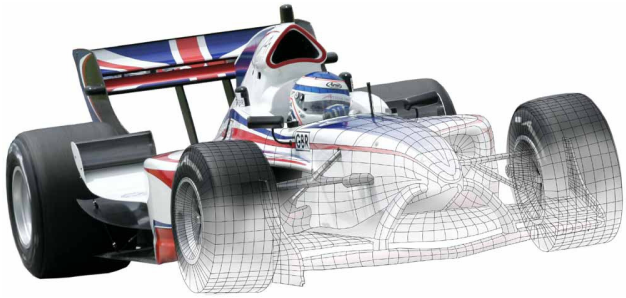

Race Technology
www.Race-Technology.com

BRAKEBOX – Very high accuracy, non-contact, braking distance measurement system

Product Overview

The BRAKEBOX is a self contained and exceptionally accurate system for measuring braking distances of cars, bikes and trains, using the very latest GPS technology with a typical accuracy of 2cm . The BRAKEBOX needs no connections to the car and so can be fitted and working in seconds. The system requires no calibration, and is engineered to very high standards, ensuring long reliable service in demanding industrial environments.

The BRAKEBOX can be configured to measure all the standard parameters for industrial brake tests. The unit can measure and display tables of stopping distance (speed, time, distance), the deviation from the braking line and average accelerations. The results can be viewed on the in-car display, printed out or stored in internal memory. Optionally the results can be downloaded and analysed on the PC or recalled on the unit itself.

The BRAKEBOX is based on Race Technology's own 20Hz ***PurePhase*** GPS receiver, this GPS receiver is not a general purpose "survey" or "military" receiver, but a receiver purpose designed for automotive testing. When used in automotive test applications, the performance of the Race Technology GPS receiver is simply the best available at any cost.

Applications

The BRAKEBOX is designed for any companies or individuals requiring accurate braking distances. Typical applications would include:

- Tyre testing
- Braking system testing (including ABS)
- Suspension and chassis development
- Road surface testing
- Accident investigation

The unit can be fitted to cars, bikes, trains or boats.

With its simple user interface the BRAKEBOX can be used by engineers and technicians alike.

The BRAKEBOX is a superior replacement for 5th wheel installations, optical sensors and GPS based systems from other manufacturers.

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Standard Features

- Typical braking distance accuracy of 2cm. Industry leading performance based on the very best GPS technology available.
- Simple, intuitive user interface. The system has a very simple menu driven interface meaning that an absolute minimum of training is required to use the system.
- Optional printer output. As soon as the test is completed the results can be viewed on the screen and printed to an optional serial printer if a hardcopy is required.
- Upgradeable firmware. The firmware of the BRAKEBOX is flash-upgradeable through the serial port of a PC.
- Water resistant. The BRAKEBOX and display are housed within a machined aluminium billet casing that is water resistant to IP65 standard.
- Software and documentation. The BRAKEBOX is supplied with a comprehensive software CD providing full instructions for installation, configuration, use and output data processing.

Specifications

- External power supply requirements: 10-15V (12V nominal). Current consumption is approximately 450mA.
- Case construction: CNC machined aluminium, black anodised, 'o' rings sealed to IP65.
- Connector type: 1 x Binder 723 Series 12-way male bulkhead connector, 2 x SMA female bulkhead connectors.
- Main processor: High performance 200MHz TI DSP.
- GPS antenna: Magnetic base, 3.3V active antenna with male SMA connector.
- GPS receiver: Race Technology ***Pure*Phase** receiver. Calculates position, altitude, speed, distance, heading, positional accuracy, speed accuracy and heading accuracy 20 times a second. Tracks all satellites in view.

Overall system accuracy

The accuracy of the BRAKEBOX is typically 2cm. The following analysis explains the sources of these errors.

There are 3 factors that determine the accuracy of a brake measurement system:

- Accuracy of the velocity measurements. The GPS system in the BRAKEBOX has a typical velocity bias error of about 0.01kph and a sample to sample noise level of about 0.1kph . This is currently as good as current GPS technology permits.
- Latency of the speed measurements. The BRAKEBOX accounts for all speed latency effects and cancels them out to an accuracy of 6uS. Assuming that the vehicle is accelerating at 1g, this is equivalent maximum error of 0.0002kph.
- Defining the exact start point of braking. The time that the braking measurement begins is to within 8uS. Assuming that the vehicle is accelerating at 1g, this is equivalent maximum error of 0.0003kph.

A typical error analysis for a typical 100kph to stop braking test assuming an average deceleration of 0.8g, lasting approximately 3.5 seconds is:

Error Source	Calculation	Error in braking distance
Error due to speed inaccuracies*	0.01kph x 3.5s=	9.7mm
Error due to speed latency	25mS x 0.24m/s x 0.5=	3mm
Error due to latency in defining braking point	8uS x 27.8m/s=	0.2mm
Total error bands		**13mm**

*In practice since the noise on the speed measurements is Gaussian this will cancel out over a practical braking test lasting over a second and can therefore be ignored in the error analysis.

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Results available.

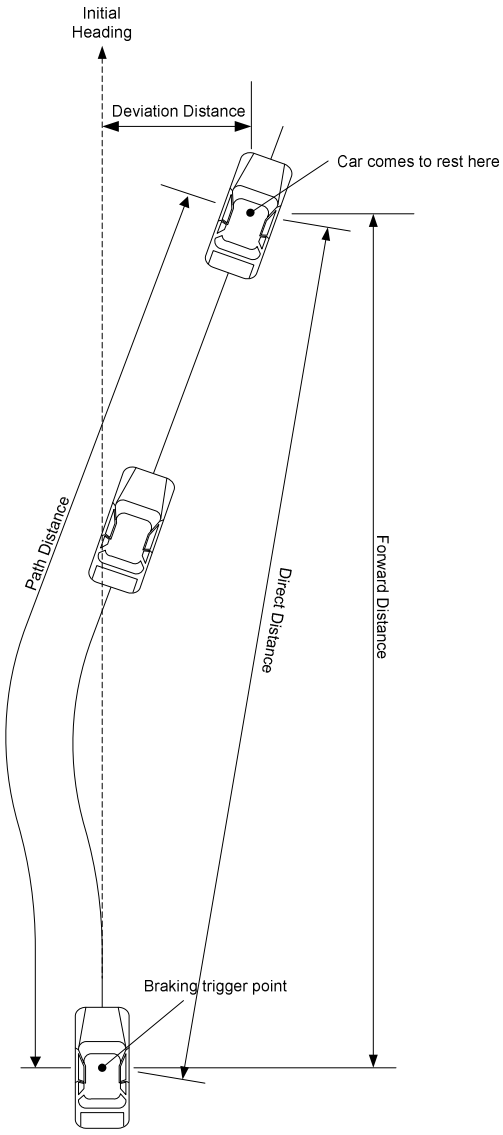
Immediately after a test the following results are available:

- Total braking distance
- Total braking time
- Average braking acceleration
- Initial Heading
- MFDD (Mean fully-developed deceleration)

As well as:

- Braking distance in the forward direction
- Distance deviated from the braking centre line
- The straight line distance from the start of braking to where the vehicle came to rest.

Depending on the application some of these measurements can be disabled for clarity if required.



The final total figures are available on the data display, in addition printed tables of results can be output to the optional printer. The data can also be stored in the units internal memory and later downloaded to a PC for detailed analysis.

The following is a typical output file from the optional serial printer:

```
  RACE TECHNOLOGY
  *** BRAKEBOX ***

Run: ABCDE000
MFDD:   0.80g
Initial Heading 021°

SPEED  DIST  TIME
100.0  0.00  0.00
 90.0 24.19  0.57
 80.0 45.84  1.14
 70.0 64.93  1.71
```

```
 60.0 84.12  2.36
 50.0 98.13  2.93
 40.0 109.6  3.50
 30.0 118.5  4.07
 20.0 124.9  4.64
 10.0 128.7  5.21
  0.0 130.0  5.83
```

Hardware Supplied

The BRAKEBOX comprises the following parts:

- The BRAKEBOX unit itself which houses the GPS receiver and control electronics.
- The display module with large backlit LCD display for controlling the testing and displaying the braking results immediately after the test
- GPS antenna with magnetic base
- Cables for powering the system and downloading data to the PC
- (optional) Battery pack, for use where there is no 12v in car supply
- (optional) Printer, for printing out tables of results in the car

The complete system is supplied in a Peli case, with cut foam interior ready to use.

Dimensions: Approximately 160mm x 100mm (overall) x 30mm.

Weight: Approximately 400 grams.

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Vehicle Installation and Setup

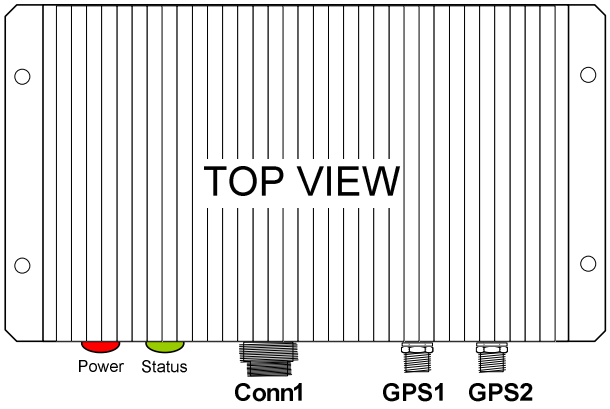

Figure 3: BRAKEBOX connectors

GPS

GPS speed and position readings are unaffected by unit mounting position. The GPS unit requires a 3.3V active antenna (supplied) which must be mounted in a position giving a good view of the sky. On top of the vehicle is recommended. Care must be taken not to crush the antenna lead with the vehicle window or door closure.

Power

12V DC power is required, to be connected to the supplied cable loom assembly.

Connections

There are 3 connections on the unit, labelled Conn1, GPS1 and GPS2 in Figure 3. The main connector block, Conn1, should be connected to the large connector labelled "CONN1" on the supplied cable loom. The pin assignments for connector Conn1 on the BRAKEBOX are illustrated in Figure 4. The other connectors on the loom are all individually labelled. The positive wire on the power lead has a grey or white stripe.

Connector GPS1 is the GPS antenna connection, and requires a 3.3V active antenna to be connected as described above. Connector GPS2 is not used on the BRAKEBOX, and should not be connected.

Status LEDs

There are 2 status LEDs on the front of the unit. The red LED labelled "Power" is an indication that power has been applied to the unit, and the green LED labelled "Status" indicates current GPS status. Short flashes of the status LED at 1Hz indicate that the GPS has a positional lock but no speed data. Long flashes at 1Hz indicate that the GPS has doppler speed data. When the status LED is continuously lit, this indicates that the GPS has carrier speed data, which is the most accurate mode of operation, and the one which should normally be used for brake testing.

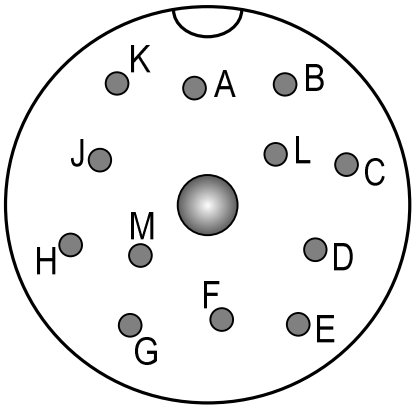

Figure 4: Pin view of CONN1 (Binder 723 series male bulkhead connector). Pin assignments are listed below.

Pin	Function
A	GND
B	RS232 1 Tx (connected to the data display)
C	Trigger
D	Not used
E	RS232 2 Rx (connected to the optional printer or PC)
F	RS232 2 Tx (connected to the optional printer or PC)
G	Not used
H	Not used
J	+12V
K	RS232 1 Rx (connected to the data display)
L	Not used
M	Not used

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