TECHNICAL BULLETIN

GPS OBSERVATION AND POST-PROCESSING TECHNIQUES FOR DUAL FREQUENCY RECEIVERS

This bulletin is intended to provide some guidelines and insight regarding appropriate observation time and post-processing techniques when using dual frequency GPS receivers. One primary advantage of dual frequency equipment is the ability to observe baselines using much shorter occupation times. It is difficult to state exactly what this occupation time should be since every observation session will be different. 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. Therefore, if the sky visibility at either station is poor, one may consider increasing the occupation times. 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 dual frequency receivers are capable of resolving baselines in less than a minute under ideal conditions, we suggest the following conservative rule of thumb:

5 minutes for baselines up to 1 kilometer + 1 minute 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. The use of dual frequency receivers provides a number of processing options that are not available with the use of single frequency equipment. Specifically, the data from the L2 or second carrier frequency can be applied in different ways to effectively obtain a baseline solution. The following table provides some guidelines regarding the most commonly used solutions:

Solution Type	Solution Characteristics	Solution Application
L1 Fixed	Uses both L1 and L2 data to fix the integer ambiquities on the L1 carrier only. This solution contains the lowest noise level.	Best solution for baselines less than 10 km.
L5 Fixed (Narrowlane)	Fixes the integer ambiguities on the sum of the L1 and L2 carrier. Resulting cycle is much shorter than L1 or L2 alone (hence called 'narrowlane').	Sometimes useful for increasing the accuracy of baselines less than 10 km. Increased noise may mitigate the improved solution accuracy.
L3 Fixed (Iono-free)	Combines the L1 and L2 data to eliminate ionoshperic errors in the solution, but noise levels are increased.	Useful for baselines over 10 km. At this point, ionospheric errors become more significant than the increased noise level.
L3 Float	This combination of L1 and L2 data is not as accurate as the L3 Fixed, but will still reduce ionospherice errors.	Next best solution if the above solutions are not possible. May be only attainable solution for very long baselines.
L4 Fixed (Widelane)	Fixes the integer ambiguities on the difference of the L1 and L2 carrier. Resulting cycle is much longer than L1 or L2 alone (hence called 'widelane').	Applied over very long baselines when an L3 solution is not attainable. These integer ambiquities are easier to solve for, but are less accurate.
L1 Float	Much less accurate than L1 fixed. Generally indicates that the data collected was inadequate to obtain a good baseline solution.	These solutions should be avoided. They may be the only option if occupation times are too short given the station conditions.

Once again, the above table is only intended to provide insight regarding the different solution types. For medium baselines lengths it is often useful to try a couple of different solutions and compare the results. This process will give the operator the experience necessary to determine when one solution will be superior to the other. The following table is a summary of all the above information that will give the novice user a running start.

Baseline Lenth	Approximate Occupation Time	Suggested Data Interval	Best Processing Mode
0 – 10 km	5 to 10 minutes	5 seconds	L1 or L5 Fixed
10 – 20 km	10 to 30 minutes	10 seconds	L1, L3, or L5 Fixed
20 – 50 km	20 to 60 minutes	10 to 30 seconds	L3 Fixed or L3 Float
50 – 100 km	45 to 120 minutes	30 seconds	L3 Fixed or L3 Float
100+ km	60 to 300 minutes	30 seconds	L3 Fixed, L3 Float, or L4 Fixed

For any 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.