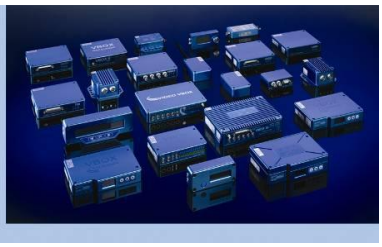
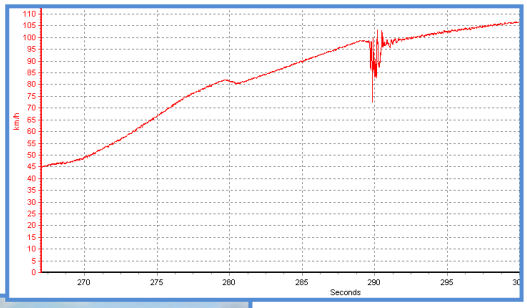
Noiseless Measurements: Integrating Inertial Sensors with GPS



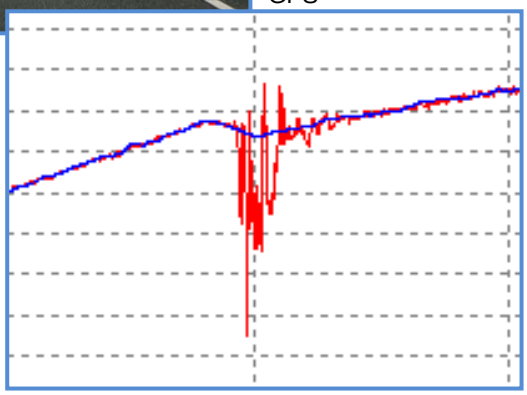
The consensus in the automotive industry is that GPS is the most effective solution for the majority of vehicle dynamics measurements, as shown by rising sales in GPS data-loggers.

Survey-grade high-speed GPS, using Doppler shift, is the most accurate way of measuring speed there is - as long as there is a clear view to the sky. Problems arise when buildings or tall trees obstruct the testing ground.



Above: GPS signal dropout under a bridge

Below: The red line shows stand alone GPS data. The blue line shows the integration of IMU with GPS



If the GPS signal is interrupted, dropouts cause spikes in data, as shown right (when the test vehicle drives under the bridge), which is not ideal when you are relying on a clean velocity signal. For example, during an acceleration test, any spikes in the data would cause inconsistent results, which would mean carrying out the test on a section of track without any bridges or trees, which is not always practical.

Carrying out a coastdown test in an unobstructed environment is even more problematic, since a complete coastdown from 120km/h can take up to 3km. However, it is sometimes hard to find a real-world testing area where there are no such signal path obstructions. So how do you solve the problem where sky visibility is less than perfect?

Addressing this issue, Racelogic have come up with a solution whereby GPS signals can be supplemented with inertial sensors (G-sensors and Gyros), which enables a far better measurement of velocity to be made during sections of poor satellite visibility.

This is achieved by connecting a VBOX 3i 100Hz GPS datalogger to an Inertial Measurement Unit (IMU), as shown below. Incorporating three accelerometers and three gyroscopes, the IMU measures Pitch, Roll, and Yaw rate up to ±150º/s, and Longitudinal, Lateral, and Vertical acceleration up to ±1.7g.

The results of IMU integration are shown above, where the blue velocity trace is the result of combining GPS and IMU data, compared with the red line, which features the noisy stand-alone GPS data as it passes under the bridge. The integration allows for far greater accuracy and test reliability in a wider range of conditions than has been achieved before.

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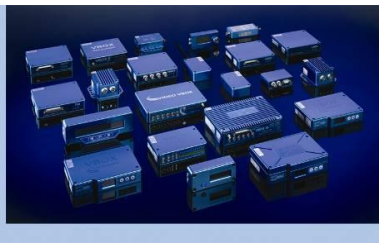

The advantage of the Racelogic system is that VBOX 3i runs a Kalman filter in real time, which seamlessly blends the GPS signals with the measurements from the IMU. This results in a smoother velocity trace with even higher dynamic capabilities, due to the mutual corrections occurring between the two data sources. This ensures more consistent results than would be achieved by GPS alone.

The use of separate modules allows for flexibility in vehicle placement, with a number of mounting options available, whilst the simplicity of the system means that you can swap the equipment between vehicles easily, meaning more time on the test track and less time setting up gear.

Analysis software - VBOX Tools – is included, allowing you to generate graphs such as the ones above.

The software is intuitive to use, yet has powerful features that enable users to carry out in depth analysis. The system is supported by a dedicated team and free training can be supplied at the Racelogic UK headquarters.

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