Application Note

RTK ASSIST and RTK ASSIST PRO

HEXAGON AUTONOMY & POSITIONING DIVISION
CONFIDENTIAL AND PROPRIETARY DATA

Contents

Overview

Hexagon | NovAtel's RTK ASSIST and RTK ASSIST PRO empower RTK users to seamlessly operate with centimetre-level accuracy during RTK correction signal outages caused by radio connectivity issues or wireless or cellular signal disruptions. RTK users can continue their operation without being impacted by signal outages, leading to increased productivity. RTK ASSIST and RTK ASSIST PRO are delivered through IP and NovAtel's satellite-based correction services which do not require any local infrastructure. RTK ASSIST is currently available for OEM7 and OEM6 product lines, and RTK ASSIST PRO is available on OEM7 for eligible hardware and firmware models.

How it Works

RTK ASSIST and RTK ASSIST PRO work by using the precise GNSS correction data delivered by the geostationary (GEO) satellites[1] to maintain centimetre-level accuracy in the absence of RTK corrections. These corrections are received through L-band tracking or IP Delivery, and subsequently used by the position engine to maintain centimetre-level accuracy.
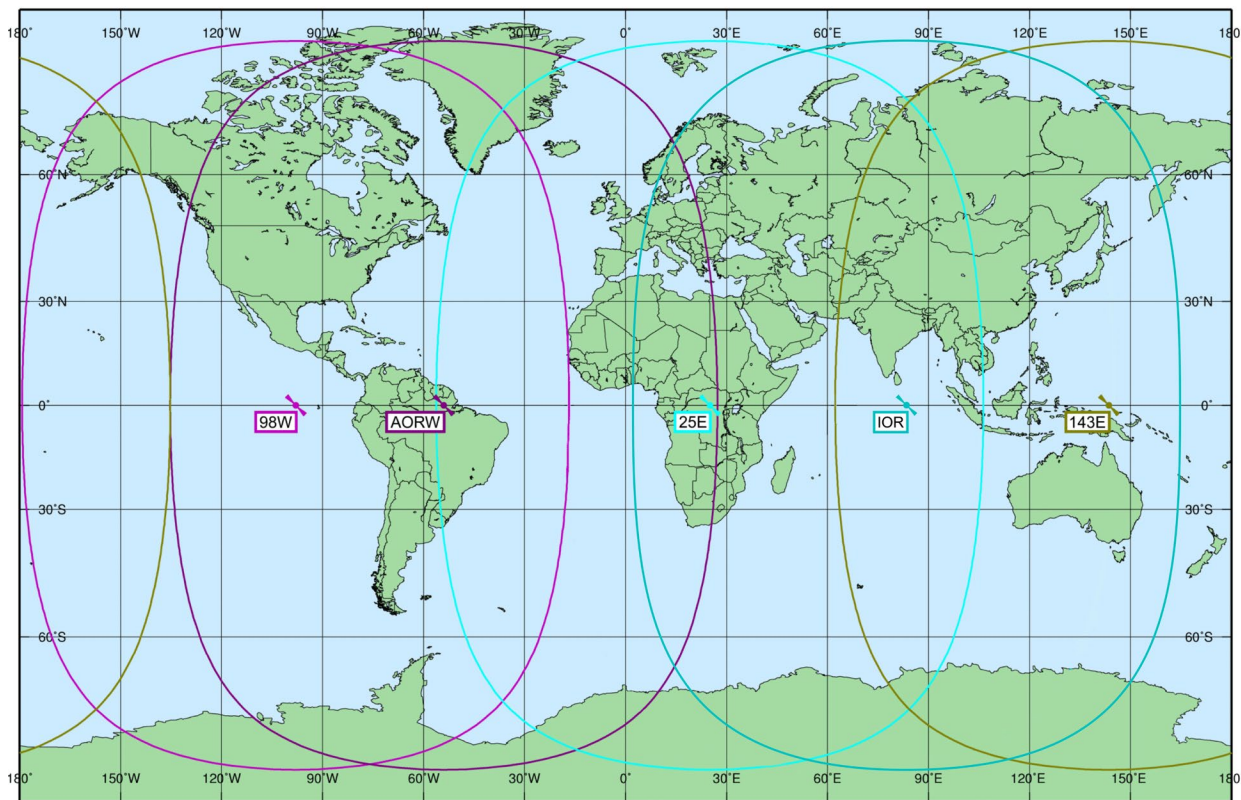
Figure 1: Global coverage map for correction delivery (L-band)

More detail on coverage areas for specific beams can be viewed in the interactive coverage map.

IP delivered corrections are received through a cellular network, requiring the user to establish an internet connection to receive the corrections, providing global coverage anywhere there is internet connectivity. As IP

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[1] GNSS correction service is provided by TerraStar.

delivery is not dependent on L-band satellite visibility, this delivery method extends the serviceable region if the application area does not have L-band coverage, or if the environment obstructs L-band signals.

RTK ASSIST

RTK ASSIST operates seamlessly in the background for up to twenty minutes from the onset of an RTK outage. After that, the position type will transition to the next most accurate available. Datum differences or biases are automatically compensated for when transitioning between position types. The algorithm is designed to facilitate smooth transitions during RTK outages. However, as with any carrier phase-based positioning, there is a possibility that a position jump may occur due to an incorrect ambiguity fix. The positioning solution will transition back to using RTK corrections once connection has been re-established with the correction source.

As the RTK ASSIST technology uses the precise correction data delivered via geostationary satellites, if L-band corrections are being used (rather than IP Delivery), any obstructions (i.e., buildings, grain tanks, tree lines) can potentially degrade or block the satellite signals. Depending on the L-band signal blockage duration, the position error will increase over time. If correction signals are lost for more than 2 minutes, RTK-level accuracies cannot be maintained and RTK ASSIST will disengage. The resulting position type will be determined by the accuracy level of the solution at the time RTK ASSIST becomes inactive.

The RTK ASSIST functionality will engage if correction data is being received and the GNSS receiver has had at least one RTK fix prior to the outage.

Users can expect centimetre-level accuracy during the RTK outage when using RTK ASSIST. However, the accuracy will degrade as the outage duration increases but will stabilise (approximately 4 cm RMS). If the RTK outage occurs in the first 30 minutes of operation, further degradation (approximately 20 cm RMS) may be observed.
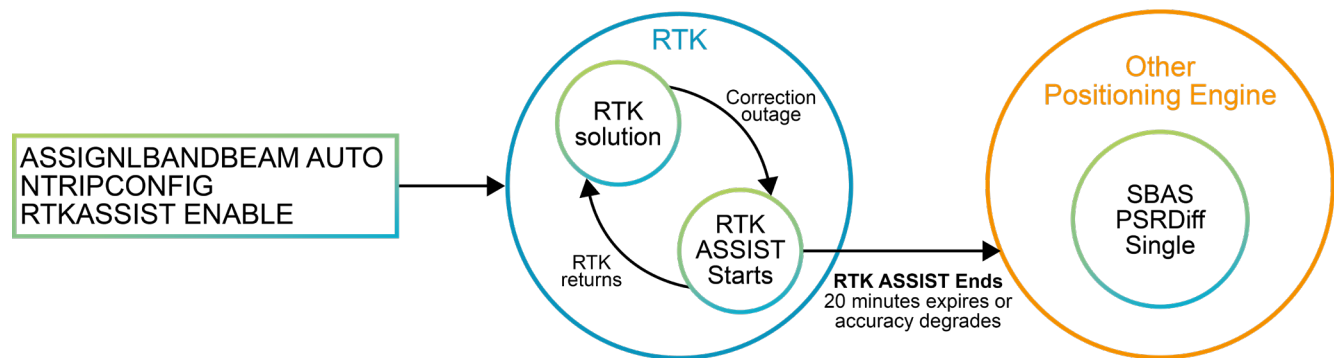

Figure 2: Summary of how RTK ASSIST works

Figure 2 shows the basic flow structure that RTK ASSIST will follow. If an outage occurs while in RTK mode, RTK ASSIST will engage. At this point, if RTK corrections return before the 20 minute period accurate position type will be used (SBAS, PSRDiff, etc.) until corrections are re-established.

RTK ASSIST PRO

Similar to RTK ASSIST, RTK ASSIST PRO will operate seamlessly in the background, however without limit after the onset of an RTK outage. RTK ASSIST PRO leverages multi constellation support to provide highly accurate and reliable positioning in RTK correction outages.

RTK ASSIST PRO also provides standalone centimetre-level positioning in areas where RTK is no longer practical or beneficial. Standalone positioning is provided at the TerraStar-C PRO level. When operating without an initial RTK fix, the user may require nudging to handle datum offsets. Please refer to TerraStar on OEM7 for information on TerraStar-C PRO.

Operating Modes

RTK ASSIST operates in two different modes: Coast and Full Assist.

Coast

Coast is available as soon as the RTK ASSIST corrections are received. In this position mode, error growth during the RTK outage is slightly greater when compared to Full Assist mode. When in this mode, RTK will not resume following a full GNSS signal outage until after RTK corrections are restored.

Full Assist

Full assist provides the lowest position error growth during RTK correction outages and makes it possible for RTK to resume even if there are complete GNSS signal outages during the RTK ASSIST period. This mode requires a convergence period of approximately 30 minutes from navigation start.

Requirements for Using RTK ASSIST and RTK ASSIST PRO

The RTK ASSIST functionality requires the receiver to be enabled for both RTK positioning, L-band tracking or IP delivery. These requirements can be checked against the model of the receiver and determine that options for L-band and RTK are both enabled.

OEM7

The firmware requirement for RTK ASSIST is 7.02 (OM7MR0200RN0000) or later.

The firmware requirement for RTK ASSIST PRO on OEM7 is 7.05 (OM7MR0500RN0000) or later.

Based on the OEM7 model structure, a minimum of dual-frequency is required, represented by the "D" or "F" in the 2nd character. An RTK model is also required, i.e "R" in the 4th character. For example:

- OEM729-D**F**N-**R**NN-CBN

Full information on the OEM7 model structure and firmware model options can be found within the NovAtel Model List.

With an RTK ASSIST PRO subscription and 7.08.10 firmware or later, a feature called SMCC (Subscription Managed Channel Configuration) is available, which will automatically update the channel configuration. Refer to the SMCC section for further details.

OEM6

The firmware requirement for RTK ASSIST is 6.710 (OEM060710RN0000) or later.

Based on the OEM6 model structure, firmware Option 4 must be RTK (i.e., "R"), the firmware Option 2 must be "2" or higher, and the firmware Option 3 should be "L" or "J". For example:

- OEM628-D**2L**-**R**0G-TT0
- OEM628-D**2J**-**R**PR-TTN
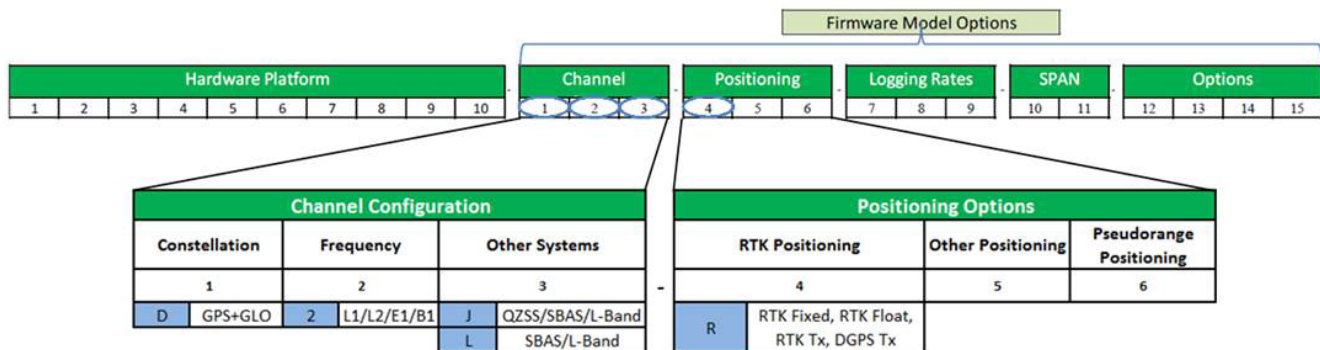- SM6L-D**2L**-**R**PG-0T0

Figure 3: OEM6 model structure and firmware model options for RTK ASSIST

The "L" or "J" option enables L-band tracking, and the "R" option allows the receiver to use RTK ASSIST service. However, the user must configure the receiver to track the L-band signal (see Enable L-band Tracking) and an RTK ASSIST subscription must be purchased and activated before the receiver will start using the corrections and providing RTK ASSIST functionality.

To use the RTK ASSIST service, the channel configuration options for dual-frequency (L1 & L2) tracking must be included in the model, as well as a minimum of GPS+GLONASS tracking. To allow for this, the first two firmware options must be a minimum of "D" and "2" as shown in the examples and Figure 3 above.

RTK ASSIST and RTK ASSIST PRO Subscriptions

A valid subscription is required to use RTK ASSIST services. To purchase an RTK ASSIST subscription, contact your NovAtel dealer or sales office[2]. NovAtel's eStore also allows purchasing of RTK ASSIST subscriptions.

NovAtel Customer Support can provide free 3 or 5-day trial RTK ASSIST subscriptions for test and demonstration purposes [3]. Users cannot subscribe to both RTK ASSIST and TerraStar (e.g. TerraStar-L) subscriptions simultaneously.

The receiver's NovAtel Product Serial Number (PSN) or TerraStar Product Activation Code (PAC) is needed to obtain a demo or purchase subscription. Before contacting your NovAtel sales office, obtain the PSN for the receiver you wish to activate using the command **LOG VERSION**.

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[2] http://www.novatel.com/where-to-buy/sales-offices/
[3] Contact support@novatel.com for more details. Maximum of 3 test subscriptions will be provided per receiver.

To verify an RTK ASSIST subscription, users can use the TERRASTARINFO log as demonstrated below:

```
LOG TERRASTARINFO
```

```
< TERRASTARINFO COM1 0 87.0 FINESTEERING 1919 247530.423 02000020 a7ce 32768
    "QU075:2185:6222" PAYG 00000800 0 0 0 LOCAL_AREA 51.11639 -114.03806 2
```

Table 1: TERRASTARINFO bit mask description

Bits	Mask	Description
0-8	0x000001FF	Reserved
9	0x00000200	TerraStar-C
10	0x00000400	TerraStar-L
11	0x00000800	RTK ASSIST
12	0x00001000	RTK ASSIST PRO
13	0x00002000	TerraStar-C PRO
12-31	0xFFFFF000	Reserved

The bit mask (0x00000800) indicates that the receiver has a TerraStar RTK ASSIST service.

Verifying RTK ASSIST

Users can check the status of their RTK ASSIST solution by looking at the RTKASSISTSTATUS log[4].

```
LOG RTKASSISTSTATUS
< RTKASSISTSTATUS COM1 0 68.0 FINESTEERING 1919 166861.000 00040020 80fe 46774
ACTIVE COAST 1085.0 21.0
```

ACTIVE: The active keyword indicates that RTK ASSIST is engaged and currently providing positioning. This field will report **INACTIVE** when not being used.

1085.0: This is the time remaining (seconds) in the RTK ASSIST mode before transitioning to the next most accurate available positioning mode. The maximum is 20 minutes (1200 seconds) for RTK ASSIST, and unlimited for RTK ASSIST PRO.

21.0: The corrections age reported in the RTKASSISTSTATUS log should typically be below 30 seconds. If the age exceeds this value, then L-band tracking is likely being degraded. The most likely cause of degraded L-band tracking is obstructions between the antenna and the L-band satellite.

An alternative way to see if RTK ASSIST is active for users using the BESTPOS log is to look at Field #20 (Extended Solution Status) to see if bit four is active.

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[4] Users can find the relevant logs and commands in the user manual for their product.
- OEM7: http://docs.novatel.com/OEM7/Content/Home.htm
- OEM6: http://www.novatel.com/assets/Documents/Manuals/om-20000129.pdf

Bit	Mask	Description
0	0x01	If an RTK solution: NovAtel CORRECT solution has been verified If a PDP solution: solution is GLIDE Otherwise: Reserved
1-3	0x0E	Pseudorange Iono Correction 0 = Unknown or default Klobuchar model 1 = Klobuchar Broadcast 2 = SBAS Broadcast 3 = Multi-frequency Computed 4 = PSRDiff Correction 5 = NovAtel Blended Iono Value
4	0x10	RTK ASSIST active
5	0x20	0 - No antenna warning 1 - Antenna information is missing See to the RTKANTENNA command
6-7	0xC0	Reserved

Figure 4: BESTPOS extended solution status

Enable L-band Tracking

To enable a receiver to use L-band beam corrections for RTK ASSIST and RTK ASSIST PRO, please follow the instructions below.

Before a receiver can start using corrections through a TerraStar service, it first must be configured to track the L-band beams from the TerraStar geosynchronous satellites. For this, 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.

```
ASSIGNLBANDBEAM AUTO
```

The AUTO setting allows the receiver to automatically track the highest elevation TerraStar satellite for best performance. The receiver firmware includes a default list of TerraStar satellites beams (see LBANDBEAMTABLE).

The receiver uses its position to determine which TerraStar signal is the best to use in a particular location.

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

```
<LBANDTRACKSTAT COM1 0 80.5 FINESTEERING 1835 140789.000 00000020 29fd 13306
<     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 beams. Some important fields are highlighted above for three beams that the receiver is tracking and are described below for beam "98W":

- **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.
- **42.398**: This is the C/No or "Carrier to Noise Density Ratio" (in dB-Hz). The C/No is typically about 40-45 dB-Hz in ideal tracking conditions. A low C/No value (below 38 dB-Hz) can result in missed corrections and correspondingly degraded performance.
- **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 actual tracking of the L-band beam does not require a subscription, the receiver will not decode and use the TerraStar service data until a valid subscription has been activated.

Enable IP Delivery

To enable a receiver to use corrections by IP delivery for RTK ASSIST and RTK ASSIST PRO, the receiver requires:

- Active RTK Assist/RTK Assist Pro Subscription
- NTRIP enabled receiver
- Internet connection to the receiver

Ensure the receiver has the IP address configured. To configure the receiver for Static IP address please follow the instructions in Static IP Address Configuration. To configure Dynamic IP address please follow the instructions in Dynamic IP Address Configuration.

Once configured, IP address assignment can be confirmed by the IPSTATUS log. It should report similar to below:

```
#IPSTATUSA,COM1,0,90.5,FINESTEERING,1609,500464.121,02000000,7fe2,6259;1,ETHA,
"10.4.44.131","255.255.255.0","10.4.44.1",1,"198.161.72.85"*ec22236c
```

In the above example, the receiver has been assigned the IP address **10.4.44.131**.

Now that we have established the receiver has an IP address assigned, the following commands should be sent to the receiver to configure the receiver as an NTRIP client:

```
NTRIPCONFIG NCOM1 CLIENT V1 sid-output.com:2101 SID08 SID MELs9tPw4 ALL
INTERFACEMODE NCOM1 VERIPOS NONE OFF
```

The 'NCOM1' port is used in the above commands, however this can be changed to any free NCOM port as long as both commands are issued to the same NCOM port. Credentials used in the command above are as follows:

Table 2: IP delivery Credentials

	Value
Username	SID
Password	MELs9tPw4
Mountpoint	SID08

Configuration for RTK ASSIST

To enable RTK ASSIST on a receiver with a valid model and subscription, use the commands provided below.

- **LOG TERRASTARINFO** (indicates a valid RTK ASSIST subscription)
- **RTKASSIST ENABLE** (on by default – users can verify by logging the command)
- **RTKASSISTTIMEOUT SUBSCRIPTION_**LIMIT (use the maximum amount of time possible)
- **LOG RTKASSISTSTATUS** (users can verify that RTKASSIST is working when there is no RTK correction signal)

> *Note: L-band Tracking or IP Delivery must be enabled before RTK ASSIST is enabled.*

Subscription Managed Channel Configuration (SMCC)

For the receiver to maximise the benefit of all constellations and frequencies available, it will enable additional channels upon receipt of an RTK ASSIST PRO subscription and a subsequent power cycle or reset. SMCC automatically configures the subscribed device to the best channel configuration. Changing the configuration allows the receiver to use the entirety of the applicable correction messages for the given receiver hardware and subscription combination without user intervention or configuration.

SMCC was first introduced with firmware version 7.08.10 and our product support for this feature has increased with subsequent firmware releases, as detailed below:

- 7.08.10: OEM7700, OEM719, OEM729, PwrPak7 and CPT7700.
- 7.08.12: SMART7 (select variants).
- 7.08.14: OEM7720, OEM7500, CPT7 and PwrPak7D.
- 7.08.15: SMART7 (all variants) and remaining agriculture products.

> *Notes:*
> - *SMCC is not enabled with RTK ASSIST, it applies to an **RTK ASSIST PRO subscription only**.*
> - *If the channel configuration is changed using SELECTCHANGONFIG, it must be removed using the FRESET command for SMCC to function properly. The FRESET command will remove all configuration and set the receiver to a factory reset mode.*

Table 3: RTK ASSIST PRO SMCC behavior and model requirements

	RTK ASSIST PRO	
	OEM7700, OEM719, OEM729, PwrPak7, SMART7[5], CPT7700	OEM7720[6], OEM7500[6], CPT7[6], PwrPak7D[6]
Minimum model required to purchase a subscription	DDN-R	DDN-R
Model that supports full subscription functionality	FFN-R	MFN-R
Once active subscription is received, receiver automatically applies SMCC	FFN FF config (7)	MFN MF config (6) MFD MF config (6)

The CHANCONFIGLIST log will show the new channel configuration number, as per Table 3: RTK ASSIST PRO SMCC behavior and model requirements.

SMCC is enabled by default, however it can be disabled if it is not your preferred configuration, as RTK may have different channel configuration requirements to match the RTK source. It can be changed using the TERRASTARAUTOCHANCONFIG command.

If a FRESET is sent after SMCC has changed the channel configuration, a power cycle or RESET must be done once the receiver boots for SMCC to re-enable and change the channel configuration as described above.

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[5] FW 7.08.12 and newer only
[6] FW 7.08.14 and newer only

Support

To help answer questions and/or diagnose any technical issues that may occur, the NovAtel Support website is a first resource.

Remaining questions or issues, including requests for test subscriptions or activation resends, can be directed to NovAtel Support.

Before contacting Support, it is helpful to collect data from the receiver to help investigate and diagnose any performance-related issues. A list of appropriate troubleshooting logs can be found on the OEM7 Documentation Portal (the LOG command with the recommended trigger and data rate is included with each log).

The data can also be collected using NovAtel Application Suite.

Documentation

For any questions on logs and commands, please visit the OEM7 Documentation Portal.