A Comparison of non-contact speed sensors

The most common method of evaluating the braking performance of a car, is to measure the total distance travelled during an ABS assisted stop. The method of measuring this distance needs to be accurate and repeatable in order to detect small variations in braking performance.

A number of different technologies exist to measure the vehicle speed and from this calculate the distance travelled which include fifth wheels, radar, microwave, optical and GPS.

Optical and GPS are now the two most common forms of non-contact speed measurement, and the following is a comparison of these two forms of measurement.

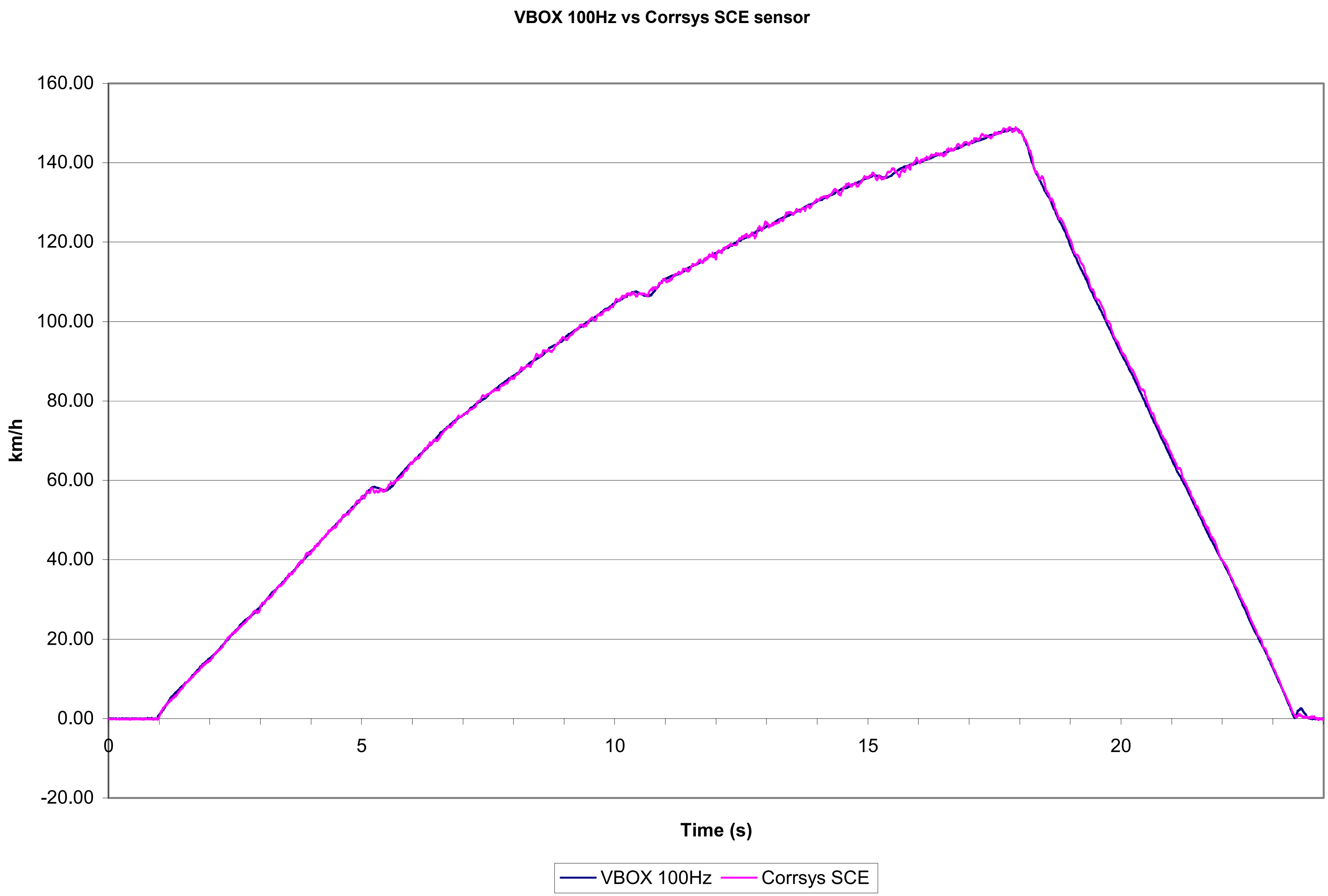
Test procedure

A vehicle was fitted with a Corrsys SCE optical two axis sensor which had been recently calibrated, and careful attention was paid during fitting in order to maintain the correct height above the ground, and additional mounting brackets and supports were utilised to keep any unwanted vibration of the sensor to an absolute minimum. The sensor was setup with the recommended minimum smoothing constant, in order to reduce latency to a minimum. The output scale was set to 25mV per km/h.

In addition to this sensor, a VBOX 100Hz velocity sensor was fitted with the same output scale of 25mV per km/h, and the antenna placed in the centre of the roof. Both sensors were then connected to an analogue data logger which was logging at 250Hz.

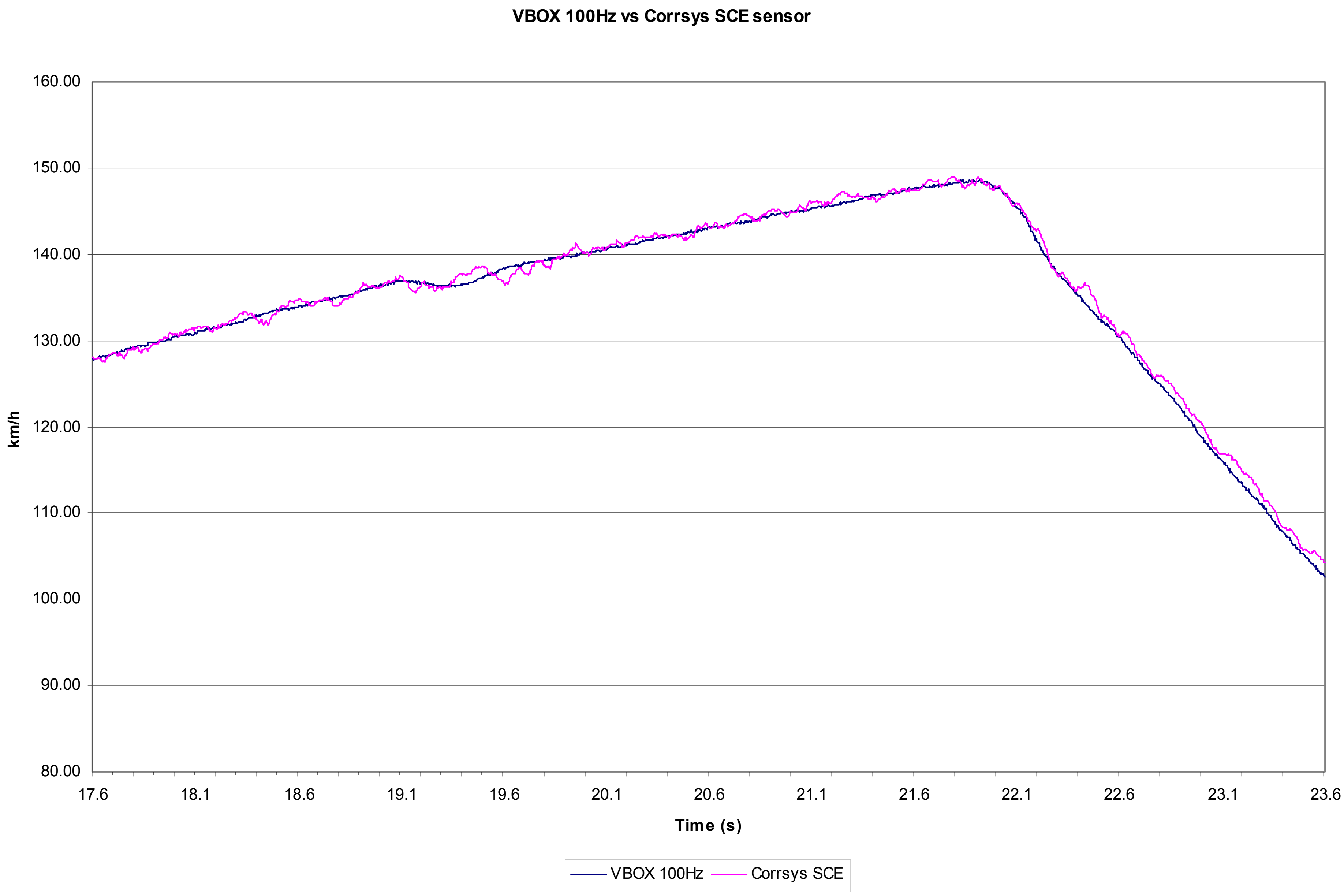
The test consisted of a full throttle standing start up to 145 km/h, and then an ABS assisted stop. This test was performed a number of times until it was clear that we had obtained a fair representation of a typical stop, with both sensors working to the best of their ability.

The following graphs are overlays of the two analogue signals coming from either sensor during a representative stop.

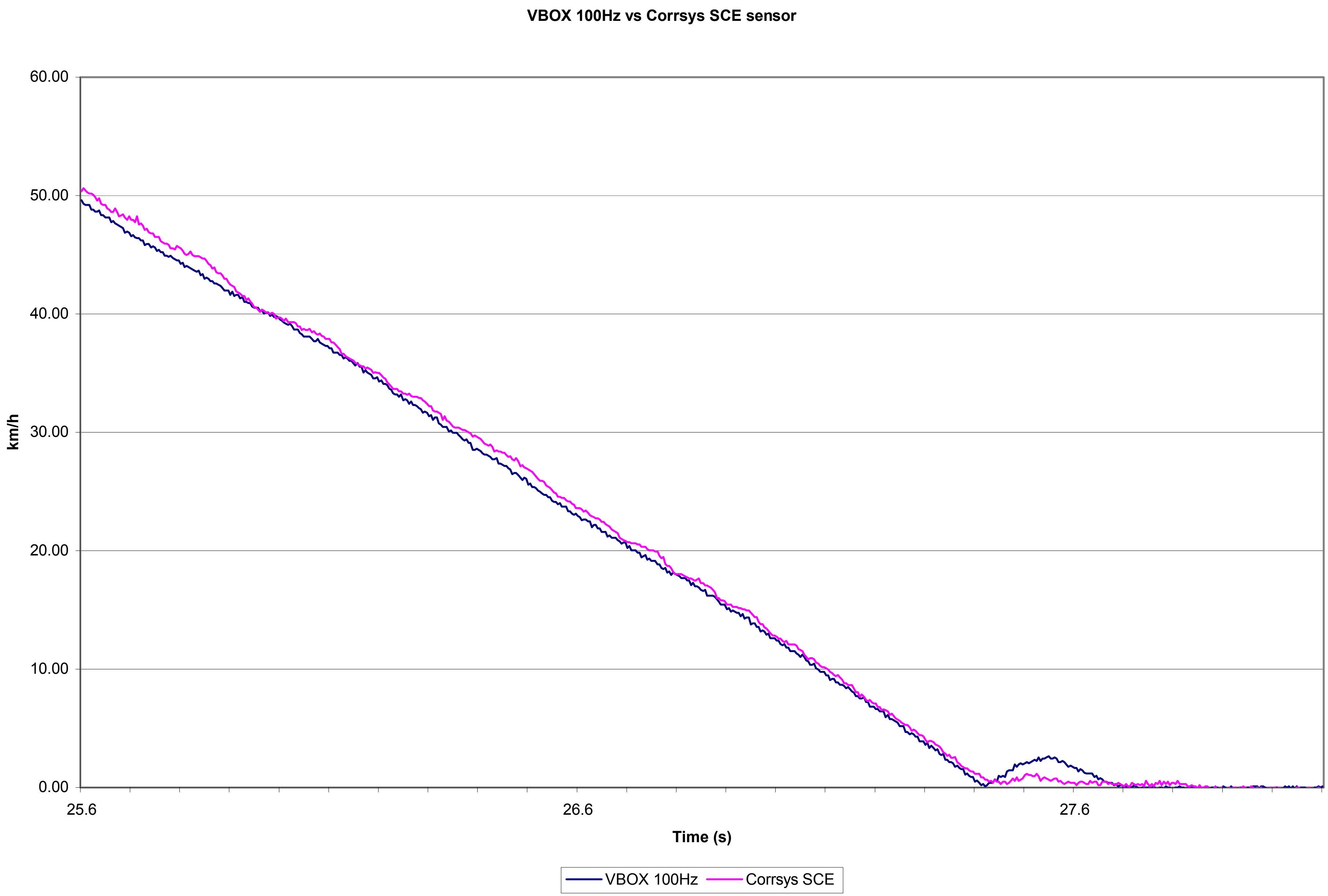


VBOX 100Hz vs Corrsys SCE sensor
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
-20.00
km/h
0
5
10
15
20
Time (s)
VBOX 100Hz
Corrsys SCE

Graph 1


VBOX 100Hz vs Corrsys SCE sensor
160.00
150.00
140.00
130.00
120.00
110.00
100.00
90.00
80.00
km/h
17.6
18.1
18.6
19.1
19.6
20.1
20.6
21.1
21.6
22.1
22.6
23.1
23.6
Time (s)
VBOX 100Hz
Corrsys SCE

Graph 2



VBOX 100Hz vs Corrsys SCE sensor
60.00
50.00
40.00
30.00
20.00
10.00
0.00
km/h
25.6
26.6
27.6
Time (s)
VBOX 100Hz
Corrsys SCE

Graph 3

Graph 1
In this graph it can be seen that there is a good overall correlation between the optical and GPS sensors, validating both methods as useful ways of measuring the true vehicle speed.

Graph 2
On closer examination of the traces, the noise which is present on the optical system increases with velocity, and is of a much larger magnitude than the noise on the GPS trace. This is very likely to be due to vibration of the sensor, which is down to it's mass and the fact that it needs to be mounted slightly away from the vehicle. To accurately measure the point at which the vehicle passes through a set velocity you must then carry out some significant post processing to eliminate the sensor noise.

(During the test it was also noted that the optical sensor showed a number of large velocity spikes apparently caused by puddles of water, these were left out of the end test results.)

The GPS sensor shows significantly less noise, the magnitude of which does not change with velocity.

Graph 3
Looking at the end of the test in more detail, you can see the GPS signal leading the Optical signal by about 20-25ms. This shows the latency of the GPS signal to be significantly less than the latency of the optical sensor. The GPS sensor also reads right down to zero, and then shows a small hump, which the "rock-back" as the vehicle settles on its suspension. The Optical sensor decays slowly down to zero, taking another 0.2-0.3s, making it difficult to define the exact point the vehicle came to a rest, and again this requires some post processing to get a accurate representation of the vehicle's behaviour.

Conclusion

The GPS sensor shows a number of important advantages over the optical sensor in response time, signal to noise ratio, robustness and fitting time. For measuring braking distances, the GPS sensor can be used to replace the Optical sensor without any loss of accuracy or usability.