CHAPTER

4

Setup Guidelines

In this chapter:

- Base station operation guidelines
- Rover operation guidelines

GPS Real-Time Kinematic (RTK) operation provides centimeter-level accuracy by eliminating errors that are present in the GPS system. For all RTK operations, you require both a base station and a rover receiver.

This chapter introduces the concepts of base station and rover operation, provides information to help you identify good setup locations, describes best practices for setting up the equipment, and outlines the precautions that you need to take to protect the equipment.

Base station operation guidelines

A base station consists of a receiver that is placed at a known (and fixed) position. The receiver tracks the same satellites that are being tracked by the rover receiver, at the same time that the rover is tracking them. Errors in the GPS system are monitored at the fixed (and known) base station, and a series of position corrections are computed. The corrections are sent through a radio link to the rover receiver, where they are used to correct the real time positions of the rover.

Base station components

The base station has the following components:

- GPS receiver
- GPS antenna
- Base station radio
- Power supply

GPS receiver and GPS antenna

A GPS receiver, such as the *Ag*GPS 442 receiver, incorporates a GPS receiver, power supply, and base station radio in a single unit. The GPS antenna and the base station radio antenna are separate from the receiver. Because the GPS antenna is separate, you can use the following optimized components:

- a geodetic antenna with large ground plane, to eliminate multipath (the major source of GPS errors) at the base station
- a high-gain or directional radio antenna, to increase broadcast range and to provide maximum coverage

You can also place the GPS receiver in an easily accessible and secure location, safe from theft and the weather, while the antennas are placed high on a tower or building, clear of obstructions, and able to deliver maximum performance.

The GPS antenna included with the *Ag*GPS 432 or 442 receiver is a Trimble Zephyr Geodetic™ Model 2 antenna. The Zephyr Geodetic Model 2 antenna has a large ground plane to eliminate multipath and can be used in both fixed (permanent) installations and mobile base station applications.

Base station setup guidelines

For good performance, observe the following base station setup guidelines:

- Place the GPS antenna in a location that has a clear line of sight to the sky in all directions. Do not place the GPS antenna near vertical obstructions such as buildings, deep cuttings, fences, towers, or tree canopy.
- Mount the GPS antenna securely to minimize movement of the antenna. Any movement of the base station GPS antenna will cause corresponding movement in the rover.
- Place the GPS and radio antennas as high as practical. Radio antenna height is a significant factor in the broadcast range of the radio.

Note – The GPS antenna must have a clear line of sight to the sky at all times during operation.

- Choose the most appropriate radio antenna for the desired coverage area. The higher the gain on the antenna, the longer the range. If there is more focus on the transmission signal, there is a reduced coverage area. A 3 dB or 5 dB gain antenna provides a mix of good range and reasonable directional coverage.

- Make sure that the GPS receiver does not lose power. The GPS receiver has an integrated battery, which has to be charged. To operate for the full day without loss of power at the base station, provide external power. Sources of external power include:
  - AC power
  - 12 V car or truck battery
  - Generator power
  - Solar panel

  When you use an external power supply, the integrated battery provides a backup power supply, enabling you to maintain continuous operation through a mains power failure.

  When the GPS receiver is connected to a power source greater than 15 V, the integrated battery is continuously charged from the connected power source. This helps to ensure that the battery stays charged.
- Do not locate a GPS receiver, GPS antenna, or radio antenna within 400 meters (about 1,300 feet) of:
  - a powerful radar, television, or cellular communications tower
  - another transmitter
  - another GPS antenna

  Cell phone towers can interfere with the base station radio broadcast and can stop corrections from reaching the rover receiver. High-power signals from a nearby radio or radar transmitter can overwhelm the receiver circuits. This does not harm the receiver, but can prevent the receiver electronics from functioning correctly.

  Low-power transmitters, such as those in cell phones and two-way radios, do not interfere with receiver operations.

- Do not set up the base station directly beneath or close to overhead power lines or electrical generation facilities. The electromagnetic fields associated with these utilities can interfere with GPS receiver operation. Other sources of electromagnetic interference include:
  - Gasoline engines (spark plugs)
  - Televisions and computer monitors
  - Alternators and generators
  - Electric motors
  - Equipment with DC-to-AC converters
  - Fluorescent lights
  - Switching power supplies
- Place the GPS receiver in a protected and secure location.
- If you place the *Ag*GPS 442 receiver in a lock box or other enclosure to protect the receiver from theft or from the weather, shield the lock box from direct sunlight and provide ventilation for the receiver through an inlet and extractor fan. A receiver that has a broadcast radio generates significant heat. Do not allow the temperature in the box to exceed 50 °C (122 °F).
- If working in a cold climate, you may need to provide heat to the receiver. Do not operate the receiver below –40 °C (–40 °F).
- Trimble recommends that, wherever possible, you keep GPS receiver equipment dry. The receivers are designed to withstand wet weather, but keeping them dry prolongs their life and reduces the effects of corrosion on ports and connectors. If the equipment gets wet, use a clean dry cloth to dry the equipment and then leave the equipment open to the air to dry. Do not lock wet equipment in a transport case for prolonged periods. Avoid exposing the GPS receiver to corrosive liquids and salt water wherever possible.

- Trimble recommends that you install lightning protection equipment at permanent base station locations. Equipment should include a gas capsule lightning protector in the GPS and radio antenna feed line and appropriate safety grounding. A static dissipater near the antennas can reduce the likelihood of a direct lightning strike. Also protect any communications and power lines at building entry points. For more information, contact your local Trimble dealer, or go to the Huber and Suhner website (www.hubersuhnerinc.com).
- Trimble recommends that you use surge protection equipment on all permanently installed equipment.

Permanent installation antenna cabling for the *Ag*GPS 442 GPS receiver

Many permanent base station installations have unique cabling requirements. Depending on the available infrastructure, you may need to mount the antenna a considerable distance from the receiver.

The *Ag*GPS 442 receiver can withstand a loss of 12 dB between the GPS antenna and the receiver. The degree of loss in a coaxial cable depends on the frequency of the signal passing through it. This table lists some common cable types and the maximum length you can use before an inline amplifier for GPS frequencies is required.

Cable type	Maximum length (for use without an inline amplifier)
RG-214	30 m (100 ft)
LMR-400	70 m (230 ft)
LMR-500	85 m (280 ft)
LMR-600	106 m (350 ft)
Heliax LDF4/50	165 m (540 ft)
Heliax LDF4.5/40	225 m (740 ft)

Rover operation guidelines

The second part of the RTK GPS system is the rover receiver.

The rover receiver is mounted in a vehicle and is receiving corrections from an RTK base station. The connection is provided by the integrated radio or other communications device connected to the receiver.

The correction stream for some other positioning solutions, such as SBAS (WAAS/EGNOS/MSAS), is broadcast through geostationary satellites, and detected by the GPS antenna itself. No integrated radio or base is required.

Rover receiver components

The rover receiver has the following components:

- GPS receiver
- GPS antenna
- Radio antenna

In most rover applications the receiver operates from the power supplied from the vehicle. In some instances, the rover can be operated using only the integrated battery unit. Use external power if it is available, the internal battery then acts as an uninterruptable power supply.

Rover receiver setup guidelines

For good rover operation, observe the following setup guidelines:

- Place the GPS antenna in a location that has a clear line of sight to the sky in all directions. Do not place the antenna near vertical obstructions. GPS rovers and base station receive the same satellite signals from the same satellites: if you obscure the signals at times, the system will be unable to provide RTK Fixed positions.
- Place the GPS and radio antennas as high as possible to minimize multipath from the surrounding area. The receiver must have a clear line of sight to the sky at all times during operation.

- GPS satellites are constantly moving. Because you cannot measure at a specific location does not mean that you will not be able to measure there later, when satellite coverage or location improves. Use GPS planning software to identify the daily best and worst satellite coverage times for your location and then choose measurement times that coincide with optimal GPS performance. This is especially important when operatin gin the worst GPS locations.
- The *Ag*GPS 432 and *Ag*GPS 442 receivers can track the GPS L2C modernization signal. Additionally, the *Ag*GPS 442 receiver can track the GPS L5 modernization signal and the GLONASS satellite constellation. These signals can help you get positions at the worst times of the day and in the worst locations, but do not guarantee that you will.
- To get a fixed position solution with sub-inch accuracy, initialize the rover receiver. For initialization to take place, the receiver must track at least 5 satellites that the base station is also tracking. In a dual-satellite constellation operation for example, GPS and GLONASS, the receiver must track at least six satellites.
- To maintain a fixed position solution, the rover must continuously track at least four saltellites that the base station is also tracking. In a dual-satellite constellation operation, GPS plus GLONASS, the receiver must track at least 5 satellites that the base station is also tracking. The radio link to the base station must be maintained.
- Loss of satellite signals or the loss of radio link results in a loss of sub-inch position accuracy. From Fixed, the receiver changes to Float or Autonomous mode:
  - In Float mode, the rover has a connection to the base station through the radio, but has not yet initialized
  - In Autonomous mode, the rover has lost radio contact with the base station and is working by itself with the available GPS signals.

- On a vehicle, place the GPS antenna in a location as free from shock and vibration as possible. A single magnetic mount is normally sufficient to hold the antenna in a suitable location.
- Make sure that the rover receiver does not lose power. An *Ag*GPS 4x2/5x2 receiver is typically powered by its internal battery. You cannot change the battery, but the charge typically lasts for longer than a working day. If you do not use the rover receiver very often, ensure that it is charged at least every three months.
- For vehicle operation, Trimble recommends that you use an external power source so that the internal battery can be saved for times when the receiver is being used off the vehicle.
- Do not locate the receiver or antenna within 400 meters (1312 ft) of powerful radar, television, cellular communications tower, or other transmitters or GPS antennas. Low-power transmitters, such as those in cellular phones and two-way radios, normally do not interfere with receiver operations. Cellular towers can interfere with the radio and can interfere with GPS signals entering the receiver. High-power signals from a nearby radio or radar transmitter can overwhelm the receiver circuits. This does not harm the receiver, but it can prevent the receiver electronics from functioning correctly.
- Do not use the rover receiver directly beneath or close to overhead power lines or electrical generation facilities. The electromagnetic fields associated with these utilities can interfere with GPS receiver operation. Other sources of electromagnetic interference include:
  - gasoline engines (spark plugs)
  - televisions and computer monitors
  - alternators and generators
  - electric motors
  - equipment with DC-to-AC converters

  - fluorescent lights
  - switching power supplies

- Trimble recommends that, wherever possible, all GPS receiver equipment is protected from rain or water. Although, the receivers are designed to withstand all wet weather conditions, keeping the receivers dry prolongs the life of the equipment and reduces the effects of corrosion on ports and connectors. If the equipment gets wet, use a clean dry cloth to dry the equipment, and then leave the equipment open to the air to dry. Do not lock wet equipment in a transport case for prolonged periods. Wherever possible, avoid exposing the GPS receiver to corrosive liquids and salt water.
- If you are using the rover receiver in open spaces, Trimble recommends that you stop work during electrical storms where the risk of lightning strike is high.
- Where cables are involved, Trimble recommends that you use cable ties to secure the cables to the rod or other equipment to avoid inadvertent snagging while moving about the jobsite. Be careful not to kink, twist, or unnecessarily extend cables, and avoid trapping them in vehicle doors or windows. Damage to cables can reduce the performance of GPS equipment.