

Complete Automotive Testing System - CATS-INS

Performance Testing Guide

Installing the system in the vehicle

Important: It's essential that the roof mounted sensor and antenna assembly is installed correctly in accordance with these guidelines, failure to do so can dramatically increase error. Further, note that the roof assembly includes a very high precision sensor array that is shock sensitive – please take care not to drop!

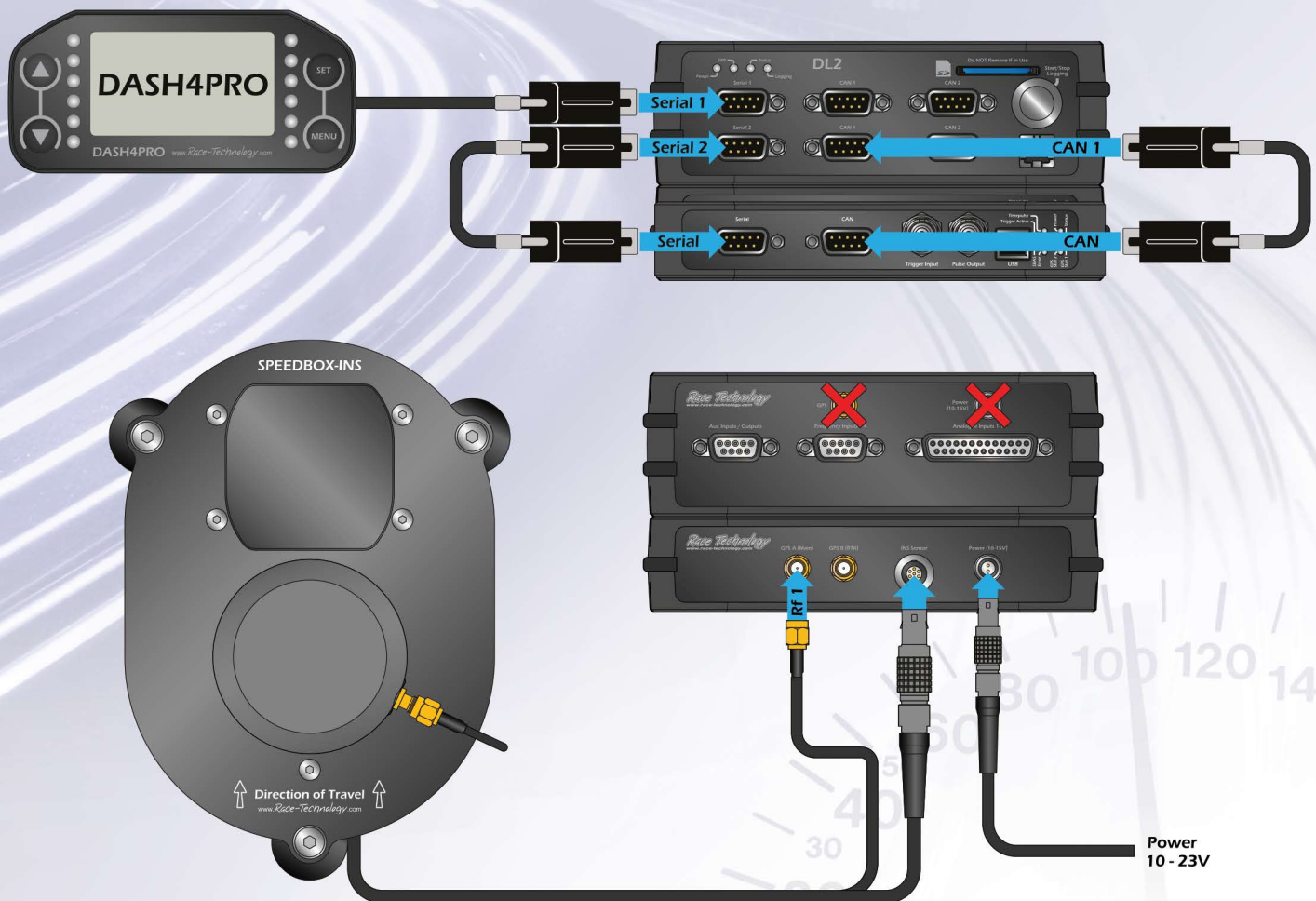
The roof mounted sensor assembly should be mounted to meet the following criteria:

- It must be mounted on an area of the roof with high stiffness, this is typically on the leading or trailing edge of the roof.
Do not mount in the centre of the roof.
- The cable should exit from the roof assembly towards the rear of the car
- Typically the unit should be on the centre line of the car
- The unit should be within 10 degrees of level in the pitch direction
- The unit should be as level as possible with regards the roll direction

The main electronics unit can be mounted almost anywhere in the vehicle, subject to keeping it away from sources of high radio interference, high vibration, and high temperature. It doesn't need to be mounted in any particular orientation.

The DASH4PRO is typically mounted on the windscreen.

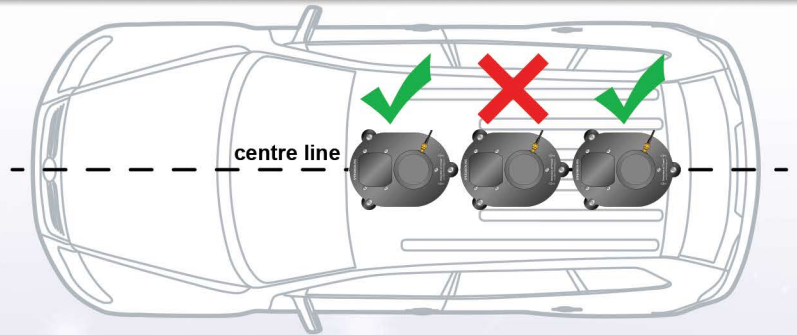
Connections:



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Roof mounting position diagram:



Installation checklist:

- The system requires a nominally 12v power supply from the vehicle at about 500mA, a fuse rating of around 2A is recommended. If this power is lost, even briefly then the system will have to be re-initialised so a reliable connection is essential.
- Make sure that the antenna connection to the SPEEDBOX (with the gold SMA connector) is "finger tight", or about 0.5Nm. If this connection becomes loose then the quality of the GPS data is severely affected. If it is over tightened then the connector may be damaged.
- Please use the screws to secure all D type connectors to the SPEEDBOX and DL2 data logger.
- Take care not to pinch/damage the cables that go from the roof INS assembly to the main SPEEDBOX unit
- Use the supplied SD card, formatted as FAT32. Whilst the DL2 is compatible with nearly all SD cards, the cards we supply are pre-tested for speed, compatibility and errors.
- Keep the GPS antenna and all system cables away from any sources of radio interference. Sources of high radio interference include, but are not limited to, video cameras, radio telemetry equipment and mobile phones.
- Make sure that all equipment is securely fixed down in the car prior to use, in particular check that the main unit is held down in the vehicle, and the DASH4PRO's windscreen suction mount is securely mounted.
- Before using the SPEEDBOX it is good practice to check the "error" light. If this is flashing then count the flashes and check what the error code means.
- Make all connections (including roof sensor, radio connections, all d-types) before powering the system.
- Whilst there are no particular mounting requirements for the in car electronics, they should be mounted in a way to avoid excessive vibration, and when possible not in direct sunlight. If the vehicle is parked with strong sunlight directly onto the windscreen, it is good practice to remove the DASH4PRO. Strong sunlight can cause the vacuum mount to release, and the DASH4PRO unit itself to get very hot.
- Finally note that whilst the roof assembly and the DASH4PRO are water resistant, the main electronics unit is not and needs to be protected for rain or spray.
- The CAN data is taken from CAN port 1 on the DL2. The default configuration is for a latency of 150ms and 1Mbit. The .dbc file for this can be found as part of the standard installation:
C:\Program Files (x86)\RaceTechnologyV8.5\Otherfiles\DBC Files.
- There is one termination resistor at the SPEEDBOX, so a 120 ohm termination resistor will be required at the data logger. Standard pinout for the d-type, CAN L on pin 2, CAN H on pin 7.

Output offset

Once the system is installed on the vehicle the output offset from the antenna on the roof to the point of interest must be set. The reference point can be to the centre of gravity or to match another sensor.

1. Start up the SPEEDBOX configuration software, connect to the USB port on the DL2. Wait for Windows to install the USB driver.
2. Select the serial port from the drop down list in the **Communications**, most likely USB Port xx, where xx is a number from 1 to 99.
3. Click **Read Configuration** and the configuration will be read back from the SPEEDBOX.
4. Click on the **Vehicle Installation** box, make sure that **Measurement output offset** is enabled and fill in the measurements. These are the measurements from the roof unit to the point of interest. There are various pictures available from a drop down menu to help.
5. Click OK to store these and then **Send Configuration** to store this on the SPEEDBOX, a bar will show progress during the configuration process.

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System initialisation

Once the CATS-INS system is installed in the vehicle the system needs to be initialised before you can start any brake testing. The procedure is very simple and typically takes a few minutes. If power is lost from the system then the procedure needs to be repeated:

- Power up the system. At this stage the DASH4PRO will report the firmware versions, and report any system errors.
- Allow the system to get a GPS fix, with a clear view of the sky this takes about 30 seconds to 1 minute. The number of satellites are displayed on the DASH4PRO.
- The vehicle now needs to be driven to allow the INS system to “converge”. For initial INS convergence no particular driving manoeuvres are needed, and typically 2 minutes of normal driving is sufficient. Whilst at this stage the INS system is useable, it hasn't achieved full accuracy. To achieve full accuracy, the INS needs to see a wider range of dynamics. The quickest way to achieve this is to drive in a figure of 8 to achieve significant lateral forces in both directions, followed by some accelerations and braking manoeuvres. There is no need for very high accelerations, 0.5g is certainly sufficient, although in practice the higher the dynamics the INS sees, the quicker the INS will achieve full accuracy.

DASH4PRO screen



The DASH4PRO screen is highly configurable, it's possible to display any parameter anywhere on the screen in a range of font sizes. Further, it's also possible to add on almost any text messages, bar charts, alarms, user defined equations and functions for the LEDs. The display is supplied with a default configuration that has been developed in conjunction with existing users which suits many brake test application requirements. If you want to change any aspect of the DASH4PRO behaviour, then please refer to the DASH4PRO configuration software.

- ① The “LOG” text is displayed when the DL2 is currently logging
- ② Number of satellites; note that this only counts the number of satellites that have a high enough quality to be fully used in the solution. Satellites that are very low in the sky, WAAS satellites, or satellites with a poor signal to noise ratio are not counted.
- ③ Convergence, this goes from 0 to 100%, 0% means the INS system has not started to converge, 100% means the system is fully converged and all data is available, although not necessary at full accuracy.
- ④ System accuracy, this goes from 0% to 100%. 0% means minimum accuracy, or not converged. 100% means the system has recently seen some high dynamics and the GPS system has a good view of the sky and as such the system is operating near its maximum accuracy. In practice, for a very typical 100kph brake test error will be in the range of 10cm for a reported accuracy of 50%, down to a few cm at a reported accuracy of 100%.
- ⑤ Speed, this is the current measured speed, note that this will display “0.0” until the INS system is converged.
- ⑥ Screen number.
- ⑦ T is displayed when the trigger input is active, this is used for testing the input is connected properly.
- ⑧ Test status, this is either:
 - Prepare to test**, this means that the initial test conditions have not been met, for example the vehicle is not going quickly enough to start the brake test.
 - Test armed**, this means that the initial test conditions are met and the test can be started.
 - Test in progress**, this means that a test is underway.
- ⑨ This is the path distance of the last test completed.
- ⑩ This is the estimated accuracy of the last test completed.
- ⑪ These LEDs indicate the system accuracy, with all LEDs illuminated the system is at full accuracy.
- ⑫ These LEDs indicate the test status. All red LEDs means the system is ready and the brake test can start, all green LEDs means that the braking test is currently in progress.

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General system operation

The CATS-INS system is preconfigured and ready for use, the up and down buttons on the DASH4PRO switch between screens, and each screen is preconfigured for a different brake test.

The set button on the DASH4PRO starts and stops the DL2 logging data (there is also a button directly on the DL2 that does the same)

How to change test parameters

The system is supplied with a default set of tests preconfigured, one for each screen of the DASH4PRO:

- Screen 1 is set for 50kph to 2kph
- Screen 2 is set for 100kph to 2kph
- Screen 3 is set for 130kph to 2kph
- Screen 4 is set for 200kph to 2kph

To change the test parameters, there are 2 alternatives:

- To change the parameters from the DASH4PRO, then go to menu 10.1 on the unit, and all parameters can be adjusted. In practice this works well for simple changes, but can be frustrating and slow for extensive changes.
- Alternatively all the tests can be set up from the PC. To do this use the DASH4PRO configuration software. Load the DASH4PRO configuration file, and go to the menu "configuration->Trigger SPEEDBOX tests". Once the changes are completed, connect the PC to the main system USB port on the DL2 and upload the changes.

Reviewing the performance test results

There are 4 places where you can access the performance test results, each suited to different applications:

- On the DASH4PRO. This is typically used to check that the test was completed okay.
- Stored as a simple ASCII text file on the DL2's SD card. This is a quick and simple to review all the results that were generated in real time.
- The raw data can be post processed using the "Run Processor" software. This allows processing of a single run, or a whole directory of runs, with new test parameters.
- For complete flexibility the raw data can be loaded into the "Analysis" program. This allows you to view the results that were taken in real time, generate other statistics, as well as carry out any general analysis. This is ideal for any non-standard or specialist applications.

Each of these alternatives is set out below:

DASH4PRO

On the main screens of the DASH4PRO can be configured to display performance testing results. For displaying a few key parameters, its possible to just display individual

variables. In the example DASH4PRO layout supplied, the focus is on brake testing variables, just the path distance and the distance accuracy is shown, which is typically enough to confirm that the test worked. Alternatively, the DASH4PRO can be configured to display all the test results in a "SB text results" window. This has the advantage of displaying more information, including the tabular results – but it can result in a cluttered screen.

In addition after a test is completed, the results from the last test are available in menu 10.2.

Finally there is also a performance meter mode of the DASH4PRO, under menu 9. In theory this can also be used for simple straight line performance tests, however this mode is not recommended for high accuracy testing, instead it is aimed at simple magazine testing and autosport applications.

SB text files on the DL2.

The real time data from the SPEEDBOX are stored on the memory card of the DL2 in 2 ways. Firstly there is a binary "RUN" file that contains all data in a proprietary, but documented, format. In addition the results generated from the SPEEDBOX are also stored in a simple ASCII format, which can be viewed just using a standard text editor. This later file has a SB extension. A separate RUN and SB files are generated for each logged session. If a separate file for each test then its possible to set autostart and autostop conditions on the DL2. Alternatively its normally simpler to log continuously and have multiple braking tests in a single file.

Post-processing a RUN file - Run Processor tool

The "Run Processor" software can be use to process a single run, or batch process a directory of run files. It has a number of uses, including converting binary RUN files into text suitable for excel or Matlab. The application includes the "performance results" mode. This mode can be used to configure braking and acceleration performance tests in the same way as on the SPEEDBOX, or the DASH4PRO. Up to 10 different tests can be set up in the software and run at the same time, for example the system can be set to do both triggered to stop, and 62kph to 10kph at the same time – something that is not possible in real time. Results can be saved in a CSV format file, or viewed directly in the application and cut and pasted as needed.

Loading RUN data files into Analysis

The data analysis program is extremely comprehensive and powerful piece of software, please refer to the help file for documentation on the operation of this program. However, in brief the "performance calculations" window is the simplest way to access braking results in the run file.