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TECHNICAL BULLETIN

GPS OBSERVATION AND POST-PROCESSING TECHNIQUES FOR SINGLE FREQUENCY RECEIVERS

This bulletin is intended to provide some guidelines and insight regarding appropriate observation time and post-processing techniques when using single frequency GPS receivers. There are two basic techniques that can be applied to single frequency processing:

1. Code only – the C/A code based pseudoranges are used for differential processing,
2. Full carrier phase – the carrier signal is used for processing.

Code only processing is a relatively simple and fast technique that is typically used for lower accuracy applications such as mapping and GIS data collection. Full carrier phase data processing is a much more complicated procedure that will improve differential GPS accuracy to the level required for precise surveys. Both of these differential solution types will be considered.

The accuracy of single frequency differential processing is much more dependent on occupation times than dual frequency processing. It is important to keep the following factors in mind when trying to determine how long a station should be occupied (occupation time refers to the *simultaneous* observation time at both base and rover):

- **The distance between rover and base station:** As the distance between the base and rover receivers increases, the occupation times should also increase.
- **Sky visibility at each of the base and rover receiver:** The accuracy and reliability of differential GPS is proportional to the number of *common* satellites that are visible at the base and rover. Effective differential processing usually requires at least 6 satellites visible above 10 degrees elevation. This condition is best measured by monitoring the number of visible satellites during data collection along with the PDOP value (a value less than 3 is ideal).
- **Time of day:** The location and number of satellites in the sky is constantly changing. As a result, some periods in the day are slightly better for GPS data collection then others. The Planner utility that is included with the SoftSurv package is useful for monitoring the satellite constellation at a particular place and time.
- **Station environment:** It is always good practice to observe the site conditions surrounding the station to be occupied. Water bodies, buildings, trees and nearby vehicles can generate noise in the GPS data. Any of these conditions may warrant an increased occupation time.

Although we usually wish to opt for the shortest occupation time possible, it is wise to rely on a conservative time for all GPS operations. It will end up costing a great deal more in terms of time and resources if a session or survey has to be repeated because of an insufficient occupation

time. Although NovAtel single frequency receivers are capable of resolving baselines in only a few minutes under ideal conditions, we suggest the following conservative rule of thumb:

20 minutes for baselines up to 1 kilometer + 2 minutes per additional kilometer.

Eventually the user will be able to determine, based on previous experience, when and where this occupation time may be reduced and under what conditions it must be increased.

Once the data has been collected, post-processing must take place to obtain final station coordinates. Depending on the type of processor used some or all of the solution options in the following table will be available:

Solution	Processor	Solution Characteristics	Solution Application
L1 Fixed	SoftSurv	Fixes the integer ambiguities on the L1 signal. Accuracy will typically be at the centimeter level.	Best solution for all applications.
L1 Float	SoftSurv	Less accurate than the L1 fixed solution (decimeter level), but may be the only option over long baselines.	If an L1 fixed solution is not possible, an L1 float will usually be the result.
Raw Pseudorange	GIS Mobile or SoftSurv	This is a code-only solution. The result is much less accurate than either of the two options above – typically meter level.	Applies when using a code-only processor or when carrier phase data is extremely noisy (may happen in dense trees).

Code-only processors use the pseudorange processing technique. A carrier smoothing function will improve the result, but accuracy is typically limited to around 0.75 to 1 meter. An L1 fixed solution involves full carrier phase processing and can provide geodetic level accuracy rivaling that of dual frequency equipment. Single frequency receivers, however, are much more sensitive to long baselines and short occupation times. The following table is a summary of single frequency observation and processing techniques that can be used as a guideline until the user is experienced with the equipment.

Baseline Lenth	Suggested Occupation	Suggested Data Rate	Best Processing Mode	Accuracy*
0 – 10 km	20 to 60 minutes	5 seconds	L1 fixed	1 to 5 cm
10 – 20 km	40 to 90 minutes	10 seconds	L1 fixed	2 to 10 cm
20 – 50 km	60 to 180 minutes	10 to 30 seconds	L1 fixed (if possible)	5 to 20 cm
50 – 100 km	120 to 300 minutes	30 seconds	L1 float (fixed not likely)	10 to 50 cm
100+ km	180+ minutes	30 seconds	L1 float (fixed not likely)	sub-meter

*** Accuracies are a typical range given PDOP < 4.0 and mimimum 5 satellites tracked and may vary.**

For further enquiries regarding this information or any other concerns, please contact NovAtel Customer Service toll free at 1-800-NOVATEL (Canada and the US) or at (403) 295-4900.