

# **APN-038: Pseudorange/Delta-Phase (PDP) and GLIDE™ Filters**



## Pseudorange/Delta-Phase (PDP) and GLIDE Filters

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## Introduction

This application note contains NovAtel Pseudorange/Delta-Phase (PDP) filter details and general guidance on how to use it. Revision 4 of this document also introduces **GLIDE** (relative PDP) to the PDPFILTER command and the PDPMODE command. In addition, Revision 5B of this document introduces dual-frequency GLIDE and additional information surrounding its use.

## PDP (Normal Mode PDP)

### About PDP

The PDP filter provides a filtered position and velocity solution based on assumed vehicle dynamics. The advantage of this approach is smoother solution output and greater solution availability. The PDP solution optimizes the absolute positioning accuracy of the GPS code observation and leverages the excellent relative stability of the GPS carrier phase and Doppler observations. By optimally combining these satellite signal observations, the solution stability improves over a traditional code-only positioning algorithm.

PDP differs from a standard instantaneous positioning algorithm, which will only give a solution when more than 3 satellites are visible. The PDP allows a solution to be generated for short periods when fewer than 4 satellites are visible using what observations are available and assumptions about vehicle dynamics. Having more observations available allows better observation error detection so that poor observations are rejected before making it into the solution.

In conditions where GPS signal tracking is hampered by obstructions such as trees or buildings, the PDP filter will bridge through brief partial or even complete GPS outages while providing a continuous position/velocity solution. In conditions where satellites are coming in and out of the solution, the PDP helps minimize position solution jumps often associated with satellite geometry changes.

The PDP is not intended to provide a solution in all conditions. In conditions where satellite signals are completely blocked for extended periods, such as in a tunnel or severe urban settings, the PDP will have the same problems as all satellite based navigation systems and a solution will not be possible.

### History

The motivation for the PDP filter approach came from Sportvision, a customer of NovAtel Inc. Sportvision brought NovAtel a set of racing environment requirements. They wanted to have meter-level positioning accuracy on NASCAR racecars so they could provide real-time computer graphics that followed the cars as they went across the television screen. The difficulty in this problem was that better-than-normal pseudorange positioning was required, but the duration of the satellite constellation was too short for either fixed ambiguity positioning or accurate floating ambiguity positioning. PDP satisfied the requirements to the extent that Sportvision uses the technology and the results can be seen during televised NASCAR races on either FOX or NBC.

## Test Results

The plots in Figure 1 and Figure 2 show data from a residential Calgary neighborhood known for its mature trees. The plots in Figure 5 and Figure 6 on pages 7 and 8 respectively show data position improvement through downtown Calgary, with its associated urban canyon geography.

### Data from a Residential Neighborhood with Mature Trees

Compare the least-squares trajectory with the inertial control trajectory in Figure 1 and the PDP trajectory in Figure 2. NovAtel's inertial system generated the inertial control and consisted of the integration of an OEM4 receiver operating in differential carrier mode and a Honeywell HG1700-AG11 inertial measurement unit. The PDP trajectory shows the output of the PDP Kalman filter.

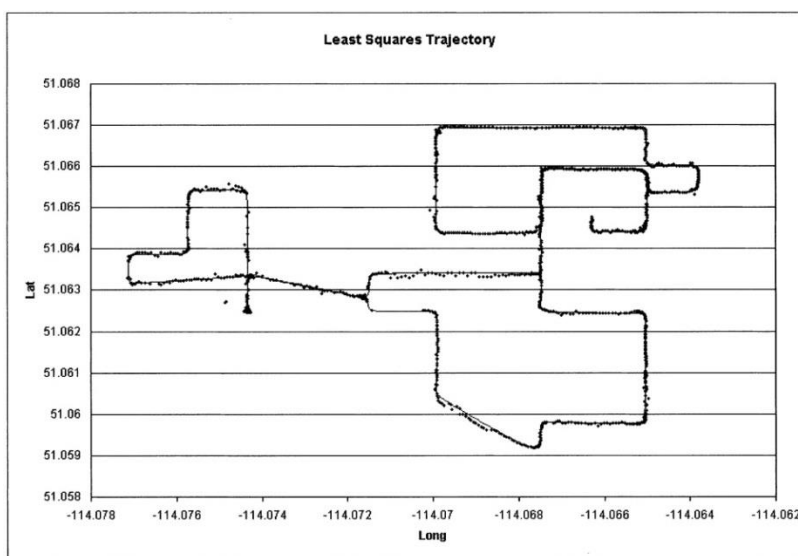


Figure 1: Residential Neighbourhood Least Square Plot of Inertial Trajectory

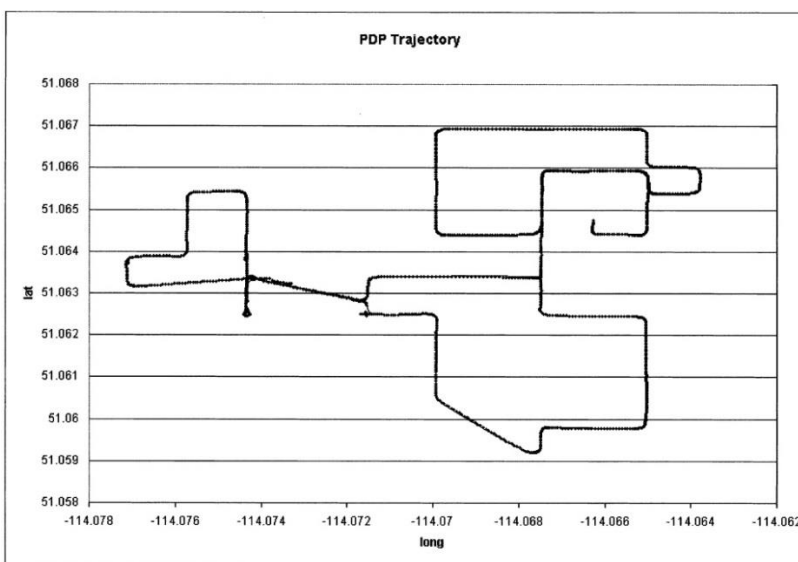


Figure 2: Residential Neighbourhood PDP Plot of Inertial Trajectory

The result is a much smoother and more accurate trajectory. The filter also bridges through the portions of the test when fewer than four satellites are in view. The maximum horizontal position error for this test has been reduced by half—from over 40 m to approximately 20 m. The position availability percentage has increased from 87 to 100 percent (see Table 1 below and Table 2 on page 6).

**Table 1: Residential Neighbourhood Solution Availability**

Parameter	Least Squares	PDP Filter, All Solutions
Computed Solution Epochs	1,270	1,459
Total Possible	1,459	1,459
% Achieved	87	100

**Table 2: Residential Neighbourhood Position Accuracy**

Parameter	Least Squares	PDP Filter, All Solutions
Latitude Error RMS	3.814	2.788
Longitude Error RMS	1.784	0.786
Height Error RMS	13.721	12.508
2D Position Error RMS	4.210	2.896

### Data from an Urban Canyon

In the urban canyon setting, improvements are even more evident. Figure 3 and the satellite visibility plot in Figure 4, below, shows the tracking environment in the urban core. Not only is the constellation masked, but the receiver must also occasionally track a reflected signal rather than the direct signal. Figure 4 shows that there are fewer than four satellites available for a significant portion of the time.



**Figure 3: Urban Canyon (4th Avenue, Calgary, facing west)**

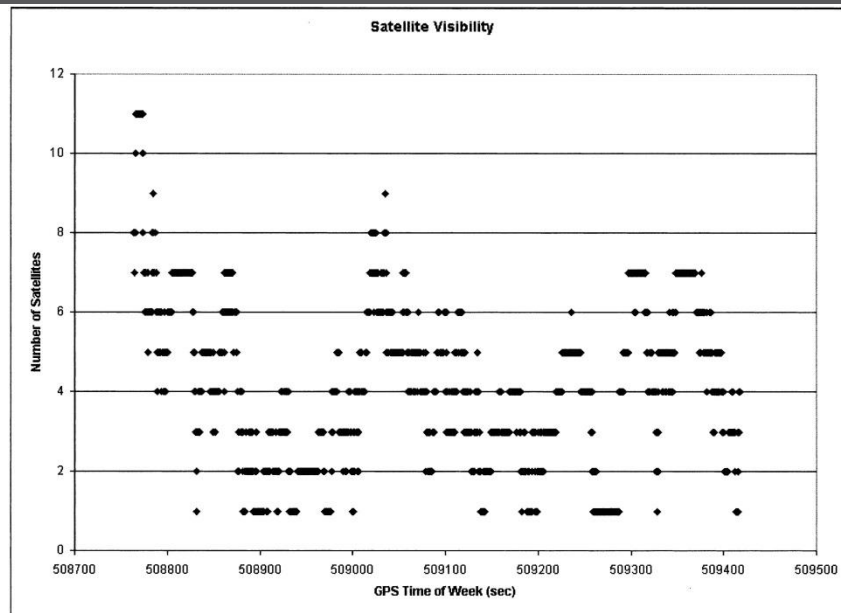


Figure 4: Urban Canyon Satellite Visibility

Figure 5 shows least-squares-derived horizontal positions in the downtown corridors. The least squares trajectory for the first downtown dataset shows very noisy data and clearly demonstrates the effect of unchecked multipath errors. Maximum horizontal position error is approaching 600 m during portions of this dataset.

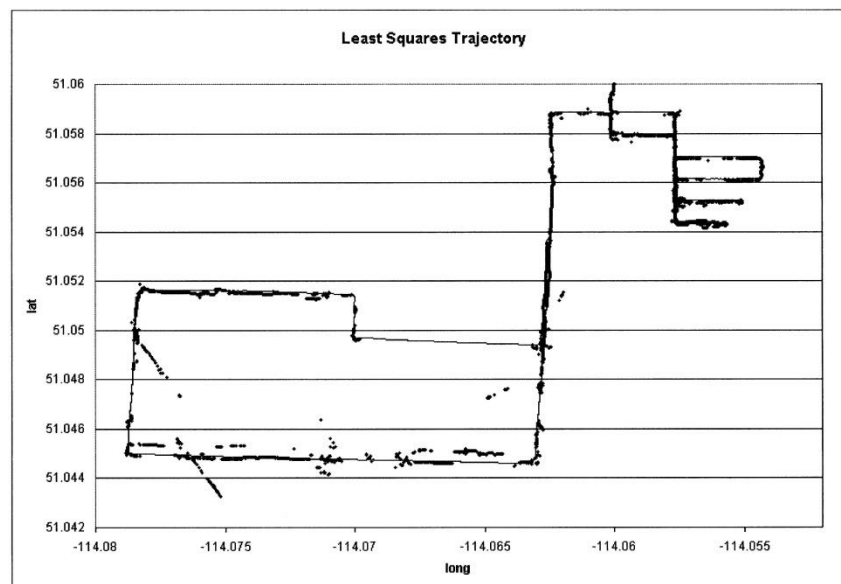
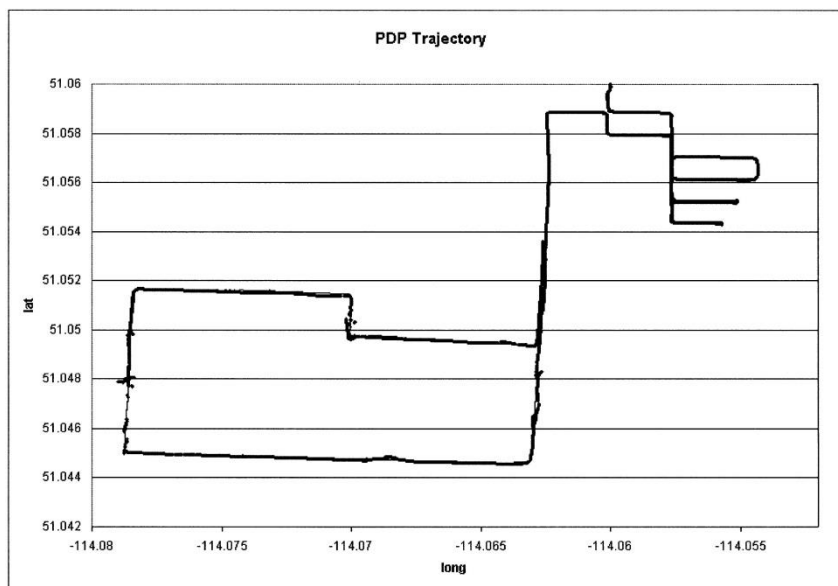


Figure 5: Urban Canyon Least-Squares Plot of Inertial Trajectory

The PDP trajectory in Figure 6 below shows the results of filtering the GPS observations and the solution availability when fewer than four satellites are in view. The solution availability improves to 99 percent (see Table 3 below). The maximum horizontal position error reduces from 600 m to 95 m. The position error in the north/south direction (latitude) is significantly higher than that in the east/west direction (longitude), as shown in Table 4 below. Since this test is performed primarily driving in east/west directions with high buildings on the north and south of the vehicle, the satellite geometry is such that the along-track direction (east/west) will be better constrained than the across-track (north/south).



**Figure 6: Urban Canyon PDP Plot of Inertial Trajectory**

**Table 3: Urban Canyon Solution Availability**

Parameter	Least Squares	PDP Filter, All Solutions
Computed Solution Epochs	5,021	7,103
Total Possible	7,180	7,180
% Achieved	70	99

**Table 4: Urban Canyon Position Accuracy**

Parameter	Least Squares	PDP Filter, All Solutions (m)
Latitude Error RMS	58.359	19.632
Longitude Error RMS	26.443	4.454
Height Error RMS	42.038	26.218
2D Position Error RMS	64.070	20.130



## Test Conclusions

There are improvements in solution availability with the PDP filter. This is evident in the reduction of both the amount of time a solution is not available and the position spikes from multipath. With PDP, satellites that lose lock can be reacquired without significant loss in performance provided that at least four satellites (the same or various) are maintained across the delta time between epochs.

The test results show that PDP improves positioning availability in established residential neighborhoods by over 10 percent and in urban canyon settings by 40 percent. PDP has also improved single-point horizontal accuracy from 4 m (2 dRMS) to 3 m (2 dRMS) in residential neighborhoods. In urban canyon settings, with PDP, accuracy has improved significantly, from 64 m (2 dRMS) to 20 m (2 dRMS) in one test and from 7.6 m (2 dRMS) to 6.0 m (2 dRMS) in another.

## GLIDE (Relative Mode PDP)

### About GLIDE

GLIDE is a PDP mode that is tuned and optimized for error consistency rather than absolute accuracy. It is therefore intended for users who prefer precision over accuracy, and for applications that do not require long-term repeatability.

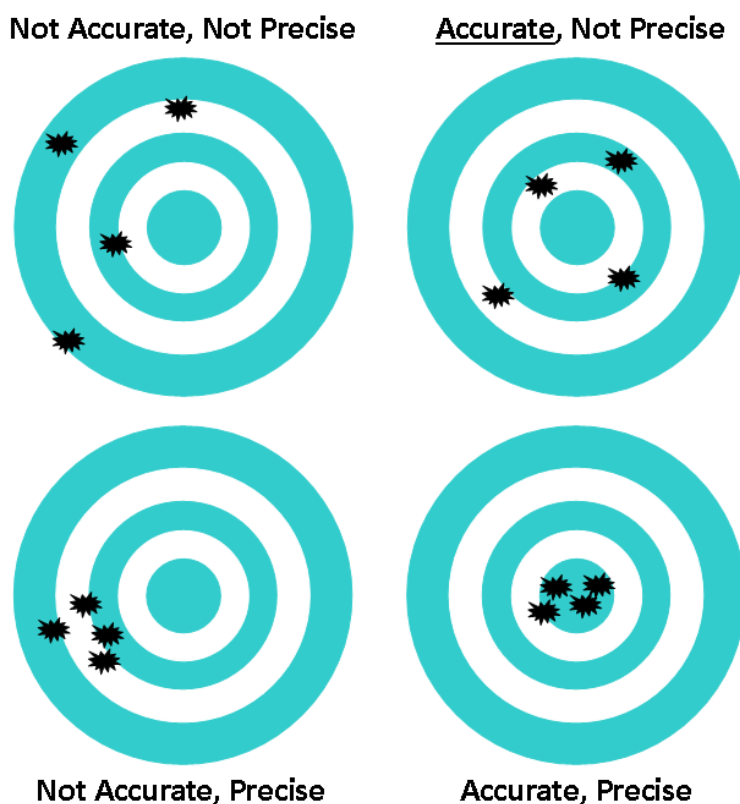


Figure 7: Precision versus Accuracy

GLIDE combines code, phase, and Doppler measurements from each satellite.

- Code: accurate but not precise
- Phase: precise but not accurate

While normal mode PDP optimizes a solution in multiple conditions, GLIDE is designed for one major purpose – position smoothing to provide accurate “pass-to-pass”<sup>1</sup> performance. This is ideally in clear sky conditions where the user needs a tight, smooth, and consistent output. An example of an application for which GLIDE is optimized is shown in Figure 8 below.

<sup>1</sup> The term “pass-to-pass” is used to describe a standard 15 minute time frame for evaluating relative accuracy. The idea is that in 15 minutes, in an agricultural application, the user will have completed one pass of a field, or a portion thereof, and be separated from the starting location by a fixed path width plus a position error. The purpose of GLIDE is to minimize the change in error over time (ie: 15 minutes).



Figure 8: Broad Acre Farming and Pass-to-Pass Example

Normal mode PDP is smoother than a least squares fit but is still noisy in places. GLIDE produces a very smooth solution with consistent rather than absolute position accuracy. See Figure 9 on page 12 for a comparison of a least squares, PDP, and GLIDE solution. Using GLIDE significantly reduces the variation in position errors to less than 1 cm from one epoch to the next. GLIDE works with single point, DGNSS and SBAS modes and can use signals from GPS, GLONASS and BeiDou constellations when available.

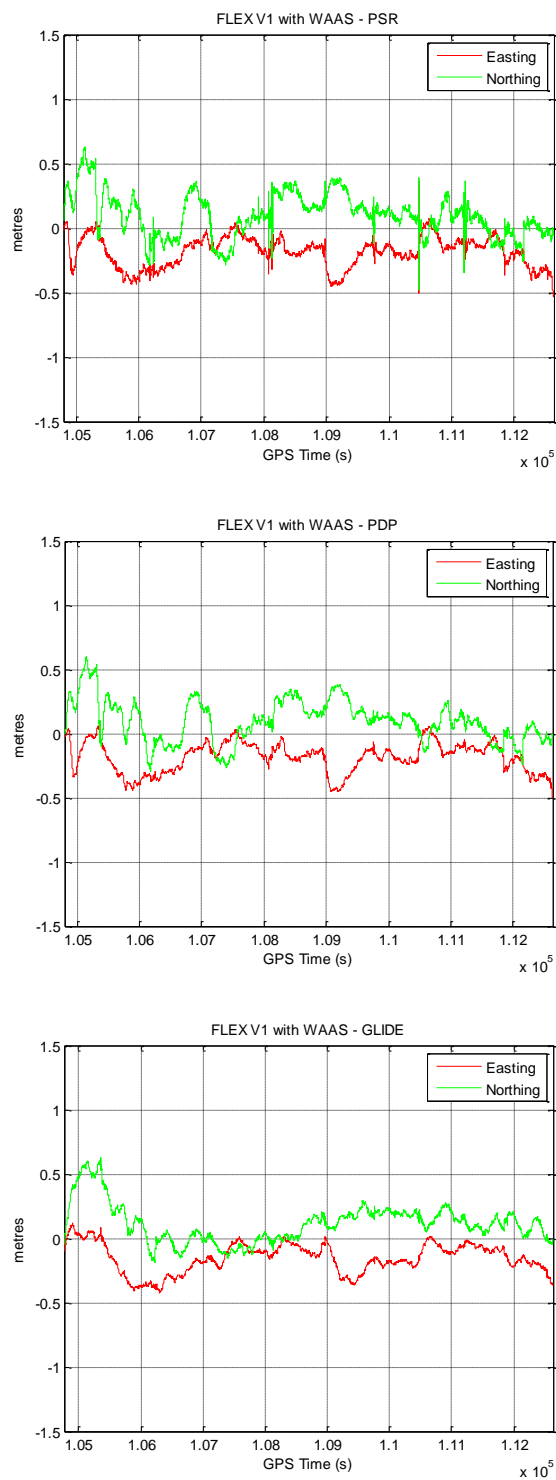


Figure 9: Position Error with WAAS for Least Squares (PSR) vs. PDP vs. GLIDE

For the comparisons above, we used a FlexPak-V1 receiver with a GPS-702-GGL antenna mounted on a vehicle traveling east to west at speeds of 5 to 12 km/hour. We collected approximately 2 hours of data. Notice how the PDP solution is much less noisy than the least-squares pseudorange (PSR) solution. Then, the GLIDE solution is even smoother.

The GLIDE effect is most noticeable when using a SMART-V1 antenna, which has a lower quality antenna than the 700-series antenna we used in the above comparison. Its PSR solution is much noisier and the GLIDE solution smoothes it exceptionally well. Please refer to our GLIDE white paper, available on our website at <http://www.novatel.com/products/whitepapers.htm>, for more results and comparisons using different products.

Consider the case of an agricultural user plowing rows in a field. This user, with clear skies, prefers to have minimal differences in position between now and 15 minutes ago rather than knowing the exact position to within millimeters. See Figure 10 below.

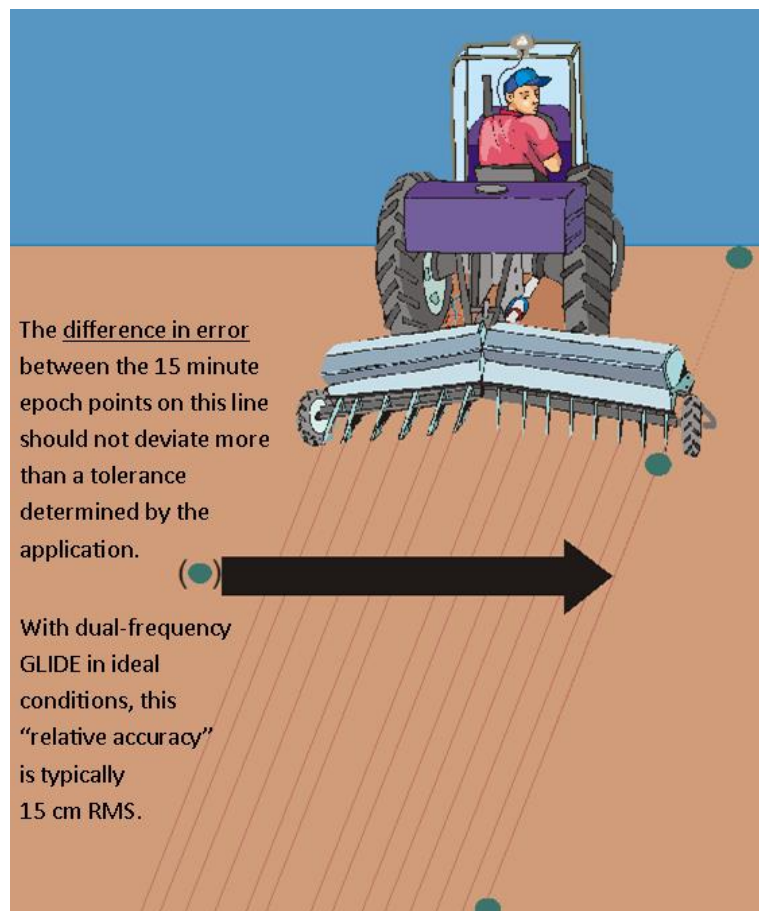


Figure 10: Agricultural User and GLIDE

## Dual-Frequency GLIDE

Introduced in firmware version 6.200 (OEM060200RN0000) for OEM6® receivers is dual-frequency GLIDE. This new functionality, available with dual-frequency receiver models, uses both code and phase measurements from L1 and L2 signals to compensate for delays due to the signals passing through the ionosphere. Ionospheric delay is typically the largest error source in GNSS positioning.

- Single-frequency (L1) GLIDE uses models to estimate the ionospheric delay.
- Dual-frequency (L1+L2) GLIDE uses measurements to compute the delay.

Dual-frequency GLIDE improves the absolute and relative (pass-to-pass) accuracy of the GLIDE position and creates a robust solution, resistant to the effects of high ionospheric activity. Figure 11 below illustrates the evolution of GLIDE using data collected in a high-ionospheric environment. The plots specifically highlight the benefits of dual-frequency GLIDE for pass-to-pass performance.

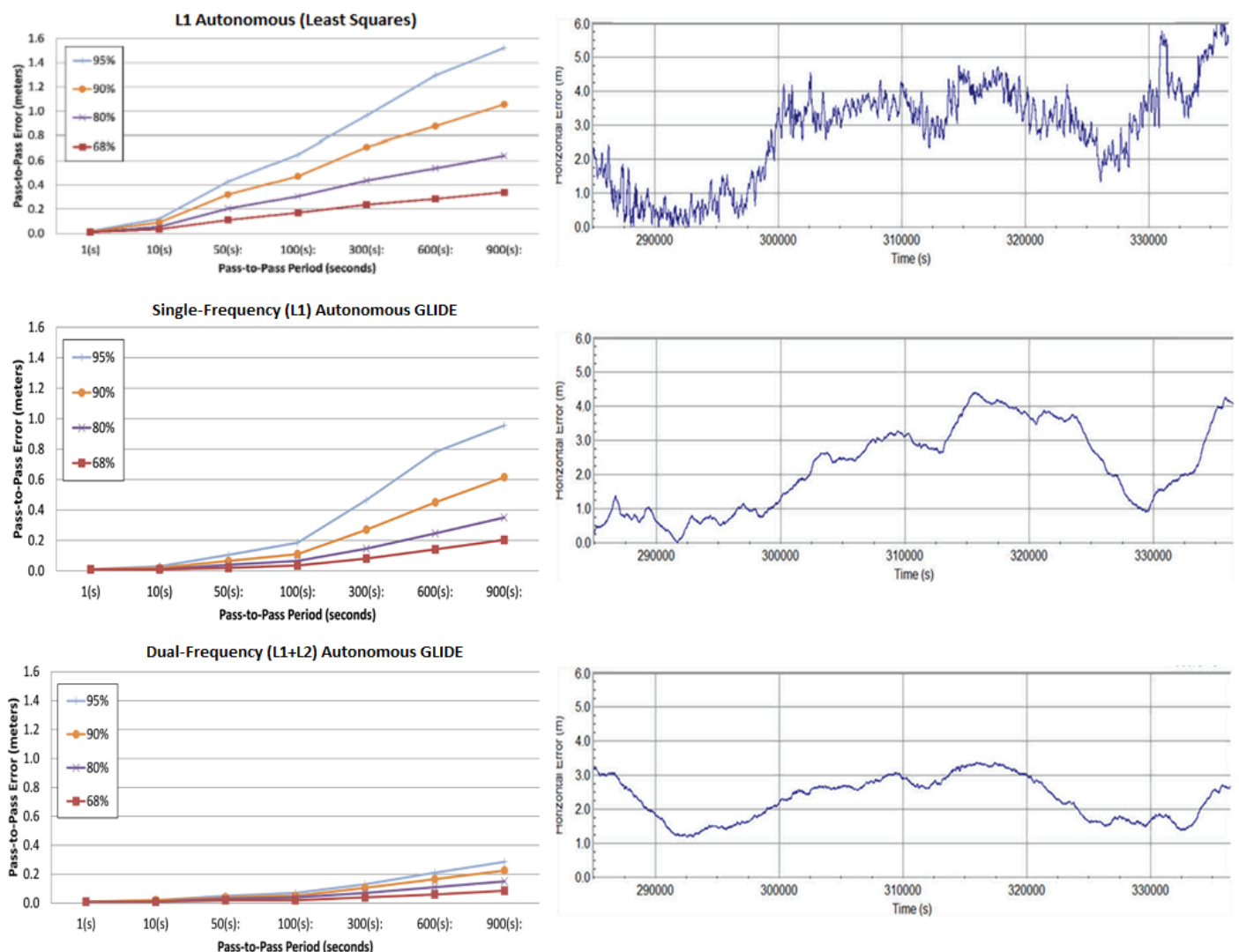


Figure 11: GLIDE Pass-to-Pass Performance Comparison in High Ionospheric Activity

In challenging ionospheric environments, the dual-frequency GLIDE solution maintains solid pass-to-pass performance compared to other solutions. It is important to note that the key objective achieved with GLIDE is a smooth solution with good time-relative accuracy which can sometimes be at the expense of absolute accuracy. The GLIDE solution can have a bias which can be compensated for with steering and guidance systems.

## GLIDE Initialization

When the receiver is first configured for GLIDE, it will operate in normal mode PDP for a period of time until GLIDE has initialized. The initialization period allows the receiver to improve the absolute accuracy and gather SBAS corrections if SBAS has been enabled<sup>2</sup>.

It is important to have open sky conditions during initialization although the antenna can be moving or stationary. When using the automatic dynamics setting, it can be beneficial to remain stationary during initialization to take advantage of the auto-detection of dynamics for improved absolute accuracy. The default GLIDE initialization time is 300 seconds, but it can be adjusted using the GLIDEINITIALIZATIONPERIOD command (page 22) in special cases. At the same time, the startup time for an SBAS solution is 3-5 minutes to allow for a full set of SBAS ionospheric grid corrections to be received.

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<sup>2</sup> To enable SBAS tracking, use the SBASCONTROL command. See [www.novatel.com/assets/Documents/Manuals/om-20000129.pdf](http://www.novatel.com/assets/Documents/Manuals/om-20000129.pdf) for more details.

## Using PDP/GLIDE

### Hardware Requirements

Normal mode PDP is available on all OEMStar and OEM6 receivers. GLIDE is also available on both platforms but a specific model option is required.

### Firmware Requirements

All OEMStar and OEM6 firmware versions support single-frequency GLIDE and PDP mode. To take advantage of dual-frequency GLIDE on OEM6 receivers, version 6.200 (OEM060200RN0000) or later is required along with dual-frequency receiver and antenna hardware.

For best performance and solution availability on either platform, a model enabled for both GPS and GLONASS is required. In regions where SBAS corrections are available, PDP and GLIDE are able to continue using GLONASS satellites in the solution even though current SBAS systems do not provide corrections for those satellites. For users operating in mature SBAS regions, such as WAAS or EGNOS, it is recommended to always enable SBAS along with PDP or GLIDE for best overall accuracy.

### OEM6

Based on the OEM6 model structure, firmware model option 6 must be enabled (“G” or “R”) to use GLIDE on OEM6 receivers. For example:

- OEM615-G1S-00**G**-OT0
- SM6L-D2L-OP**G**-OT0
- PP6-D2J-RP**R**-TTN

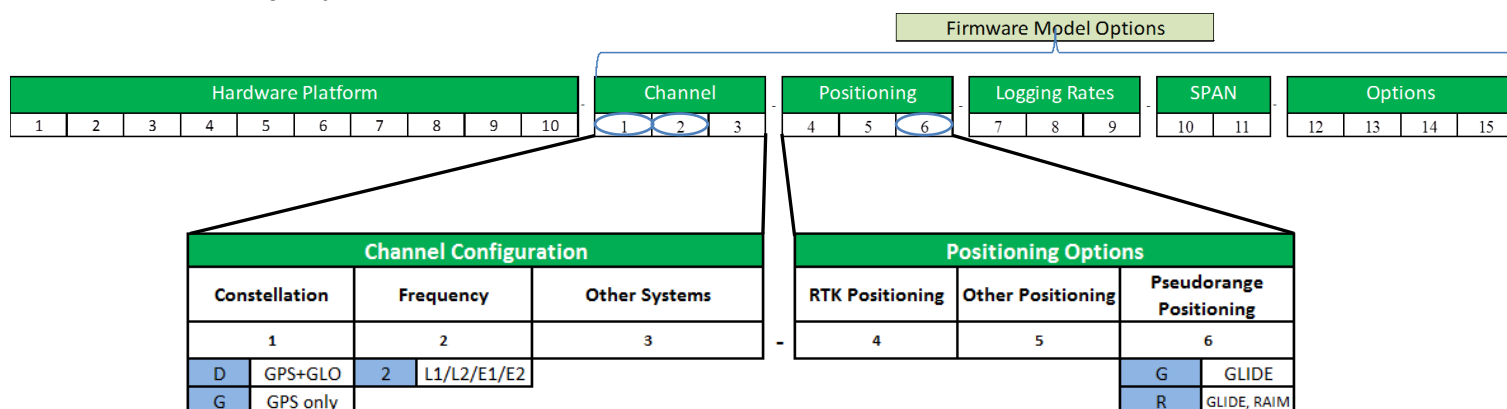


Figure 12: OEM6 Model Structure & Firmware Model Options Required for GLIDE

Channel configuration options for dual-frequency (L1 & L2) tracking must be included in the model to use dual-frequency GLIDE, as well as GPS+GLONASS tracking to take advantage of both constellations. To allow for this, the first two firmware options must be “D” and “2” as shown in the examples and in Figure 12.



There are many other OEM6 firmware model options available, such as those that enable NovAtel's ALIGN®, RTK, API, SPAN, etc., but the options mentioned above are the minimum requirements to use GLIDE.

To verify the model currently loaded and being used on a receiver, use the command "LOG VERSION" to output the version information. For example:

```
<VERSION COM1 0 83.0 FINESTEERING 1786 421494.851 00000020 3681 13498
< 1
< GPSCARD "D2LRPGTT0" "BFN11210275" "OEM628-1.01" "OEM060620RN0000"
"OEM060200RB0000" "2015/Jul/08" "16:47:41"
```

In this example, the model options indicate the following:

- Channel configuration options allow tracking of:
  - D: GPS+GLONASS
  - 2: L1/L2/E1/B1 signals
  - L: SBAS/L-Band
- Positioning options available:
  - R: RTK Fixed, RTK Float, RTK Tx (transmit), DGPS Tx/Rx (transmit/receive)
  - P: PPP
  - **G: GLIDE**

## OEMStar

For OEMStar and Ag-Star receivers, the model structure is simpler but the model must include the “S” option to allow the use of GLIDE.

Table 5: Position Types by Log

Designator	Description
G	L1 GLONASS channels, frequencies to match GPS configuration
D	Transmit DGPS corrections
M	Measurements
T	10 Hz logging
S	GLIDE
A	API
I	Raim

Some examples are provided in Table 6.

Table 6: Example Models with Corresponding Marketing Name

Marketing Name	Receiver Software Model
OEMSTAR-10HZ	LXMTS
OEMSTAR-10HZ-G	LXGMTS
AG-STAR-10HZ-G	LXGMTSA

OEMStar models with “PVT” in the marketing name, such as “OEMSTAR-PVT-1HZ” (M6XV1G or LX as reported by the receiver), support normal mode PDP only and not GLIDE.

The VERSION log can be requested from an OEMStar receiver to verify the model currently loaded.

Example:

```
<VERSION COM1 0 65.5 FINESTEERING 1878 234092.513 00000000 3681 12778
< 1
< GPSCARD "LXGMTS" "BHD10040038" "M6XV1G-1.01-TT" "L6X010201RN0000" "1.001"
"2014/Feb/27" "16:49:20"
```

## Configuring a Receiver

### Enable the PDP Filter

By default, the PDP filter is disabled on OEM6 receivers. To enable the filter, the “PDPFILTER” command is used. On OEMStar and AG-STAR, the filter is enabled in normal mode by default.

To enable the PDP filter:

**PDPFILTER ENABLE**

The command above is required for both normal mode PDP and GLIDE. The mode used depends on the “PDPMODE” command setting which is described in the next section. The PDPFILTER command must be used first.

### Specify the PDP Mode

Once enabled, the “PDPMODE” command is used to specify the operating mode and dynamics of the PDP filter. By default, the filter mode is “normal” and the dynamics is “auto”.

The “PDPFILTER” command must be sent first, before modifying “PDPMODE” settings.

#### *NORMAL Mode*

To select normal mode PDP with automatic dynamics, this is the required command:

**PDPMODE NORMAL AUTO**

The above command is also the default setting for PDPMODE.

#### *GLIDE/RELATIVE Mode*

For GLIDE (also known as “relative” mode), the PDPMODE command supports two options:

**PDPMODE RELATIVE [dynamics mode] or PDPMODE GLIDE [dynamics mode]**

There is no difference between “GLIDE” and “RELATIVE” in terms of the PDPMODE command. However, some users may prefer to use “GLIDE” as it is most intuitive and direct in its name.

#### *Dynamics Mode*

In most cases “auto” is the recommended setting and will provide optimum PDP performance for both normal and GLIDE modes. However, the dynamics mode can also be explicitly set to “static” or “dynamic” for applications that require it. For example, these are some exceptions where the mode should explicitly be set to “dynamic” or “static”:

- In applications with extremely slow motion (movement at less than a 2 cm/s for a number of seconds) it is best to use the “dynamic” setting.
- In extremely noisy environments with high logging rates (10 or 20 Hz) “static” mode can be selected when the user knows they are stationary.

## Verify the PDP/GLIDE Position

To verify the availability of a PDP position solution, either normal mode or GLIDE, the following position logs can be output using the “LOG” command:

- PDPPPOS
- PDPXYZ
- BESTPOS
- GPGBA

For example, the following command will request the PDPPPOS log in binary format on the Com1 port with a rate of 2 Hz:

**LOG COM1 PDPPPOSB ONTIME 0.5**

The PDPPPOS log will always output the PDP solution when available, whereas the BESTPOS and GPGBA logs will output the “best available” solution. When using BESTPOS or GPGBA logs, another solution can be output in some cases. The receiver uses the estimated standard deviations, based on the “SETBESTPOSCRITERIA” command setting<sup>3</sup>, to determine the “best” solution available. By default, the receiver will use the three dimensional standard deviation.

For BESTPOS and PDPPPOS logs, the “extended solution status” can be used to determine when GLIDE has initialized. See PDPPPOS (page 24) for more details.

## Using GLIDE with STEADYLINE™

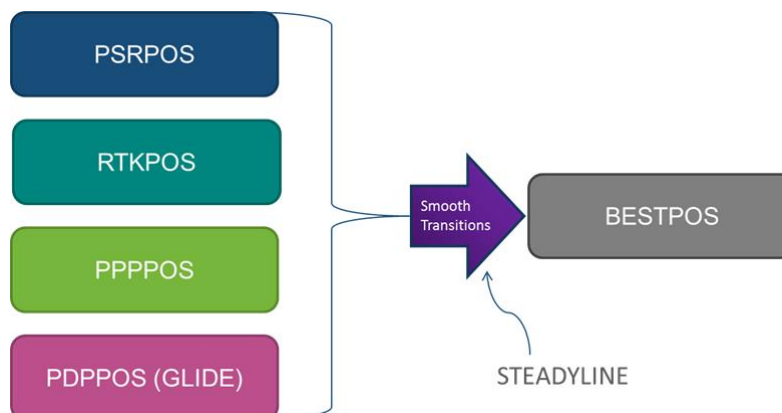
The stability and pass-to-pass performance of GLIDE make it an optimal fallback when using higher accuracy solutions such as RTK. However, for GLIDE to be available when necessary, it must be enabled in the background even if the GLIDE solution is not the best available.

NovAtel receivers have multiple positioning filters or “engines” that can run simultaneously and the “BEST” filter will select and provide the best solution based on variance and availability. Offsets or “biases” between the solutions can cause position “shifts” when directly switching between solutions from different filters. STEADYLINE<sup>4</sup> is a feature that handles such position shifts and operates as the last step before populating the BESTPOS log.

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<sup>3</sup> See [www.novatel.com/assets/Documents/Manuals/om-20000129.pdf](http://www.novatel.com/assets/Documents/Manuals/om-20000129.pdf) for the SETBESTPOSCRITERIA definition.

<sup>4</sup> See OM-20000129 (previous link) for details on STEADYLINE.



**Figure 13: Position Engines and STEADYLINE**

In cases where a receiver is configured for RTK and there is an outage in the radio link, STEADYLINE will use the next available solution to either maintain the RTK path until the corrections come back or provide the smoothest transition possible between the RTK and GLIDE trajectories. The receiver must be initially configured with GLIDE and STEADYLINE enabled to take advantage of this functionality when necessary.

The effects of STEADYLINE can be especially evident in cases where the RTK solution is biased due to an offset in the base station coordinate or the use of different reference datums. In those cases, using STEADYLINE and GLIDE with RTK can prevent large position jumps in the BESTPOS solution in the event that RTK is lost.

## Commands

All of the commands and logs mentioned in this document are described in full detail in the OEM6 Firmware Reference Manual ([www.novatel.com/assets/Documents/Manuals/om-20000129.pdf](http://www.novatel.com/assets/Documents/Manuals/om-20000129.pdf)).

### BESTVELTYPE

The BESTVELTYPE can be used to configure the source of the velocity that is output in the BESTVEL and GPVTG logs. With the default setting of “BESTPOS”, the BESTVEL and GPVTG logs will contain the velocity associated with best solution available. If the PDP solution is currently the best available, the velocity will come from a delta-position calculation and is typically more latent than other solutions due to additional filtering.

Some applications require a low-latency velocity and in those cases it can be beneficial to always output a Doppler velocity since it is the lowest latency velocity available from the receiver. To always output the Doppler velocity, regardless of the source of the position solution in BESTPOS, use the following command:

#### **BESTVELTYPE DOPPLER**

Otherwise, this is the default setting:

#### **BESTVELTYPE BESTPOS**

### GLIDEINITIALIZATIONPERIOD

The GLIDEINITIALIZATIONPERIOD command is an advanced setting that can be used in special cases to adjust the length of time GLIDE takes to initialize. The setting can be increased to as much as 20 minutes in environments with very high multipath. The default setting is 300 seconds.

#### **GLIDEINITIALIZATIONPERIOD 300**

When using the automatic dynamics setting, GLIDE will perform a static initialization for as long as the user remains static. If the user begins to move before the initialization period is up, GLIDE will continue with a dynamic initialization until the initialization time is complete.

Increasing the initialization period will delay the transition of the PDP filter from normal mode to GLIDE. The added delay can help improve the absolute error as much as possible before changing to GLIDE where pass-to-pass accuracy is preferred. Decreasing the initialization period will shorten the time before the PDP filter will transition to GLIDE mode. However, doing so can result in degraded absolute accuracy of the GLIDE solution when initialized. It is recommended to only increase or decrease the initialization period in special cases, or for testing, and only if the application can tolerate the resulting behaviour.

## **PDPFILTER**

The PDPFILTER command is used to enable the PDP filter and must be used before modifying PDP mode settings. PDPFILTER is disabled by default on OEM6 receivers but is enabled by default on OEMStar and AG-STAR products. The command to enable the PDP filter is:

### **PDPFILTER ENABLE**

In special cases the PDPFILTER command can also be used to reset GLIDE to remove any accumulated biases, but doing so will cause a re-initialization of the filter. The command to reset the PDP filter is:

### **PDPFILTER RESET**

## **PDPMODE**

Once the PDP filter has been enabled with the PDPFILTER command, the PDPMODE command is used to specify the PDP mode (normal or GLIDE) and the dynamics setting. The default setting is normal mode with automatic dynamics.

### **PDPMODE NORMAL AUTO**

For GLIDE, the mode can be specified as “RELATIVE” or “GLIDE”. For example:

### **PDPMODE GLIDE DYNAMIC**

In most cases “auto” is the recommended dynamics setting and will provide optimum PDP performance for both normal and GLIDE modes. However, the dynamics mode can also be specifically set to “static” or “dynamic” for applications that require it. For example, these are some exceptions where the mode should explicitly be set to “dynamic” or “static”:

- In applications with extremely slow motion (movement at less than a 2 cm/s for a number of seconds) it is best to use the “dynamic” setting.
- In extremely noisy environments with high logging rates (10 or 20 Hz) “static” mode can be selected when the user knows they are stationary.

## Logs

Any of the logs described below can be output using the LOG command. Appending an “A” or a “B” to the log name when sending the LOG command will output the message in full ASCII (examples below are ‘abbreviated’ ASCII) or binary respectively. For example, the command “LOG PDPPOSB” will log the PDPPOS log in binary format.

For complete details about the LOG command, including how to specify the data rate/interval and trigger, see the LOG command definition in the OEM6 Firmware Reference Manual ([www.novatel.com/assets/Documents/Manuals/om-20000129.pdf](http://www.novatel.com/assets/Documents/Manuals/om-20000129.pdf)).

## PDPPOS

The PDPPOS log contains the position solution computed specifically by the PDP filter. For example:

```
<PDPPOS COM1 0 67.0 FINESTEERING 1878 235100.000 00000000 21dc 12778
< SOL_COMPUTED SINGLE 51.11680432844 -114.03886985769 1063.5435 -16.9000 WGS84
0.2878 0.2126 0.4029 "" 0.000 0.000 14 14 0 0 0 12 00 11
```

The 19<sup>th</sup> field after the header in the PDPPOS log (also included in BESTPOS) is the “Extended Solution Status”. Bit 0 of this field indicates when the solution is a GLIDE solution. When that bit is not set, the solution will be a normal mode PDP solution. In the above example, the extended solution status is “12”, which means that the receiver is in normal mode PDP. Here is another example with a GLIDE solution:

```
<PDPPOS COM1 0 58.5 FINESTEERING 1878 247099.000 00000000 21dc 12778
< SOL_COMPUTED WAAS 51.11679370493 -114.03886763918 1064.4956 -16.9000 WGS84
0.3994 0.2571 0.5246 "138" 4.000 0.000 14 12 0 0 0 1b 00 11
```

The possible position types associated with a PDP solution (GLIDE or normal mode) are outlined in Table 7 below. Note that the BESTPOS log will report the same position types when the PDP solution is the best available.

Table 7: PDPPOS Position Types with Equivalent GPGGA Quality Indicator Values

PDPPOS Type	GPGGA Quality	Description
NONE	0	No solution
SINGLE	1	Autonomous or “single point”
WAAS	9 <sup>5</sup>	SBAS solution (EGNOS, WAAS, etc.)
PSRDIFF	2	Differential (DGPS) solution
PROPAGATED	6	Propagated solution using previous velocity

When there are significant signal blockages, such as those caused by trees, the previous velocity can be used by the PDP filter to provide a propagated solution for a brief period of time.

<sup>5</sup> NovAtel labels SBAS solutions with a value of 9 by default, but the GGAQUALITY command can be used to remap the GPGGA quality indicator. See [www.novatel.com/assets/Documents/Manuals/om-20000129.pdf](http://www.novatel.com/assets/Documents/Manuals/om-20000129.pdf) for more details.



## PDPSATS

This log provides a list of the used and unused satellites for the corresponding PDPPPOS solution. The signals of the used satellites are also described, along with the reasons for exclusions.

For example:

```
<PDPSATS COM1 0 63.5 FINESTEERING 1878 234901.000 00000000 be33 12778
< 14
< GPS 21 GOOD 00000001
< GPS 20 GOOD 00000001
< GPS 22 GOOD 00000001
< GPS 15 GOOD 00000001
< GPS 10 GOOD 00000001
< GPS 27 GOOD 00000001
< GPS 14 GOOD 00000001
< GPS 24 GOOD 00000001
< GPS 8 GOOD 00000001
< GPS 18 GOOD 00000001
< GLONASS 21+4 GOOD 00000001
< GLONASS 7+5 GOOD 00000001
< GLONASS 22-3 GOOD 00000001
< GLONASS 6-4 GOOD 00000001
```

## PDPVEL

This PDPVEL log contains the velocity computed by the PDP filter when it is enabled. For example:

```
<PDPVEL COM1 0 69.5 FINESTEERING 1878 411638.000 00000000 2208 12778
< SOL_COMPUTED SINGLE 0.250 0.000 1.5208e-08 348.658906 4.4341e-10 0.0
```

## PDPXYZ

The PDPXYZ log contains the Cartesian position and velocity in X, Y and Z coordinates as computed by the PDP filter when it is enabled. For example:

```
<PDPXYZ COM1 0 70.5 FINESTEERING 1878 411641.000 00000000 6750 12778
< SOL_COMPUTED SINGLE -1634550.4061 -3664567.9584 4942526.7319 0.2971 0.4434
0.3632 SOL_COMPUTED SINGLE 0.0000 0.0000 0.0000 0.0011 0.0011 0.0011 "" 0.250 0.000
0.000 12 12 0 0 0 1b 00 11
```

This log also contains corresponding standard deviations (X, Y and Z components) for the position and velocity.

## Additional Information and Recommendations

In general, with any NovAtel product, it is recommended to use normal mode PDP as a minimum when operating in autonomous or SBAS modes.

While GLIDE is optimized for agriculture, specifically open-sky conditions, “normal mode” PDP can provide good performance in cases where a constant clear view of the sky is not possible. For example, small fields that are lined with tall trees can cause frequent or extended (and significant) signal blockages for a GNSS receiver. Such blockages can result in extra biases in GLIDE that can be undesirable for some applications. This can be especially evident when turns at tree lines (headland turns) are combined with a change in dynamics. As well, headland turns can be multi-point which can increase signal blockages due to extended time spent in close proximity of trees. In some cases, normal mode PDP can provide better performance in those conditions. However, GLIDE is still recommended if pass-to-pass accuracy is crucial for the application.

To provide the best performance with GLIDE:

- Ensure the antenna is located in an area that has a clear view of the sky with no obstructions, especially during initial startup and initialization.
- If the vehicle and antenna can and will be stationary during convergence, use the “AUTO” setting for PDPMODE (page 23) to take advantage of automatic dynamics detection and filtering.
- Use SBAS or DGNSS corrections when available.
- Select a high quality antenna with good multipath rejection capabilities, such as NovAtel’s Pinwheel™ antennas.
  - An agricultural environment can often have multiple sources of multipath, including surfaces of surrounding machinery, trees, buildings, etc.

## Where to go for Support

To help answer questions and/or diagnose any technical issues that may occur, the NovAtel Support website is a first resource: [www.novatel.com/support/](http://www.novatel.com/support/).

Remaining questions or issues can be directed to NovAtel Support by visiting [www.novatel.com/support/contact/](http://www.novatel.com/support/contact/). To enable the online form and submit a ticket, first select a "Product Line" and then an associated "Product" from the list.

However, before contacting Support, it is helpful to collect data from the receiver to help investigate and diagnose any performance-related issues. In those cases, if possible, collect the following list of logs (the LOG command with the recommended trigger and data rate is included):

```
LOG VERSIONA ONCE
LOG RXSTATUSA ONCHANGED
LOG RAWEPHEMB ONCHANGED
LOG ALMANACB ONCHANGED
LOG IONUTCb ONCHANGED
LOG GLORAWEPHEMB ONCHANGED
LOG GLORAWALMB ONCHANGED
LOG GLOCLOCKB ONCHANGED
LOG RANGEb ONTIME 1
LOG BESTPOSb ONTIME 1
LOG PDPOSb ONTIME 1
LOG PDPSATSB ONTIME 1
```

The data described above can be collected using a terminal program that supports binary data logging, or NovAtel's CONNECT utility can be downloaded and installed from the NovAtel website: [www.novatel.com/support/info/documents/809](http://www.novatel.com/support/info/documents/809)

