APN-061:
NovAtel CORRECT™ with TerraStar

NovAtel CORRECT™ with TerraStar

Contents

April 8, 2014

What is NovAtel CORRECT™?

NovAtel CORRECT optimally handles multiple GNSS satellite constellations and corrections, from a variety of sources, to deliver the best positioning solution possible. GPS, GLONASS, Galileo, BeiDou, L-Band or NTRIP—NovAtel CORRECT manages it all.

Providing a single source of GNSS hardware, correction services and support, NovAtel CORRECT simplifies the process of acquiring decimetre-level or better positioning. Most importantly, it exemplifies NovAtel's OEM partnership model by offering machine manufacturers and system integrators flexible, scalable and competitive positioning technology with great opportunity for future innovation. For more details on NovAtel CORRECT, visit our website: www.novatel.com/products/novatel-correct/

RTK Corrections →
PPP Corrections →   OEM6 with   → Centimetre Solution
SBAS Corrections →   NovAtel CORRECT™   → Decimetre Solution
                                               → Metre Solution

Figure 1: NovAtel CORRECT

What is PPP?

Precise Point Positioning (PPP) is a positioning method that uses precise GNSS orbit and clock corrections to obtain a solution with decimetre-level accuracy. A PPP solution can be obtained either through post-processing or in real-time. NovAtel CORRECT offers an innovative, real-time PPP solution designed for NovAtel OEM6® receivers with no additional base station infrastructure required.

Acquiring a real-time decimetre-level PPP solution depends on the reception of GNSS satellite clock and orbit corrections, which are generated from a network of global reference stations. Once the corrections are calculated, they are delivered to the end user via satellite or over the Internet. These corrections are used by NovAtel CORRECT on a dual-frequency OEM6 receiver, resulting in decimetre-level or better positioning with no user-supplied or local base station required.

A typical PPP solution requires a period of time to resolve any local biases and converge to decimetre accuracy. The actual accuracy achieved and the convergence time required is dependent on the quality of the corrections and how they are applied in the receiver, as well as the local observing conditions.

NovAtel CORRECT with TerraStar is NovAtel's satellite (L-Band) delivered PPP solution that is available for land, airborne and near-shore applications[1], providing up to 6 cm of horizontal accuracy (95%)[2]. For more details, see the NovAtel CORRECT with PPP data sheet:
www.novatel.com/assets/Documents/Papers/CORRECTPPP.pdf

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[1] For marine applications, refer to "APN-062 NovAtel CORRECT with Veripos" available here:
www.novatel.com/support/search/items/Application%20Note
[2] Calculated from 7 day static data collected in Calgary using GPS & GLONASS. Accuracy will vary with observing conditions.
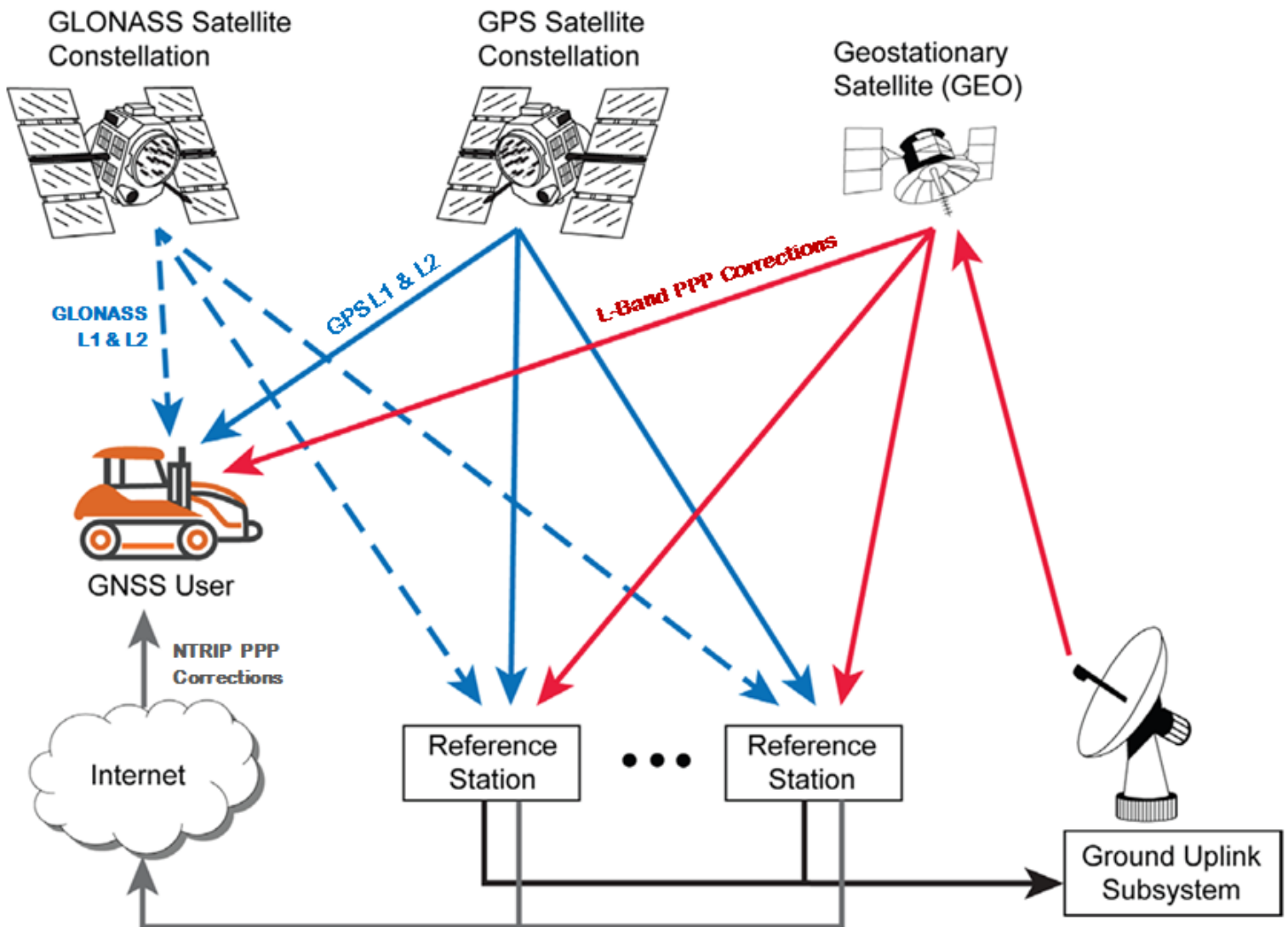
Figure 2: Typical PPP Infrastructure (L-Band & Internet Delivery)

GLONASS Satellite Constellation

GPS Satellite Constellation

Geostationary Satellite (GEO)

GLONASS L1 & L2

GPS L1 & L2

L-Band PPP Corrections

GNSS User

NTRIP PPP Corrections

Internet

Reference Station

• • •

Reference Station

Ground Uplink Subsystem

What is TerraStar?

TerraStar is a global provider of precise satellite positioning services for land and near-shore applications. TerraStar owns, operates, maintains and controls its global network of over 80 GNSS reference stations and the associated infrastructure to ensure maximum operational reliability of its augmentation services for land precise positioning[3]. Corrections provided by the network are broadcast via 7 geostationary satellites. For more information about TerraStar, visit www.terrastar.net.

TERRASTAR-D

NovAtel CORRECT with TerraStar is available using the TERRASTAR-D service for decimetre-level accuracy. TERRASTAR-D is a real-time correction service that provides GPS and GLONASS PPP corrections for use in land and near-shore applications[4].

In order to use the TERRASTAR-D service, a subscription must be purchased for each receiver. Depending on the specific needs of the application, different types of subscriptions can be purchased with flexibility in length and region. Subscriptions can be purchased with monthly, yearly or "Pay As You Go" (PAYG) options.

To purchase a TERRASTAR-D subscription, contact your NovAtel dealer or sales office[5].

Coverage

There are seven different L-Band satellites that broadcast TERRASTAR-D corrections for specific regions. The distribution of the L-Band satellites allows for dual coverage in virtually any location so information for regional subscriptions is broadcast on the two beams covering that region.
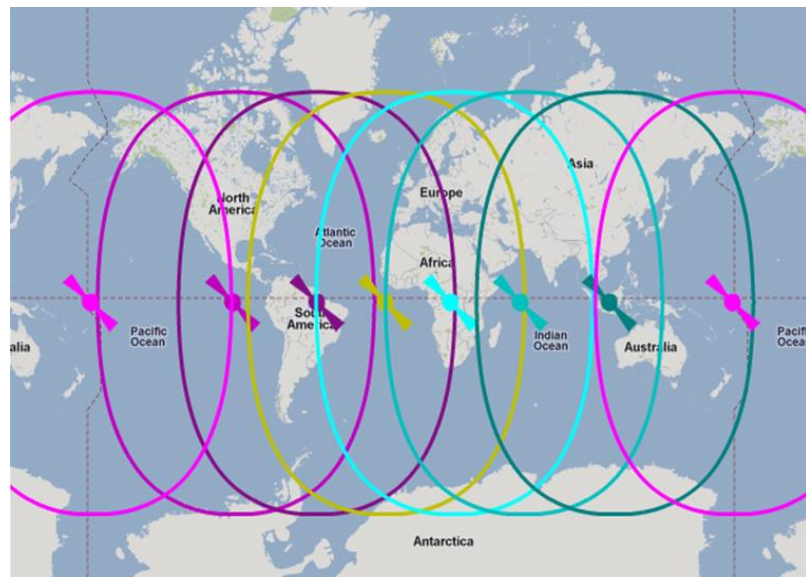
Figure 3: Global TERRASTAR-D Coverage

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[3] www.terrastar.net/about-terrastar.html
[4] For marine applications, refer to "APN-062 NovAtel CORRECT with Veripos".
[5] www.novatel.com/where-to-buy/sales-offices/

Coverage areas for specific beams can be viewed on TerraStar's website:
www.terrastar.net/coverage.html

For example, Figure 4 shows the region covered by one specific beam, "25E".

Figure 4: Example Coverage by TERRASTAR-D Beam[6]

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[6] www.terrastar.net/coverage.html

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Using TerraStar

In addition to a TERRASTAR-D subscription (see **Subscriptions**, page 12), there are specific hardware and software requirements that must be met in order to use TERRASTAR-D and obtain a PPP solution.
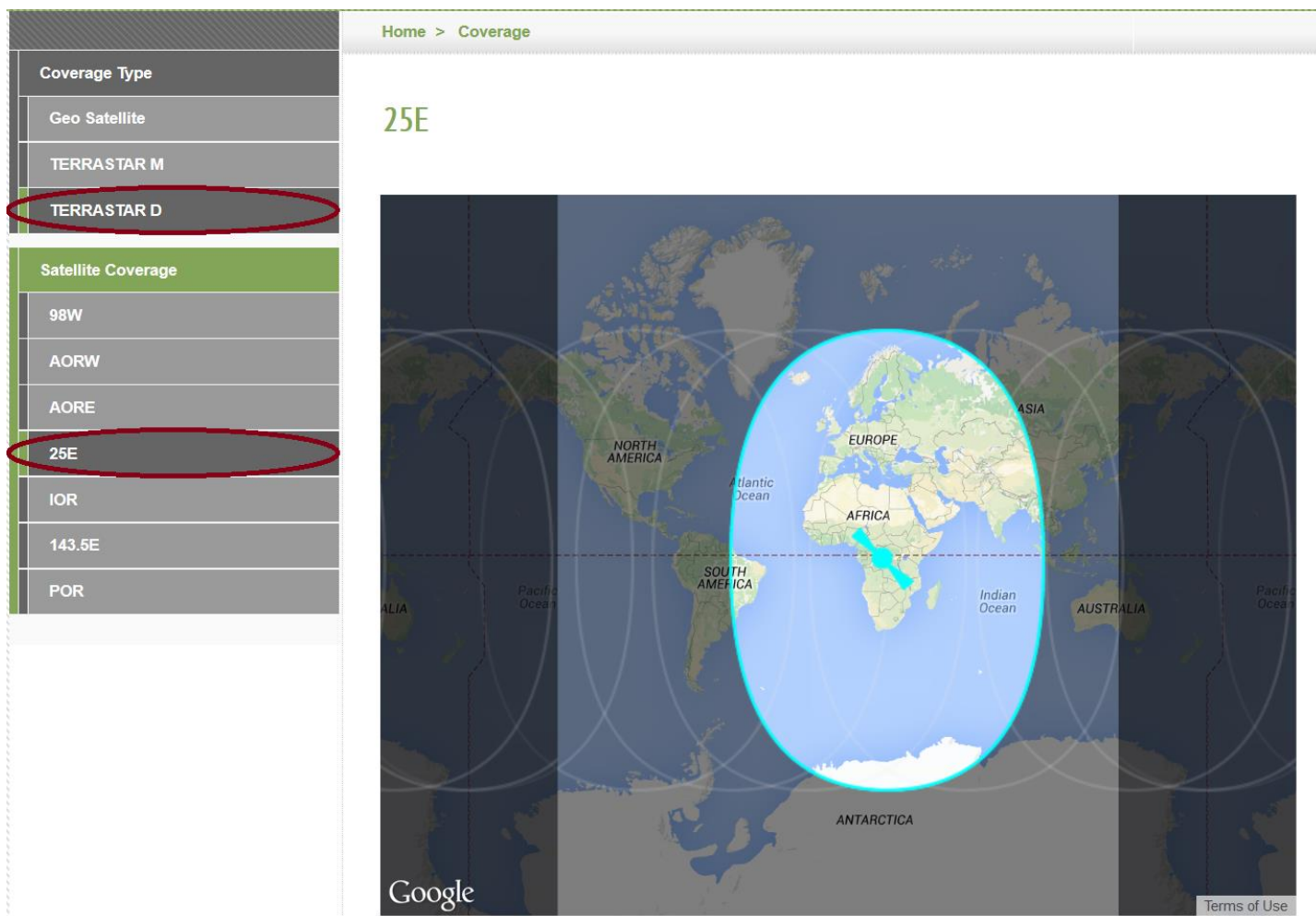
Hardware Requirements

To use TERRASTAR-D corrections and obtain the best performance, the following hardware is required:

1. NovAtel OEM6 receiver capable of L-Band tracking, as well as dual-frequency GPS and GLONASS, including:
   - Receiver cards: OEM628™, OEM638™
   - Enclosures: FlexPak6™, ProPak6™, SMART6-L™
   - SPAN® on OEM6 (OEM628, OEM638, FlexPak6 and ProPak6)
2. Dual-frequency antenna compatible with GPS, GLONASS and L-Band signals. For example:
   - GPS-702-GGL

Note that OEM615™ hardware does not support L-Band tracking and therefore does not support TerraStar. This is also true for SMART6™.

Firmware Requirements

NovAtel CORRECT is available with firmware version 6.400 (OEM060400RN0000) or later[7]. Also, specific model options are required to track and use the TERRASTAR-D service.

To track and use TERRASTAR-D, both L-Band and PPP options must be enabled. Based on the OEM6 model structure, firmware options 3 and 5 must be "L" (or "J") and "P" respectively. For example:

- OEM628-D2**L**-0**P**G-TT0
- OEM638-D2**J**-R**P**R-TTN
- SM6L-D2**L**-0**P**G-0T0
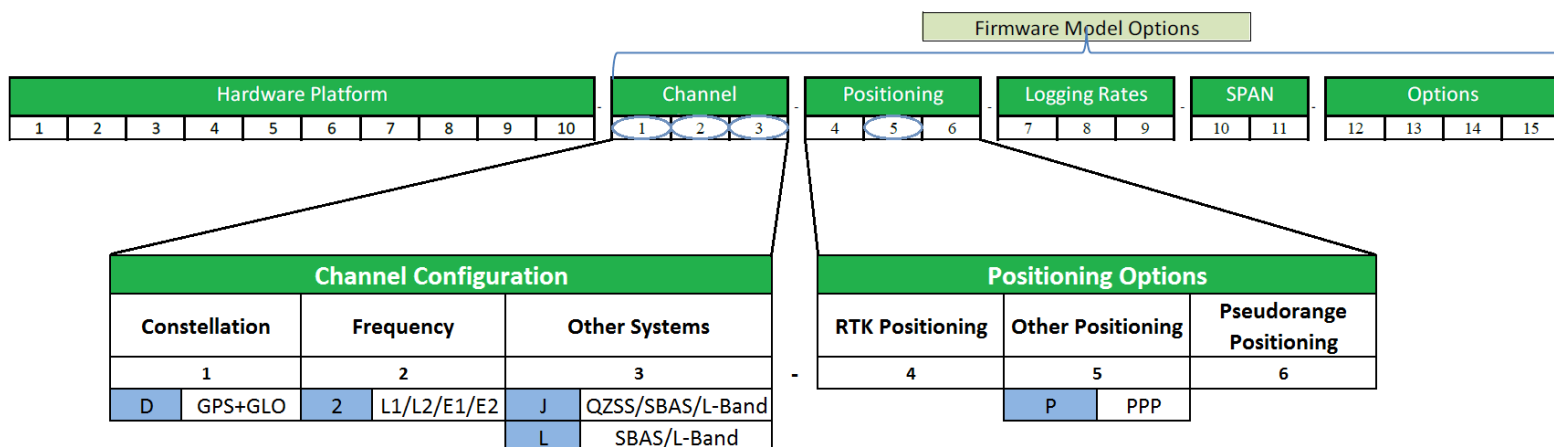

Figure 5: OEM6 Model Structure & Firmware Model Options Required for TerraStar

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[7] www.novatel.com/support/firmware-downloads

The "L" or "J" option enables L-Band tracking, and the "P" option allows the receiver to use PPP corrections, including those from TERRASTAR-D. However, the user must configure the receiver to track the TerraStar L-Band signal and a subscription must be purchased and activated before the receiver will start using the corrections and providing a PPP solution.

Channel configuration options for dual-frequency (L1 & L2) tracking must be included in the model to use TERRASTAR-D, as well as GPS+GLONASS tracking for best performance. To allow for this, the first two firmware options must be "D" and "2" as shown in the examples and **Figure 5** on page 8.

While NovAtel recommends TERRASTAR-D with GPS+GLONASS for optimal results, it is possible and still beneficial to use TERRASTAR-D with dual-frequency GPS-only receivers. A GPS-only receiver model will have a "G" in the constellation model option instead of a "D". For example: **G**2L-0PG-TT0

Stated performance specifications for NovAtel CORRECT with TERRASTAR-D are based on GPS+GLONASS operation, which is required for the best performance and convergence time. The plots on the next page show typical results using GPS-only and GPS+GLONASS with TERRASTAR-D.
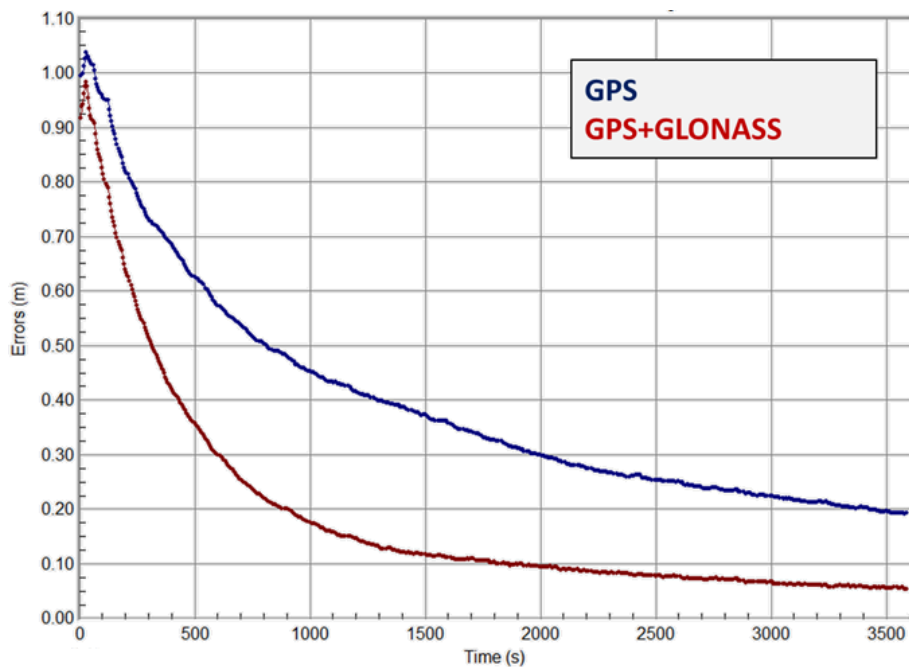
Figure 6: NovAtel CORRECT with TERRASTAR-D -- Horizontal Position Accuracy during Convergence[8]
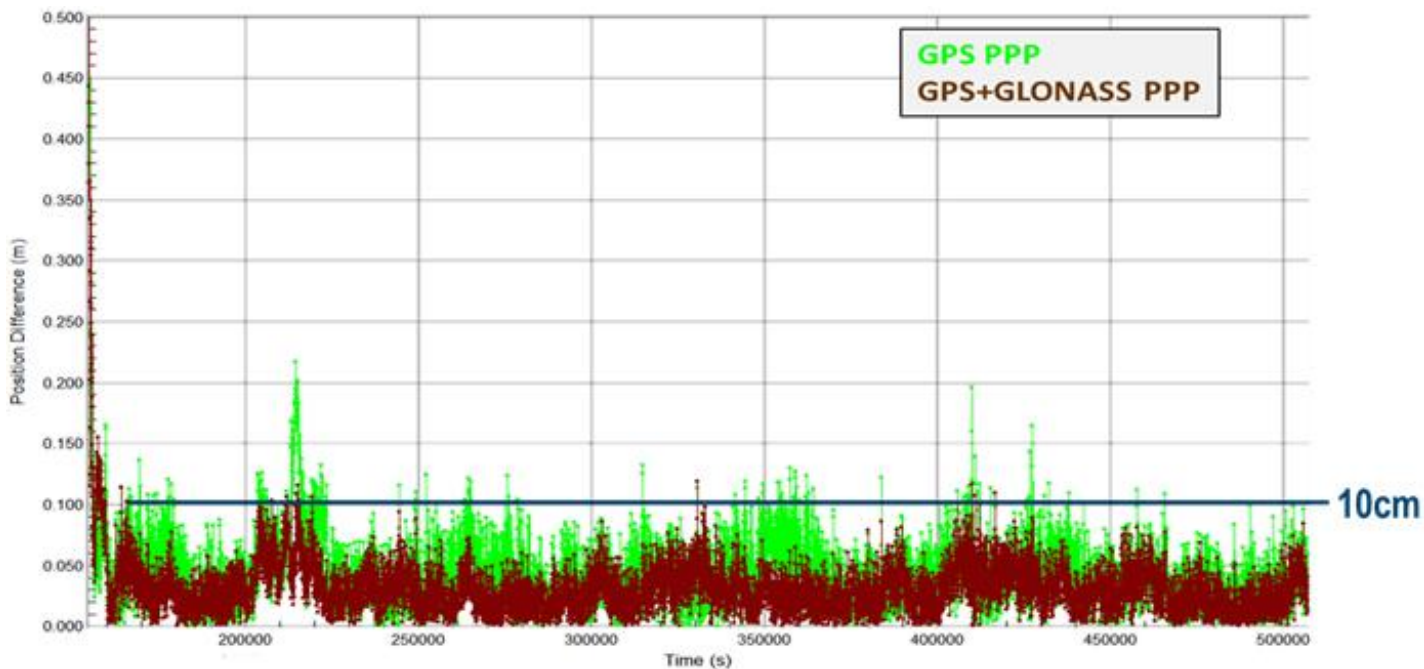

Figure 7: NovAtel CORRECT with TERRASTAR-D – Horizontal Position Accuracy with GPS-only and GPS+GLONASS[9]

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[8] Data collected over five days with solution reset every hour. Convergence is improved with GPS+GLONASS.
[9] Data collected over four days with no solution resets. Accuracy is improved with GPS+GLONASS configuration.

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There are many other OEM6 firmware model options available, such as those that enable ALIGN®, RTK, API, SPAN, etc., but the options mentioned above are the minimum requirements to track and use TERRASTAR-D corrections. In the future it is possible that corrections for additional constellations will be broadcast by TerraStar and in that case a different "constellation" option will be required in the model, as well as a compatible antenna, in order to take advantage of those corrections.

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 12832**
> **<   1**
> **<   GPSCARD "D2LRPGTT0" "BFN11210275" "OEM628-1.00" "OEM060400RN0000"**
> **"OEM060200RB0000" "2014/Mar/26" "15:24:43"**

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™

Subscriptions

To purchase a TERRASTAR-D subscription, contact your NovAtel dealer or sales office[10]. The receiver's TerraStar Product Activation Code (PAC) or the NovAtel Product Serial Number (PSN) is needed to obtain a subscription. Before contacting your NovAtel sales office, obtain the PAC and/or PSN for the receiver you wish to activate using the commands "LOG TERRASTARINFO" or "LOG VERSION" respectively. In the example VERSION log on the previous page, the PSN is "BFN11210275". An example PAC is highlighted in the TERRASTARINFO log below.

> **<TERRASTARINFO COM1 0 76.5 FINESTEERING 1785 150622.703 00000020 e776 12832**
> **<   "R244:2228:3410" TERM 00000101 0 0 0 GEOGATED 0.00000 0.00000 0**

Once a subscription is purchased, TerraStar begins broadcasting the details at a specific time. In order for the receiver to download the subscription information, it must be configured to track the TerraStar L-Band signal shortly before the activation time. However, the subscription information will be rebroadcast periodically every few hours. In those cases where the initial broadcast is missed, if the receiver remains powered on and tracking it will simply download the subscription the next time it is broadcast. This is because TerraStar re-broadcasts all known and valid subscriptions in sequence.

The steps required to configure the receiver to track and use TerraStar are described in the next sections.

To verify the TerraStar subscription and status, use the command "LOG TERRASTARSTATUS" to output the TERRASTARSTATUS log. For example:

> **<TERRASTARSTATUS COM1 0 79.0 FINESTEERING 1785 154612.705 00000020 fdc1 12832**
> **<   ENABLE LOCKED 0 DISABLED ONSHORE**

In this typical example for a term subscription, the access status is "ENABLE" indicating the subscription is valid, the TerraStar decoder is "LOCKED" onto the data stream and the geogating status is showing that the receiver is "ONSHORE". For PAYG subscriptions, the third field after the header ("0" in this example) will indicate the minutes remaining in the subscription. If activating a PAYG subscription[11], see the **TERRASTARPAYG** (page 18) command to allow the receiver to use the corrections and, therefore, use the purchased time.

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[10] www.novatel.com/where-to-buy/sales-offices/

[11] A PAYG subscription provides a set number of hours that can be used within a validity period. For example, 20 hours with a validity period of 30 days. PAYG subscriptions can be purchased directly from TerraStar.

Configuring a Receiver

Enable L-Band Tracking

Before a receiver can download the required subscription information and start using TERRASTAR-D corrections, it first must be configured to track the L-Band signal from a TerraStar geostationary satellite. To enable L-Band tracking, the "ASSIGNLBANDBEAM" command is used. The factory default setting for "ASSIGNLBANDBEAM" is "IDLE", which means that the receiver will not track an L-Band signal unless configured to do so.

To enable L-Band tracking, the "AUTO" setting is recommended in most cases. Specifically:

ASSIGNLBANDBEAM AUTO

The auto setting allows the GNSS receiver to automatically track the signal from the highest elevation TerraStar satellite for the best performance. The receiver firmware includes a default list of TerraStar satellites (see **LBANDBEAMTABLE** on page 19) and the receiver will search through the list as part of signal acquisition and tracking. To determine which TerraStar signal is the best to use in a particular location, the receiver must have a position solution available.

A manual setting is also available with the "ASSIGNLBANDBEAM" command, which allows a user to specify a specific TerraStar satellite to track. For example:

ASSIGNLBANDBEAM 98W   or   **ASSIGNLBANDBEAM MANUAL 98W**

Verify L-Band Tracking

To verify the L-Band tracking status, the "LBANDTRACKSTAT" log can be used. For example:

<LBANDTRACKSTAT COM1 0 80.5 FINESTEERING 1770 147622.000 00000020 29fd 12832
<   1
<   "98W" 1539902500 1200 974c 00c2 0 345.395 42.398 3.5073 71580.844 1363392 1168 1085 173150784 136010 0.0038

This log reports the L-Band tracking status of the TerraStar signal. Some helpful fields are highlighted above and described below:

- **98W**: This is the name of the TerraStar beam or transmitting satellite being tracked. Additional details for the tracked beam can be output and viewed with the **LBANDBEAMTABLE** log.
- **00c2**: This is the "Tracking Status Word". A tracking status of "00c2" indicates that the receiver is tracking and locked onto the TerraStar signal.
- **71580.44**: This is the "Lock Time" (in seconds). This field can be monitored to ensure that the L-Band signal is being tracked continuously without any loss of lock.

While the TerraStar signal can be tracked even without any subscription, the receiver will not decode and use the TERRASTAR-D service data until a valid subscription has been activated. See **Subscriptions**.

Obtaining a PPP Position Solution

When the receiver is configured to track the TerraStar signal and has downloaded a valid subscription, it will then begin decoding the correction data coming from the TERRASTAR-D service. Shortly after the receiver begins decoding the corrections it will automatically[12] start using the corrections to compute a PPP position solution. To verify the availability of a PPP position solution, the following position logs can be output using the "LOG" command:

- PPPPOS
- BESTPOS
- GPGGA

The PPPPOS log will always output the PPP solution when available, whereas the BESTPOS and GPGGA logs will output the "best available" solution. When using BESTPOS or GPGGA logs, another solution can be output in some cases, typically an autonomous or SBAS ("SINGLE" or "WAAS") position type, until the accuracy of the PPP solution becomes the best available. The receiver uses the estimated standard deviations, based on the "SETBESTPOSCRITERIA" command setting[13], to determine the "best" solution available. By default, the receiver will use the three dimensional standard deviation.

At first, the PPP solution will be flagged as "converging" in the position logs. After the convergence period, the position type will change to indicate a converged solution with the following position types:

Table 1: Position Types by Log

PPP Solution Status	BESTPOS/PPPPOS	GPGGA (Quality Indicator)
Converging	PPP_CONVERGING	2
Converged	PPP	5

The PPP solution will transition from "PPP_CONVERGING" to "PPP" based on the "**PPPCONVERGEDCRITERIA**" command setting. By default, the solution will be flagged as converged when the horizontal (2D) standard deviation of the solution is 0.20 meters.

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[12] For all subscriptions except PAYG. If you purchased a PAYG subscription, see the **TERRASTARPAYG** command.
[13] See www.novatel.com/assets/Documents/Manuals/om-20000129.pdf for the SETBESTPOSCRITERIA definition.

For example, when the PPP solution is converging and is the best available:

<PPPPOS COM1 0 64.5 FINESTEERING 1785 150920.000 00000020 e2df 12832
< SOL_COMPUTED PPP_CONVERGING 51.11679486247 -114.03886448423 1065.2213
-16.9000 WGS84 0.5505 0.5237 0.8792 "TSTR" 4.754 0.000 22 19 19 19 2 00 00 33

<BESTPOS COM1 0 65.5 FINESTEERING 1785 150920.000 00000020 7145 12832
< SOL_COMPUTED PPP_CONVERGING 51.11679486247 -114.03886448423 1065.2213
-16.9000 WGS84 0.5505 0.5237 0.8792 "TSTR" 4.754 0.000 22 19 19 19 0 00 00 33

$GPGGA,175504.00,5107.0077,N,11402.3319,W,2,19,0.8,1065.22,M,-16.90,M,04,TSTR*66

And when the solution has converged:

<PPPPOS COM1 0 63.5 FINESTEERING 1785 152400.000 00000020 e2df 12832
< SOL_COMPUTED PPP 51.11679169050 -114.03886785696 1064.5243 -16.9000 WGS84
0.0828 0.0947 0.1150 "TSTR" 15.972 0.000 22 19 19 19 2 00 00 33

<BESTPOS COM1 0 63.5 FINESTEERING 1785 152400.000 00000020 7145 12832
< SOL_COMPUTED PPP 51.11679169050 -114.03886785696 1064.5243 -16.9000 WGS84
0.0828 0.0947 0.1150 "TSTR" 15.972 0.000 22 19 19 19 0 00 00 33

$GPGGA,181944.00,5107.0075,N,11402.3321,W,5,19,0.8,1064.52,M,-16.90,M,15,TSTR*6D

The "station ID" field in all three position logs can also be used to verify the type of corrections being used in the solution. For TERRASTAR-D, the station ID will be "TSTR" as shown in the above examples.

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).

ASSIGNLBANDBEAM (Configure L-Band Tracking)

The "ASSIGNLBANDBEAM" command is used to configure L-Band tracking, which is disabled by default. In most cases, the "AUTO" setting can be used to enable tracking of TerraStar and to download subscription information as necessary (see **Enable L-Band Tracking**, page 13). In some cases it can be desirable to use a specific beam in which cases the "MANUAL" setting can be used. The **LBANDBEAMTABLE** log (page 19) contains a list of TerraStar beams known to the receiver and can be helpful when using the manual option.

Examples:

> ASSIGNLBANDBEAM AUTO

> ASSIGNLBANDBEAM MANUAL AORW

The default setting for ASSIGNLBANDBEAM is:

> ASSIGNLBANDBEAM IDLE

PPPCONVERGEDCRITERIA (Configure the Decision for PPP Convergence)

The receiver uses the standard deviation of the solution to determine when the PPP position has converged. By default, the receiver will label the PPP solution as "converged" when the horizontal standard deviation (2D) is 0.20 m or less. The "PPPCONVERGEDCRITERIA" command allows the user to control how the receiver determines if the solution has converged. This is the default setting:

> PPPCONVERGEDCRITERIA HORIZONTAL_STDDEV 0.20

Another example is as follows:

> PPPCONVERGEDCRITERIA TOTAL_STDDEV 0.15

The second example will use the total position standard deviation (3D) to determine when the solution has converged.

Relaxing the convergence threshold shortens the time before a PPP solution is reported as converged. However, it does not alter the absolute behavior of the solution. During the initial PPP solution period, the positions can have decimetre error variation. It is recommended to only relax the convergence threshold if the application can tolerate higher solution variability.

PPPDYNAMICS (Set the PPP Dynamics Mode)

This command configures the dynamics assumed by the PPP filter. The default setting is "DYNAMIC":

PPPDYNAMICS DYNAMIC

To take advantage of automatic detection of antenna dynamics, specify the "AUTO" setting:

PPPDYNAMICS AUTO

"AUTO" will allow the receiver to detect the antenna dynamics and adapt filter operation accordingly. This can be especially beneficial during convergence if the antenna will remain stationary during that time. However, very slow "creeping" motion, where the antenna consistently moves 2 cm/s or less, can be interpreted by the receiver as stationary. In such cases, the mode should remain as the default or explicitly be set to DYNAMIC.

PPPSEED (Control Seeding of the PPP Filter)

The "PPPSEED" command controls the seeding of the PPP filter. Accurate position seeding can accelerate PPP convergence. The command "PPPSEED SET" is used to explicitly specify a seed position. The seed position must be in a datum consistent with the PPP corrections that will be used. For NovAtel CORRECT with PPP, this is ITRF2008.

Caution must be exercised when using "PPPSEED SET". While a "good" or accurate seed position can accelerate convergence, a "bad" or inaccurate seed hurts performance. In some cases, a bad seed can prevent a solution from ever converging to a correct position. In other cases, a bad seed might be rejected immediately or the filter might operate with it for a period of time only to reject it later. In the last case, the filter position is partially reset with a corresponding discontinuity in the PPP position.

The available options with the PPPSEED command are as follows:

- CLEAR – resets the stored seed, and prevents any auto seeding from occurring
- SET – immediately apply the specified coordinates as a seed position
- STORE – store the current PPP position in NVM for use as a future seed
- RESTORE – retrieve and apply a seed that was saved in NVM via the STORE or AUTO options
- AUTO – automatically store and restore PPP seed positions

PPPSEED command uses this format:

PPPSEED option [<latitude> <longitude> <height> <northing_std_dev> <easting_std_dev> <height_std_dev>]

Examples:

PPPSEED SET 51.11635322441 -114.03819311672 1064.5458 0.05 0.05 0.05

PPPSEED STORE

PPPSOURCE (Specify the PPP Correction Source)

The PPPSOURCE command allows the user to specify the type or source of corrections the PPP filter will use. It can also be used to disable the PPP filter. The default setting is "AUTO", which allows the receiver to automatically select and use the best corrections.

Examples:

PPPSOURCE NONE

PPPSOURCE AUTO

PPPSOURCE TERRASTAR

PPPTIMEOUT (Set the Maximum Age of the PPP Corrections)

The maximum age of corrections that will be used by the PPP filter is determined by the PPPTIMEOUT command. If the correction stream is interrupted, the receiver will continue using the last received corrections but the age of those corrections will begin to grow. If the corrections become older than the specified PPPTIMEOUT duration, the receiver will no longer use those corrections. The default setting is 360 seconds (6 minutes), the minimum is 5 seconds and the maximum duration is 900 seconds. For example:

PPPTIMEOUT 360

PPPTIMEOUT 900

PPPTIMEOUT 200

TERRASTARPAYG (Enable the use of TerraStar Pay-As-You-Go Time)

This command enables use of TerraStar Pay-As-You-Go (PAYG) time. For TerraStar term subscriptions, the corrections are used automatically. For PAYG subscriptions, the use of the corrections must be explicitly enabled using this command to guard against inadvertent use of the PAYG period. Furthermore, in conjunction with the ASSIGNLBANDBEAM command, this command permits the receiver to track and receive subscriptions from TerraStar L-Band satellites without using the purchased PAYG period.

To start using the PAYG time that has been purchased, use this command:

TERRASTARPAYG ENABLE

Otherwise, this is the default setting:

TERRASTARPAYG DISABLE

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 PPPPOSB" will log the PPPPOS 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).

LBANDBEAMTABLE (List of L-Band Beams)

This log provides a list of TerraStar L-Band beams known to the receiver. The receiver firmware contains a default list that will be output until the receiver downloads new beam information from TerraStar. Using the command "LOG LBANDBEAMTABLE", this is an example output:

```
<LBANDBEAMTABLE COM1 0 78.5 UNKNOWN 0 1.775 004c0020 f3b2 12832
<    7
<       "AORE" "A" 1539982500 1200 -15.50 1
<       "AORW" "B" 1539892500 1200 -54.00 1
<       "IOR" "C" 1539902500 1200 64.50 1
<       "POR" "D" 1539942500 1200 178.00 1
<       "25E" "E" 1539882500 1200 25.00 1
<       "143.5E" "F" 1539992500 1200 143.50 1
<       "98W" "G" 1539902500 1200 -98.00 1
```

The first two fields in each entry, for example ""POR" "D"", correspond to the beam/transmitting satellite name and the region ID. The next three fields correspond to the broadcasting frequency (Hz), the baud rate and the longitude (degrees) of the L-Band satellite.

LBANDTRACKSTAT (Report the L-Band Tracking and Viterbi Decoding Status)

The LBANDTRACKSTAT log provides information that can be used to verify L-Band tracking. Specifically, the name of the L-Band satellite or beam and its frequency, baud rate and service ID are included in this log. Also, the carrier to noise ratio (CNo) and lock time (in seconds) are indicators of tracking performance.

For example:

```
<LBANDTRACKSTAT COM1 0 78.0 FINESTEERING 1785 160741.000 00000020 29fd 12832
<    1
<       "98W" 1539902500 1200 974c 00c2 0 -271.092 44.380 4.8400 10121.678 192704 91 91
24473408 11363 0.0002
```

In this example, the receiver is tracking the "98W" beam with a frequency of 1539902500 Hz and a baud rate of 1200. Also, the CNo is 44.380 dB-Hz and the continuous lock time is 192704 seconds, indicating solid tracking performance. The CNo is typically about 40-45 dB-Hz in ideal conditions.

PPPPOS (PPP Filter Position)

The PPPPOS log contains the position solution computed specifically by the PPP filter. The possible position types in this log are as follows:

Table 2: PPPPOS Position Types

Position Type	Description
NONE	No solution
PPP_CONVERGING	Converging PPP Solution
PPP	Converged PPP Solution

Examples:

    <PPPPOS COM1 0 63.5 FINESTEERING 1785 152400.000 00000020 e2df 12832
    <   SOL_COMPUTED PPP 51.11679169050 -114.03886785696 1064.5243 -16.9000 WGS84
    0.0828 0.0947 0.1150 "TSTR" 15.972 0.000 22 19 19 19 2 00 00 33

    <PPPPOS COM1 0 64.5 FINESTEERING 1785 150920.000 00000020 e2df 12832
    <   SOL_COMPUTED PPP_CONVERGING 51.11679486247 -114.03886448423 1065.2213
    -16.9000 WGS84 0.5505 0.5237 0.8792 "TSTR" 4.754 0.000 22 19 19 19 2 00 00 33

See also **Obtaining a PPP Position Solution**.

PPPSATS (Satellites Used in the PPPPOS Solution)

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

For example:

    <PPPSATS COM1 0 77.0 FINESTEERING 1785 161767.000 00000020 ce3f 12832
    <   23
    <   GPS 29 GOOD 00000003
    <   GPS 13 GOOD 00000003
    <   GPS 32 GOOD 00000003
    <   GPS 4 GOOD 00000003
    <   GPS 16 GOOD 00000003
    <   GPS 23 GOOD 00000003
    <   GPS 10 GOOD 00000003
    <   GPS 31 GOOD 00000003
    <   GPS 7 GOOD 00000003
    <   GPS 2 GOOD 00000003
    <   GPS 20 GOOD 00000003
    <   SBAS 138 NOTUSED 00000000
    <   SBAS 133 NOTUSED 00000000
    <   SBAS 135 NOTUSED 00000000
    <   GLONASS 14-7 GOOD 00000003
    <   GLONASS 23+3 GOOD 00000003

<	**GLONASS 5+1 GOOD 00000003**
<	**GLONASS 15 GOOD 00000003**
<	**GLONASS 22-3 GOOD 00000003**
<	**GLONASS 13-2 GOOD 00000003**
<	**GLONASS 6-4 GOOD 00000003**
<	**GLONASS 3+5 GOOD 00000003**
<	**GLONASS 4+6 GOOD 00000003**

TERRASTARINFO (TerraStar Subscription Information)

Details about the current TerraStar subscription are contained in the "TERRASTARINFO" log. Also, the receiver-specific "Product Activation Code" or PAC is available from this log and is required when purchasing a subscription.

For "Term" subscriptions, the expiry or contract end date is indicated by the year and day of year (DOY). If using a PAYG subscription, this log provides the duration of the subscription in hours.

Example:

> **<TERRASTARINFO COM1 0 76.5 FINESTEERING 1785 150622.703 00000020 e776 12832**
> **<   "R244:2228:3410" TERM 00000101 0 0 0 GEOGATED 0.00000 0.00000 0**

In this example the PAC is "R244:2228:3414" and it has a term subscription. As of the time of printing, the contract end date information is not yet populated by TerraStar.

TERRASTARSTATUS (TerraStar Decoder and Subscription Status)

Additional TerraStar decoder and subscription status information is provided in the TERRASTARSTATUS log. This log can be used to verify that the receiver is locked onto the TerraStar signal and is decoding data.

For example:

> **<TERRASTARSTATUS COM1 0 79.0 FINESTEERING 1785 154612.705 00000020 fdc1 12832**
> **<   ENABLE LOCKED 0 DISABLED ONSHORE**

If the receiver currently has a valid subscription, the first field will be "ENABLE" and in most cases last field or "geogating status" will be "ONSHORE". For PAYG subscriptions, the third field indicates the minutes remaining ("0" in the example above).

Convergence Recommendations

The TERRASTAR-D solution will have an associated convergence time during which the accuracy will stabilize and converge towards the quoted accuracy for NovAtel CORRECT with TERRASTAR-D[14].

Although it is not currently possible to completely remove the convergence period of the PPP solution, there are techniques to help improve or shorten the time required to reach the specified accuracy. Some of these include:

- Ensure the antenna is located in an area that has a clear view of the sky with no obstructions, especially during initial startup and convergence.
- If the vehicle and antenna can and will be stationary during convergence, use the "AUTO" setting for **PPPDYNAMICS** (page 17) to take advantage of automatic dynamics detection and filtering.
- Use the **PPPSEED** (page 17) command to specify the location of the antenna if it is located in a known position, but at the same time avoid using a "bad" seed if the accuracy of the known location is poor as this can increase the convergence time.

For most applications it is best to allow the PPP solution to be flagged as "converged" before proceeding with operation. This is due to the variation that can be present in the solution as it converges. Waiting for a converged position status will help ensure the solution has stabilized and is operating within the expected accuracy. If the application can tolerate higher solution variability, the **PPPCONVERGEDCRITERIA** command, page 16, can potentially be used to relax the convergence tolerance or threshold.

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[14] www.novatel.com/products/novatel-correct/novatel-correct-ppp/

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/

Remaining questions or issues can be directed to NovAtel Support by visiting 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 PPPPOSB ONTIME 1
    LOG PPPSATSB ONTIME 1
    LOG LBANDTRACKSTATB ONTIME 1
    LOG TERRASTARINFOA ONCHANGED
    LOG TERRASTARSTATUSA ONCHANGED
    LOG LBANDBEAMTABLEA ONCHANGED

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