RACELOGIC

Application Note

DGPS Base Station Test

Abstract

This application note describes a test to determine the increase in positional accuracy that can be achieved by using a local Base Station in conjunction with a VBOX. In order to collect the data, two similar VBOXs were used throughout the test. One VBOX was in “stand alone” mode, the other was receiving DGPS corrections via a telemetry link from a Racelogic DGPS Base Station.

Two different tests were performed: a stationary test and a dynamic test. The stationary test is easy to perform, but does not represent the conditions in which a VBOX customer would use the system, so a dynamic test was also devised.

The results show that without the Base Station corrections the absolute position was within the VBOXII specification of 3m, whilst with the Base Station corrections the results were improved to an accuracy of 40cm.

Introduction

The positional information generated using GPS is subject to a number of errors, the largest of which is caused by varying conditions in the ionosphere. The ionosphere is the region of our atmosphere that starts at 85km from the surface of the Earth and extends many hundreds of kilometres. The weather we experience on Earth does not play a large part, as this occurs only in the first 10km of the atmosphere, called the troposphere.

The effect of the ionosphere is to change the length of time that the signals take to travel from the satellites (which have an orbit of around 18,000km above the Earth’s surface) to the surface of the Earth. The variation in the ionosphere means that each satellite is subjected to a different delay, which changes slowly during the course of a day.

When it is first switched on, the Base Station receives signals from each satellite and computes a position. The Base Station knows that it is stationary, so any changes in the signals coming from the satellites which would result in a change of position are used to send out corrections to any moving receivers in the vicinity, which will cancel out any such variations.

Equipment

1 x BMW Mini Cooper S
1 x VBOXIII (for dynamic test)
2 x VBOXII DCF (for static test)
1 x GPS magnetic aerial, RLVBACS050
1 x VBOX telemetry module (including RF antenna and RLVBCAB05 cable)
1 x GPS antenna splitter (for static test)
1 x PC running VBOX software
1 x VBOX DGPS Base Station (including RF antenna GPS antenna and tripod)

Test Setup – Base Station

The DGPS Base Station was placed on a position near the test track on some high ground, so that the radio antenna had the best line of sight to as many parts of the track as possible, and also so that the GPS antenna had a good clear view of the skies away from obstructions like buildings or trees. The RF antenna and GPS antenna were then connected to the Base Station and placed on the supplied metal plate that was fixed to the tripod. The GPS antenna was placed on the plate so that it sat directly over the centre of the tripod. After putting the tripod in place, a cross was marked on the floor directly under the GPS antenna (the centre of the tripod). This was to ensure that the tripod and GPS antenna could be accurately placed on the same spot for each consecutive test.

The Base Station was switched on and the option “Set to Average” was chosen. This took 5 minutes, during which time an on-screen counter indicated the time left to complete the averaging. When the count was over “Set to Average” was selected, and the position was stored using the

"Store Location" option, which meant that on another day the Base Station could be returned to exactly the same spot and the original location could be reloaded.

The Base Station was now ready and transmitting positional correction information via radio.

Static Test Setup – VBOX
Two VBOXIIs were placed in a waterproof box, then they were both connected to the same survey grade antenna via an antenna splitter. The antenna was placed on a tripod and the VBOXs were set with "Log Conditions" as "Continuously". The radio telemetry module was plugged into the CAN port of one of the VBOXIIs and the unit was put into Local DGPS mode.

Dynamic Test Setup – VBOX
The VBOXIII was placed on the test vehicle with the GPS antenna on the roof and power taken from the cigar lighter. The radio telemetry module was then connected to the VBOXIII via a RLVBCAB05 lead that was plugged into the socket labelled CAN. The RF antenna was then connected to the telemetry module and placed on the roof at least 10cm away from the GPS antenna.

Once the telemetry unit was connected and powered up, the blue light on the telemetry module flashed once a second indicating that the Base Station signal was being received satisfactorily. A laptop was connected and the VBOX was put into Local DGPS mode.

Test Procedure

Static Test
The two VBOXIIs were left to record data at 2Hz over a period of 24 hours.

Dynamic Test
A point on the test track was chosen and permanently marked with a painted cross. The vehicle was then driven to the test area, making sure that the approach to the painted cross was from the same direction each time, and the vehicle was stopped so that the tyre sat squarely on the marked cross.

Full steering lock to the right was then applied whilst the car was stationary. The telemetry was unplugged so that DGPS was disabled; this was confirmed by the lack of blue outline around the "Satellites in View" bar in the VBOX software.

The vehicle was then driven in a circle on full lock at low speed with an outside observer confirming that the front wheel went over the start point each time a circle was completed. After two laps the telemetry link was reconnected so that DGPS would be activated and another two laps recorded.

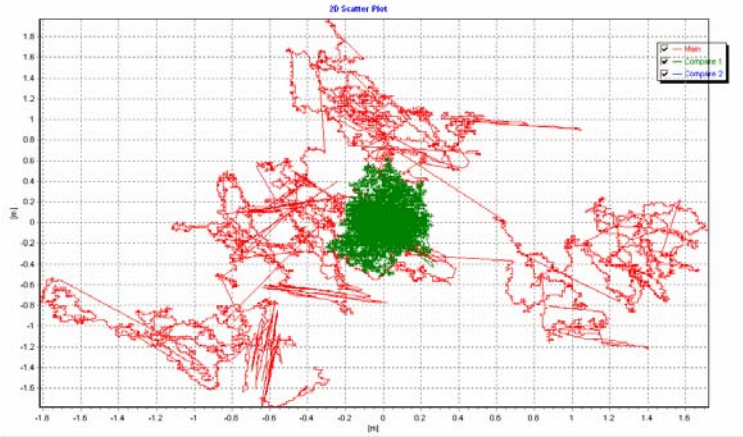
This whole procedure was completed in the afternoon and morning of the next three days.

Viewing the Data / Results

Static Test
The files from each VBOX were loaded into the VBOX software and the resulting scatter plots were overlaid as shown below.

Application Note

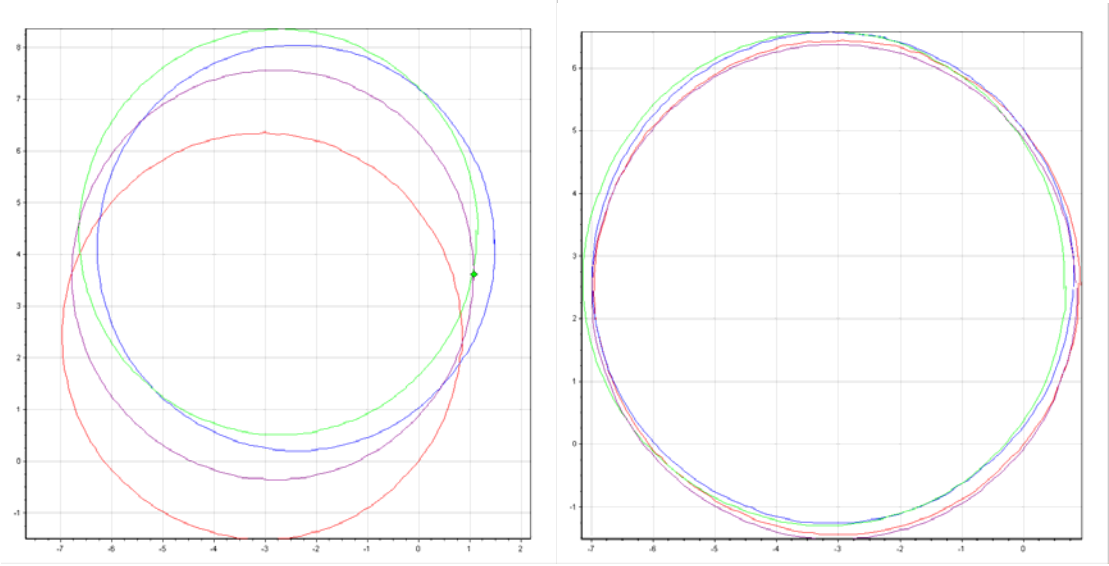
DGPS Base Station Test



In “Stand Alone” mode the positional accuracy was 1.73m 95% CEP. In Local DGPS mode the accuracy was 35cm 95% CEP*.

*35cm 95% CEP defines a circle of diameter 35cm which will contain 95% of all the readings.

Dynamic Test
To analyse the results a single circle was taken from each test. The VBOX software was used to separate out and save each run. This was done by creating a start/finish line on an arbitrary point on the circle and saving a single lap from each test by using “Select Run”. These files were then loaded back into the VBOX software and overlaid.



Non-DGPS – spread of 2.03 metres **Local DGPS – spread of 28cm**

Conclusion

The use of a Local DGPS Base Station improved the positional accuracy of the VBOX to a useful level. The results from this sample of tests carried out on different days showed that the positional accuracy with a DGPS Base Station was within the 40cm CEP stated on the data sheet.