maxed (100%)

VBOX Tools view



VBOX Setup view

The log channel usage is influenced by what operational mode the VBOX 3i is in. For example, if the IMU filter is enabled, the number of channels available to log will be reduced.

CAN channel availability – Multi-Function Display

A Multi-Function Display (RLDSP03) can display any channel that is present on the Racelogic CAN bus, and in the first 32 CAN channel ordering.

First 32 CAN channel ordering priority goes to any external data source. Therefore if there are 32 external channels set to log by the VBOX 3i, no internal module channel will be present for selection on the MFD.

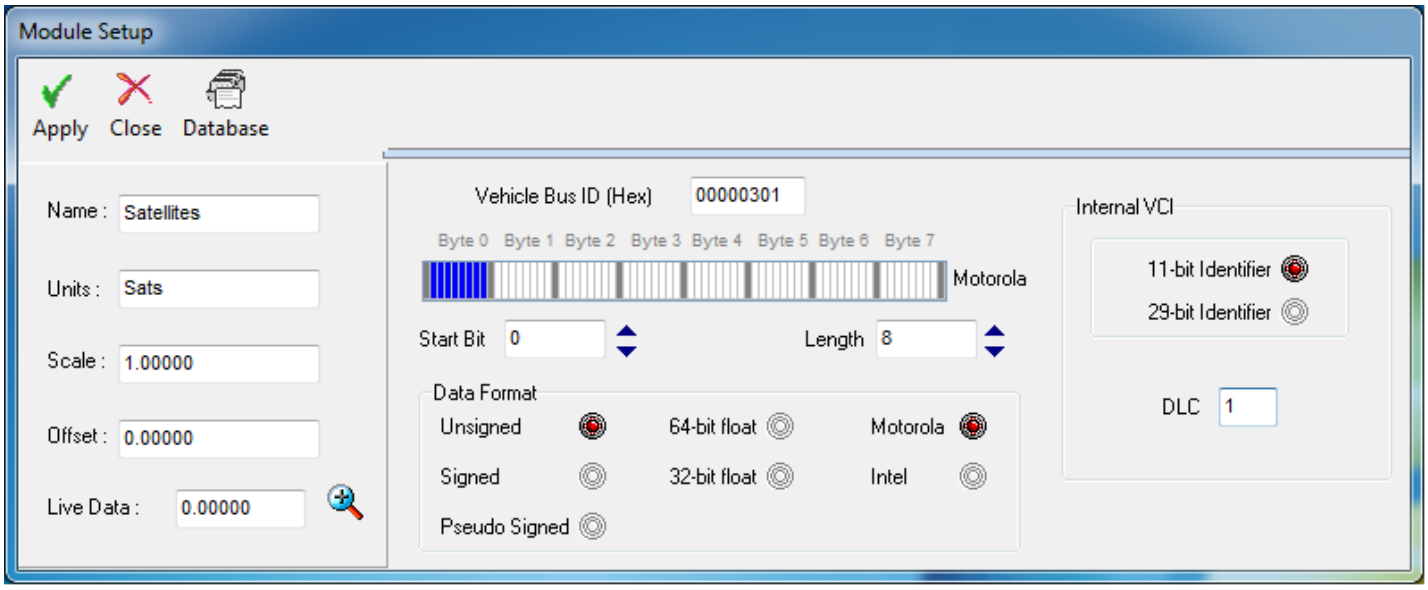
CAN channel availability – send over serial

Same as the MFD, a data channel must be in the first 32 CAN channel ordering for the VBOX 3i to send out data over serial to a 'live data window' on VBOX Tools or VBOX Test Suite.

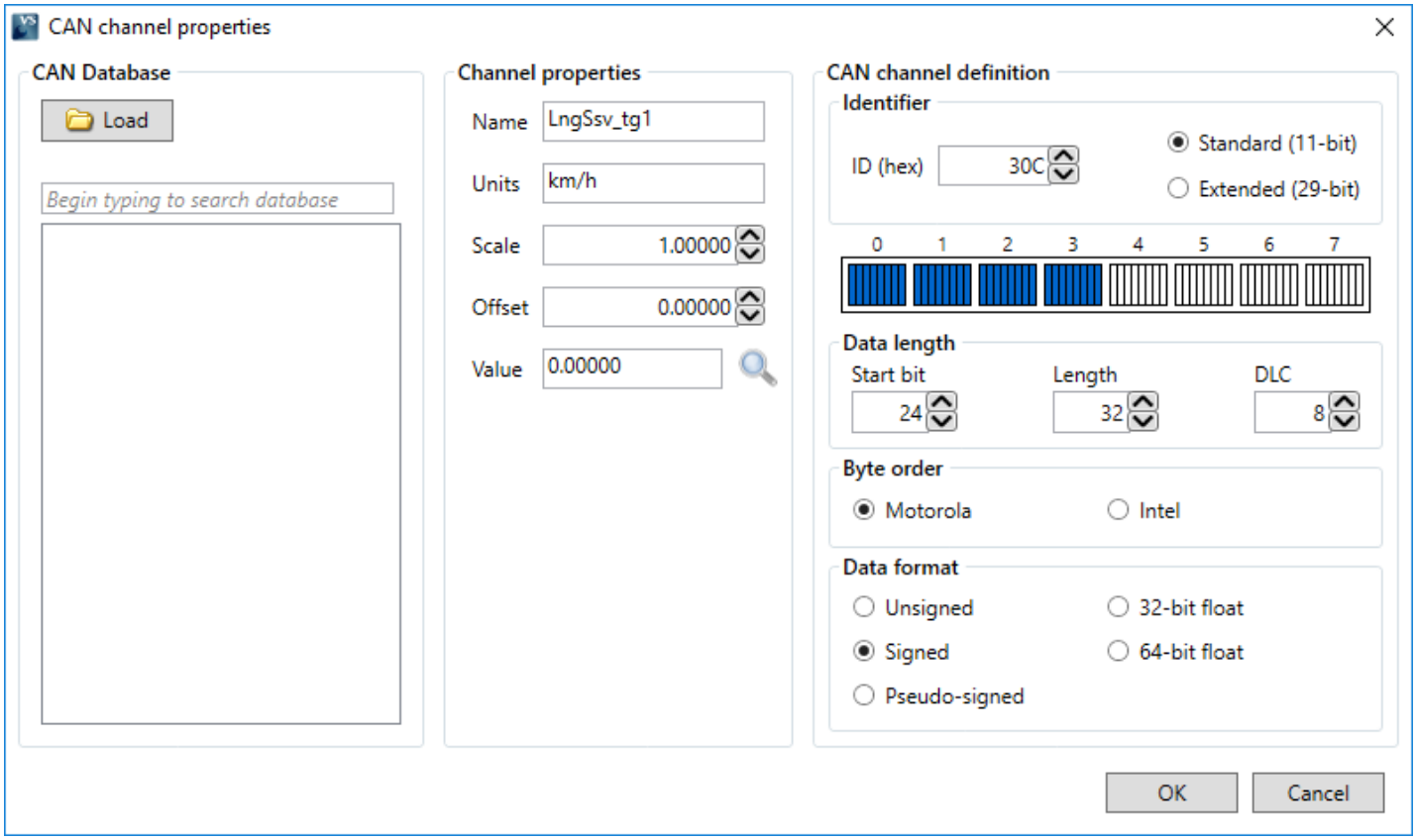
First 32 CAN channel ordering priority goes to any external data source. Therefore if there are 32 external channels set to log by the VBOX 3i, no internal module channel will be present for selection on the MFD.

VCI Input (vehicle CAN interface)

Configuration is performed using the VCI modules tab under log channels in VBOX Tools Setup or VBOX Setup software. CAN signal parameters can be entered manually by the user or imported directly from a CAN database (.dbc) file if available.



VBOX Tools view



VBOX Setup view

Racelogic Vehicle CAN database

Racelogic supplies a free, encrypted vehicle CAN database, giving the user the ability to log basic CAN data from a large number of current vehicles from a broad selection of manufacturers.

All of the CAN database files for vehicles we have reverse engineered can be downloaded from **our website**.

Please note to access these downloads you will need a username and password - to retrieve this, please **register (or re-register) your VBOX unit**.

VB3i CAN pass through

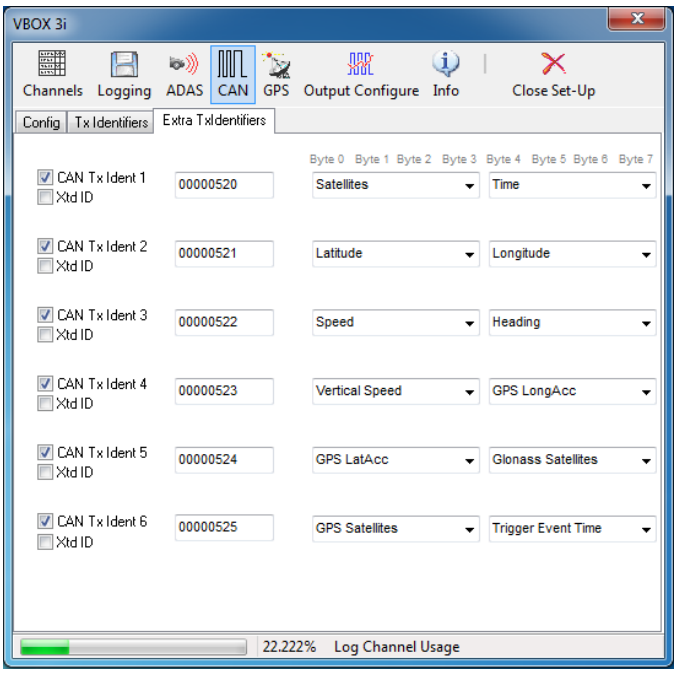
Ability to output channel data from the Racelogic CAN bus (i.e. Racelogic modules such as TC8) on the isolated customer VCI bus. The user can configure output data (in VBOX Tools Setup) using channels from the available channels dropdown list, and configure the identifier as required.

Example application: Racelogic IMU connected to the Racelogic CAN bus to use IMU yaw rate for improved dual antenna slip translation data. Same IMU data being transmitted from the customer VCI bus to be logged by third party CAN logging equipment.

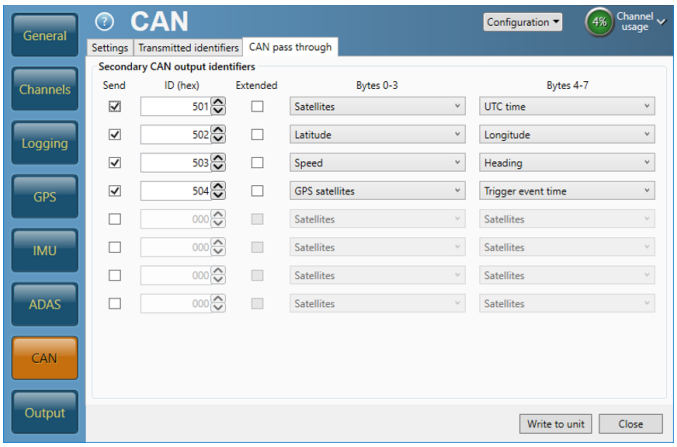
The VBOX3i can output up to 6 user configured CAN messages, and 12 CAN channels over the customer VCI bus.

Be aware of checking CAN pass through channel selection when re-entering VBOX Tools Setup or VBOX Setup. If the VBOX has many external CAN channels being logged, then the dropdown channel selection can re-adjust. When VBOX Tools Setup or VBOX Setup is then exited, the adjusted CAN channels will be applied.

Note: If you are loading VB3i configuration settings from a previously saved .RCF file and external modules were connected during the save, selected CAN pass through channels may not be reloaded correctly. Please check and directly configure the channels through VBOX Setup or VBOX Tools Setup.



VBOX Tools view



VBOX Setup view

Note: These output CAN channels will be in a 32 bit IEEE float format. 29 bit extended identifiers optional.

VB3i CANVEL

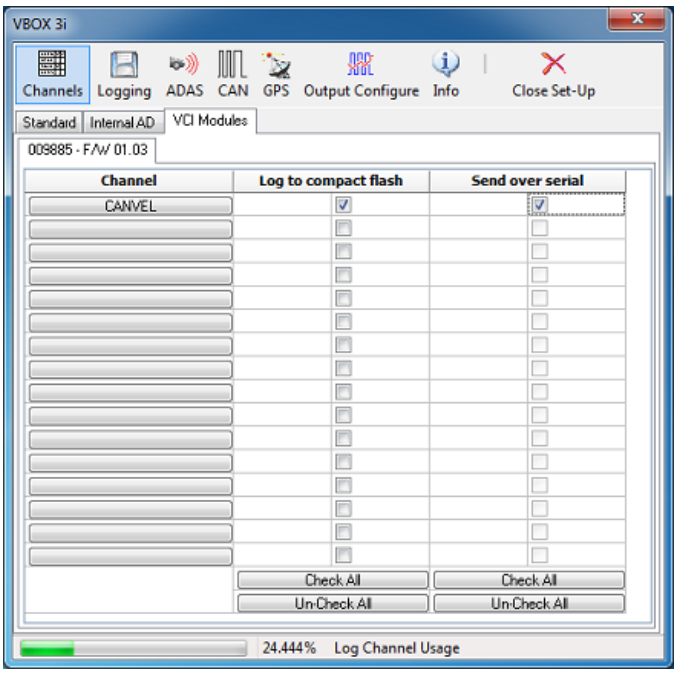
If an input channel is given the name 'CANVEL', then the VBOX will translate the data of this channel directly through to the GPS speed channel under the following criteria.

- IMU integration is not enabled
- The VBOX cannot calculate speed, i.e. no satellite signal (complete satellite drop out)

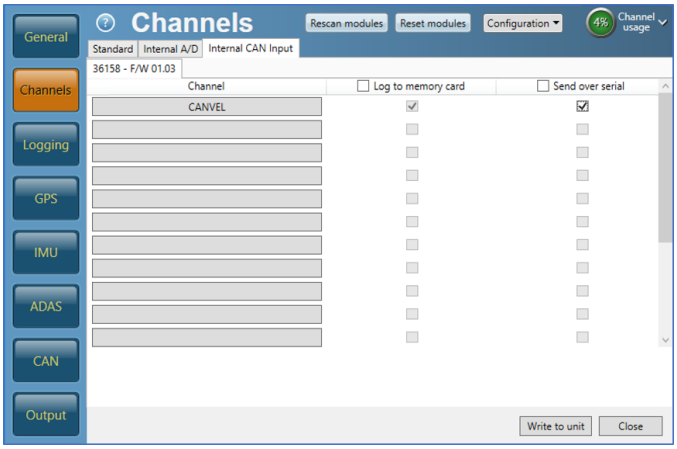
The VBOX will scale the input channel to the default speed output format of km/h according to what units have been assigned to the substitution speed channel. VBOX will recognise the following unit names: MPH, KM/H, Knots, m/s, and ms-1.

Note: If no UNITS have been assigned to the input channel then VBOX will assume that it is KM/H.

This function is useful while testing around built up areas or driving under large bridges.



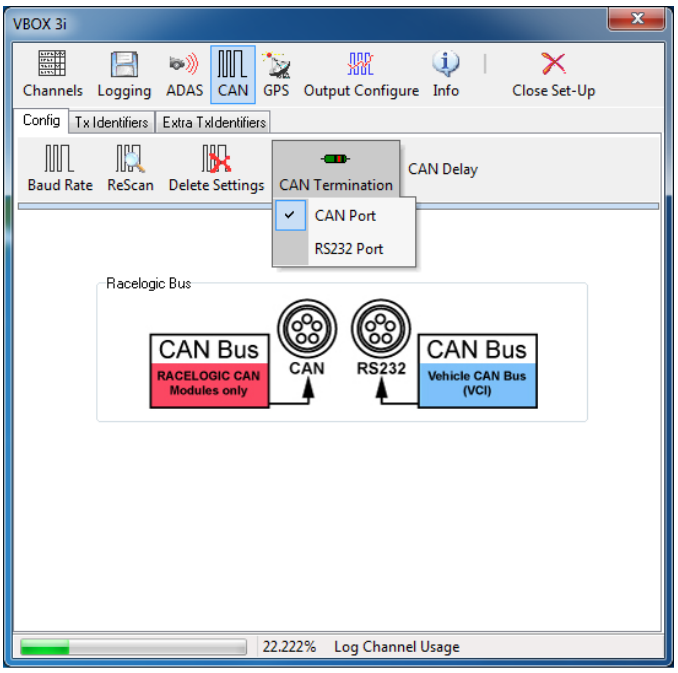
VBOX Tools view



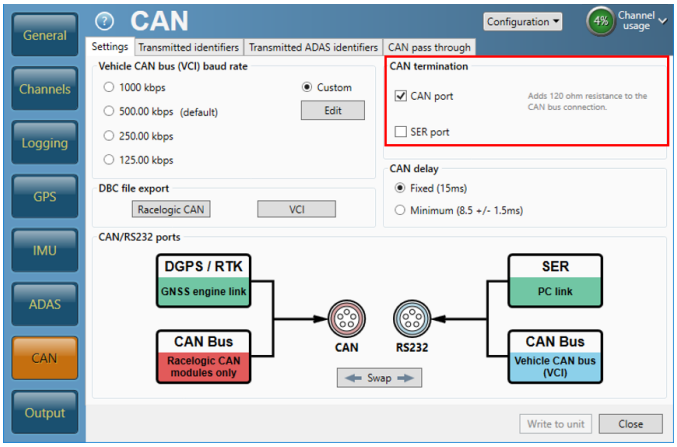
VBOX Setup view

VB3i CAN termination

The VBOX3i contains an active termination between 0 Ohms and 120 Ohms, the active terminations are selectable via VBOX Tools or VBOX Setup as shown below.



VBOX Tools view



VBOX Setup view

Note: When the Usage of the CAN ports is swapped from one output socket to the other the termination resistor setting does not follow. So you should check that the Termination is correctly set for the output socket that you are then using.

VB3i CAN Delay

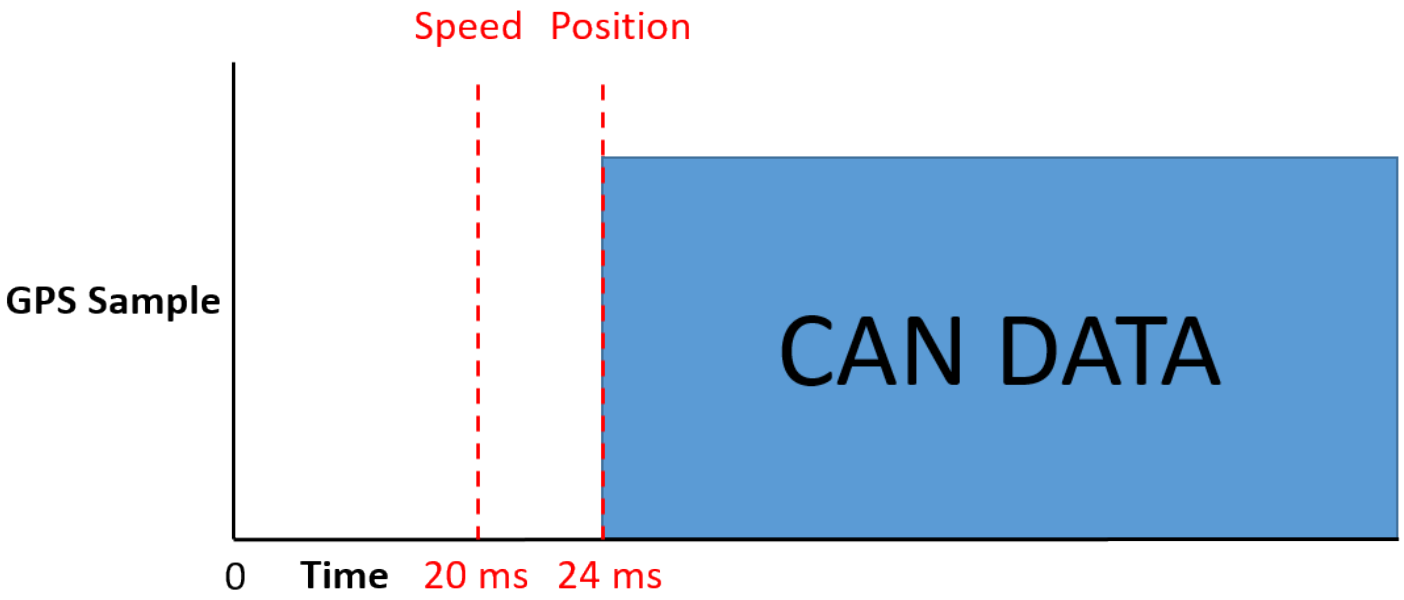
When to use the Fixed CAN Delay?

'Fixed CAN Delay' is recommended for use when using an external event marker or trigger, or for other external CAN devices that require precisely timed CAN outputs. This is the default setting.

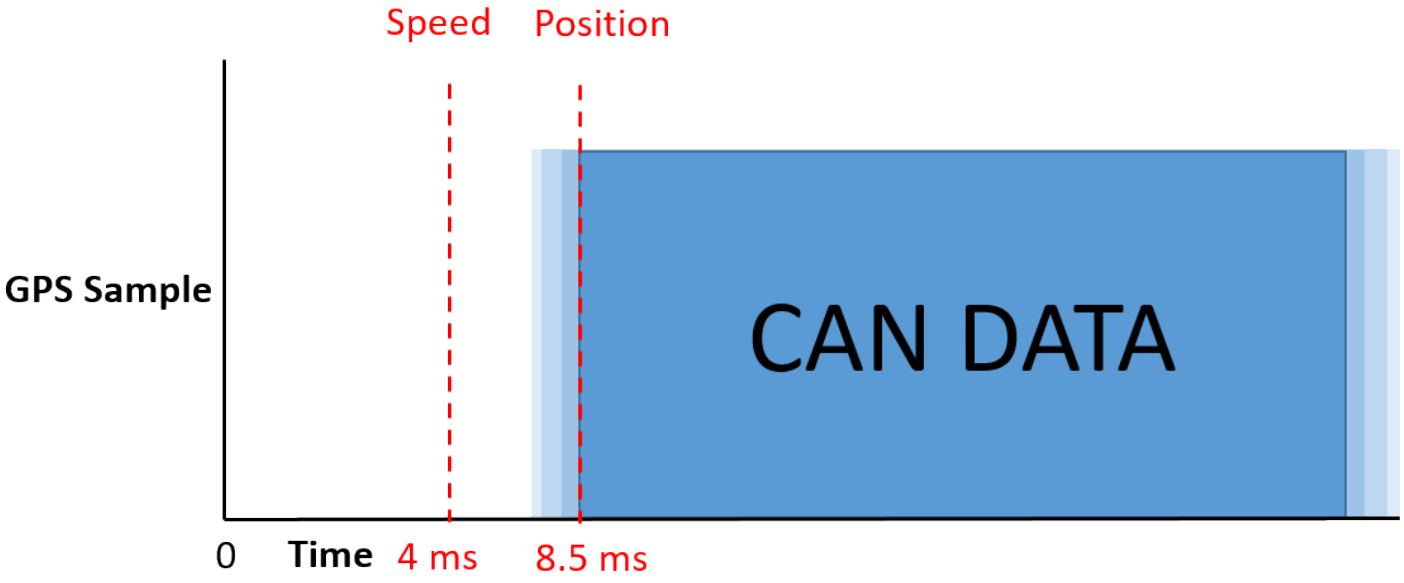
'Fixed' and 'Minimum' CAN Delay

When CAN Delay is set to 'Fixed', the speed delay is 20 ms and the position delay is 24 ms. When CAN delay is set to 'Minimum', the speed delay is 4 ms (±1.5 ms) and the position delay is 8.5 ms (±1.5 ms). The data comes out faster in the 'Minimum' setting, but the delay is unpredictable.

Note: Do not use Minimum CAN Delay mode if you are using a lot of Racelogic input modules connected to the CAN bus as the variability of the output could cause loss of samples from the modules.



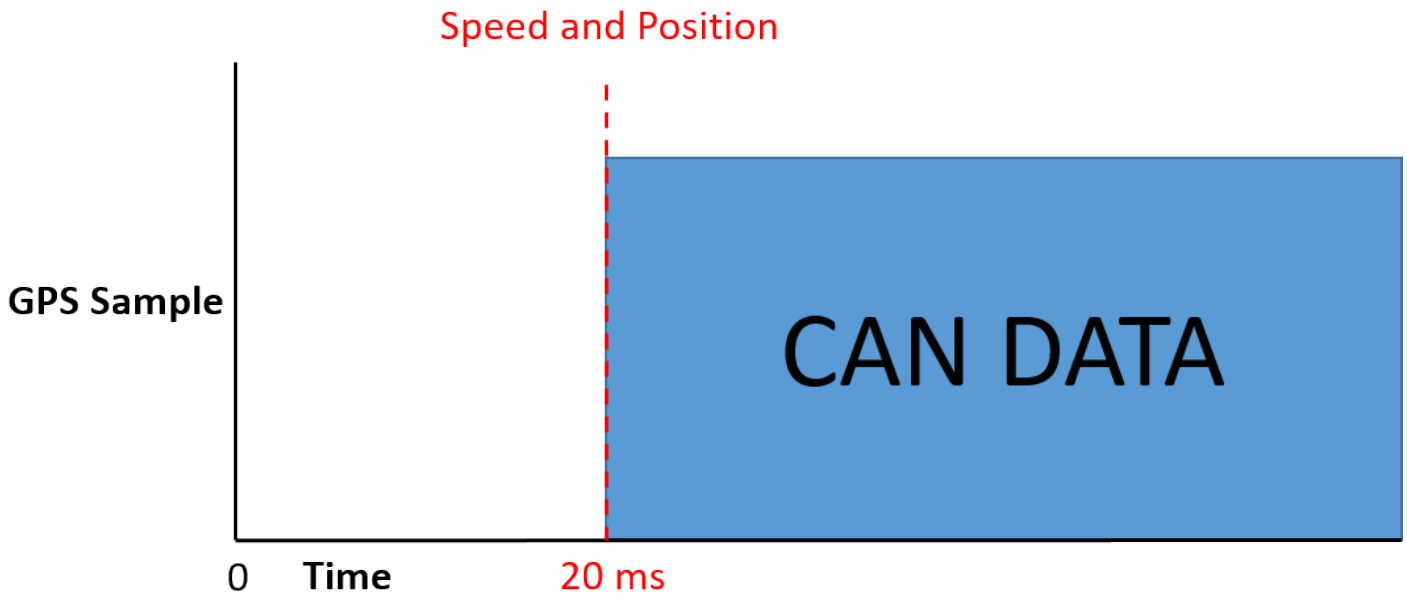
Fixed CAN Delay Example



Minimum CAN Delay Example

CAN delay with Kalman Filter enabled

When Kalman Filter is enabled, the CAN Delay is automatically set to ‘Fixed’; the speed and position delay is 20 ms.



Kalman Filter CAN Delay Example

ADAS Modes

Fixed

- Static Point and Lane Departure: 20 ms; Total delay: 20 ms.
- All vehicle separation modes: 20 ms + 3 samples; Total delay: 50 ms.

Minimum

- Static Point and Lane Departure: 4.5 ms (+/- 1.5); Total delay: 4.5 ms (+/- 1.5 ms).
- All vehicle separation modes: 4.5 ms (+/- 1.5) + 4 samples; Total delay: 44.5 ms (+/- 1.5 ms).

09 - VB3i Analogue and Digital I/O

Analogue Inputs

For PIN outs of the Analogue Input Connector click here.

The VBOX 3i contains four differential 24 bit analogue input channels with a maximum sample rate of 500 Hz. Each channel has its own dedicated analogue to digital (A/D) converter with all four channels being sampled synchronously to each other. The voltage range of the input channels is ±50 V. Note that unlike the ADC03 module, the analogue channels in the VBOX 3i are not electrically isolated from each other.

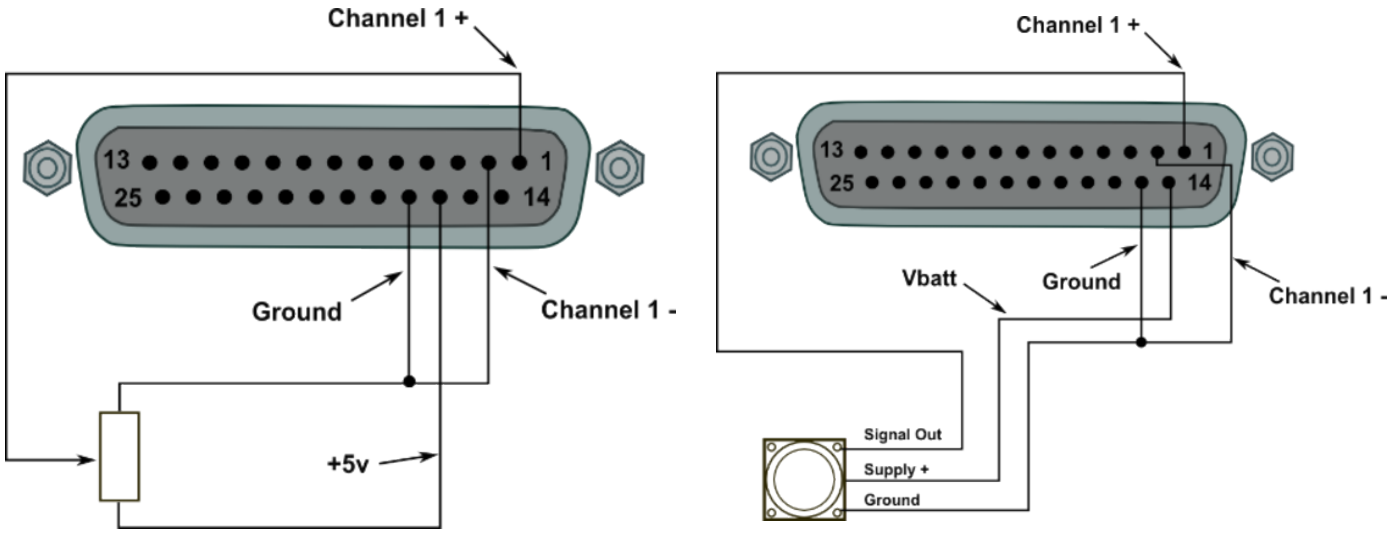
The analogue input connector also contains voltage outputs that can be used to power external sensors. These are a Vbatt connection which is equal to the VBOX input voltage level and a 5 V DC out connection which is equal to 5 V ±2%.

- **VB3i V1-V3 units:** The 5 V out connection is internally protected by 350 mA thermal fuse.
- **VB3i V4 / V5 units:** The 5 V out connection is electrically isolated, allowing for up to 120 mA of current to be drawn.

The Vbatt connection is internally protected by a thermal fuse.

- **VB3i V3 - V5 units:** 300 mA
- **VB3i V2 units:** 200 mA
- **VB3i V1 units:** 100 mA

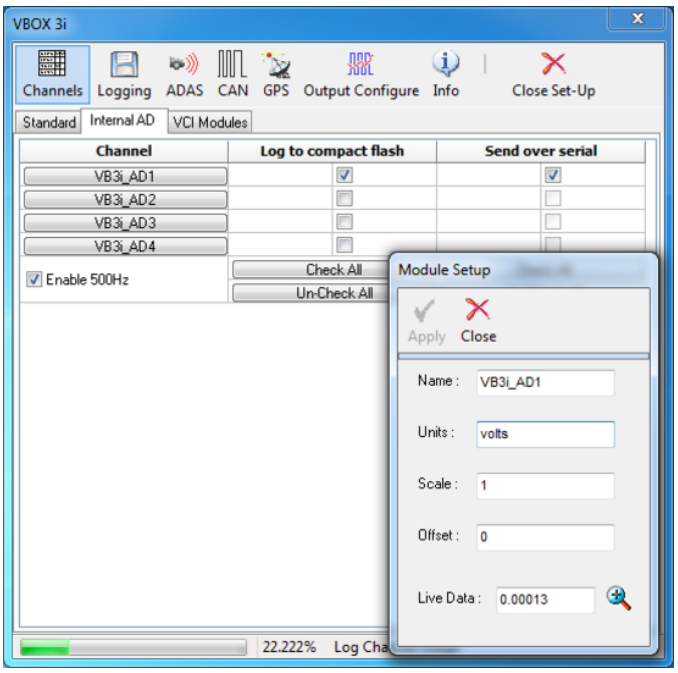
A screw-terminal connector block is available as an option for easy connection of signal pins.



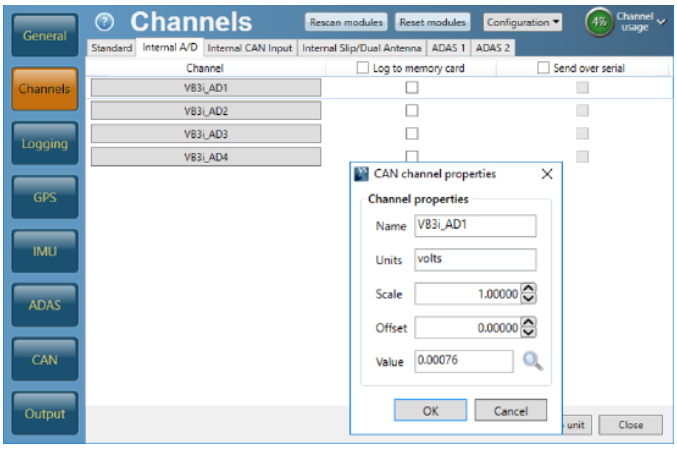
Note: A 25 W D-sub to 4 W BNC adaptor block is available through your VBOX distributor, part number RLVBACS054

Using VBOX Tools or VBOX Setup software, logging of the analogue channel data can be switched on or off. It is also possible to change the name of each input channel and configure scale and offset values for calibration of sensors. A scale value of 1 and offset of 0 correspond to a channel reading in V DC. This means that the value stored on the compact flash card for the channel will also be in volts. When using a sensor such as a load cell, it may be desirable to store a reading in kg. In this case, changing the scale and offset to suit the sensor data sheet allows the data stored onto the compact flash to be in kg. When changing settings for an analogue channel using VBOX Tools or VBOX Setup software, a live data view of the current channel is shown. The value shown is the value after scale and offset is applied and can therefore be used to aid sensor calibration.

Note: The 5 V regulated output on pin16 is only good for VBOX power supply voltages >8.5 V



VBOX Tools view



VBOX Setup view

500 Hz logging

VB3i has the ability to log 4x analogue channels at 500 Hz. With this feature enable the file sizes will increase as a result.

The 500 Hz analogue logging functionality is only fully supported when Fixed CAN timing is used. For more information on Fixed CAN timing **read here**.

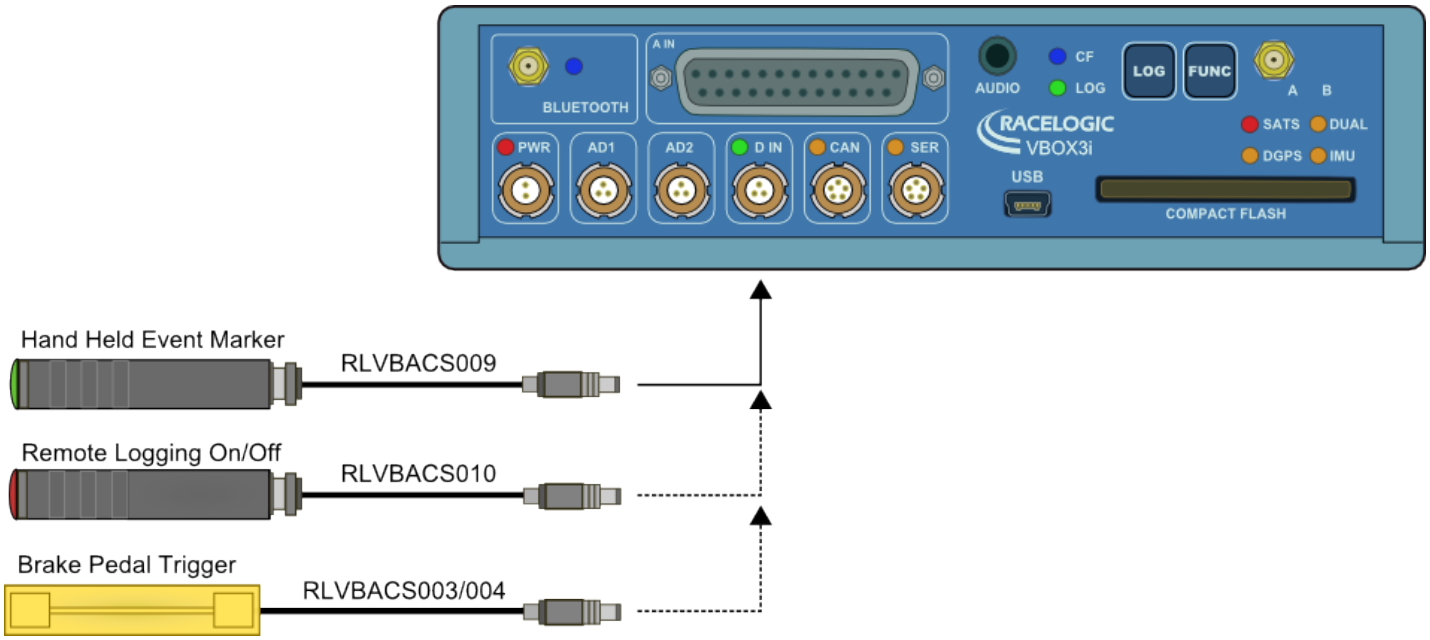
When loading the VBO file into VBOX Tools or VBOX Test Suite, ensure you are running the very latest version as older versions are not compatible with 500 Hz data.

Digital Inputs

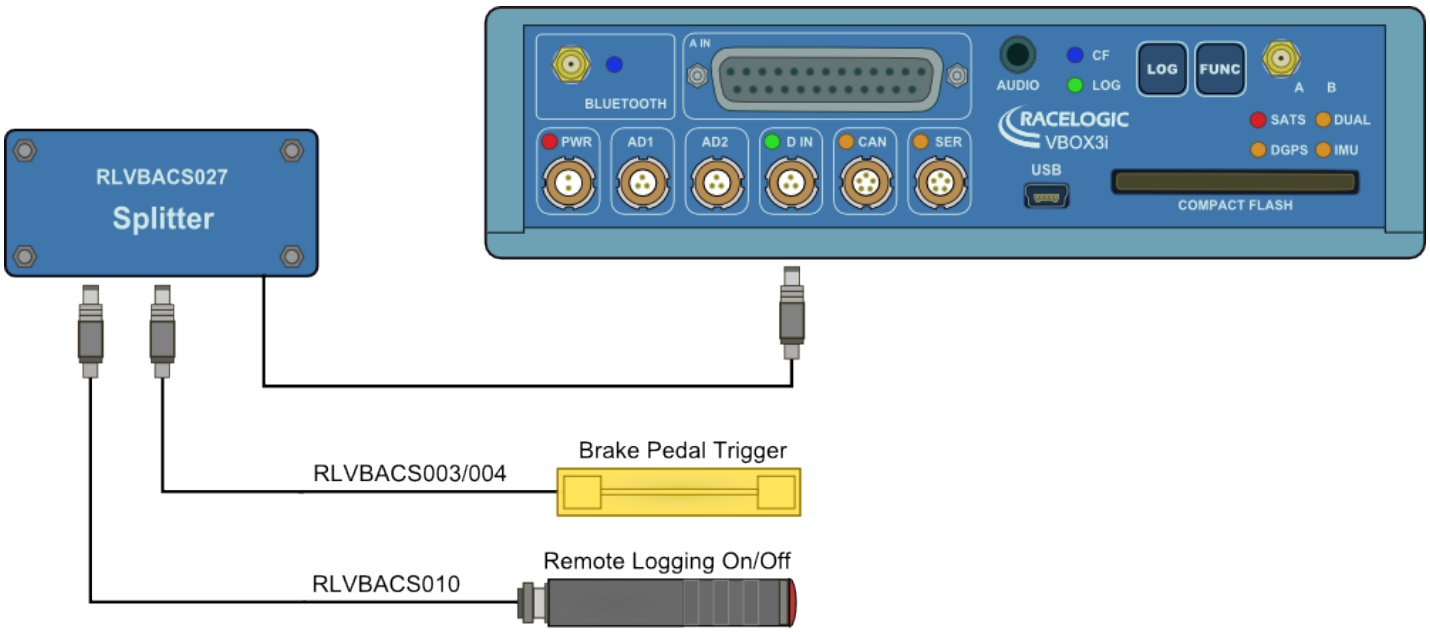
The ‘D IN’ connector contains the two digital inputs for the VBOX 3i. Digital input 1 is also referred to as the brake trigger input. This input is connected to an event capture input on the GPS engine. This captures precisely the trigger event time (10 ns resolution) for use in brake distance calculation. The trigger event time is logged and used to correct the measured brake stop distance to the exact point at which the trigger was pressed.

A hand-held event marker is also available to allow the user to record marker events in the VBOX 3i data file.

A remote logging on/off switch is also available for ease of use and when the front panel switch is not accessible.



Two digital inputs devices can be connected to the VBOX 3i with the use of an additional splitter box, as shown in the image below.



Analogue and Digital Outputs

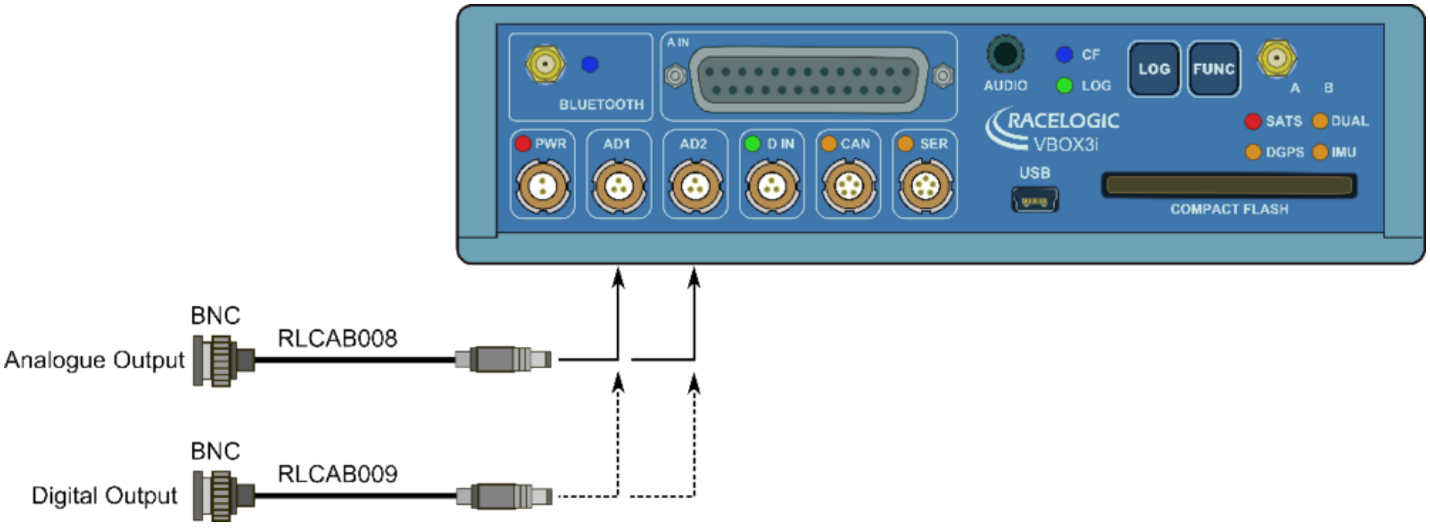
The AD1 and AD2 connectors each have 1 analogue voltage and 1 digital output. The digital output on connector AD2 is a frequency/pulse output corresponding to velocity. The pulse per meter range is adjustable in software. The digital output on connector AD1 is a simple on/off state output. This digital output can be associated with any of the data channels being logged by the VBOX. A threshold level can be set for the selected data channel where a true condition gives a 5 V output and a false condition gives a 0 V.

i.e. Data channel –Speed, threshold 40 km/h. When speed is >40 output = 5 V, speed, 40 output = 0 V.

A hysteresis and tolerance value can also be associated to this condition.

The default function of this digital output is to indicate the current logging status of the VBOX.

The analogue outputs on connectors AD1 and AD2 are both user configurable. For example, analogue output 1 could be configured to output velocity while analogue output 2 might be configured to output lateral acceleration. The voltage range of both analogue outputs is 0 to 5 V DC.

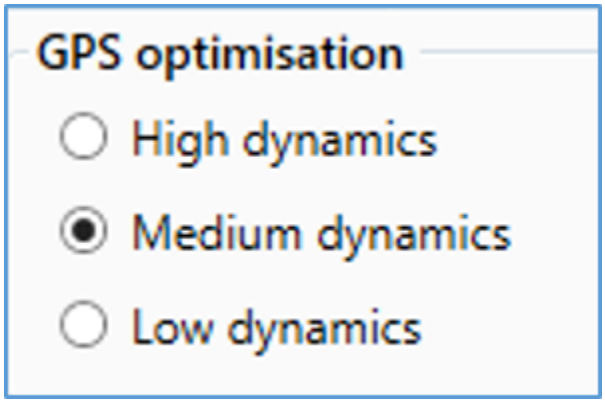


10 - VB3i Dynamic Modes

The VBOX has three dynamic modes. These dynamic modes directly change the SMI smoothing index applied by the GPS engine to all Doppler-derived data, notably speed and heading. The lower smoothing levels have a higher dynamic response but are adversely noisier.

The three options are:

- **High dynamics:** The ‘High dynamics’ setting should be used for high accuracy trigger brake stops or any test where time and distance are critical and the vehicle test incorporates highly dynamic manoeuvres.
- **Medium/ Normal dynamics:** The 'Medium' or ‘Normal’ mode should only be used for any testing that does not involve any high dynamic manoeuvres.
- **Low dynamics:** The ‘Low dynamics’ mode can be used for smoother velocity and heading data and less acceleration noise only in lower dynamic tests.



11 - VB3i DGPS / RTK

For more information on what DGPS is and how it works, click here. For more information on RTK, click here.

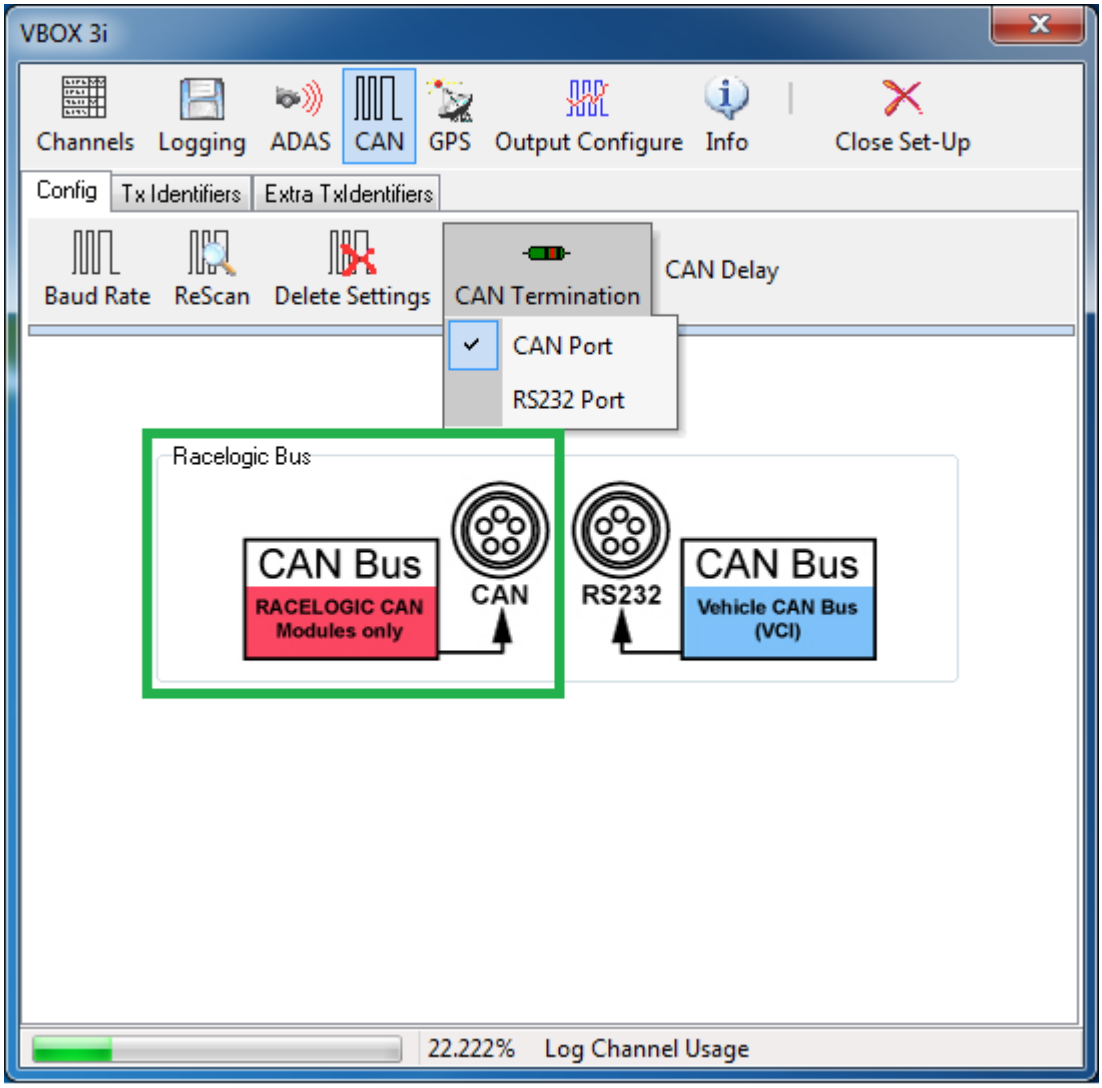
VBOX 3i now supports an RTK connection using NTRIP. For more information on how this is set up, click here.

How to enable DGPS Modes

The VBOX must have the correct DGPS mode enabled in VBOX Tools, VBOX Setup or VBOX Manager before it is capable of receiving and using the DGPS correction information transmitted by a Local Base Station.

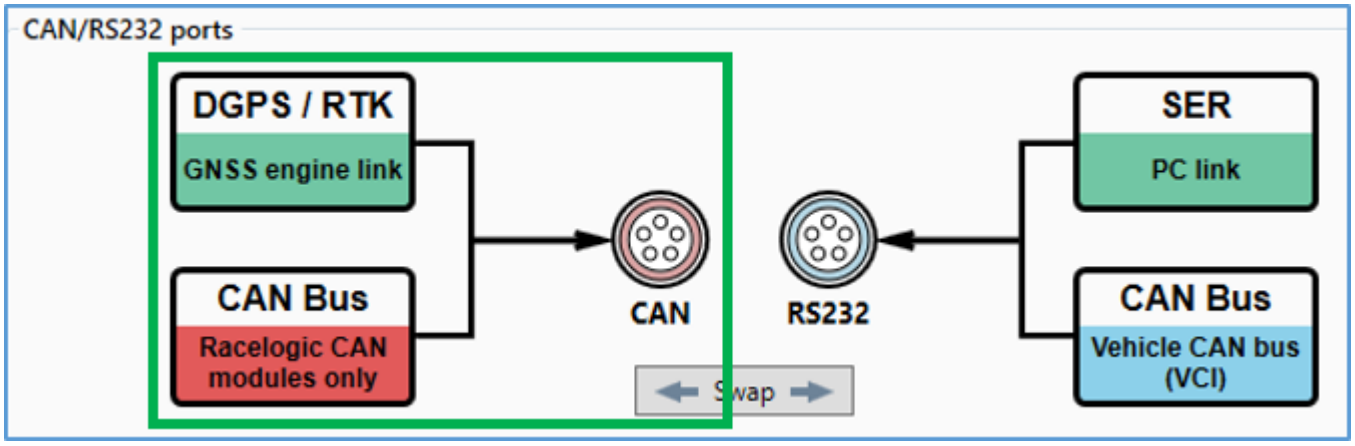
Setup using VBOX Tools

1. Run the latest VBOX Tools software.
2. Enter the VBOX setup screen and go to the '**GPS**' page.
3. Click on the '**DGPS**' button and select the correct DGPS mode and baud settings from the available options.
4. Close the VBOX setup screen.
   *Note: Ensure that the Racelogic Bus is assigned to the CAN port within the '**CAN**' menu.*



Setup using VBOX Setup

1. Run the latest VBOX Setup software.
2. Select the correct COM Port and go to the '**GPS**' menu.
3. Go to the '**DGPS/ RTK**' option and select the correct DGPS mode and baud settings from the available options.
4. Select '**Write to unit**' to upload settings to VB3i.
   *Note: Ensure that DGPS / RTK is assigned to the CAN port within the '**CAN**' menu.*



Setup using VBOX Manager

1. Enter '**SETUP**', select '**VBOX**' and then '**DGPS MODE**'.
2. Select the correct DGPS mode from the available options.
3. Select '**BACK**' and then select '**DGPS RS232 RATE**' within the '**VBOX**' menu.
4. Choose the correct DGPS baud rate from the available options.
5. Select '**EXIT**' to return to main menu.

Using with Local DGPS Base Station

When the VBOX 3i is used in conjunction with a local DGPS Base Station the positional accuracy can be improved from the standard 3 m 95 % CEP.

There are two available Base Station options:

40 cm positional accuracy:

If the VBOX 3i is used with a RTCM-V2 enabled Base Station then the positional accuracy is increased to 40 cm 95 % CEP. The height accuracy is improved to 1 m 95 % CEP.

2 cm positional accuracy:

If the VBOX 3i has an RTK upgrade option installed and is used with a RLVBBS4RG then the positional accuracy is increased to 2 cm.

- **Racelogic** proprietary 2 cm correction (Not compatible with VB3iSL-RTK)
- **CMR** 2 cm correction (Trimble standard message type)
- **RTCMv3** 2 cm correction (RTCM standard message type) **RECOMMENDED**

RTCMv3 is recommended as the default RTK 2 cm correction type. This message format is a globally recognised type and more resilient to data loss caused by radio errors.

Notes:

- RLVB3iR2G2 has a max. log rate of 20 Hz when in RTK mode.
- RLVB3iR10G10 & RLVB3iSL-RTK have a max. log rate of 100 Hz when in RTK mode.
- If the VBOX 3i is issued a **coldstart command** (from front panel, software or VBOX Manager) any DGPS settings will be disabled.

Solution type lookup table

Solution Type	Definition
0	None
1	GNSS only
2	GNSS DGPS (inc RTCMv2 40 cm)
3	RTK Float

Solution Type	Definition
4	RTK Fixed
5	Fixed position
6	IMU Coast (Kalman Filter)

0 = None

GNSS receiver cannot compute a solution for position.

1 = GNSS only

Position computed from GNSS only.

2 = GNSS DGPS

Position computed from assisted GNSS, this includes SBAS and base station DGPS corrections.

3 = RTK Float

Position computed from GNSS corrected by RTK. Float means the GNSS receiver is still calculating the integer ambiguity, a small error will be present on the position computation at this time.

4 = RTK Fixed

Position computed from GNSS corrected by RTK. Fixed means the integer ambiguity is established and the optimum position correction is applied resulting sub 2 cm relative accuracy in good conditions.

5 = Fixed position

GNSS receiver position is fixed/locked. This is primarily used for base station receivers.

6 = IMU Coast

Position computed from the Kalman filter when RTK is lost, inertial data from the IMU is used to maintain a solution for position until the RTK is re-established.

12-1 - VB3i IMU Integration

Required equipment

IMU04

VB3i (IMU04 ready)

IMU04

VBOX Tools or VBOX Setup

RLCAB119 – VBOX - IMU connecting cable

RLCAB001 / RLCAB066-2 – VB3i PC connection cable

VBOX Manager (optional)

IMU03

VB3i (works with all VB3i units)

IMU03

VBOX Tools or VBOX Setup

RLCAB005-CS – VBOX - IMU connecting cable

RLCAB001 / RLCAB066-2 – VB3i PC connection cable

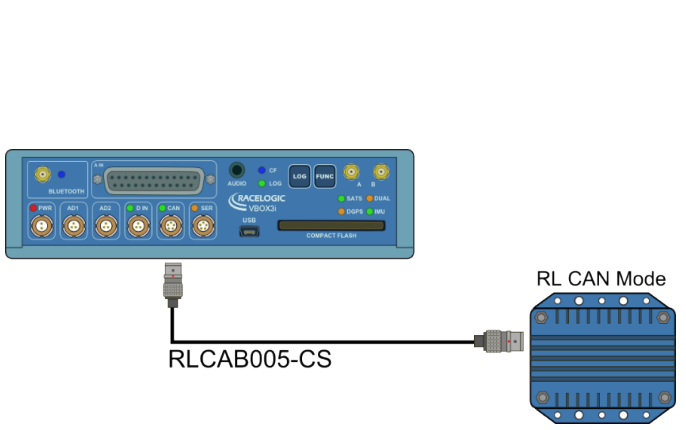
VBOX Manager (optional)

Setup

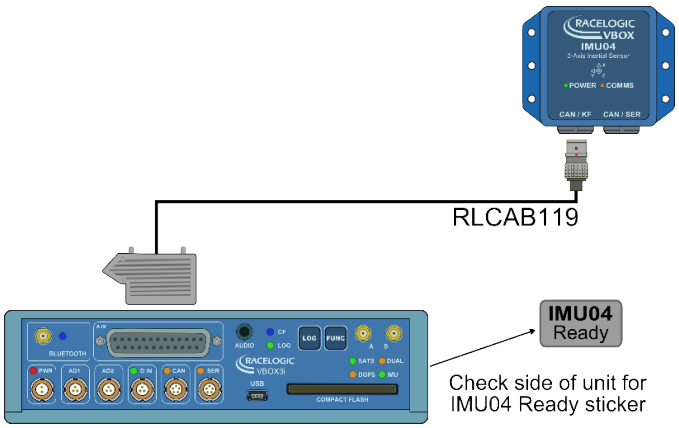
Hardware

Important note: IMU04 must be connected to VB3i before power is applied to ensure data is correctly synchronised.

1. Fit the VBOX 3i into the test vehicle, and mount the IMU **as described here**.
2. Fit VBOX 3i GPS, GPS/GLONASS antenna to centre of vehicles roof. Connect antenna to VBOX 3i.
3. Measure the relative position from the top centre of the GPS antenna* to the top centre of the IMU (see mounting section for more detail) and enter these distances in the highlighted box below. Measurements need to be made in all 3-axis, X, Y and Z.
   *When using a twin antenna system, these measurements must be taken from the main antenna (A).
4. **IMU04** – Connect CAN/KF port to VBOX 3i V3-V5 25W D analogue input port using RLCAB119 cable.
   IMU03 – Connect either port on IMU to VBOX RL CAN port using RLCAB005-CS cable.
5. After IMU is connected, apply power to VB3i.
6. Enable IMU integration using either VBOX Manager, VBOX Tools - VBOX Setup or VBOX Setup.



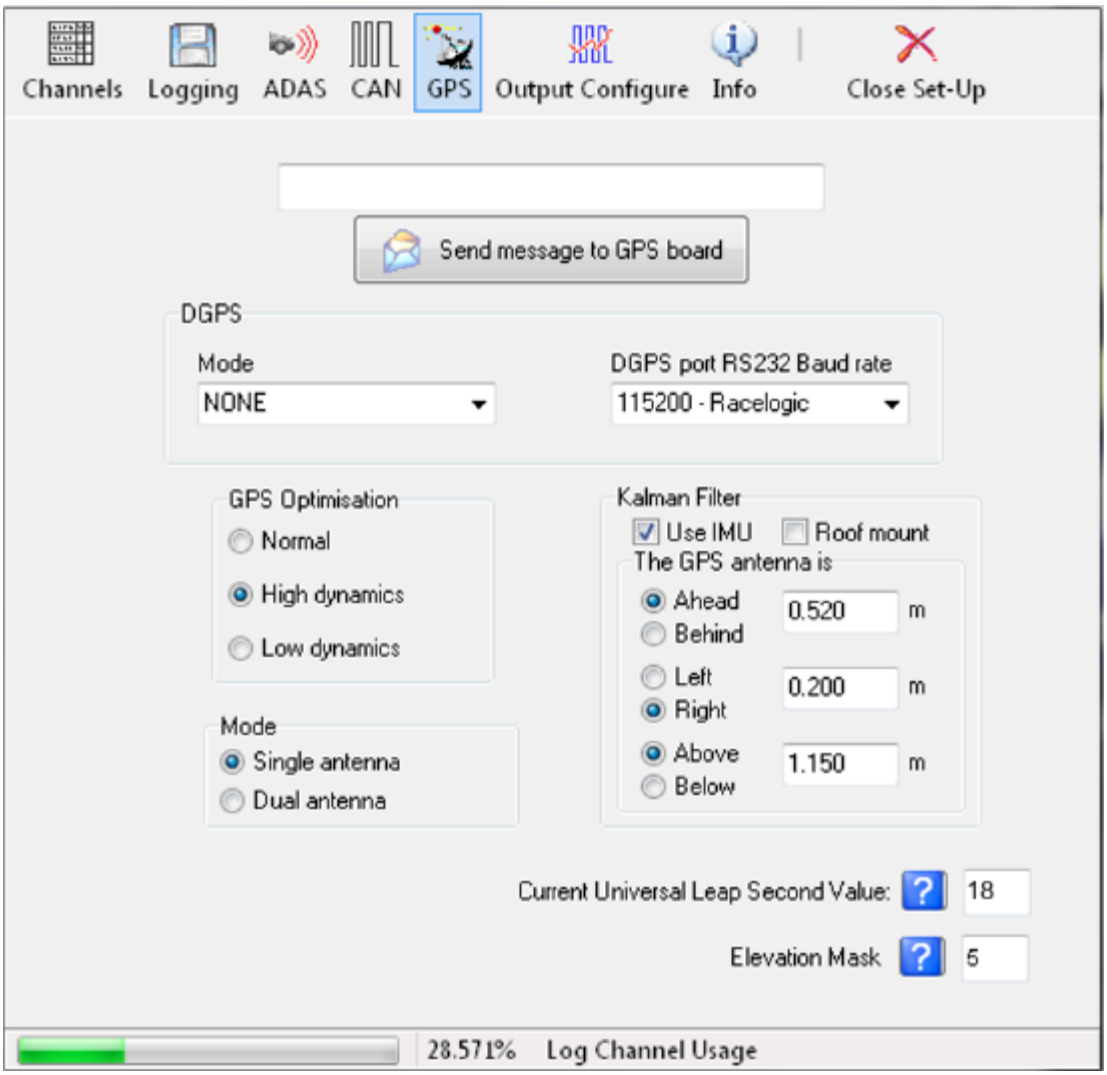
VBOX 3i and IMU03



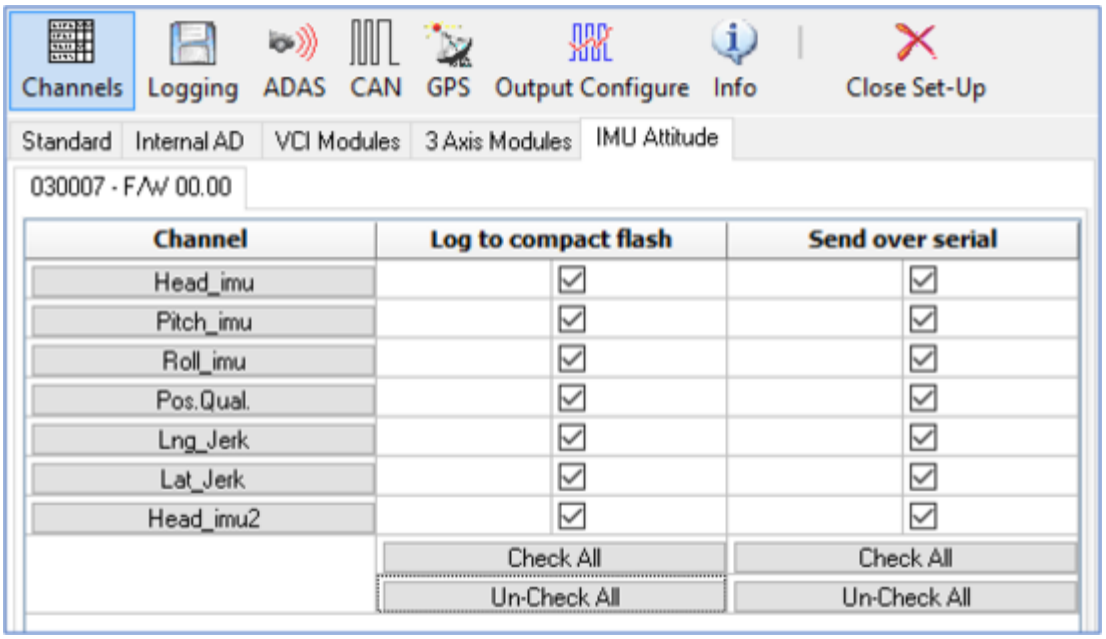
VBOX 3i V3-V5 and IMU04

VBOX Tools

1. Ensure IMU03/04 is connected, and the VBOX 3i is powered on.
2. Connect VBOX 3i to PC using RLCAB001 or RLCAB066-2 cable (RS232 or USB).
3. Open **VBOX Tools** and connect to VBOX 3i by selecting **COM Port** (**Options** from Toolbar).
4. Run **VBOX** Setup.
5. Ensure '**High Dynamics**' GPS Optimisation is selected, and log rate is set to '**100 Hz**' (Logging tab).
6. Tick '**Use IMU**' box and enter the **distances measured from GPS antenna to the IMU**.



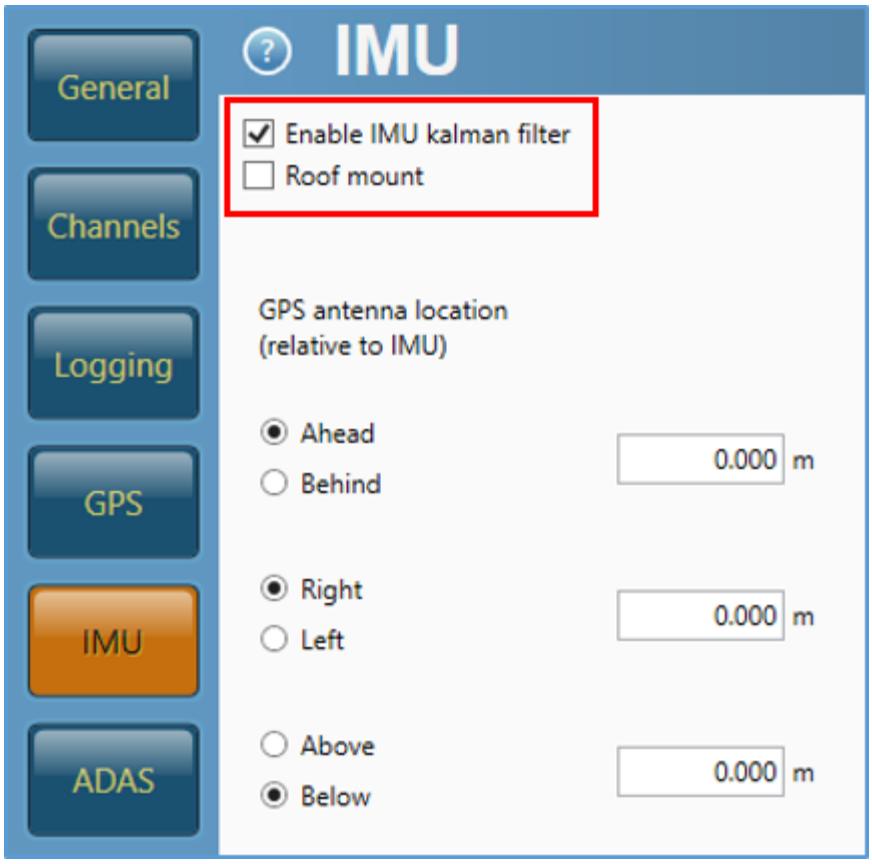
7. If using IMU04, **IMU Attitude** channels (**Head_imu**, **Pitch_imu, Roll_imu, Pos.Qual., Lng_Jerk, Lat_Jerk and Head_imu2**) will automatically be set to log. If IMU Attitude data is required to be displayed as a Live Serial **data display** then the user must tick the channels for '**Send over serial**'.



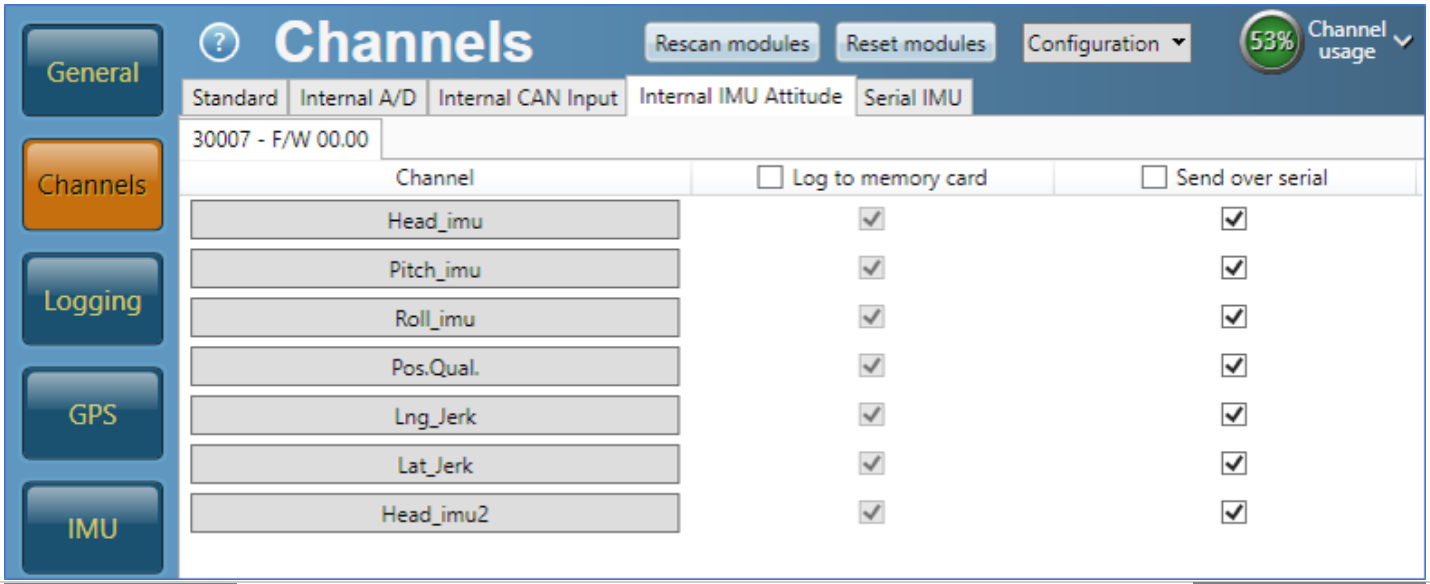
8. Perform [initialisation and full calibration] procedure before commencing testing.

VBOX Setup

1. Ensure IMU04 is connected via RLCAB119, and the VBOX 3i is powered on.
2. Connect VBOX 3i to PC using RLCAB001 or RLCAB066-2 cable (RS232 or USB).
3. Open **VBOX Setup** and connect to VBOX 3i by selecting **COM Port**.
4. Select the '**GPS**' menu and the '**Settings**' tab, ensure that '**GPS Optimisation**' is set to '**High dynamics**'.
5. Select the '**Logging**' menu and ensure that '**Log rate**' is set to '**100 Hz**'.
6. Select the '**IMU**' menu and tick '**Enable IMU kalman filter**'.



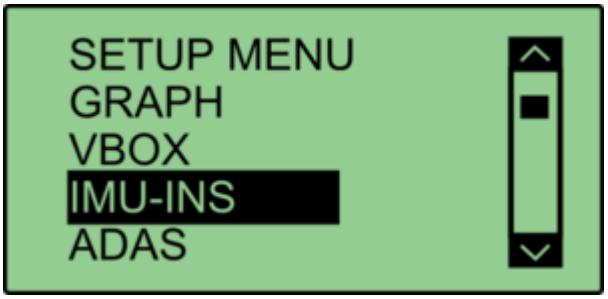
7. Enter the **distances measured from IMU to required translation point.**
8. If using IMU04, **Internal IMU Attitude** channels (**Head_imu**, **Pitch_imu, Roll_imu, Pos.Qual., Lng_Jerk, Lat_Jerk and Head_imu2**) will automatically be set to log. If IMU Attitude data is required to be displayed as a Live Serial **data display** then the user must tick the channels for '**Send over serial**'.

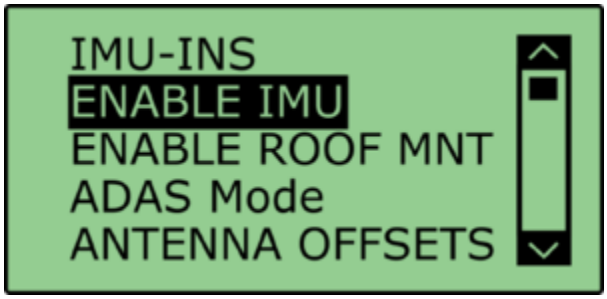


9. Select '**Write to unit**' to upload settings to VB3i.
10. Perform [initialisation and full calibration] procedure before commencing testing.

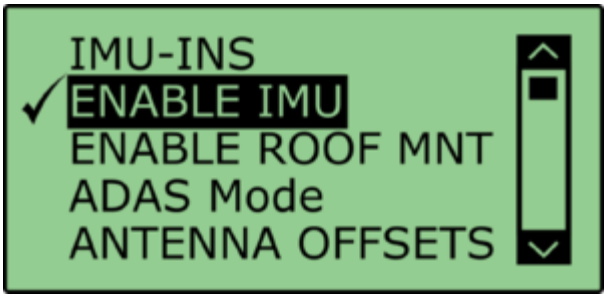
VBOX Manager

1. Ensure IMU04/03 is connected, and the VBOX 3i is powered on.
2. Enter '**SETUP**', select '**IMU-INS**' then click on '**ENABLE IMU**'.

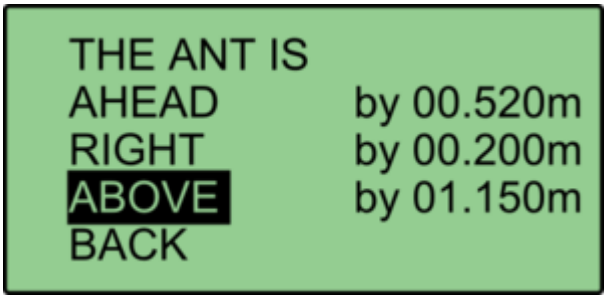




3. Once '**OK**' confirmation screen has cleared, ENABLE IMU should be ticked.

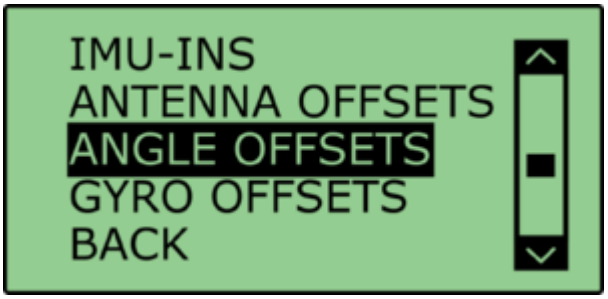


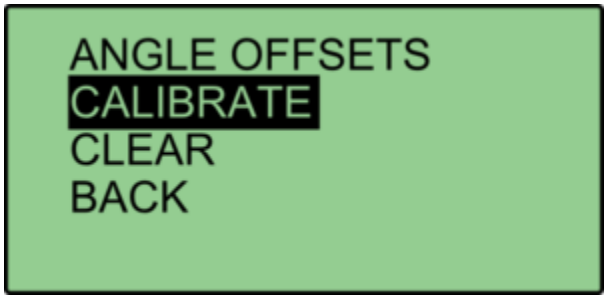
4. Set ANTENNA OFFSETS with the distances measured between the IMU and antenna A.



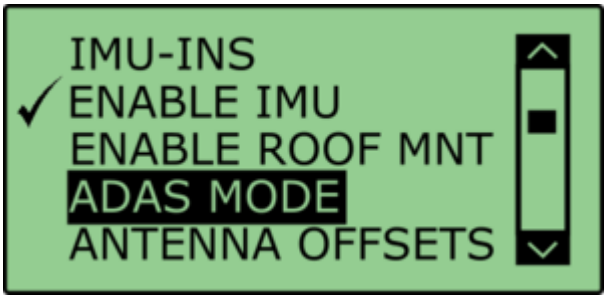
5. IMU Attitude and 3 Axis Modules channels will be automatically set to log. If IMU Attitude or 3 Axis data is required to be displayed as a Live Serial **data display** (with VBOX Tools) then the user must enter VBOX Setup and tick the channels for **Send over serial**.
6. Perform [initialisation and full calibration] procedure before commencing testing.

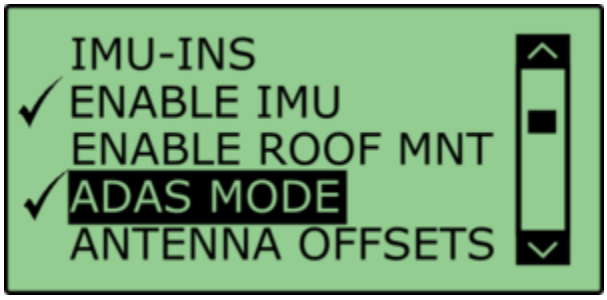
7. If the IMU is not mounted on a flat surface, perform **ANGLE OFFSETS** calibration. This will zero the **Pitch_imu** and **Roll_imu** channels. Angle offsets calibration must be performed after the IMU kalman filter calibration has been completed, and the vehicle is static on a level surface.





8. If ADAS testing is being conducted, select '**ADAS Mode**' from the menu. This option changes the rate at which the kalman filter takes a GPS positional sample to improve the positional performance of the filter. Whilst this is beneficial to ADAS testing, it slightly decreases the accuracy of the filtered speed and therefore shouldn't be selected when undertaking speed based testing such as brake stops.
Note: Option not available with IMU03.





9. Once **OK** confirmation screen has cleared, **ADAS Mode** should be ticked.

Important notes

1. To use **IMU04** integration, a **VB3i-V3, V4 or V5** must be used. This is an IMU04 enabled VBOX 3i unit.
2. IMU04 cannot be used with IMU integration if it is connected to a VBOX via CAN (RLCAB120 / RLCAB005-CS). This method of connection will only allow standard IMU channels to be logged. See **using IMU as CAN module** section for details.
3. The IMU04 standard channels can also be logged when the IMU04 is connected via KF port with cable RLCAB119, without enabling IMU integration
4. The IMU04 must be in a Racelogic CAN mode to be used for IMU Kalman Filter.
5. **NB ADAS -** If using IMU filter with ADAS mode, the GPS antenna and IMU must be co-located (roof mount) or positioned so there is no relative X or Y offset between them. If there is a difference, manual contact points should reference the IMU location, rather than the GPS antenna.
6. **NB ADAS -** When using IMU Filter the user cannot use SET POINTS functionality to define contact points in single or multi target ADAS modes

Initialisation

When using IMU integration, an **initialisation phase is required** when the IMU is first connected to the VBOX after being set up. This will be run through automatically after the VBOX has successfully gained satellite lock. When the IMU LED on VB3i front panel has turned a flashing green, the initialisation is complete. Note, if you are using a VB3i-V1, which has no IMU LED, read the LED indicators section below for LED behaviour.

LED Indicators VBOX 3i (V2/V3/V4) and IMU04

VBOX 3i LED Colour	Description
Solid Orange	IMU enabled, no IMU connected.
Flashing Orange	SAT lock OK. 30 second stationary initialisation in progress. If vehicle moves, LED will continue to flash until 30 seconds stationary completed.
Flashing Green	Initialisation complete – movement not yet detected.
Solid Green	Movement detected – IMU integration working OK.

IMU04 LED Colour	Power	Coms
Red	Initial boot up phase.	No coms.
Orange	Temperature checks. If temperature outside optimum operation range, LED will remain orange.	Using IMU integration, inertial data being sent to host VBOX via RS232.
Green	Fully operational.	Inertial data being sent to host system via CAN.

LED Indicators VBOX 3i (V1)

When the filter is enabled and the IMU is connected, the satellite LED will remain off to act as an indicator for the IMU integration status. Only when the filter is initialised and movement is detected will the SAT LED return to its normal operation.

The user will need to leave 1 minute after powering the VBOX on with the IMU connected before starting to move. This occurs on every power up of the VBOX unit.

LED Indicators IMU03

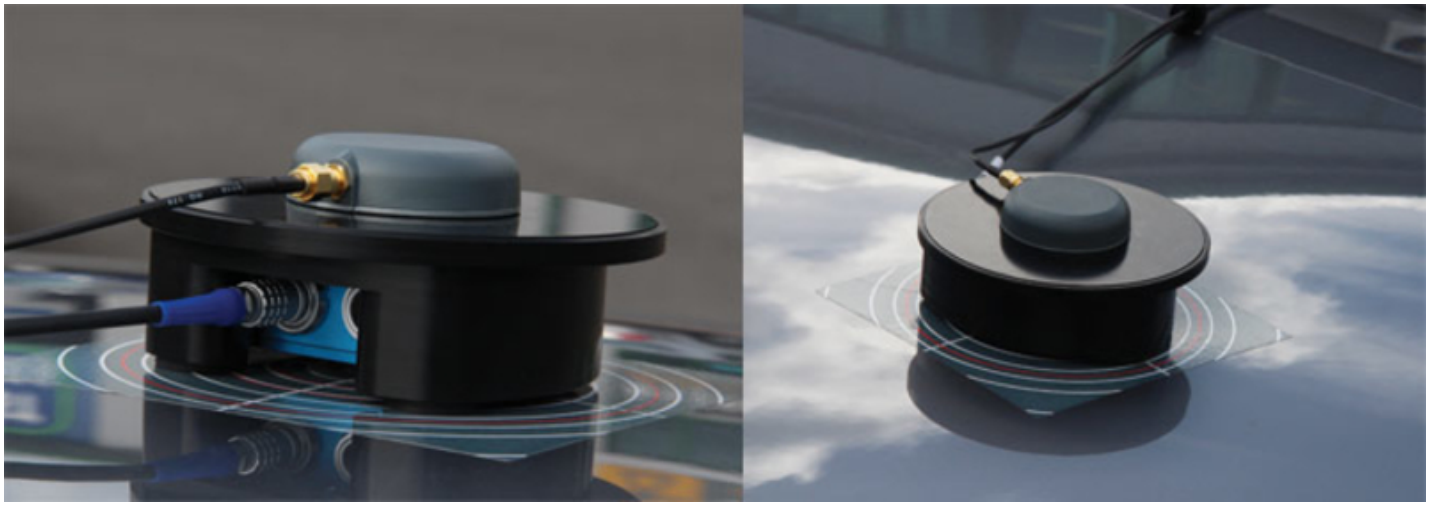
IMU03 LED	Colour	Description
Power	**Red**	IMU03 / YAW 03 is connected to a live power source.
Coms	**Blue**	Serial or CAN data communications are active.

How to Mount the IMU

Option 1: Roof-Mounting (Recommended)

The VBOX IMU roof-mounting option allows for an **IMU04 (only)** to be placed directly on the vehicle roof, co-located with the GPS antenna. The IMU is securely fastened within the machined enclosure which has a magnetic base to ensure that it stays in place.

Co-locating the antenna and IMU improves the performance of the Kalman filter. Putting the two together and mounting them on the vehicle's roof, removes the requirement to measure the separation (difference between IMU and antenna automatically accounted for).



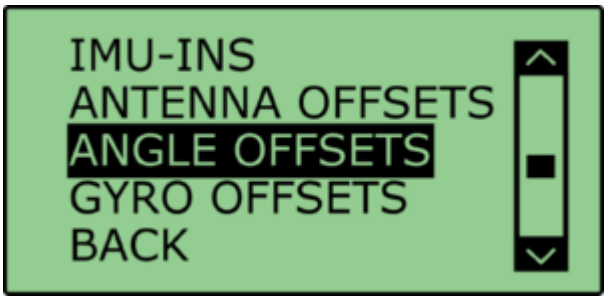
Please contact **vbox@racelogic.co.uk** for more information, or to order an IMU Roof Mount (RLACS216).

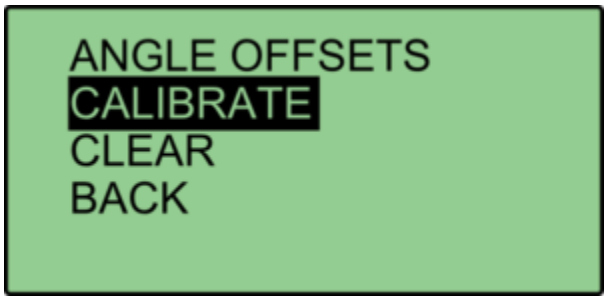
Mounting Suggestions

The IMU roof mount should be mounted on a braced, stable part of the roof, such as the area over the A or B Pillar.

Care should be taken to avoid placing the mount in a half braced position, where the front or rear magnetic support is on a supported part of the roof, and the opposite end is on a flexible location. The potential pivot can induce a pitch rate oscillation that will influence the accuracy of the results.

The IMU roof mount can be placed on a non-flat surface. When placed on a non-flat surface, the '**ANGLE OFFSET**' action should be used to compensate the IMU attitude angle channels (Pitch angle, roll angle). This is performed from VBOX Manager.

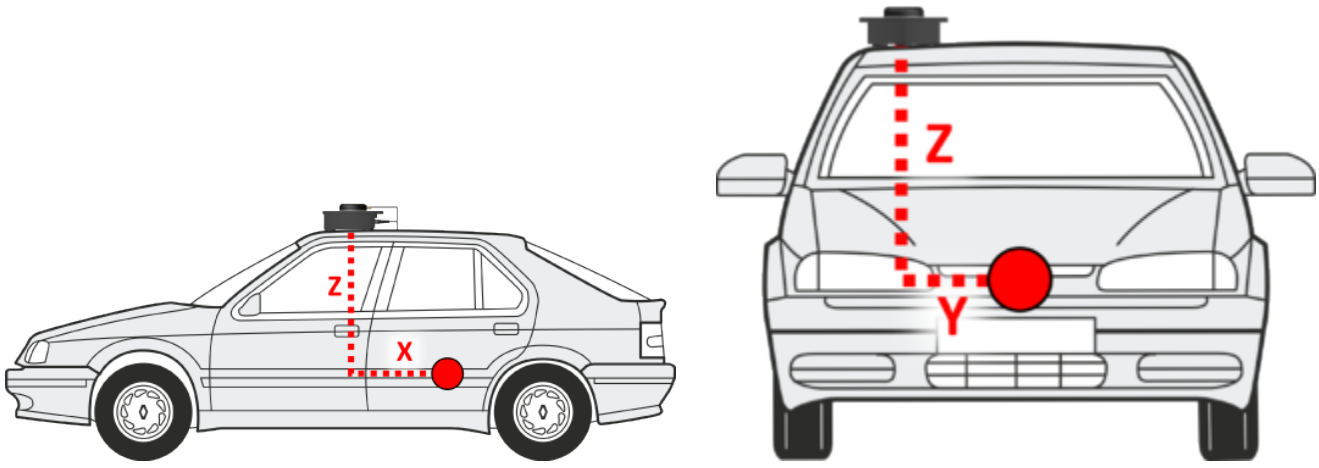




Be aware that when mounting the IMU on an angle, that the raw accelerometer and gyro data will be incorrect, as the channels are not pitch compensated.

Measuring Translation Points

Customer required translation measurements should be made in the same plane as to which the IMU is mounted (i.e. perpendicular to the IMU base, not straight down to the ground).



Important notes when using ADAS Setup

1. If using IMU filter with ADAS mode, the GPS antenna and IMU must be co-located (roof mount) or positioned so there is no relative X or Y offset between them. If there is a difference, manual contact points should reference the IMU location, rather than the GPS antenna.
2. When using IMU Filter the user cannot use '**SET POINTS**' functionality to define contact points in single or multi target ADAS modes.

Option 2: Using a Mounting Arm

A flexible way to fix the IMU rigidly within the vehicle is by using the Racelogic Mounting Arm. The three-part telescopic handle is fully adjustable to any length between 70 and 150 cm to which another 20 cm can be added by extending a third section using the compression lever.

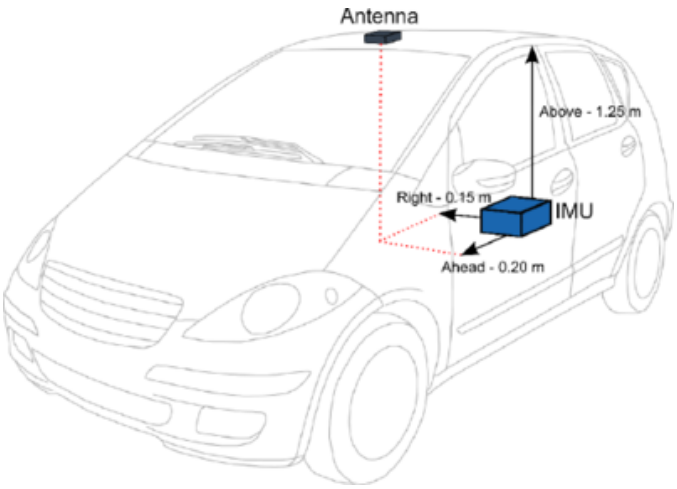
Both ends are fixed to an 8 cm x 13 cm plate which sits on a joint to accommodate for uneven surfaces. Pressed against the IMU on the floor and the vehicle's ceiling, the mounting prop ensures that the IMU is fixed tightly.

Please contact **vbox@racelogic.co.uk** for more information or to order a mounting arm (RLACS212)

Measuring IMU-Antenna Offsets

When using either a fixed mounting point or the mounting arm, you must measure the relative position of the antenna* in relation to the IMU to at least within +/- 5 cm. These distances must then be entered into the VBOX via VBOX Tools > VBOX Setup, VBOX Setup or using VBOX Manager. These measurements are required when using either an IMU04 or an IMU03 unit.

*When using a twin antenna system, these measurements must be taken from the primary antenna (A).

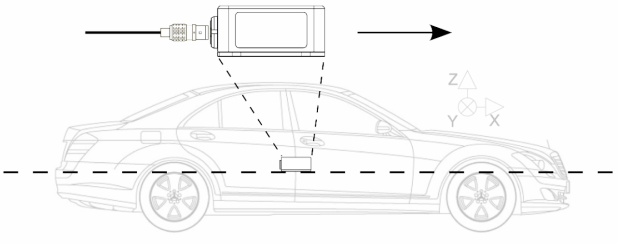


Option 3: Fixed Mounting

The IMU should be mounted rigidly to the vehicle mid-way along the wheelbase. Try to position the unit as close as possible to the centre of the vehicle, making sure it is mounted in the direction of travel - as shown in the image below. It is also important to mount the sensor so that it is level with the ground.

For best results, mount the IMU and GPS antenna as close to each other as possible. For example: Bolt the IMU to the seat rails and place the GPS antenna on the roof directly above.

Note that the IMU and antenna should be mounted on the same rigid body, to provide a relative reference. So for a vehicle such as a truck cabin, both the IMU and antenna should be fitted to the cabin body (if cabin is air-sprung) or to the vehicle chassis.



Kalman Filter Calibration

When using IMU filter it is important to perform the full calibration procedure before meaningful testing commences. The calibration procedure is a series of specific manoeuvres that should be performed that help the Kalman filter characterise the outputs from the IMU.

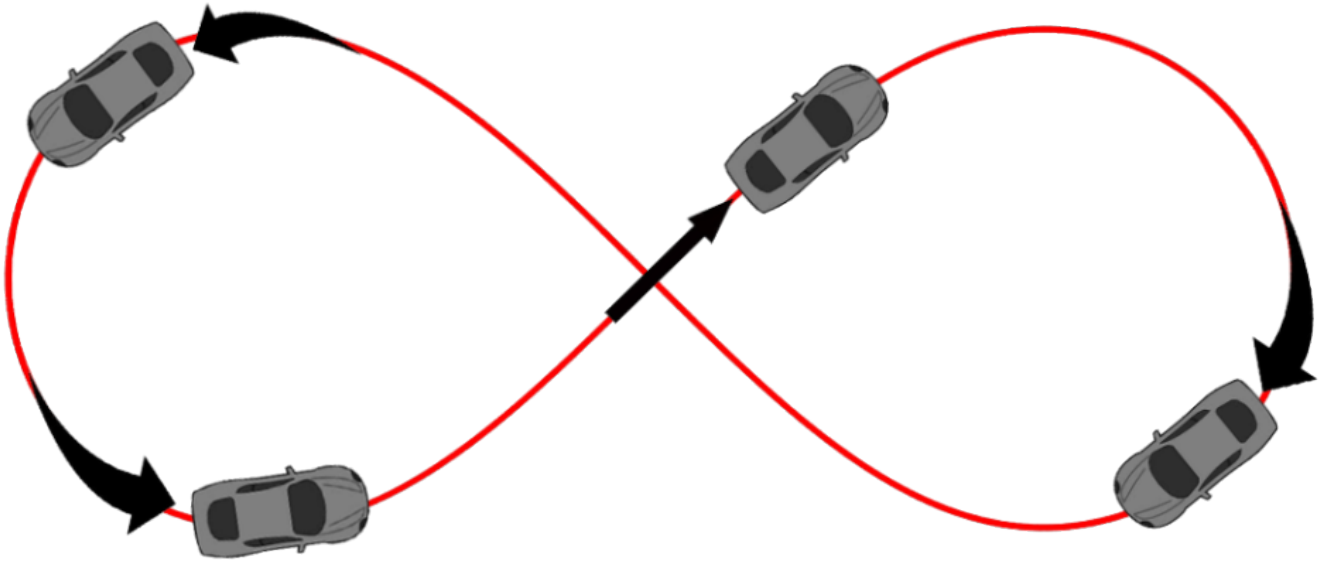
If the calibration procedure is not performed, the Kalman filter will still function, but may not produce the high level of accuracy until dynamic manouevres in the X and Y plane have been performed (i.e. left and right hand turns, braking and accelerating). This should occur after a few minutes driving.

Recommended procedure

1. Park the vehicle in an open area, where the GPS antenna has clear view of the sky. Remain static and wait for the IMU to complete the 30 second stationary initialization. As this happens the VB3i front panel IMU LED will change from flashing orange to flashing green upon completion. If the vehicle moves before initialisation finishes, the 30 second process will restart once stationary again.

2. When the IMU LED is flashing green, drive forward to complete initialization of the IMU. Continue to an open area to perform calibration procedure.

3. Drive in a ‘figure of eight’ at least twice. These can be as little as 5m in radius (almost full-lock in some vehicles), but 10 m is better. The vehicle should be travelling above 15 km/h during this procedure in order to generate sufficient forces for the calibration process.



4. Accelerating hard from standstill to 50 km/h or above, perform two brake stops with a decel force of at least 0.5 g.

When is the calibration required?

When carrying out high dynamic tests such as braking and ESC testing, this recommended process calibrates the Kalman filter as quickly as possible. When carrying out low dynamic tests such as driving on urban routes, or doing long term data collection, then this calibration is not as critical.

Re-running the calibration

The Kalman filter is constantly adapting its calibration depending on the information received from GPS and the IMU. Therefore, if the vehicle is left stationary for a long time, or the IMU is moved from its mounting position, then the calibration procedure should be repeated if further high dynamic testing is to be carried out.

The calibration should also be repeated after anything which causes the communication to break between IMU and VBOX, such as:

- Power cycle to either IMU or VBOX.
  *Note: Using an **external power backup** stops the system shutting down under temporary power loss.*
- 'VBOX Setup' software is used to read IMU settings.
- 'VBOX Tools' OR 'VBOX Setup' software is used to read VBOX settings.
- Modes change using VBOX Manager.

- A GPS Coldstart is performed.

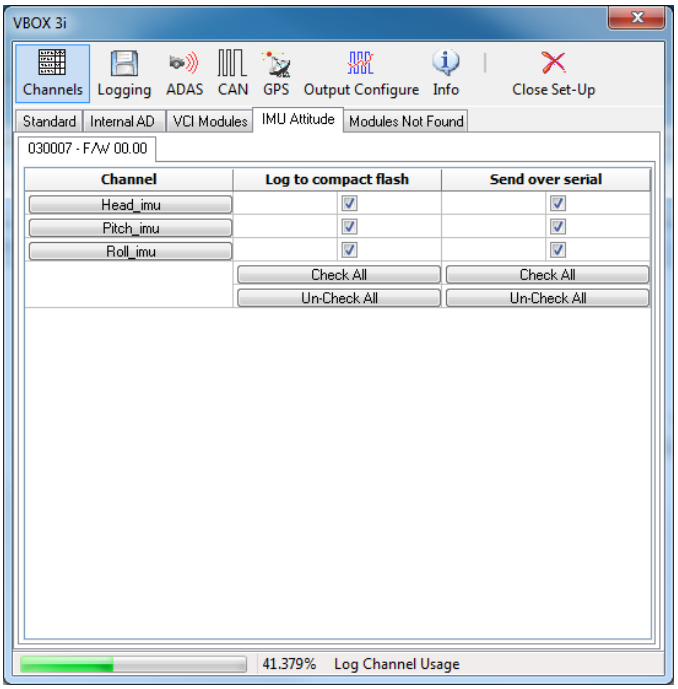
What happens if this isn’t done?

If this procedure cannot be carried out as above then the speed accuracy will be reduced, especially for the first few minutes until the Kalman Filter is able to calibrate itself. We strongly recommend that the Kalman Filter is calibrated when carrying out high dynamic tests.

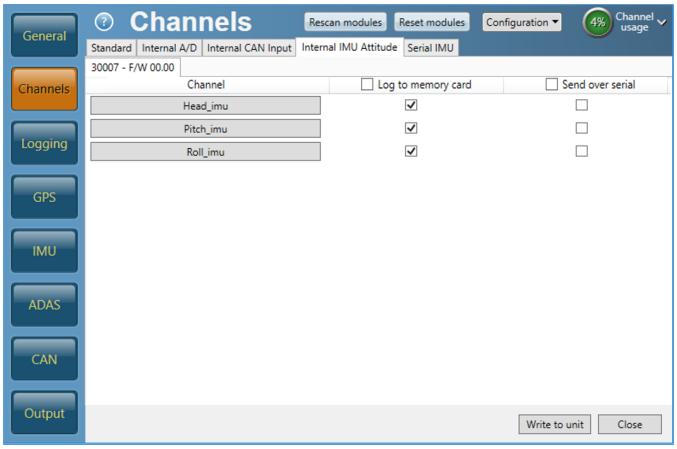
VB3i V3-V5 Additional IMU04 Channels

IMU Attitude

When using IMU04 integration with a VB3i-V3, there are three IMU attitude channels which can be logged. These body angle channels are heading, pitch and roll calculated from IMU derived data.



VBOX Tools view



VBOX Setup view

RMS Channels

These four channels are for diagnostic purposes only and cannot be turned on or off. They show the noise which is present on the vertical and horizontal speed channels, as calculated by the VB3i GPS engine.
The RMS (root mean square) channels which will be logged are listed below.

RMS_HPOS ***RMS_VPOS*** ***RMS_HVEL*** ***RMS_VVEL***

T1 channel

Internal debug channel logged when IMU Filter is running.

12-2 - VB3i IMU Integration - Roof Mount

When using the IMU roof mount, the user has the option to translate the data from the roof to another point on the vehicle. By default, when the roof mount is enabled, a 1 m Z offset is added, translating the filtered speed down in to the vehicle, towards the centre of gravity.

If the Kalman Filter data is required relative to an alternate or more precise location on the vehicle, then measurements should be made from the centre of the IMU to the desired location. As the IMU is housed within the enclosure, precise measurements are not easy to make. So a Z measurement can be taken from the centre of the GPS antenna, provided 3 cm is subtracted from the physical measurement. Translation measurements need to be made in all 3 axis, X, Y and Z.

Required equipment

IMU04

VB3i (IMU04 ready)

IMU04

VBOX Tools or VBOX Setup

RLCAB119 VBOX – IMU connecting cable

RLCAB001 / RLCAB066-2 – VB3i PC connection cable

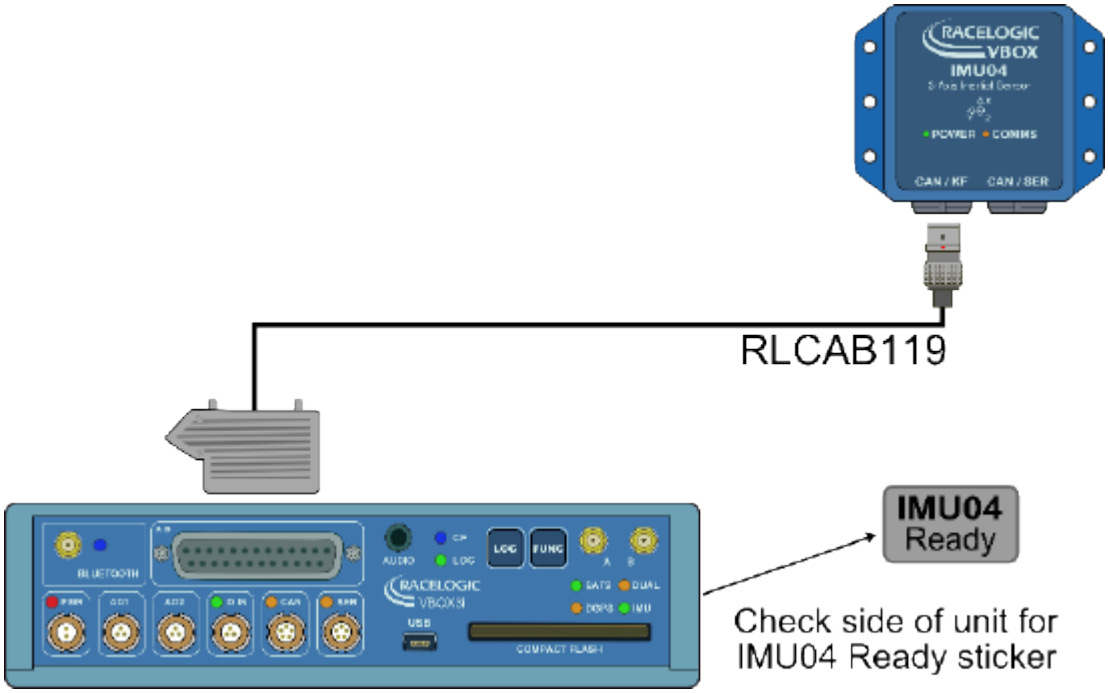
VBOX Manager (optional)

Setup

Hardware

Important note: IMU04 must be connected to VB3i before power is applied to ensure data is correctly synchronised.

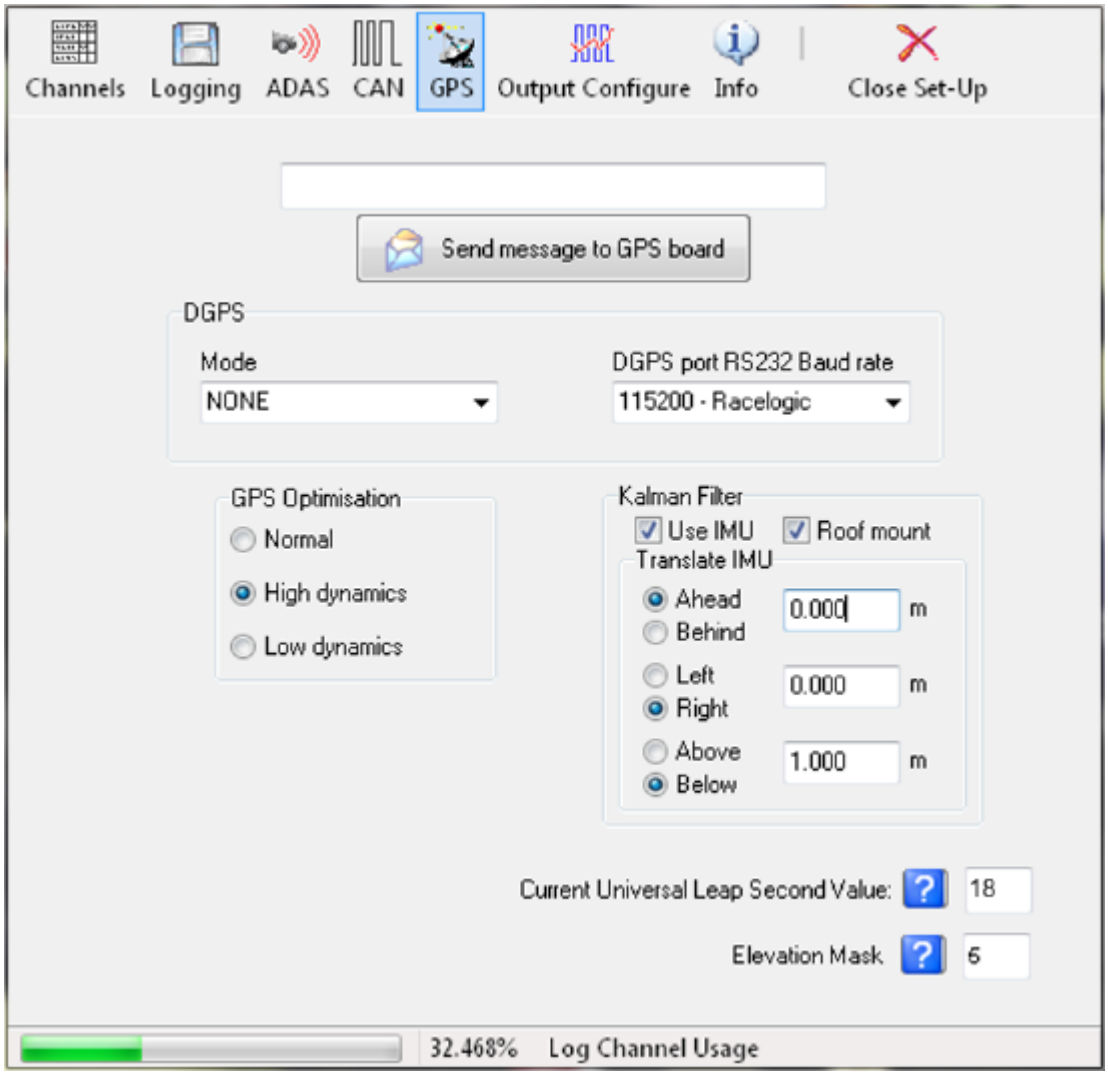
1. Fit the VBOX 3i into the test vehicle, and mount the IMU roof mount **on the vehicle roof.**
2. Connect antenna from IMU roof mount to the primary antenna of the VB3i (antenna A).
3. Connect RLCAB119 cable from left hand port on roof mount IMU (CAN/KF) to VBOX 3i V3-V5 25W D analogue input port.
4. Take data translation measurements in X, Y and Z axis from centre of IMU, if required. Default 1 m under IMU.
5. After IMU is connected, apply power to VBOX 3i.
6. Enable IMU integration using VBOX Manager, VBOX Tools - VBOX Setup or VBOX Setup.



VBOX 3i V3-V5 and IMU04

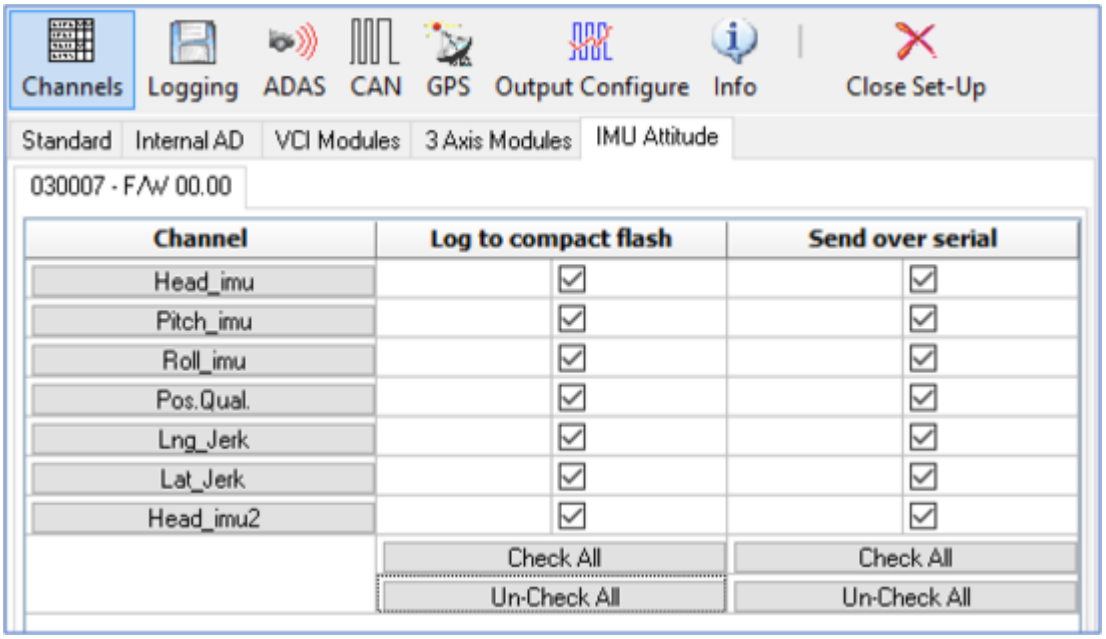
VBOX Tools

1. Ensure IMU04 is connected via RLCAB119, and the VBOX 3i is powered on.
2. Connect VBOX 3i to PC using RLCAB001 or RLCAB066-2 cable (RS232 or USB).
3. Open **VBOX Tools** and connect to VBOX 3i by selecting **COM Port** (**Options** from Toolbar).
4. Run **VBOX** Setup.
5. Ensure '**High Dynamics**' GPS Optimisation is selected, and log rate is set to 100 Hz (Logging tab).
6. Tick '**Use IMU**' box. Once VBOX Tools has completed the initial enabling, tick the '**Roof mount**' box.



7. Enter the [distances measured from IMU to required translation point.]
8. The **IMU Attitude** channels (**Head_imu**, **Pitch_imu, Roll_imu, Pos.Qual., Lng_Jerk, Lat_Jerk and Head_imu2**) will automatically be set to log. If IMU Attitude data is required to be displayed as a Live Serial **data**

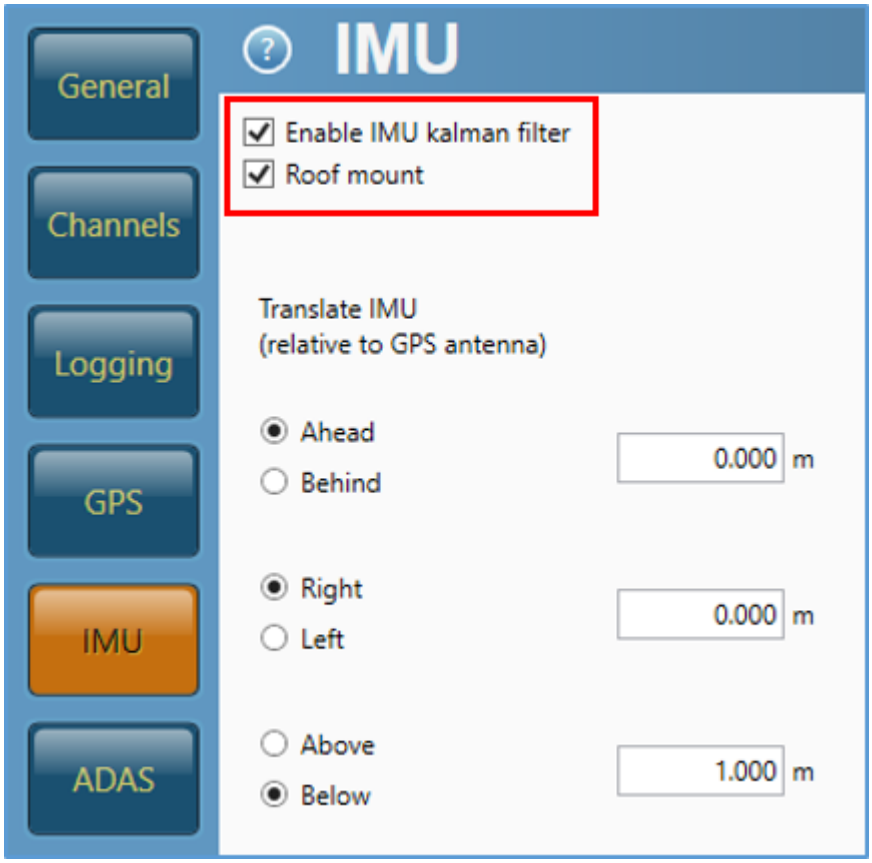
display then the user must tick the channels for **Send over serial**.



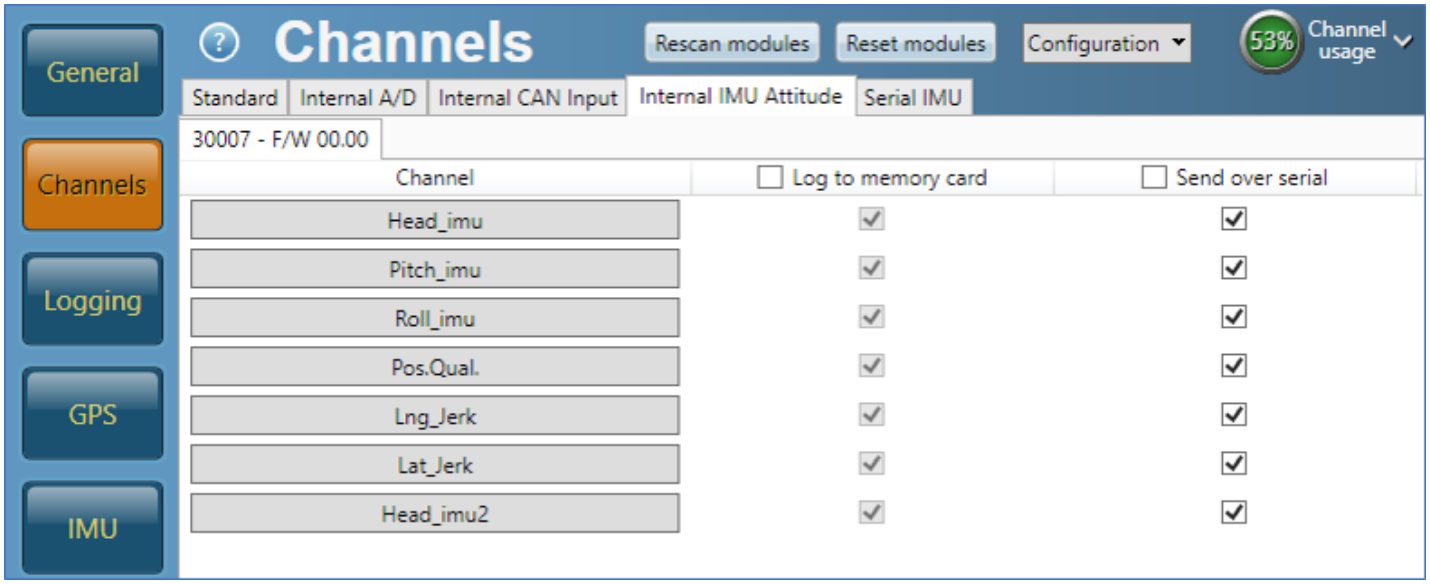
9. Perform **initialisation and full calibration** procedure before commencing testing.

VBOX Setup

1. Ensure IMU04 is connected via RLCAB119, and the VBOX 3i is powered on.
2. Connect VBOX 3i to PC using RLCAB001 or RLCAB066-2 cable (RS232 or USB).
3. Open **VBOX Setup** and connect to VBOX 3i by selecting **COM Port**.
4. Select the '**GPS**' menu and the '**Settings**' tab, ensure that '**GPS Optimisation**' is set to '**High dynamics**'.
5. Select the '**Logging**' menu and ensure that '**Log rate**' is set to '**100 Hz**'.
6. Select the '**IMU**' menu and tick '**Enable IMU kalman filter**'. Once VBOX Setup has completed the initial enabling, tick the '**Roof mount**' box.



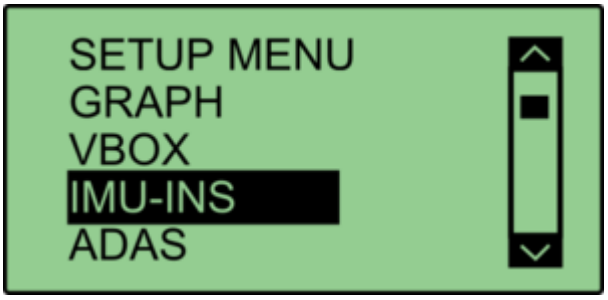
7. Enter the [distances measured from IMU to required translation point.]
8. The **Internal IMU Attitude** channels (**Head_imu**, **Pitch_imu, Roll_imu, Pos.Qual., Lng_Jerk, Lat_Jerk and Head_imu2**) will automatically be set to log. If IMU Attitude data is required to be displayed as a Live Serial **data display** then the user must tick the channels for '**Send over serial**'.

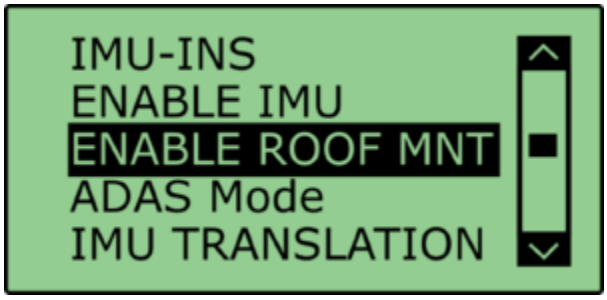


9. Select '**Write to unit**' to upload settings to VB3i.
10. Perform [initialisation and full calibration] procedure before commencing testing.

VBOX Manager

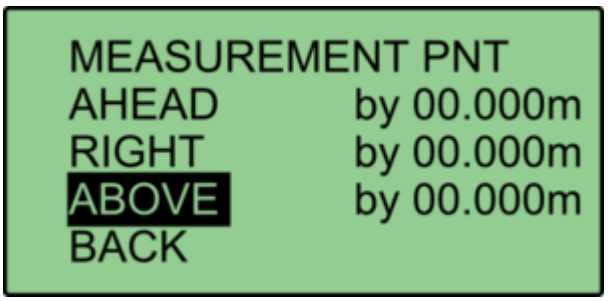
1. Ensure IMU04 is connected via RLCAB119, and the VBOX 3i is powered on.
2. Enter **SETUP**, select '**IMU-INS**' then click on '**ENABLE ROOF MNT**'.



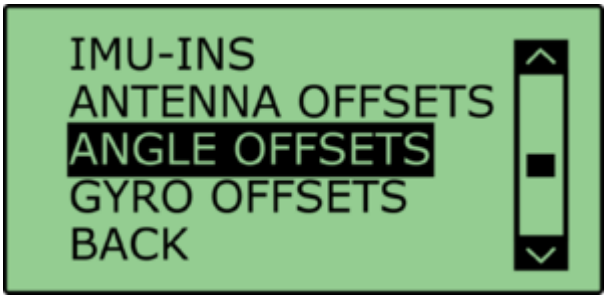


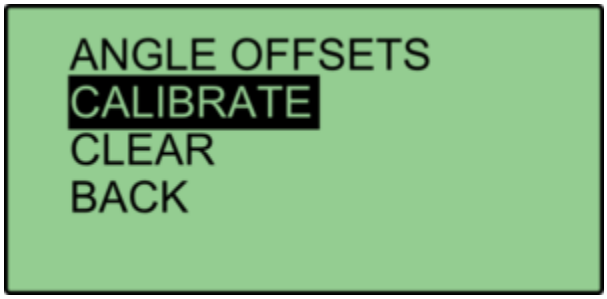
3. Once **OK** confirmation screen has cleared, **ENABLE IMU** and **ENABLE ROOF MNT** should be ticked.

4. Apply IMU TRANSLATION using [IMU to translation point measurement](#) distances.

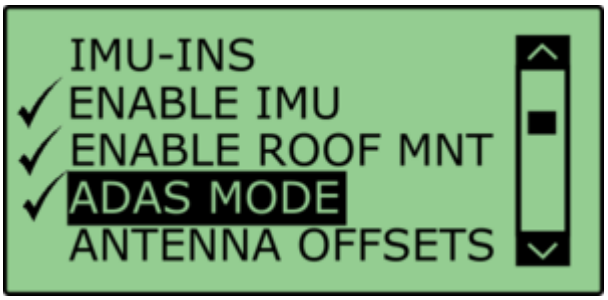


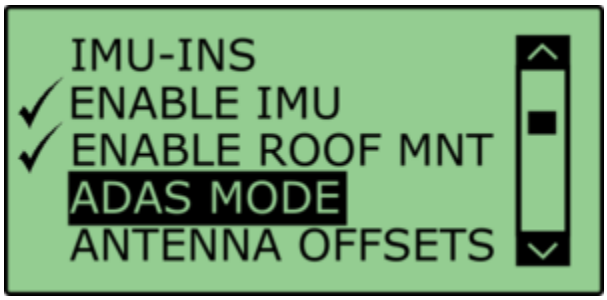
5. IMU Attitude and 3 Axis Modules channels will be automatically set to log. If IMU Attitude or 3 Axis data is required to be displayed as a Live Serial **data display** (with VBOX Tools) then the user must enter VBOX Setup and tick the channels for '**Send over serial**'.
6. Perform [initialisation and full calibration](#) procedure before commencing testing.
7. If the IMU is not mounted on a flat surface, perform **ANGLE OFFSETS** calibration. This will zero the **Pitch_imu** and **Roll_imu** channels. Calibration must be performed after the calibration has been completed, and the vehicle is static on a level surface.





8. If ADAS testing is being conducted, select '**ADAS Mode**' from the menu. This option changes the rate at which the kalman filter takes a GPS positional sample to improve the positional performance of the filter. Whilst this is beneficial to ADAS testing, it slightly decreases the accuracy of the filtered speed and therefore shouldn't be selected when undertaking speed based testing such as brake stops.





9. Once **OK** confirmation screen has cleared, **ADAS Mode** should be ticked.

Important notes

1. To use **IMU04** integration, a **VB3i-V3, V4 or V5** must be used. This is an IMU04 enabled VBOX 3i unit.
2. IMU04 cannot be used with IMU integration if it is connected to a VBOX via CAN (RLCAB120 / RLCAB005-CS). This method of connection will only allow standard IMU channels to be logged. See **using IMU as CAN module** section for details.
3. The IMU04 standard channels can also be logged when the IMU04 is connected via KF port with cable RLCAB119, without enabling IMU integration
4. The IMU04 must be in a Racelogic CAN mode to be used for IMU Kalman Filter.
5. **NB ADAS -** If using IMU filter with ADAS mode, the GPS antenna and IMU must be co-located (roof mount) or positioned so there is no relative X or Y offset between them. If there is a difference, manual contact points should reference the IMU location, rather than the GPS antenna.
6. **NB ADAS -** When using IMU Filter the user cannot use SET POINTS functionality to define contact points in single or multi target ADAS modes

Initialisation

When using IMU integration, an **initialisation phase is required** when the IMU is first connected to the VBOX after being set up. This will be run through automatically after the VBOX has successfully gained satellite lock. When the IMU LED on VB3i front panel has turned a flashing green, the initialisation is complete.

Note: If you are using a VB3i-V1, which has no IMU LED, read the LED indicators section below for LED behaviour.

LED Indicators VBOX 3i (V2/V3/V4) and IMU04

VBOX 3i LED Colour	Description
Solid Orange	IMU enabled, no IMU connected.
Flashing Orange	SAT lock OK. 30 second stationary initialisation in progress. If vehicle moves, LED will continue to flash until 30 seconds stationary completed.
Flashing Green	Initialisation complete – movement not yet detected.
Solid Green	Movement detected – IMU integration working OK.

IMU04 LED Colour	Power	Coms
Red	IInitial boot up phase	No coms
Orange	Temperature checks. If temperature outside optimum operation range, LED will remain orange.	Using IMU integration, inertial data being sent to host VBOX via RS232.
Green	Fully operational.	Inertial data being sent to host system via CAN.

13 - VB3i Bluetooth Pairing

The VBOX 3i comes equipped with a Bluetooth radio allowing configuration of the VBOX remotely along with remote output of real-time VBOX 3i serial data, at the full 100 Hz data rate, to any Bluetooth capable PC or Data logger.

The VBOX 3i will need the Bluetooth antenna connected and the computer will require a Bluetooth module or dongle to establish a virtual connection.

VBOX 3i will connect to the computer via SPP (serial port profile) this can be done as a secure or unsecure connection.

Note: Pairing code for secure connection is 1234.

Notes on connecting to a Windows 8 PC can be found here.

14 - VB3i Voice Tagging

The VBOX 3i has the ability to record audio tags synched with a set GPS timestamp, with an accuracy of 0.5 seconds along with the .vbo data file. Voice notes regarding test conditions or erroneous runs can be recorded, which can be replayed instantly when viewing logged files in the graph facility of the VBOX Tools software.

A .wav file will be recorded onto the CF card along with the normal VBOX data file.

The supplied headset/ microphone includes a switch, which is used to start and stop the recording of an audio tag.

Recording a Sound WAV

Pressing the headset switch once will sound an audible beep, through the headset, to confirm that recording of the .wav file has begun.

Pressing the switch for a second time will then stop recording, this will be confirmed by a second beep through the headset.

If the switch has only been pressed once the VBOX 3i will record for 30 seconds then automatically stop recording.

Replaying Voice Tags in VBOX Tools

When a logged VBOX data file .vbo is loaded into VBOX Tools and displayed in the Graph screen, any associated .wav files will appear in the speed data trace as green circles provided that the logged file is in the same folder as the loaded VBOX data file.

Play the associated .wav file by clicking the Green circle.

Note: If a Red circle is seen on the graph screen in VBOX Tools then the associated WAV file is not present in the same folder as the loaded VBOX data file.

15 - VB3i Technical Properties

VB3i Firmware Upgrade

VB3i CAN Output

VB3i EC Declaration of Conformity

VB3i PIN OUTS

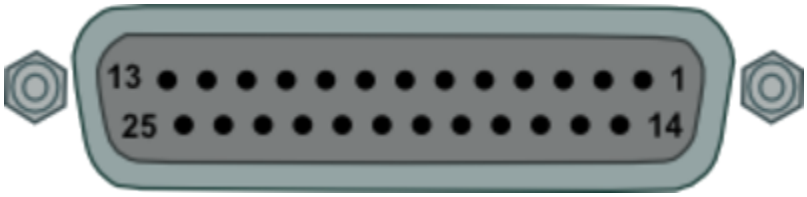
VB3i Analogue Input PIN OUTS

VB3i Technical Specification

VB3i Analogue Input PIN OUTS

For PIN out information on other VB3i ports, **click here.**

V1



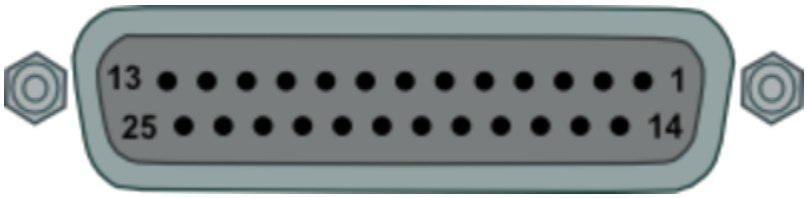
View of Sub-D 25-way socket

Note: A screw terminal connector block is available to purchase on request from your VBOX supplier.

PIN	In / Out	Description	Range
1	I	Channel 1 +	
2	I	Channel 1 -	
3	I	Channel 2 +	
4	I	Channel 2 -	
5	I	Channel 3 +	
6	I	Channel 3 -	
7	I	Channel 4 +	
8	I	Channel 4 -	
9 - 13	**N/C**		

PIN	In / Out	Description	Range
14	O	Vbatt	Equal to Input Voltage. 100 mA
15	O	GND	Ground
16	O	5 V Out	5 V ±2 %. 350 mA
17	O	GND	Ground
18-25	**N/C**		

V2

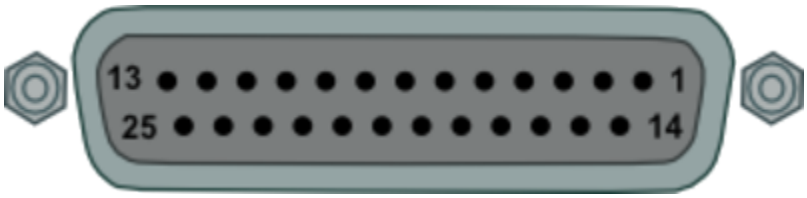


View of Sub-D 25-way socket

Note: A screw terminal connector block is available to purchase on request from your VBOX supplier.

PIN	In / Out	Description	Range
1	I	Channel 1 +	
2	I	Channel 1 -	
3	I	Channel 2 +	
4	I	Channel 2 -	
5	I	Channel 3 +	
6	I	Channel 3 -	
7	I	Channel 4 +	
8	I	Channel 4 -	
9 - 13	**N/C**		
14	O	Vbatt	Equal to Input Voltage. 200 mA
15	O	GND	Ground
16	O	5 V Out	5 V ±2 %. 350 mA
17	O	GND	Ground
18-25	**N/C**		

V3



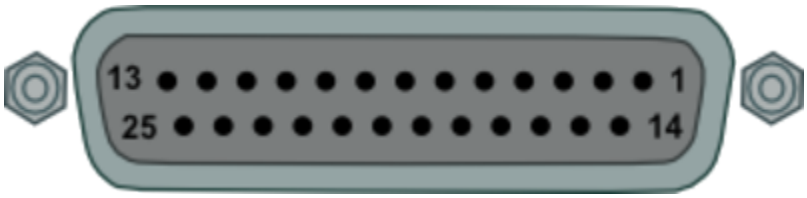
View of Sub-D 25-way socket

Note: A screw terminal connector block is available to purchase on request from your VBOX supplier.

PIN	In / Out	Description	Range
1	I	Channel 1 +	
2	I	Channel 1 -	
3	I	Channel 2 +	
4	I	Channel 2 -	
5	I	Channel 3 +	
6	I	Channel 3 -	
7	I	Channel 4 +	
8	I	Channel 4 -	
9 - 10	**N/C**		
11	O	1PPS Output	-IMU04
12	O	RS232 TxD	-IMU04
13	I	RS232 RxD	-IMU04
14	O	Vbatt	Equal to Input Voltage. 300 mA
15	O	GND	Ground
16	O	5 V Out	5 V ±2 %. 350 mA

PIN	In / Out	Description	Range
17	O	GND	Ground
18-25	**N/C**		

V4/V5



View of Sub-D 25-way socket

Note: A screw terminal connector block is available to purchase on request from your VBOX supplier.

PIN	In / Out	Description	Range
1	I	Isolated Channel 1 +	1.8 M Ohms input impedance
2	I	Isolated Channel 1 -	1.8 M Ohms input impedance
3	I	Isolated Channel 2 +	1.8 M Ohms input impedance
4	I	Isolated Channel 2 -	1.8 M Ohms input impedance
5	I	Isolated Channel 3 +	1.8 M Ohms input impedance
6	I	Isolated Channel 3 -	1.8 M Ohms input impedance
7	I	Isolated Channel 4 +	1.8 M Ohms input impedance
8	I	Isolated Channel 4 -	1.8 M Ohms input impedance
9 - 10	**N/C**		
11	O	1PPS Output	-IMU04
12	O	RS232 TxD	-IMU04
13	I	RS232 RxD	-IMU04

PIN	In / Out	Description	Range
14	O	Vbatt	Equal to Input Voltage. 300 mA
15	O	GND	Ground
16	O	5 V Out	Isolated 5 V ±2%. 120 mA
17	O	GND	Ground
18	O	ISO-GND	Isolated Ground
19-25	**N/C**		

VB3i CAN Output

The VBOX 3i has a CAN output which is present on the 5-way connector output.

Note: Channels highlighted in BLUE are present on Dual Antenna systems only.

Data format: Motorola
Baud rate: 500 kbit/s

Channel definitions are available **here**.

ID**	Data Bytes							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
0x301	(1) Satellites	(2) Time_Since_Midnight _UTC			(3) Position_Latitude			
0x302	(4) Position_Longitude				(5) Speed_Knots		(6) Heading	
0x303	(7) Altitude			(8) Vertical_Velocity_ms		Unused	(9) Status_1	(10) Status_2
0x304	(11) Trigger_Distance				(12) Longitudinal_Acceleration_g		(13) Lateral_Acceleration_g	
0x305	(14) Distance				(15) Trigger_Time		(16) Trigger_Speed_Knots	
0x306	(17) Speed_Quality_kmh		(18) True_Heading		(19) Slip_Angle		(20) Pitch_Angle	
0x307	(21) Lateral_Velocity_kmh		(22) Yaw_Rate		(23) Roll_Angle		(24) Longitudinal_Velocity (km/h)	

<table>
<tr><th rowspan="2">ID**</th><th colspan="8">Data Bytes</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th></tr>
<tr><td>0x308</td><td colspan="6" rowspan="2">(25) Position_Latitude_48bit</td><td colspan="2">Pre FW 2.5.0: (26) Kalman_Filter_Status</td></tr>
<tr><td>Post FW 2.5.0: (26) Position_Quality</td><td>Post FW 2.5.0: (27) Solution_Type</td></tr>
<tr><td>0x309</td><td colspan="6">(28) Position_Longitude_48bit</td><td colspan="2">(29) Speed_Knots_Robot_Nav</td></tr>
<tr><td>0x313</td><td colspan="2">(30) Slip_Angle_Front_Left</td><td colspan="2">(31) Slip_Angle_Front_Right</td><td colspan="2">(32) Slip_Angle_Rear_Left</td><td colspan="2">(33) Slip_Angle_Rear_Right</td></tr>
<tr><td>0x314</td><td colspan="2">(34) Slip_Angle_COG</td><td>(35) Robot_Nav_Satellites</td><td colspan="3">(36) Robot_Nav_Time_Since_Midnight</td><td colspan="2">(37) Robot_Nav_Heading</td></tr>
<tr><td>0x322</td><td colspan="3">(38) Trigger_Event_UTC_Part_1</td><td colspan="5">(39) Trigger_Event_UTC_Part_2</td></tr>
<tr><td>0x323</td><td colspan="2">(40) Heading_IMU</td><td colspan="2">(41) Roll_Ang_IMU</td><td colspan="2">(42) Pitch_Ang_IMU</td><td colspan="2">Pre FW 2.5.0: Unused
Post FW 2.5.0: (43) Status_KF</td></tr>
<tr><td>0x324</td><td colspan="4">Unused</td><td colspan="4">(44) FW Version</td></tr>
</table>

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

**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 10 ms intervals since midnight UTC. (5383690 = 53836.90 seconds since midnight or 14 hours, 57 minutes and 16.90 seconds).
3. Position, Latitude in minutes * 100,000 (311924579 = 51 Degrees, 59.24579 Minutes North). This is a true 32 bit signed integer, North being positive.
4. Position, Longitude in minutes * 100,000 (11882246 = 1 Degrees, 58.82246 Minutes West). This is a true 32 bit signed integer, West being positive.
5. Velocity, 0.01 kts per bit.
6. Heading, 0.01° per bit.
7. Altitude above the WGS 84 ellipsoid, 0.01 m 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, Bit 3 = Logging Status.
10. Status is an 8 bit unsigned char. Bit 0 = Always set, Bit 2 = Brake test started, Bit 3 = Brake trigger active, Bit 4 = DGPS active, Bit 5 = Dual Lock.
11. Distance, 0.000078125 m per bit, unsigned. Corrected to trigger point.
12. Longitudinal Acceleration, 0.01 g per bit, signed.
13. Lateral Acceleration, 0.01 g per bit, signed.
14. Distance traveled since VBOX reset, 0.000078125 m per bit, unsigned.
15. Time from last brake trigger event. 0.01 seconds per bit.
16. Velocity at brake trigger point 0.01 kts per bit.
17. Velocity Quality, 0.01 km/h per bit.
18. True Heading of vehicle, 16 bit signed integer, 0.01° per bit.
19. Slip Angle, 16 bit signed integer 0.01° per bit.
20. Pitch Angle, 16 bit signed integer 0.01° per bit.
21. Lateral Velocity, 16 bit signed integer 0.01 kts per bit.
22. Yaw Rate, 16 bit signed integer 0.01°/s per bit.
23. Roll Angle, 16 bit signed integer 0.01° per bit.
24. Longitudinal Velocity, 16 bit signed integer 0.01 kts per bit.
25. Position, Latitude 48 bit signed integer, Latitude * 10,000,000 (minutes). North being positive.
26. **Pre FW 2.5.0:** Kalman filter status, 12 bit unsigned integer. See **VBOX 3i Kalman Filter Status** for details.
    Post FW 2.5.0: Position Quality, 8 bit unsigned integer.
27. **Post FW 2.5.0:** Solution Type, 8 bit unsigned integer, 0 = None, 1 = GNSS only, 2 = GNSS DGPS, 3 = RTK Float, 4 = RTK Fixed, 5 = Fixed position, 6 = IMU Coast.
28. Position, Longitude 48 bit signed integer, Longitude *10,000,000 (minutes). East being positive.
29. Velocity, 16 bit signed integer 0.01 kts per bit (not delayed when ADAS enabled).
30. Slip Angle Front Left, 16 bit signed integer 0.01° per bit.
31. Slip Angle Front Right, 16 bit signed integer 0.01° per bit.
32. Slip Angle Rear Left, 16 bit signed integer 0.01° per bit.
33. Slip Angle Rear Right, 16 bit signed integer 0.01° per bit.
34. Slip Angle C of G, 16 bit signed integer 0.01° per bit.
35. Robot Navigation Satellites.
36. Time since midnight. This is a count of 10 ms intervals since midnight UTC. (5383690 = 53836.90 seconds since midnight or 14 hours, 57 minutes and 16.90 seconds) (not delayed when ADAS enabled).
37. True Heading2 16 bit unsigned integer 0.01° per bit (not delayed when ADAS enabled).
38. Trigger event UTC time - milliseconds since midnight UTC (part 1 of 2 part message).
39. Trigger event UTC time - nanoseconds since midnight UTC (part 2 of 2 part message).
40. Heading derived from the Kalman Filter.
41. Roll Angle derived from Kalman Filter.

42. Pitch Angle derived from Kalman Filter.
43. **Post FW 2.5.0:** Kalman filter status, 12 bit unsigned integer. See **VBOX 3i Kalman Filter Status** for details.
44. VBOX FW version, 32 bit unsigned.
    *can be split into Major (8 bit), Minor (8 bit) and build number (16 bit).

VB3i EC Declaration of Conformity

We declare that this product has been tested to and meet the requirements of:

EC directive 2004/104/EC

“Adapting to technical progress council directive 72/245/EEC relating to the radio interference (electromagnetic compatibility) of vehicles and amending directive 70/156/EEC on the approximation of the laws of the member states relating to the type-approval of motor vehicles and their trailers.”

And has also been assessed, via technical construction File, by an independent DTI competent body and found to be in conformance with the essential requirements of:

EC directive 89/336/EEC (and amending directives)

“Council directive of 03 May 1989 on the approximation of the laws of the member states relating to electromagnetic compatibility.”

DTI competent body responsible for issuing certificate of compliance:

3C Test Ltd,

Silverstone Technology Park,

Silverstone,

Northants

NN12 8GX

VB3i Firmware Upgrade

Occasionally Racelogic releases new versions of firmware (internal code) for VBOX 3i products, often to introduce new features. New firmware is loaded into the VBOX 3i using a computer and a CF card.

The latest firmware upgrade file for the VBOX 3i is available from the **VBOX Automotive website**.

If you need the latest update file, download it from the website and copy it to your CF card.

VBOX 3i V5 Units

IMPORTANT

VBOX 3i V5 units have a newer internal GPS engine. The firmware download listed on the website is for V1 – 4 only, do NOT install this firmware on a V5 unit. If you would like new firmware for a V5 unit, please Contact Support. You can find out which VBOX 3i variant you are using by looking at the silver product sticker.

How to upgrade the firmware

1. To upgrade the firmware power the VBOX 3i and wait until the box has fully booted (GREEN PWR LED).
2. Insert the CF card containing the upgrade file.
3. Once the upgrade is complete the VBOX 3i will beep twice and resume normal operation.
4. Once the upgrade is complete the upgrade file will be erased.
5. If the upgrade fails for any reason the upgrade file remains on the card and the VBOX 3i retains the previous version of firmware.

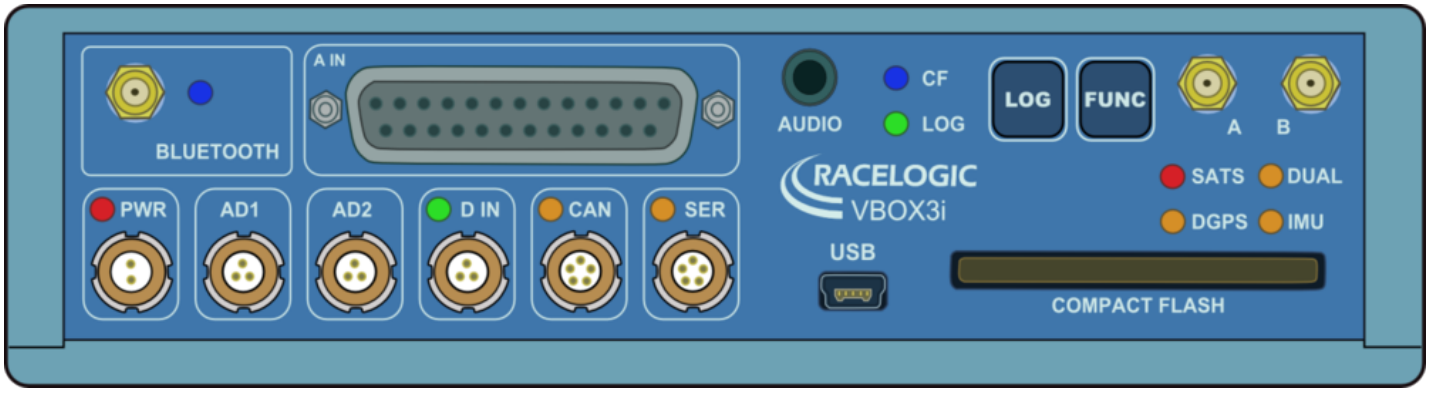
Once the firmware upgrade has completed successfully, the VBOX 3i should be power-cycled before use.

Media, iframe, embed and object tags are not supported inside of a PDF.

VB3i PIN OUTS

Please note that there are differences between VBOX3i V1/V2/V3/V4 and V5 versions relating to connectors 2 & 3. Details below.

For PIN information on the analogue input connector, **click here.**



Front View of VB3iSL (V2 / V3)

Connector 1 - POWER (Lemo 2 PIN)

PIN	I/O	Function	Range
1	I	Power+	7 – 30 V
2	I	Ground	0 V

Connector 2 / 3 - AD 1 / AD 2 (Lemo 3 PIN)

One Analogue and One Digital Output Each

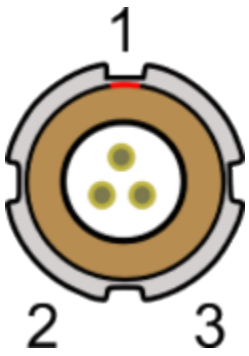
V1/V2/V3

PIN	I/O	Function	Range
1	O	Analogue Out 1 / 2	0 – 5 V
2	O	Digital Out 1 / 2	0 – 5 V
3	O	Analogue Ground	
Shell	O	Digital Ground	

V4/V5

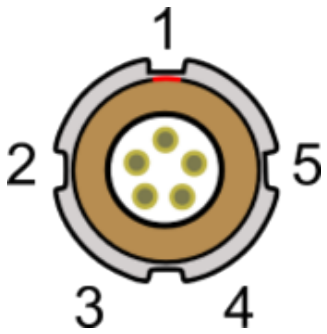
PIN	I/O	Function	Range
1	O	Isolated Analogue Out 1 / 2	0 – 5 V
2	O	Digital Out 1 / 2	0 – 5 V
3	O	Isolated Analogue Ground	
Shell	O	Digital Ground	

Connector 4 - D IN (Lemo 3 PIN)



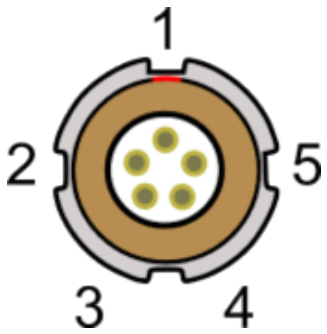
PIN	I/O	Function	Range
1	I	Ground	
2	I	Digital Input 2. Logging on/off	0 – 5 V (14 V tolerant)
3	I	Digital Input 1. Brake Trigger	0 – 5 V (14 V tolerant)

Connector 5 - CAN (Lemo 5 PIN)



PIN	I/O	Function	Range
1	O	RS232 Tx (PORT B)	+/- 12 V
2	I	RS232 Rx (PORT B)	+/- 12 V
3	I/O	CAN High (PORT A)	
4	I/O	CAN Low (PORT A)	
5	O	+V Power	Same as Power +

Connector 6 - SERIAL (Lemo 5 PIN)



PIN	I/O	Function	Range
1	O	RS232 Tx PORT A)	+/- 12 V
2	I	RS232 Rx (PORT A)	+/- 12 V
3	I/O	CAN High (PORT B)	
4	I/O	CAN Low (PORT B)	
5	O	+V Power	Same as Power +

Connector 7 / 8 - Antenna A / B

PIN	I/O	Function
Center	-	RF Signal / Power for active antenna
Chassis	-	Ground

VB3i Technical Specification

GPS Specifications

Velocity	
Accuracy	0.1 km/h (averaged over 4 samples)
Units	km/h or mph
Update Rate	100 Hz
Maximum Velocity	1000 mph
Minimum Velocity	0.1 km/h
Resolution	0.01 km/h
Latency (more information available here)	• Fixed: 20 ms/ 24 ms • Minimum: 4 ms/ 8.5 ms (±1.5 ms)

Distance	
Accuracy	0.05 % (>50 cm per km)
Units	m / ft
Update rate	100 Hz
Resolution	1 cm

Absolute Positioning - VB3i-V4G Single Antenna	
Accuracy	3 m (95 % CEP*)
Accuracy (SBAS DGPS)	<1 m (95 % CEP*)
Accuracy (RTCM DGPS)	80 cm (95 % CEP*)
Update rate	100 Hz
Resolution	1.8 mm
Height accuracy	6 m (95 % CEP*)
Height accuracy with DGPS	2 m (95 % CEP*)

Absolute Positioning - VB3iSL Dual Antenna	
Accuracy	2 m (95 % CEP*)
Accuracy (SBAS DGPS)	<1 m[1] (95 % CEP*)
Accuracy (RTCM DGPS)	80 cm[1] (95 % CEP*)
Update rate	100 Hz
Resolution	1.8 mm
Height accuracy	6 m (95 % CEP*)
Height accuracy with DGPS	2 m (95 % CEP*)

Absolute Positioning - VB3iSLR Dual Antenna with RTK	
Accuracy	2 m (95 % CEP*)
Accuracy (SBAS DGPS)	<1 m (95 % CEP*)
Accuracy (EGNOS DGPS)	70 cm (95 % CEP*)
Accuracy (WAAS DGPS)	1.5 m[1] (95 % CEP*)
Accuracy (RTCM DGPS)	40 cm[1] (95 % CEP*)
Accuracy (RTK DGPS)	2 cm (95 % CEP*)
Update rate	100 Hz
Resolution	1.8 mm
Height accuracy	6 m (95 % CEP*)
Height accuracy with DGPS	2 m (95 % CEP*)
Height accuracy with RTK DGPS	2 cm (95 % CEP*)

[1] To be confirmed

Time			
Accel/Brake Test (MFD/VBOX Tools)		**Lap Timing (OLED/VBOX Tools)**	
Resolution	0.01 s	**Resolution**	0.01 s
Accuracy	0.01 s	**Accuracy**	0.01 s**

Acceleration	
Accuracy	0.50 %
Maximum	20 g
Resolution	0.01 g
Update rate	100 Hz

Heading	
Resolution	0.01°
Accuracy	0.1°

Memory	
Compact Flash	Type I
Recording Time	Dependent on flash card capacity****

Brake stop accuracy	
Accuracy	±1.8 cm

Definitions

* Circle of Error Probable (CEP): 95 % of the time the position readings will fall within a circle of the stated diameter

** Not using DGPS and crossing the start/finish line at 100 km/h

*** With fixed CAN latency

**** Approximately 29 MB per hour used when logging GPS data at 100 Hz; Approx. 182 MB per hour total logging capacity

Slip, Pitch, Roll Angle Accuracies

Antenna Separation	Slip Angle (RMS)	Pitch / Roll Angle (RMS)
0.5 m	<0.2°	<0.14°
1.0 m	<0.1°	<0.07°
1.5 m	<0.067°	<0.047°
2.0 m	<0.05°	<0.035°
2.5 m	<0.04°	<0.028°

Outputs

CAN Bus	
Bit rate	125 kbit/s, 250 kbit/s, 500 kbit/s and 1 Mbit/s selectable baud rate
Identifier type	Standard 11 bit 2.0 A
Data available	Satellites in View, Latitude, Longitude, Velocity, Heading, Altitude, Vertical Velocity, Distance, Longitudinal Acceleration & Lateral Acceleration, Distance from Trigger, Trigger Time, Trigger Velocity

Analogue	
Voltage range	0 – 5 V DC
Default setting (The range settings can be adjusted by the user in VBOX Tools Software)	Velocity 0.0125 Volts per km/h (0 – 400 km/h)
Accuracy	0.1 km/h
Update rate	100 Hz

Digital	
Frequency range	DC to 44.4 kHz
Default setting (The range settings can be adjusted by the user in VBOX Tools Software)	Velocity 25 Hz per km/h (0 – 400 km/h) 90 pulses per metre
Accuracy	0.1 km/h
Update rate	100 Hz

Inputs

CAN Bus	
RACELOGIC modules	Up to 32 channels from any combination of ADC02, ADC03, FIM02, TC8, YAW03 or CAN01
External CAN Bus	16 Channels of user definable CAN signal from external bus, e.g. Vehicle CAN bus Can load signal data from industry standard DBC database file

Analogue	
Number of channels	4
Input range	±50 V
Input voltage	0 – 5 V
Channel sample order	Synchronous
Resolution	24 bit
DC accuracy	±2 mV (calibrated at 23°C)

Digital	
Brake event trigger	DC to 44.4 kHz
On/Off logging control	Remote log control from hand-held switch

Environmental and Physical

Input Voltage	7 – 30 V DC
Power	5.5 W (maximum)
Operating Temperature	-20°C to +60°C
Size	170 mm x 121 mm x 41 mm
Operating Temperature	-20°C to +60°C
Weight	900 g (approximate)
Storage Temperature	-30 to +80°C