Correction Services

AGRICULTURE

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TRIMBLE RESELLER CONFIDENTIAL

Correction Services Supported by Precision-IQ

GNSS satellites are in continuous motion as they orbit the earth twice per day in a repeated pattern. Satellites transmit signals that the GNSS receiver translates to determine its position.

While performing field activities, you may notice differences in:

- Where the crop row is located.
- Where the guidance line was established.
- Where the display is indicating the guidance line is now located.

This happens because GNSS satellite constellation patterns change over time and can experience interference, such as local and atmospheric conditions, temperature and humidity, etc.

Precision-IQ supports a variety of correction services that are available to compensate for deviations in GNSS constellation patterns as well as interference with the satellite signal.

Tap the **Edit** button on the GNSS details screen to display the GNSS Edit screen. By default, the Corrections option is selected. With this option, you can change the correction service, position quality, and radar output.

Correction Service: Tap this item for a pop-up list of all available correction services.

By default, Autonomous is selected as the correction source. Tap a different correction source to select it.

Note: Most correction services require a license.

If you change the correction service, then you may need to adjust additional settings, depending on your selection. Available correction services include, but are not limited to:

- SBAS Corrections
- RangePoint RTX Correction Service
- CenterPoint RTX Corrections
- CenterPoint VRS Corrections
- RTK Corrections
- xFill Premium

Position Quality: Tap this item to allow Precision-IQ to give preference to:

- Favor Accuracy: Use for operations needing highest accuracy (such as row crop planting and strip-till). This option is selected by default.
- Favor Availability: Expands production time further with potential for reduced accuracy.
- Balanced Quality: Trades potential accuracy for longer production time.

Radar Output: Tap to enable radar output. If enabled, then tap **Radar Output Frequency** to enter a specific radar frequency. You can choose between **27.36** and **96.56** Hz/mph.

Correction Services Licensing Requirements

The following permanent licenses, subscriptions, and VRS daemon licenses are required to enable the following features on supported displays:

Correction Service	License	License Type Required
RangePoint RTX	Basic	Permanent license (installed at factory)
	Valid RangePoint	Subscription
CenterPoint RTX Std-Cell	Intermediate	Permanent license (purchased)
	Valid Std-Cell, Std-Sat, or Fast-Sat	Subscription
	DCM Correction Services	VRS daemon licenses
CenterPoint RTX Std-Sat	Intermediate	Permanent license (purchased)
	Valid Std-Sat or Fast-Sat	Subscription
CenterPoint RTX Fast-Sat	Intermediate & High	Permanent licenses (purchased)
	Valid Fast-Sat	Subscription
CenterPoint RTK (SBL)	Intermediate & High	Permanent licenses (purchased)
CenterPoint VRS	Intermediate & High	Permanent licenses (purchased)
	VRS daemon	May be required on display if using third-party modem. Not required for Trimble GX450 modem,.
xFill Premium	Intermediate & High	Permanent licenses (purchased)
	Valid xFill Premium or Std-Sat or Fast-Sat	Subscription

SBAS Corrections

The satellite-based augmentation systems (SBAS) with free correction services are:

- WAAS (Wide Area Augmentation System) in North America
- EGNOS (European Geostationary Navigation Overlay Service) in Europe
- MSAS (Multi-functional Satellite Augmentation System) in Asia Pacific regions

From the GNSS Edit screen, tap **Correction Services** and then tap **SBAS** from the pop-up list to select it. Tap **Setup** to:

- **Correction Satellite Select:** By default, **Automatically selected from current location** is selected. Tap this item to select a specific correction satellite from a pop-up list.
- **SBAS+:** Tap to enable. This feature uses uncorrected satellites in addition to SBAS.

RangePoint RTX Correction Service

Note: This feature is optional and requires a subscription.

RangePoint® RTX is a satellite-based subscription service for corrections with pass-to-pass accuracy < 6" (15 cm) and GLONASS compatibility.

The GNSS receiver in the NAV-900 and TM-200 Module receives these signals.

From the GNSS Edit screen, tap **Correction Services** and then tap **RangePoint RTX** from the pop-up list to select it. Update the appropriate specific RangePoint RTX options, then tap **Home** to return to the Home screen.

CenterPoint RTX Corrections

Note: This feature is optional and requires a license and a subscription.

The types of CenterPoint® RTX correction are:

- CenterPoint RTX Modem Corrections
- CenterPoint RTX Satellite Corrections: Standard convergence, fast convergence for US, fast convergence for EU.

CenterPoint RTX Satellite Corrections

CenterPoint RTX satellite broadcast subscription services for corrections have a < 1.5" (3.8 cm) accuracy and GLONASS compatibility. The RTX satellite corrections available are:

- CenterPoint RTX Satellite Standard.
- CenterPoint RTX Satellite Fast for US and EU.

CenterPoint RTX Modem Corrections

CenterPoint RTX Modem/Standard is a cellular broadcast subscription service for corrections with < 1.5" (3.8 cm) accuracy and GLONASS compatibility. A connected wireless modem receives these signals.

From the GNSS Edit screen, tap **Correction Services** and then tap **CenterPoint RTX Modem (Standard Convergence)** from the pop-up list to select it. Update the appropriate specific CenterPoint RTX Modem options, then tap **Home** to return to the Home screen.

The GNSS receiver in the TM-200 and NAV-900 guidance controller receives these signals.

From the GNSS Edit screen, tap **Correction Services** and then tap **CenterPoint RTX Satellite (Standard Convergence)** from the pop-up list to select it. Update the appropriate specific CenterPoint RTX Satellite options, then tap **Home** to return to the Home screen.

CenterPoint VRS Corrections

Note: This feature is optional and requires an unlock.

CenterPoint® VRS™ is a cellular-broadcast RTK correction service from a ground-based reference station using the a modem. (Requires a connected wireless modem.)

From the GNSS Edit screen, tap **Correction Services** and then tap **CenterPoint VRS** from the pop-up list to select it. Update the appropriate specific CenterPoint VRS options, then tap **Home** to return to the Home screen.

RTK Corrections

RTK is a radio-broadcast correction service originating from a ground-based reference station, and received by radio signal. Follow the steps below to set RTK options:

1. From the GNSS Edit screen, tap **Correction Services**.
2. Tap **RTK** from the pop-up list to select it.
3. Update the appropriate specific RTK options.
4. Tap **Home** to return to the Home screen.

About VRS

VRS™, an integrated system available with a subscription, is complementary to RTK and provides RTK corrections over a large geographic area, where robust cellular data coverage is available. Network processing ensures high accuracy throughout the whole coverage area.

VRS consists of:

- GPS/GNSS reference stations spread out over a large area, typically 30-45 miles (50-70 km) apart.
- A central server that uses Trimble proprietary software to create a correction model for the region covered by the network. GPS rovers communicate using a cell modem with the VRS server and receive

RTK type corrections. The data from the reference stations is used to model errors throughout your region. The model is used to:

- Create a network of virtual reference stations near your current location.
- Provide a localized set of standard format correction messages for your roving receiver. Since the error models are updated every second, all rovers receive an optimal correction model after connecting on to the network. This ensures a high quality correction, and accuracy.

All reference stations used in a VRS system can be interpreted as a network of continuously operating reference stations. The difference between VRS and CORS is that VRS provides a network solution. The position accuracy is maintained even if you move away from the single base but are still within the network.

Due to the longer range, fewer base stations can cover a greater region. Additionally, VRS networks may offer better signal coverage in rough terrain if the local cellular network is robust and provides good data coverage.

xFill Premium

The xFill® Premium service allows continued field operations during RTK/VRS signal interruptions, delivering Trimble RTX position accuracy for the duration of the interruption. This service extends the Trimble standard xFill service, which is limited to 20 minutes.

In the RTK configuration setup, make sure that **xFill** is switched on. Turning on xFill will also turn on xFill Premium.

The xFill Premium service will converge in the background and then calibrate itself as a backup to the specific RTK base station or VRS stream that is being used. This automatic calibration process typically takes between 15 and 60 minutes.

Once the automatic calibration is complete, if the display experiences RTK/VRS corrections outages, then the display will initially transition into standard xFill service, and subsequently transition into xFill Premium service. The display will continue to operate in the xFill Premium service until the RTK/VRS corrections resume.

Note: The basic xFill feature is a free add-on for those using VRS or RTK corrections.

About xFill Technology

xFill technology uses Trimble RTX technology to "fill in" for RTK corrections when there are temporary radio or Internet connection outages. xFill technology is a standard feature and is compatible with the AG25 GNSS antenna. The xFill technology can function with corrections from single-baseline RTK, VRS and CORS systems.

When there is an interruption of the RTK correction signal (either from the radio base station or from the VRS cellular network), the xFill technology performs corrections. xFill technology uses the last-known RTK position combined with the RTX precision satellite data to maintain a high level of horizontal positioning accuracy for up to 20 minutes. There is a smooth transition from RTK to xFill technology and back to RTK.

Automatic Guidance Systems Using xFill

If an auto-steering system is engaged using RTK, the auto-steer system will stay engaged during the 20 minute xFill coverage. As soon as an RTK signal is available, the receiver will switch back to the RTK correction service and

xFill will remain on standby in the background. If the system cannot resume an RTK Fixed status within 20 minutes the system will fall back to DGPS correction and the auto-steer system will disengage.

Accuracy when xFill Engaged

xFill technology can maintain a relatively high level of horizontal accuracy throughout the RTK outage period. However, accuracy is primarily dependent on three factors:

- GNSS satellite availability and obstructions between the satellite and receiver (trees, buildings, and so on).
- Exactness of the base station position.
- Length of time since the last RTK position (maximum allowable time is 20 minutes).

If you are concerned with maintaining sub-inch precision, disable the xFill feature. Estimated accuracy over time while the xFill function has been active (with base station accuracy <20 cm) is as follows:

- xFill runtime - no RTK corrections estimated error
- 1-5 minutes 1-5 cm
- 6-10 minutes 5-9 cm
- 11-20 minutes 10-15 cm

Dependence on Satellite

xFill technology requires correction data from at least 5 satellites higher than 10 degrees from the horizon. If GLONASS is unlocked at the RTK level, xFill technology will also be able to use GLONASS satellites. Additionally, large objects such as trees, buildings, and grain bins will significantly decrease or completely block signal reception from all satellite types, including GPS, GLONASS, and corrections satellites. If these same obstructions are between the receiver and the satellite, they may also block xFill signals.

WARNING!

Many large and sudden changes in satellite geometry caused by blocked satellites can cause significant position shifts. If operating under these conditions, auto-guidance systems can react abruptly. To avoid possible personal injury or damage to property under these conditions, disable the auto-guidance system and take manual control of the vehicle until conditions have cleared.

Dependence on Base Station Position

When the RTK correction signal is lost, the RTX satellite begins providing correction based on the last RTK position. When you set up xFill and select the datum in which you surveyed your base station, the firmware translates your position into the ITRF datum reference frame to minimize drift. Any other inaccuracies in the base station position can cause a drift in position over time.

As time elapses, correction data from the satellites causes drift from the RTK line. The larger the difference in surveyed base station position, the larger the drift as shown in following table.

The following table shows how the xFill drift over time is impacted by the accuracy of the base station survey coordinates:

xFill Elapsed Time	Survey Accuracy <20cm	Survey Accuracy <2m	Survey Accuracy <5m
0 to 5 min	0 to 5 cm	0 to 15 cm	0 to 25 cm
5 to 15 min	2 cm to 12 cm	10 cm to 0.3 m	15 cm to 0.5 m
15 to 20 min	9 cm to 15 cm	15 cm to 0.4 m	0.3 m to 0.8 m

If you discover that the surveyed location of your base station is not accurate, your options are:

- Turn off xFill (recommended).
- Resurvey your base station. However, this will cause the movement of any stored AB lines that are reloaded/reused which is very undesirable to many RTK customers.

Base Station Survey

At initial base station installation, it is recommended that you survey base stations by taking a 24-hour log and processing the data to receive position on your local datum. The accuracy of this position is stated in the report. Over time, primarily due to normal geological events, the base station position may change up to 7 cm per year.

When you select the datum used to survey your base station during the xFill technology setup, the receiver will automatically convert your position in the datum you select to the equivalent position in ITRF2008.

If your base station was properly surveyed within the last five years using one of the following coordinate systems, the xFill technology accuracy error will typically be less than 15 cm over 20 minutes.

- WGS84/ITRF2008
- NAD83
- ETRS89
- GDA94

When working within an area with several RTK base stations, each base station should have a unique Base ID. When moving in range of another base station, go to the GPS setup on the display and enter the Base ID. This enables the receiver to recognize the new base station.

Base Station Survey with AutoBase™

If the Trimble AutoBase feature was used to survey the base, the accuracy can be >5 m, which decreases the xFill technology accuracy. The datum used for this feature is WGS84. Trimble recommends testing xFill prior to using it in an application where the base station has only been surveyed with AutoBase.

VRS Base Station

If using VRS, the accuracy is typically <1 cm . Contact your VRS network owner to determine the datum used for surveying and enter this datum during the xFill technology set-up. Trimble VRS Now™ network uses the following:

- VRS Now US: NAD83
- VRS Now Europe: ETRS89
- VRS Now TEC Europe: ETRS89

Base Station, Survey Unknown - If you do not know if your base station has been surveyed or the datum used for surveying, you should perform testing to approximate your base station errors or turn off xFill technology.

Estimating Base Station Errors

To estimate the error in the position of the base station, options include:

- **Calculate Current Position and Compare to Set Position:** Collect two hours of position logs and submit them for post-processing (using the same coordinate system as previously used). Then enter the current set position and the newly calculated position into a GPS distance tool calculator.
- **xFill Accuracy Detection Using Cross Track Error:** Set-up your antenna and receiver in an open air environment (field or parking lot). Create an A+ line based on your parked position with RTK fixed. Unplug the radio or the modem if using cellular signal. xFill technology will engage. Watch your cross track error (XTE) for a maximum of 20 minutes. Repeat several times. Keep in mind that this static test only tests the error in one direction (N/S or E/W).
- **xFill Accuracy During Passes in a Field:** To best see the drift of the xFill position over time:

Note: This procedure will only be accurate if you have already completed the Roll Calibration for auto-steering.

1. Create an A/B line in your field (or use an existing line). See Guidance Patterns: AB Line.
2. Drive the line and once your cross track error (XTE) is very small, stop and drop a flag in the center of your hitch.
3. Turn off RTK by changing the network ID or frequency.
4. Drive around the field for several minutes (to represent your typical outage time) and return to the A/B line.
5. Engage on the line and then when XTE is small and you're over you previous flag, stop and drop another flag. Compare the distance.
6. Make a pass in the other direction on the same A/B line and drop a third flag. Compare the distance.

When Not to use xFill Technology

xFill technology is not recommended for:

- Land leveling and water management applications where a high degree of vertical accuracy is required.
- Any operation where you need accuracy better than 1" (2.4 cm).
- When the base station has not been properly surveyed, or has been surveyed only with the AutoBase functionality and no tests have been performed to assess the risk of using xFill technology with that base station.

For More Information

Contact your local Trimble Regional Sales Manager.