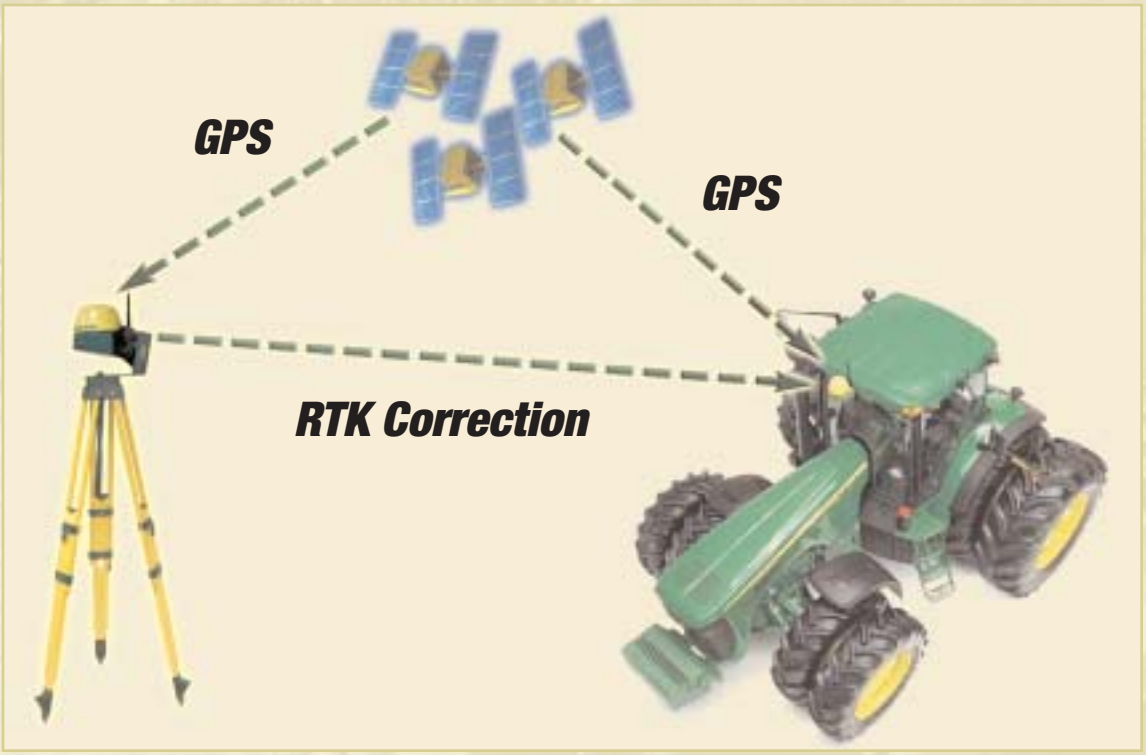
AMS Insider: John Deere StarFire™ RTK

Adding repeatability to the GreenStar™ Guidance Family

What is StarFire RTK?

StarFire RTK is a form of GPS differential correction that can deliver both high accuracy and high repeatability. The system consists of a local base station in or near the field that transmits corrections to the StarFire receiver on the RTK equipped vehicle. Corrections are transmitted from the base station to the vehicle via the RTK radio.

The base station monitors the government constellation of GPS satellites and continuously calculates a position, and since the base station is not moving, the errors can be measured in real-time. This error is sent to the vehicle via the RTK radio (see diagram below). The vehicle receiver uses this information to calculate a highly accurate, corrected position.



RTK Advantages

The key advantage of the RTK system is repeatability. StarFire RTK eliminates nearly all of the GPS drift that occurs with satellite based differential corrections systems, such as the StarFire Network (SF2 and SF1) and WAAS (Wide Area Augmentation System). By eliminating GPS drift, the vehicle can be guided down the same tracks, day after day, month after month, or year after year. What's more, without GPS drift, the operator won't have to periodically use Shift Track as he or she proceeds through the field.

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RTK Limitations

Performance of the RTK system is related to the operating distance from the base station. When operating beyond 6 miles, degraded accuracy will occur and it may take longer to initially acquire the RTK signal. The user will receive a warning on the GreenStar display when the vehicle is operating beyond 10 miles from the base station, but RTK corrections will continue to be broadcast.

RTK Extend → Industry Exclusive

An unobstructed line of sight must exist between the base station and the vehicle with any RTK system. Obstructions such as hills, trees, and buildings can interrupt the correction signal, causing the RTK signal to be dropped. However, StarFire RTK can sustain RTK accuracy using an exclusive John Deere AMS feature – RTK Extend. If the base station StarFire receiver has been powered for at least one hour, RTK Extend will deliver RTK accuracy for up to 15 minutes. When the base station signal is re-acquired, standard RTK is resumed. If the base station receiver has been powered for less than 1 hour, 2 minutes of RTK Extend will be provided.

Making the Right Choice: RTK or SF2?

Now that there will be two differential correction choices for high accuracy guidance, there are several factors to consider in order to make the right choice for your customers.

	RTK	SF2	Explanation
Long-term repeatability	X		Repeatability is important when trying to follow the same tracks during multiple passes across the field
Lower initial investment		X	Additional hardware is required for RTK when compared to SF2
Requires periodic use of Shift Track to compensate for GPS Drift		X	RTK doesn't require Shift Track to manage GPS drift
Base station distance limitation	X		The RTK-equipped machine must be within 6 miles of the base station and have a direct line of sight for reliable operation
Renewable subscription required		X	RTK requires only a one-time software activation for each StarFire receiver; an SF2 subscription is not required

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AutoTrac System Accuracy

It is important to understand that the StarFire RTK system is only one piece of the entire AutoTrac system. RTK can deliver a highly accurate, repeatable GPS position. Consider now the other factors that are just as important to overall AutoTrac performance as measured in the field.

For a detailed listing of these factors, please refer to DTAC solution 59591

*Within 6 miles of base station and 68% of time
**15 minute (Pass to Pass) Accuracy 95% of time

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Frequently Asked StarFire RTK Questions

- **How do I deal with the line-of-sight restriction with RTK?**

The RTK equipped vehicle must be within 6 miles of the RTK base station, and it must have a direct, unobstructed line of sight view of the base station. StarFire RTK will have a unique feature called RTK Extend, which will improve performance when temporary line of sight obstructions occur. If the base station StarFire receiver has been powered for more than one hour, RTK Extend will maintain RTK accuracy for 15 minutes after the base station signal is lost. If the base station receiver has been powered less than 1 hour, RTK Extend will maintain RTK accuracy for 2 minutes.

If a situation arises causing the base station signal to be lost for more than 15 minutes, the user may choose to move the base station closer to the field of operation.

A repeater, which is simply an RTK radio supplied with 12 volts of power, can be used to receive the base station signal and establish a new line of sight point (see Figure 1). However, performance limitations can still be expected if trying to use the repeater to transmit the RTK signal to a vehicle that is farther than 6 miles away from the base station.

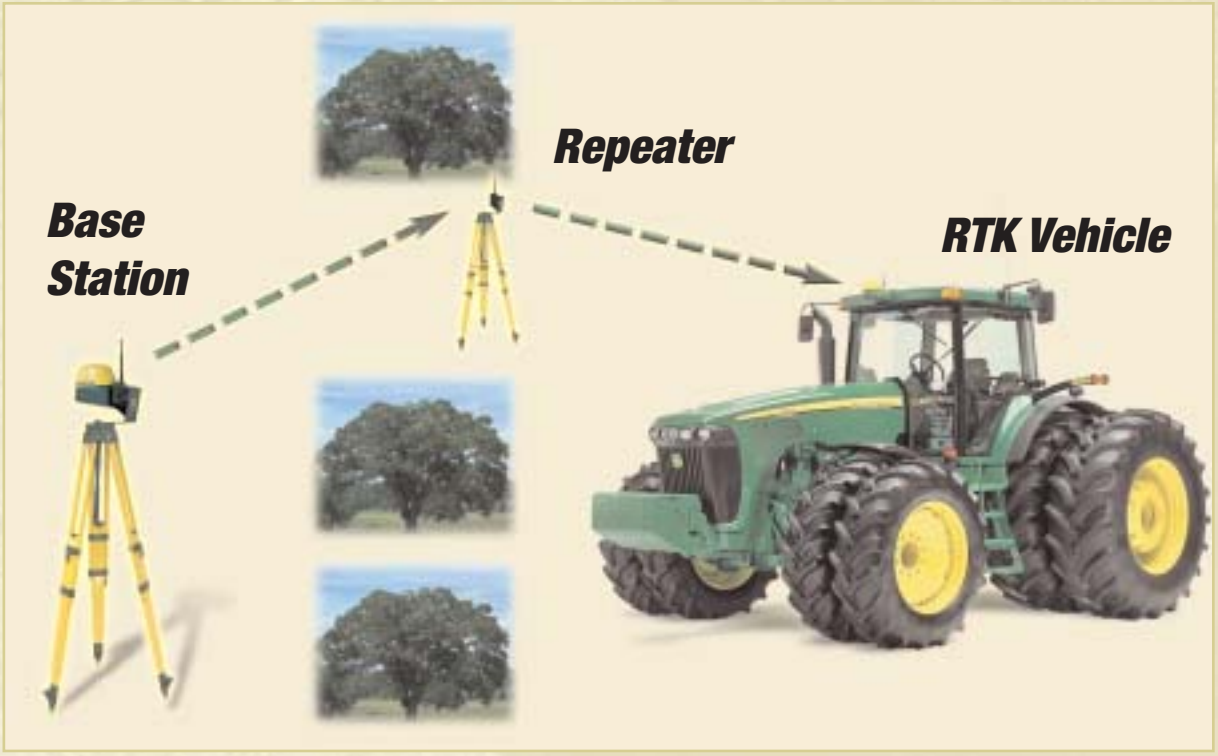

Figure 1 StarFire RTK with repeater

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Frequently Asked StarFire RTK Questions

- **Is everything in the basic AutoTrac (SF2) system used when upgrading to RTK?**
  Yes, a customer that has the basic (SF2) AutoTrac system and wants to upgrade to RTK will reuse all existing components. To upgrade to RTK, the following is needed:
  - Base Station, including a StarFire receiver, RTK radio, and RTK activation
  - Components to update the existing vehicle receiver to RTK, including the RTK radio and activation

- **Can customers share base stations?**
  Yes, one base station can send out an unlimited number of corrections to as many vehicles that are within a 6 mile line of sight of the base station. The Network ID number on the base station can be used to allow or prevent access to a specific base station's signal.

- **How accurate is StarFire RTK?**
  The StarFire RTK signal accuracy is dependent on the distance from the base station. If the vehicle is less than 1 mile away from the base station, the signal accuracy is +/- 0.5 inches or less 68% of the time, and +/- 0.9 inches or less 95% of the time. Most RTK competitors advertise only the 68% accuracy. Remember, GPS signal accuracy is only part of the whole AutoTrac system accuracy equation.

- **Does the RTK radio have to be licensed with the FCC?**
  No, the StarFire RTK radio operates at 900mhz, which means that it can be operated license free in North America, Australia, New Zealand, and South America.

- **Does the RTK radio move with the StarFire receiver?**
  Yes, the RTK radio mounts directly to the new StarFire receiver bracket, as pictured below.

- **Can the same receiver be equipped with both SF2 and RTK?**
  Yes. One StarFire receiver can utilize RTK and have an SF2 license, and the user can manually select which source is used for corrections through the GreenStar display.

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Frequently Asked StarFire RTK Questions

- **What happens when the RTK corrections are dropped (i.e. line of sight blockage)?**
  The StarFire receiver can coast for 10 seconds without receiving communications from the base station. After 10 seconds, RTK Extend mode will be enabled, providing RTK accuracy for additional time. If the base receiver has been powered for more than 1 hour, RTK Extend will provide RTK accuracy for 15 minutes. If the base receiver has been powered for less than 15 minutes, RTK Extend will be active for 2 minutes.

- **Can the base station be mounted on a tower?**
  Yes, mounting the base station radio in the air increases the chance that the vehicle will maintain a direct unobstructed line of sight view. In order to facilitate elevated mounting, a radio extension harness is available so that the radio can be mounted high and the StarFire receiver can remain on a more stable structure.

- **Why is the range limited to 6 miles?**
  In order for RTK to deliver repeatability and high accuracy, the base station receiver and the vehicle receiver need to view the same GPS satellites. As the distance between the base station and vehicle receiver increases, the difference between the atmospheric conditions through which the GPS signals must travel differ, resulting in degraded accuracy. The RTK base station will transmit corrections to the vehicle even when the separation distance is greater than 6 miles, but the accuracy will be degraded.

- **How is the base station powered?**
  The base station requires a constant supply of 12 volts. The StarFire receiver and RTK radio together draw around 1.5 amps. A 12 volt battery is commonly used. If the base station is mounted near a 110 volt power source, a 3 amp power supply (available from an electronic supplier such as Radio Shack) is recommended.

- **What happens if the base station is moved while it is being used?**
  If the base station is moved when the system is being used, position inaccuracy is immediately introduced. If the base station is moved more than 30 meters, a warning will appear and RTK corrections will be disabled.

- **How long does it take to move and setup a base station?**
  When configured as a “Quick Survey” base station, corrections will be sent out as soon as an initial GPS position is calculated. This usually takes 5-10 minutes.

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Frequently Asked StarFire RTK Questions

- **How does the customer achieve repeatability?**

  The RTK base station can be operated in two modes: Quick Survey mode and Absolute Accuracy mode.

  In Quick Survey Mode, the base station can be setup at any arbitrary location, and after an initial GPS position is acquired (usually about 5 minutes), RTK corrections are automatically transmitted. If the base station is setup in the same field, and if the user wants to follow previous tracks (i.e. established rows), he will need to recall the correct field number (Tracking Field number) in the GreenStar Display, align the vehicle on the previously established rows, and press the #2 Shift Track button. From this point on, no additional shifts will be needed since the GPS drift is eliminated with RTK.

  In Absolute Survey Mode, the base station must be mounted in a location that can be easily repeated. This can be accomplished using a quick coupler bracket on a fence post in concrete or on top of a building. The user will not want to use a tripod in this mode because of the difficulty in repositioning a tripod over the exact same spot. The first time the user mounts the base station, the receiver will need to conduct a one-time 24 hour survey so that it can determine its exact location. This survey must be conducted prior to guidance operation. After the survey is completed, the base station will then transmit RTK corrections. When the base station is brought back to the same location, it will automatically recognize that a 24 hour survey has already been conducted, and the previously stored position will be used.

- **Does RTK require an SF2 license?**

  No, an SF2 license is not needed at the base station or at the vehicle receiver. However, a one-time RTK activation code must be entered into each receiver used in the RTK system.