Application Note

TerraStar Repeatability

HEXAGON AUTONOMY & POSITIONING DIVISION
CONFIDENTIAL AND PROPRIETARY DATA

Contents

TerraStar Repeatability

Position repeatability is a measure of position accuracy over time with consideration of the datums in use. This is important to users that want a given point on the ground to have the same position reported year over year.

Examples of applications that benefit from positioning repeatability include guidance lines, waypoints, maps and boundaries in agriculture, traffic lanes on highways, or local paths in mining zones.

Datums and Positioning Repeatability

All TerraStar services provide year over year repeatability, within the position accuracy specification of each service. When used with Hexagon | Novatel's OEM7 datum transformation and tectonic plate compensation technology, a TerraStar-C PRO position computed today at a point on the ground will be computed at the same position a year, five or even ten years from today.

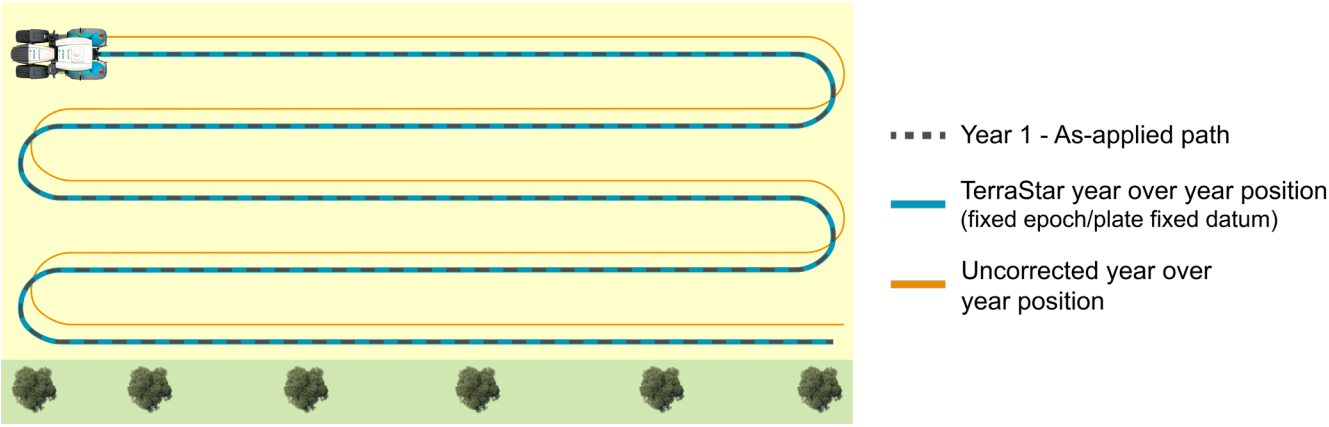

Figure 1: TerraStar year over year repeatability

TerraStar natively computes positions in a geocentric reference frame, meaning that coordinates use the centre of the Earth as their origin. This is also known as an "Earth Centred Earth Fixed (ECEF)" system. Tectonic plates on the external layer of the Earth move with respect to this reference frame. A fixed point on the ground does not appear to change its position relative to features around it on the same plate, however the position of this point changes with respect to the centre of the Earth due to plate motion. NovAtel OEM7 firmware uses models for plate motion to account for this movement and delivers repeatable coordinates with TerraStar PPP.

Note that local events such as earthquakes, which cause physical shifts in the land mass, can affect repeatability. This would appear to a user as a coordinate shift, relative to local features.

Figure 2: Earth-Centered, Earth-Fixed reference system (**left**) compared to a Plate-Fixed reference system (**right**).

Recommended Configuration

For optimum repeatability in positioning, it is recommended to use a fixed epoch (the point in time when the coordinates were measured in the given datum) *or* transform the solution to a plate-fixed datum.

Configuration for Using a Fixed Epoch with an Earth-Centered Earth-Fixed Datum

To get repeatable coordinates year over year, one recommendation is to use fixed epoch and apply plate tectonics modelling (firmware default) to account for shifts in the plates over time. For example, to output current PPP solution in the ITRF2014 datum fixed to epoch Jan 1, 2022, user should issue the command below to the OEM7 receiver:

```
OUTPUTDATUM ITRF2014 FIXED_EPOCH 2022.001
```

Resulting output datum can be checked in the BESTDATUMINFO log:

```
[ICOM1]<BESTDATUMINFO ICOM1 0 78.0 FINESTEERING 2254 242847.000 02040020 0c2b
17102
<       "ITRF2014"  1165 2022.001 GOOD
[ICOM1]
```

When using a fixed epoch on an ECEF datum, plate tectonics should be accounted for. OEM7 firmware by default compensates for tectonic motion using a plate motion model:

```
TECTONICSCOMPENSATIONSOURCE PLATE_MOTION_MODEL
```

Periodic NovAtel OEM7 receiver firmware updates allow for the latest tectonic plate motion information.

Configuration for Using a Plate-Fixed Datum

To get repeatable coordinates that do not change with the movement of the plate, use of a local, plate fixed datum is recommended. An example for North America is the North American plate, NAD83, which can be selected as the output datum by issuing the command below to the OEM7 receiver:

```
OUTPUTDATUM NAD83(NSRS2011) CURRENT_EPOCH
```

Refer to the BESTDATUMINFO log to check the resulting output datum:

```
[ICOM1]<BESTDATUMINFO ICOM1 0 18.0 FINESTEERING 2254 243430.000 02440020 0c2b
17102
<      "NAD83(NSRS2011)" 1116 2023.219 ECEF_EQUIVALENCY
[ICOM1]
```

For more in-depth information on datum transformations with NovAtel products, please refer to the Datum Transformations & Plate Tectonics Compensation Application Note.

RTK ASSIST/PRO Considerations

Datum differences and/or biases within RTK ASSIST and RTK ASSIST PRO services are handled internally and applied automatically when RTK ASSIST engages. There is no need for additional user configuration. The position will be output in the same datum as the base station or RTK network.

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.