

30 April 2013

Trimble xFill Technology: Standard RTK Feature

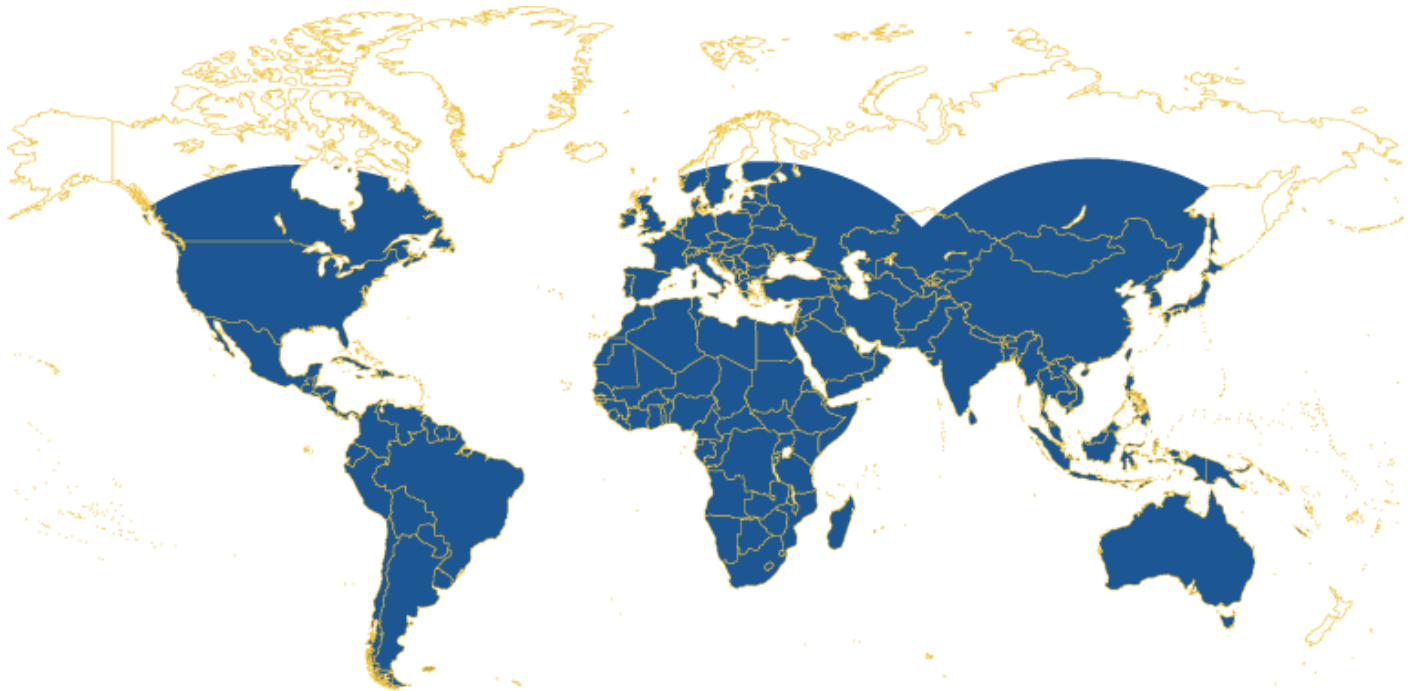
This document describes the new Trimble® xFill™ technology, a Trimble exclusive standard RTK feature.

How the xFill technology works

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 sustains RTK system operation. xFill technology combines the last-known RTK position with the Trimble RTX technology 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 the xFill technology and back to RTK. 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 the xFill technology 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.

Global coverage areas for the xFill service are the same coverage areas of the CenterPoint RTX correction service.



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Setup

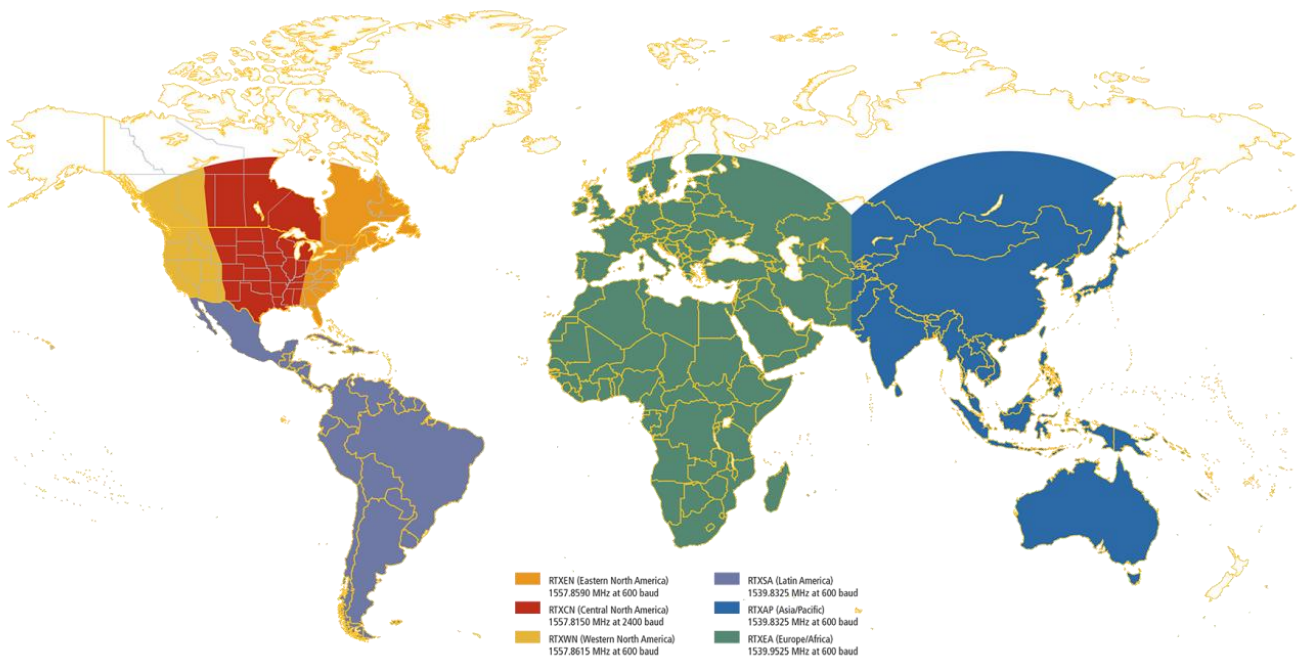
xFill technology is a standard feature that is available once the receiver is unlocked to RTK accuracy. The xFill technology is delivered by satellite broadcast, free of charge. To utilize xFill technology, make sure that your display uses an appropriate dual-frequency GNSS-compatible antenna such as the AG-25 or Zephyr™ Model 2 antenna. These antenna types are shipped as original equipment on the Trimble® FmX® integrated display and the CFX-750™ display; no additional radios, antennas or data plans are needed. The AG-372 GNSS receiver has a compatible antenna integrated into its enclosure. The xFill technology can function with corrections from single-baseline RTK, VRS and CORS systems.

To activate the xFill technology

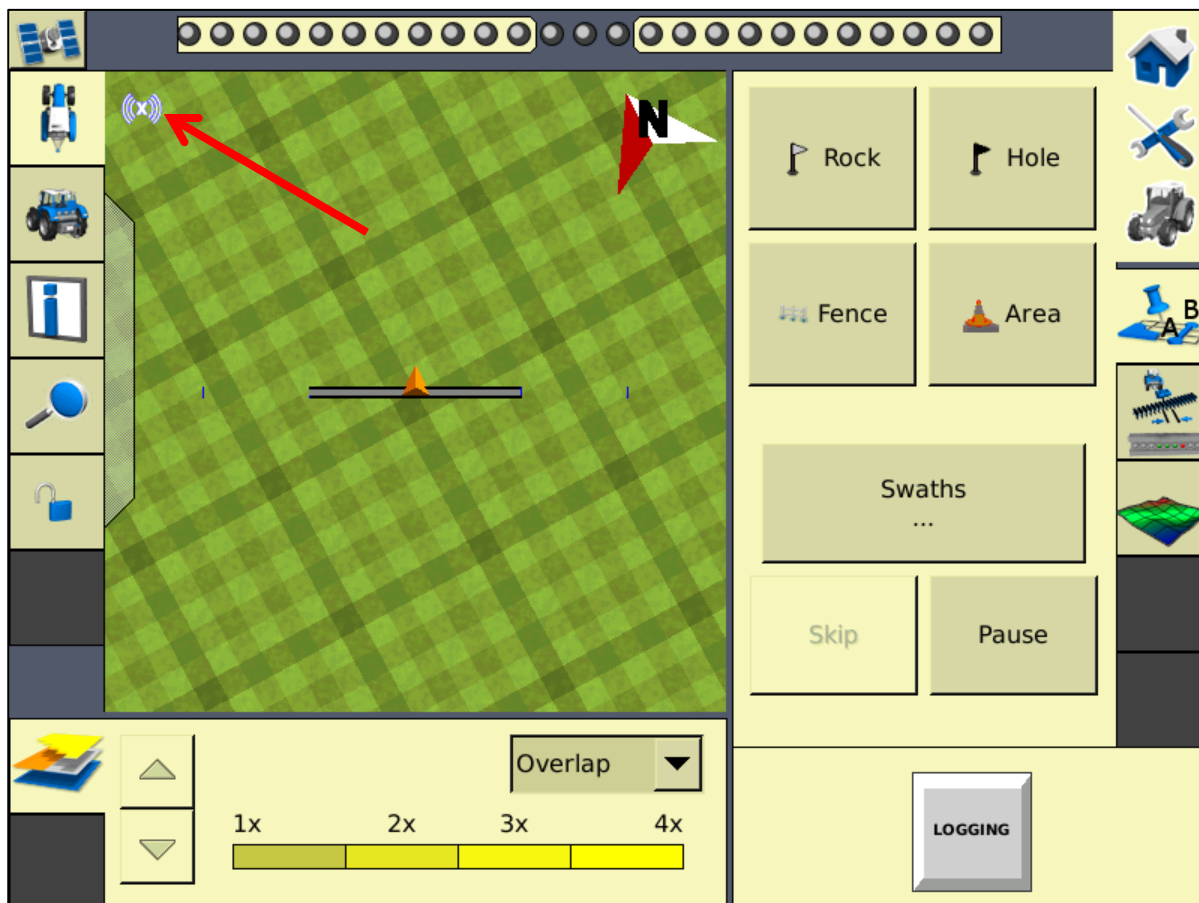
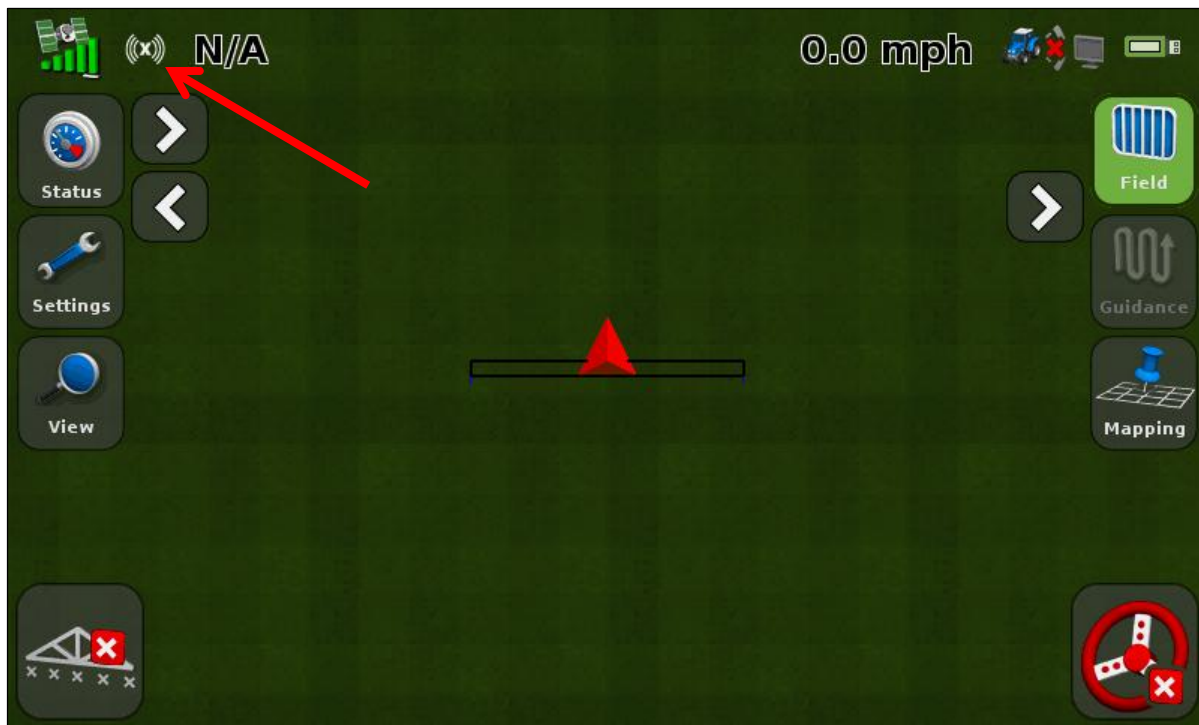
1. Download and install the latest firmware:

Display / receiver	Minimum firmware version
FmX integrated display	7.2
CFX-750 display	4.0
AG-372 GNSS smart antenna	Future - To Be Announced

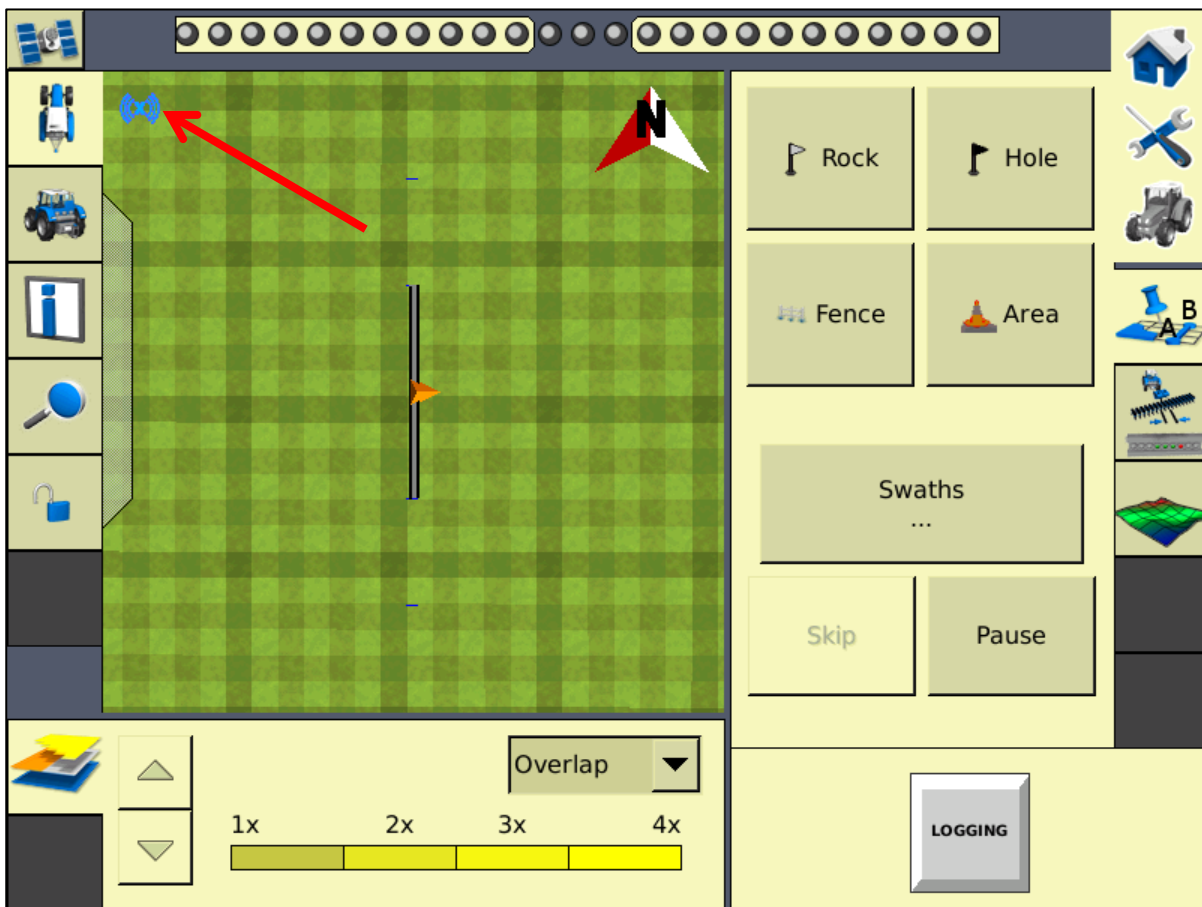
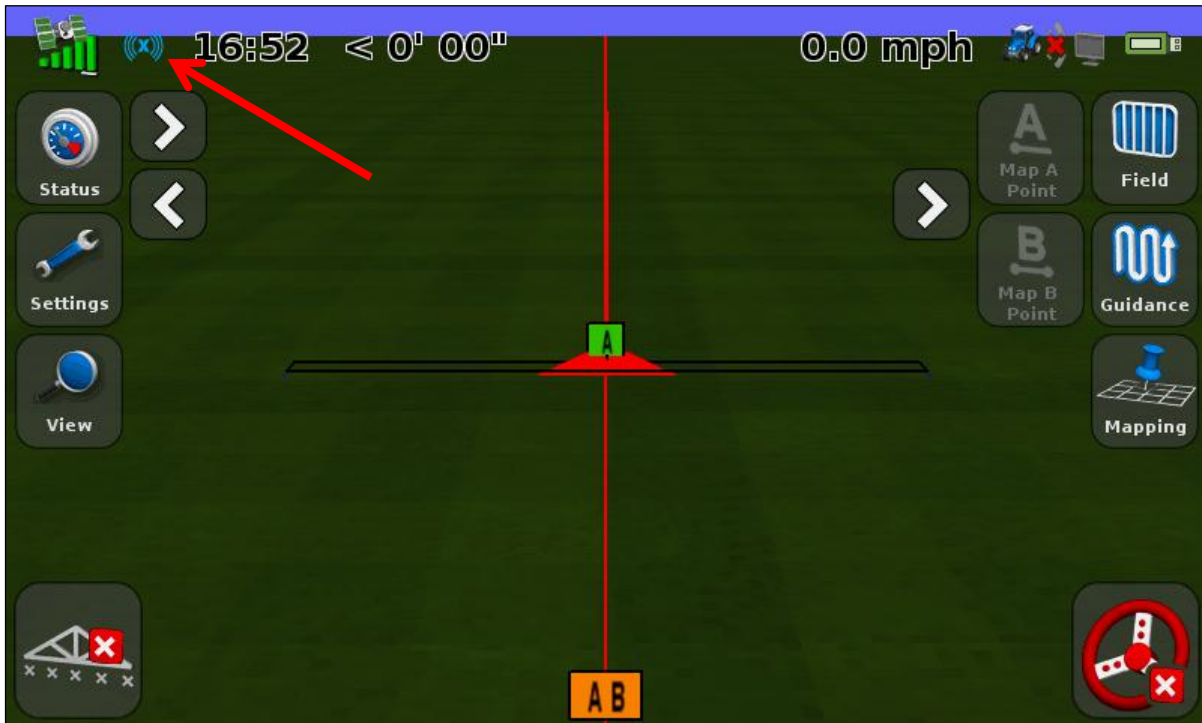
2. Ensure the system is unlocked to the RTK level accuracy.
3. Under the RTK configuration setup, verify that the xFill technology is switched on and the correct frequency and baud are selected from the list of six regionally specific frequencies:
 - Western North America (RTX WN) : 1557.8615 MHz at 600 baud
 - Central North America (RTX CN) : 1557.8150 MHz at 2400 baud
 - Eastern North America (RTX EN) : 1557.8590 MHz at 600 baud
 - South/Central America (RTX SA) : 1539.8325 MHz at 600 baud
 - Europe/Africa (RTX EA) : 1539.9525 MHz at 600 baud
 - Asia Pacific (RTX AP) : 1539.8325 MHz at 600 baud



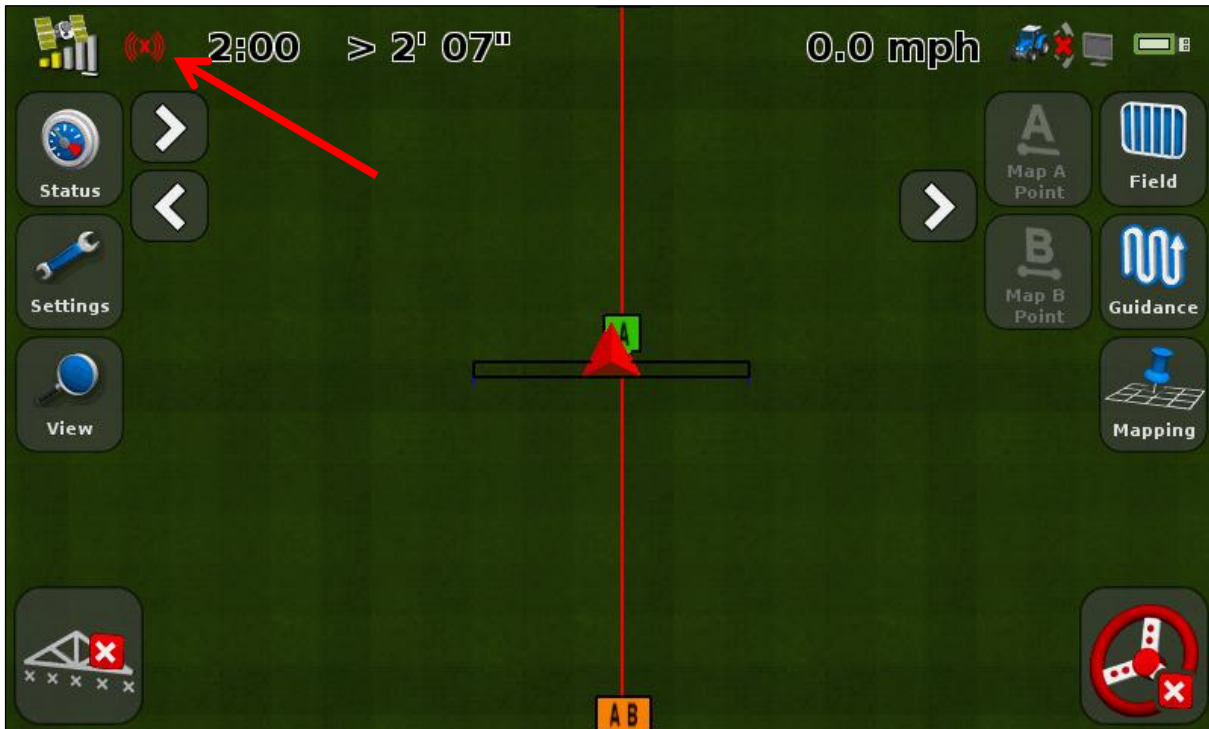
Once turned on and communicating with satellites, a white xFill icon will be displayed on the Run screen:



In the event of an RTK or VRS™ signal interruption, the system will automatically switch into xFill mode. In the run screen of the display, the xFill icon will change to a blue color:



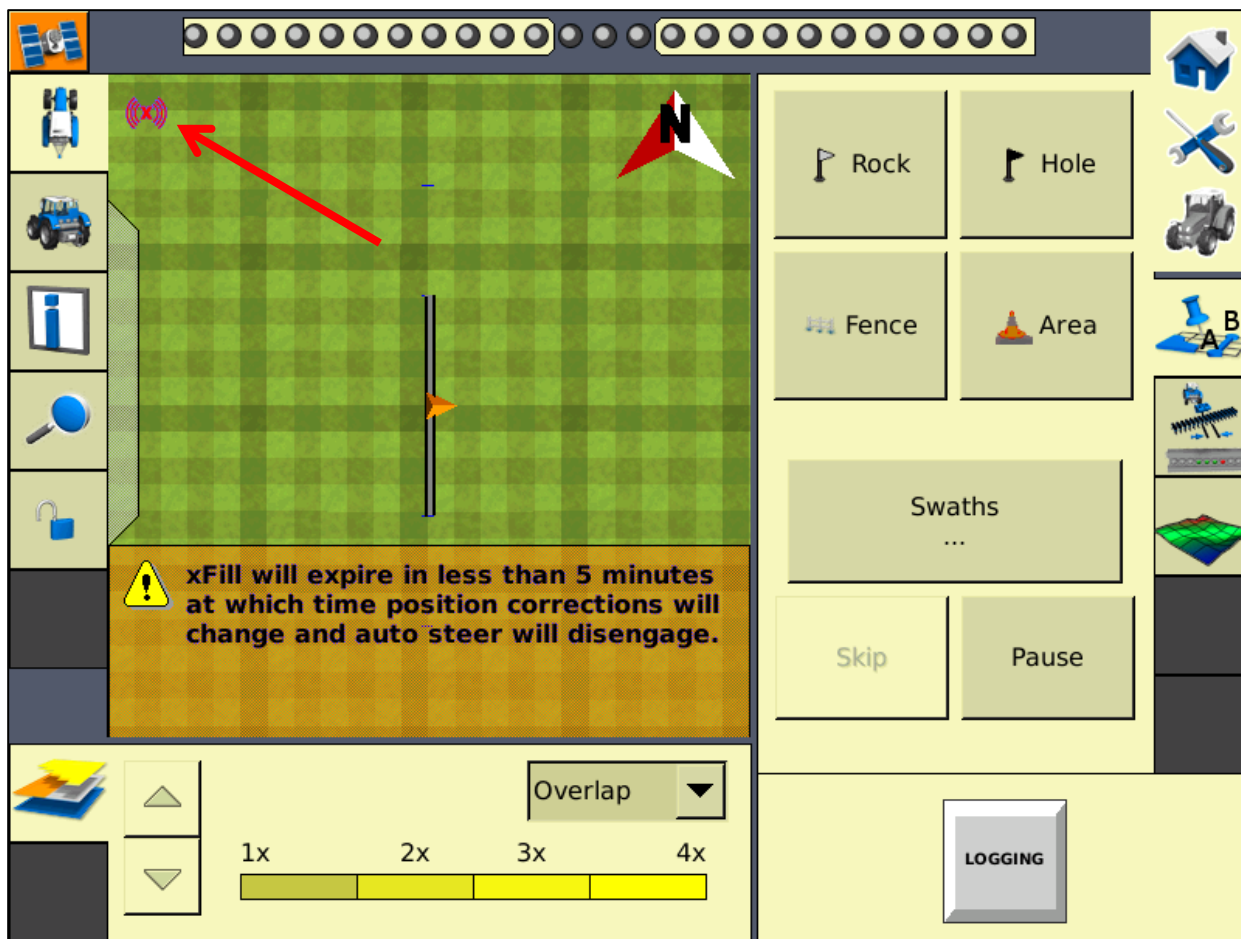
When five minutes of xFill time remains (15 minutes have elapsed), the xFill icon will change to a red color and a warning will pop-up on the display:



XFill Warning

XFill will expire in 5 minutes at which time position corrections will change and auto steer will disengage.





Accuracy

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

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

If a user is concerned with maintaining sub-inch precision, they should disable the xFill feature.

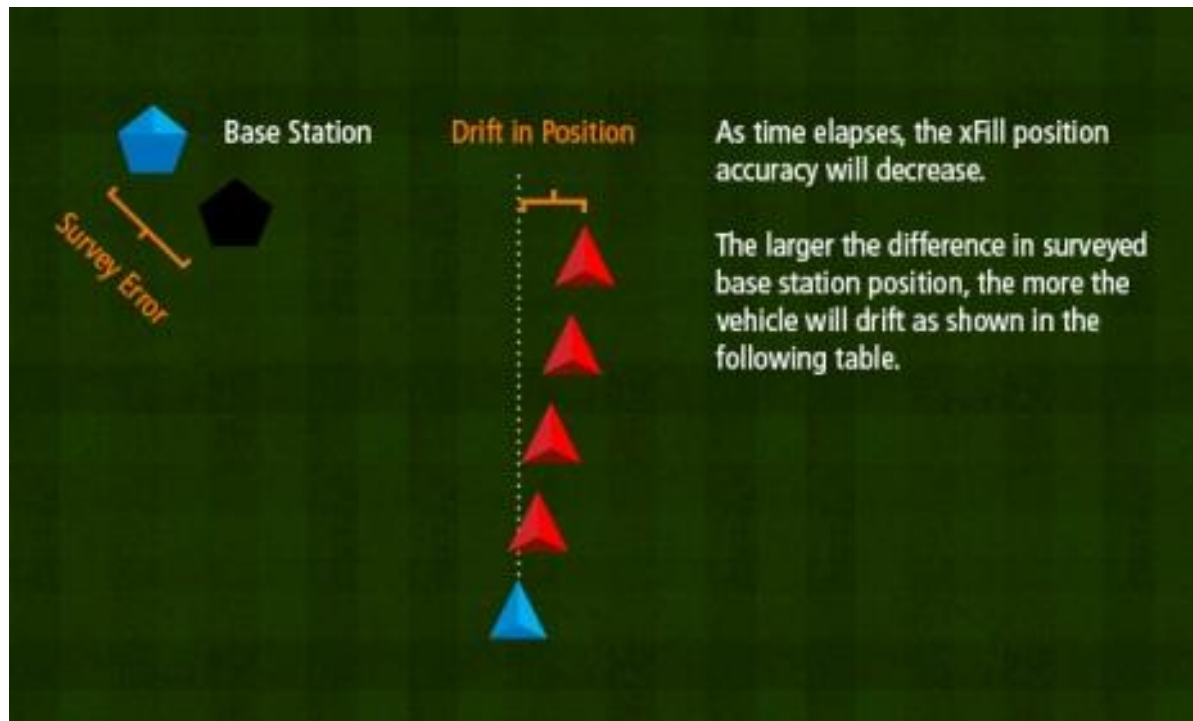
Dependence on time

The table illustrates the estimated accuracy over time while the xFill function has been active, with base station surveyed accuracy of <20cm:

xFill runtime – no RTK corrections	Estimated error
1-5 minutes	1-5cm
5-10 minutes	5-9cm
10-20 minutes	10-15cm

Dependence on base station position exactness

When the RTK correction signal is lost the xFill technology begins to provide corrections that are based on the last RTK position. When you setup the xFill technology 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 surveyed position, over time, can cause a drift in position.



Drift in position during use of xFill technology

The table below shows how the xFill drift over time is impacted by base station coordinates:

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

If you discover that the surveyed location of your base station is not accurate it is best to turn the xFill technology off. Another option is to resurvey your base station; this will result in the movement of any stored AB lines that are reloaded/reused, which is very undesirable to many RTK customers.

One safety feature of the xFill technology is to estimate the drift in position and, if the distance back to the original path is too large, to discontinue the xFill fixed position. This will disengage auto-steering. In this case, the user can manually steer until RTK corrections are available or switch their correction source to DGPS and engage on the lower accuracy correction source.

Properly Surveyed Base Station

At initial base station installation, Trimble recommends surveying 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. Please refer to [AgGPS 542 Receiver: Base Station Survey and RTX Post Processing](#) for further information. Over time, primarily due to normal tectonic plate movement, the base station position may change up to 7cm/year.

When you select the datum used to survey your base station when setting up the xFill technology, 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 accuracy error will typically be less than 15cm over 20 minutes.

- WGS84/ITRF2008
- NAD83 (North America)
- ETRS89 (Europe)
- GDA94 (Australia)

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

Base Surveyed with Auto Base feature

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

VRS Base Station

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

- VRS Now US: NAD83
- VRS Now Europe: ETRS89
- VRS Now TEC Europe: ETRS89
- OmniSTAR CORS Tasmania: GDA94

Base Station Details Not Known

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 the xFill technology off.

How to approximate base station errors

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. The Support Note [AgGPS 542 Receiver: Base Station Survey and RTX Post Processing](#) details the process of logging position data from your base station.

xFill Accuracy Detection Using Cross Track Error – Set-up your antenna and receiver in an open-air environment (such as a field or parking lot). Create an A+ line based on your parked position with RTK fixed. Unplug the radio or unplug the DCM-300 modem if using a cellular signal. The 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 (North/South or East/West).

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)
2. Drive the line. Once your cross track error (XTE) is very small, stop and drop a flag in the center of your hitch.
3. Unplug the radio or unplug the DCM-300 modem if using a cellular signal. The xFill technology will engage.
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: when the XTE is small and you are over your 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.

Dependence on satellite

The xFill technology requires correction data from at least five satellites higher than 10° from the horizon. If GLONASS is unlocked at the RTK level, the 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.

C Warning: Many large and sudden changes in satellite geometry caused by blockage 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.

It is important to realize that if you lose corrections from the satellite, you will go into DGPS corrections. Even if you regain exposure to the satellites, the xFill technology will not resume. Anytime the xFill technology degrades to DGPS, the receiver must receive RTK corrections before the xFill technology can be ready in the background again.

Additionally, if you lose any of your satellites when using the xFill technology, they will not be able to be used for the entire xFill duration of 20 minutes.

When is the use of the xFill technology not recommended?

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