Outback GUIDANCE

900 MHz Base Station Repeater

User Guide

Part No. 875-0336-000 Rev A1

AgJunction

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and
(2) this device must accept any interference received, including interference that may cause undesired operation.

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Hemisphere GPS products may be covered by one or more of the following patents:

U.S. Patents					Australia Patents
6111549	6876920	7400956	8000381	8214111	2002244539
6397147	7142956	7429952	8018376	8217833	2002325645
6469663	7162348	7437230	8085196	8265826	2004320401
6501346	7277792	7460942	8102325	8271194	
6539303	7292185	7689354	8138970	8307535	
6549091	7292186	7808428	8140223	8311696	
6711501	7373231	7835832	8174437	8334804	
6744404	7388539	7885745	8184050	RE41358	
6865465	7400294	7948769	8190337		

Other U.S. and foreign patents pending.

Notice to Customers

Contact your local dealer for technical assistance. To find the authorized dealer near you:

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Fax: (204) 888-0991

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Repeater Overview

Hemisphere GPS' 900 MHz repeater is a powerful tool that allows you to extend your RTK radio coverage with a compact and easy-to-deploy weatherproof radio repeater.

In conjunction with a Hemisphere GPS base station (Outback A321™/A221™ Smart Antenna) and rover (Outback A320™/A220™ Smart Antenna), the 900 MHz Repeater kit provides reliable, license-free RTK radio coverage for precision farming in the most challenging environments.

Base Station Antenna Height

A key factor in good RTK radio coverage is to ensure your base station external radio antenna is mounted as high above the ground as possible. Provided the terrain is relatively free of hills and trees, you can expect your base station radio to deliver RTK messages to mobile farm equipment (rover) with good reliability over distances of several miles.

With precision RTK you cannot afford to have dead spots of RTK radio coverage. When radio coverage is lost for approximately 5 to 10 seconds or more GPS precision degrades. Also, when operating farm equipment in valleys or behind patches of trees, the rover radio may not receive RTK messages from the base station. In this scenario using a repeater is key to ensuring continuous centimeter-level precision farming.

Which Kit is Right for Me?

A permanent (fixed location) repeater solution may be ideal if you have access to a location on the farm that:

- Is on the opposite edge of the property
- Can provide power
- Enables you to mount the repeater several feet off the ground (such as a silo or grain elevator)

If a permanent repeater solution is either not feasible or suitable for your location you can deploy a portable (battery-powered) repeater kit on your property on a day-to-day basis to provide the coverage you need for various sections of the farm that may be blocked from the base station (such as by hills or trees).

What's Included

There are two types of repeater kits: fixed and portable (battery-powered). The type of kit determines the parts included in your kit.

Fixed Kit Contents

The fixed kit includes the following:

- Weatherproof AC/DC power adapter/communications cable
- DB9 serial adapter cable
- External antenna and mounting hardware
- External RF cable
- USB flash drive with repeater configuration software

Portable Kit Contents

The portable kit includes the following:

- Power/communications cable with alligator power clips for battery
- DB9 serial adapter cable
- Portable tripod with telescoping mast and antenna
- External RF cable
- USB flash drive with repeater configuration software
- 12 V, 18 Ah deep cycle sealed lead acid battery
- Battery charger

Note: If your PC or laptop does not include a serial port you will need to provide a serial-to-USB cable to connect the repeater to your PC/laptop (see Chapter 3, "Connecting to Your Repeater"). Contact your dealer for assistance in obtaining this cable.

Table 1-1 provides part numbers, descriptions, and photos for the parts in your kit (fixed kit or portable kit).

Table 1-1: 900 MHz repeater kit parts list (fixed and portable kits)

Fixed Kit	Port Kit	Part No.	Description	Qty	Photo
X		050-0033-002	Antenna cable TNC male to N male, 8 m	1	

Table 1-1: 900 MHz repeater kit parts list (fixed and portable kits) (*continued)*

Fixed Kit	Port Kit	Part No.	Description	Qty	Photo
	X	050-0071-000#	Antenna cable TNC male to TNC male, 3 m	1	
X	X	051-0343-000#	Serial adapter cable 3-pin circular male to DB9 female	1	
	X	054-0154-000#	Power/data cable 18-pin circular female to 3-pin circular female, 3 m (with clamps, for portable base setup)	1	
X		054-0155-000#	Power/data cable 18-pin circular female to 3-pin circular female, 3 m (with AC adapter, for fixed base setup)	1	
	X	150-0010-000	Antenna 900 MHz	1	

Table 1-1: 900 MHz repeater kit parts list (fixed and portable kits) (*continued*)

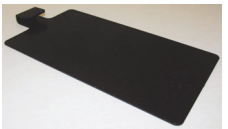
Fixed Kit	Port Kit	Part No.	Description	Qty	Photo
X		150-0026-000#	Antenna 900 MHz, 5 dBi omnidirectional	1	
	X	427-0048-000	Battery Power-Sonic, 12 V, 18 A	1	
	X	427-0050-000	Battery charger 12 V, 4 A	1	
	X	054-0095-000#	Battery charger cable	1	
	X	601-1245-000#	Tripod mounting plate for rover	1	
	X	676-0033-000#	Antenna adapter TNC female to NMO, 5/8-11 thread	1	
X	X	710-0124-000	USB flash drive, 2 GB (loaded with Hemisphere GPS Radio Configuration Tool software)	1	

Table 1-1: 900 MHz repeater kit parts list (fixed and portable kits) (*continued)*

Fixed Kit	Port Kit	Part No.	Description	Qty	Photo
	X	750-0050-000	Tripod base, black	1	
	X	750-0144-000	Mast, tripod mounted, telescoping, 2.3 m	1	
X	X	802-1075-000#	Repeater (Microhard MHX-920FS rover radio, 900 MHz)	1	
X		602-1136-000#	Antenna bracket base mount for 900 MHz antenna	1	
X		675-2071-000	U-bolt, 3/8"-16 x 2-1/2" x 3-1/8", ZP A.1	2	
X	X	875-0336-000	900 MHz Base Station Repeater User Guide (this manual)	1	*No photo*

Ports and LEDs

Figure 1-1 shows the ports of the repeater.

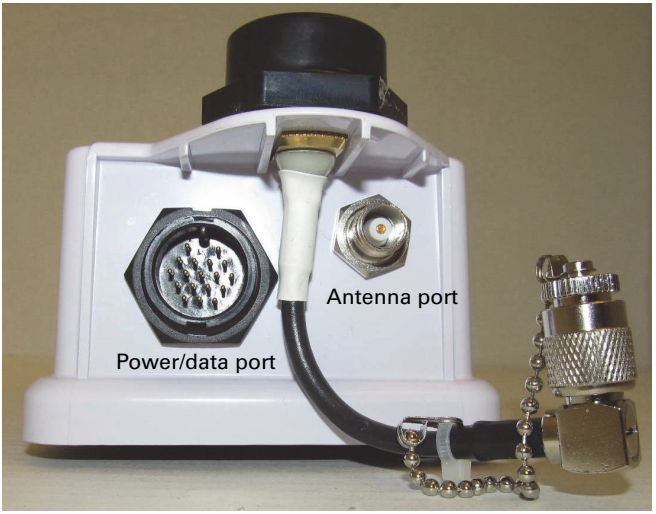


Figure 1-1: Repeater ports

Figure 1-2 shows the LEDs on the side of the repeater.

Figure 1-2: LEDs on repeater

After powering up the repeater it will typically synchronize to the network within 3 to 5 seconds. You will know it is synchronized when the Signal LED transitions from a slow blink to solid ON.

If the Signal LED blinks quickly (instead of solid ON) this indicates weak signal strength and you must find a better line of sight between the repeater and the upstream radio it is attempting to synchronize with (base or primary repeater). This means finding higher ground, raising the antenna higher, or moving it closer to the radio it is attempting to synchronize with. The repeater will synchronize with the primary repeater if it is set as a secondary repeater. The repeater will synchronize to the Base if it is set as a primary repeater.

Obtaining Product Updates

Contact your Outback Guidance dealer or Outback Guidance Customer Service to obtain product updates for your receiver, repeater, software (such as the Hemisphere GPS Radio Configuration Tool), and GPS applications.

Chapter 2: Deployment Options

Deployment Overview

Base station installation is critical for good GNSS performance and RTK coverage. You must install the base station clear of all obstacles—it must have a clear, 360° view of the sky without obstructions. If a radio tower or other obstacle blocks the view of the sky, your RTK performance may be compromised. Balancing this requirement with that of ensuring the radio antenna is as high off the ground as possible can be challenging.

The base station has an external 900 MHz cable connector, which you typically connect to a lengthy cable and that runs up to your elevated 900 MHz antenna. If this cable is too long it may weaken the radio performance. Ideally, you should keep the RF cable lengths to a minimum, while still ensuring the base station is not blocked by radio towers or other obstacles.

When using the 900 MHz repeater, you can have up to 10 repeaters per base station, where:

- The base, all repeaters, and all rovers must be set to the same channel (see "Configuring the Channel" on page 23)
- Each repeater in a network must have a unique repeater ID—select an ID 1 thru 10 for each repeater (see "Configuring the Repeater ID and Repeater Type" on page 24)

The scenarios in Figure 2-1 illustrate 5 repeaters per base station (5 primary repeaters in the left diagram or 1 primary repeater and 4 secondary repeaters in the right diagram). In each scenario, the base station broadcasts the RTK message and the repeaters rebroadcast that message.

The rover can receive the message from the base station or from any of the repeaters, depending on the distance from the rover to the base station or from the rover to the repeaters. The rover only ever receives the message from one source (repeater or base station)—the rover seamlessly connects to the repeater or base with the best signal with no user input required. This works similar to a cellular phone network, in which your cell phone (the rover) can receive its signal from the closest cell tower (repeater or base station).

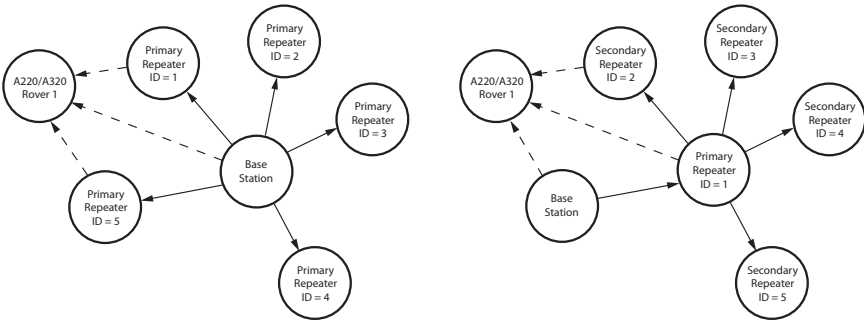


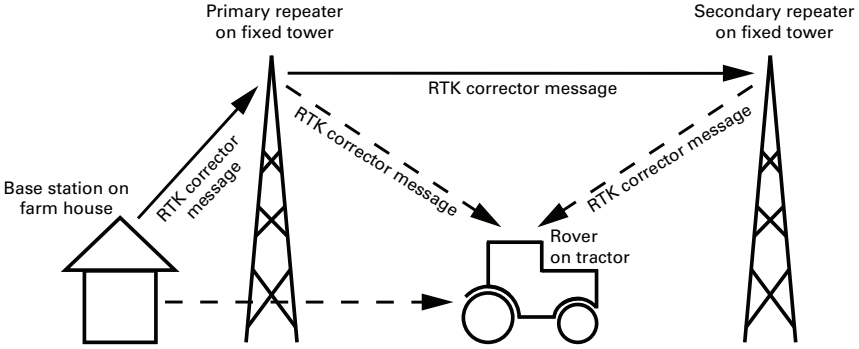
Figure 2-1: Base station that communicates with 5 repeaters

The following sections describe four sample configuration options.

Sample Configuration 1 – Two Permanent Repeaters

Farm Type:	Large farm (up to 15 miles coverage) with tree or hill blockage
Infrastructure Requirements:	Farm house or other structure with base station mounting-access and power on the roof Two towers or tall permanent structures with access to power; preferably located at opposite ends of the farm from one another
Ideal For:	Very challenging farms that may contain significant rolling hills or groves of trees interspersed throughout the property

The figure below shows a one-primary repeater, one-secondary repeater configuration. The dotted lines indicate the rover may receive the message from any of the sources, but only from one source at any given time (from the base, from the primary repeater, or from the secondary repeater). For more information on using multiple secondary repeaters see Figure 2-1 on page 10.



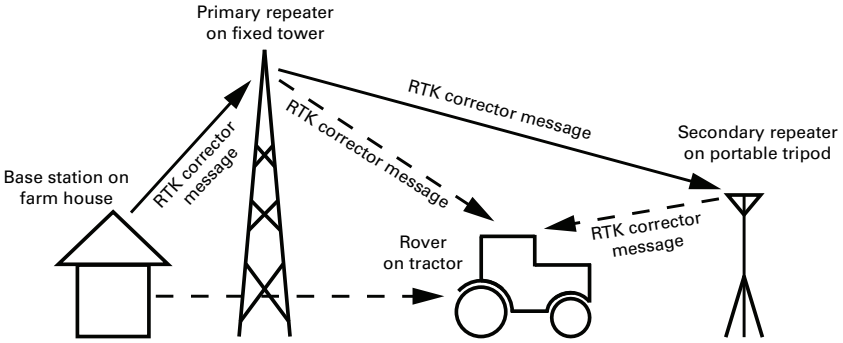
Above ground antenna height is critical for good radio coverage. Having access to tall structures with power (preferably at opposite ends of the property) ensures that if the signal to the rover (from the base or a repeater) is blocked the rover still has coverage from another repeater.

Sample Configuration 2 – One Permanent Repeater and One Portable Repeater

Farm Type:	Large farm (up to 15 miles coverage) with tree or hill blockage
Infrastructure Requirements:	Farm house or other structure with base station mounting-access and power on the roof Two towers or tall permanent structures with access to power; preferably located at opposite ends of the farm from one another
Ideal For:	Very challenging farms that may contain significant rolling hills or groves of trees interspersed throughout the property

The figure below shows a one-primary repeater, one-secondary repeater configuration. The dotted lines indicate the rover may receive the message from any of the sources, but only from one source at any given time (from the base, from the primary repeater, or from the secondary repeater). For more information on using multiple secondary repeaters see Figure 2-1 on page 10.

Note: Sample Configuration 2 differs from Sample Configuration 1 in that the second repeater is portable as opposed to being mounted on a tall permanent structure.



The first repeater is mounted on a tall structure or tower and provides the primary radio coverage of the farm property. The portable repeater is tripod-mounted and designed for quick deployment at various locations around the property.

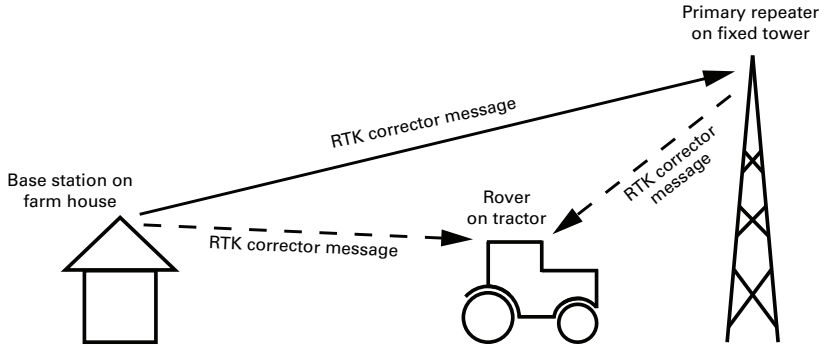
When farming behind trees or in valleys where the radio signals are too weak to be received by the rover directly from the permanent repeater, simply deploy the portable repeater on a nearby hilltop. The portable repeater will receive the RTK message from the permanent repeater and forward it to the rover.

The portable repeater kit takes only a few minutes to set up and is equipped with a sealed lead acid battery that provides up to approximately 18 hours of operation on a single charge.

Sample Configuration 3 – One Permanent Repeater

Farm Type:	Small to medium size farm (up to 10 miles coverage) with minimal tree or hill blockage Smaller farm (up to 5 miles coverage) with some tree or hill blockage
Infrastructure Requirements:	Farm house or other structure with base station mounting-access and power on the roof One tower or tall permanent structure with access to power
Ideal For:	Small to medium sized farms (up to about ten miles of radio coverage), which feature generally flat terrain and have minimal tree blockage Also recommended for smaller farms (up to about five miles of radio coverage), with some hilly areas or tree groves

The figure below shows a one-primary repeater configuration. The dotted lines indicate the rover may receive the message from either of the sources, but only from one source at any given time (from the base or from the primary repeater). For more information on using multiple primary repeaters see Figure 2-1 on page 10.



The distance of coverage is limited by the following factors:

- Height of the repeater structure above ground
- Severity of the hills
- Height and density of tree blockage

After installing the repeater on the fixed structure you should verify the radio signal strength on the rover to ensure you have good coverage in the most challenging locations of the property. If there are still issues you can resolve them by reverting to Sample Configuration 2.

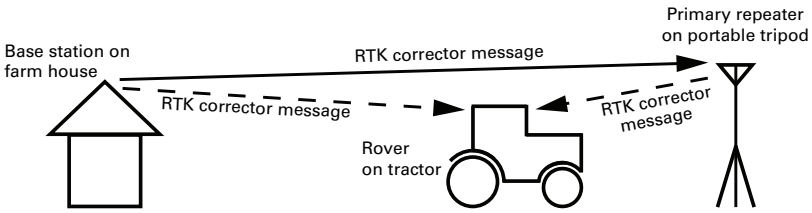
In Sample Configuration 3 the repeater provides the primary radio coverage for the rover; however, the rover is still capable of receiving the RTK message directly from the base station if it is in range.

Sample Configuration 4 – One Portable Repeater

Farm Type:	Small to medium size farm (up to 10 miles coverage) with minimal tree or hill blockage Smaller farm (up to 8 miles coverage) with some tree or hill blockage
Infrastructure Requirements:	Farm house or other structure with base station mounting-access and power on the roof
Ideal For:	Small to medium sized farms (up to about ten miles of radio coverage), which feature generally flat terrain and have minimal tree blockage Also recommended for smaller farms (up to about eight miles of radio coverage), with some hilly areas or tree groves

The figure below shows a one-primary repeater configuration. The dotted lines indicate the rover may receive the message from either of the sources, but only from one source at any given time (from the base or from the primary repeater). For more information on using multiple primary repeaters see Figure 2-1 on page 10.

Note: Sample Configuration 4 differs from Sample Configuration 3 in that the repeater is portable as opposed to being mounted on a tall permanent structure.



The distance of coverage is limited by the following factors:

- Access to convenient hilltop locations for deploying the portable repeater
- Severity of the hills
- Height and density of tree blockage

This configuration provides a great deal of flexibility; however, you must occasionally redeploy the portable repeater to provide adequate radio coverage for the area of the property that is currently being farmed.

Depending on the severity of the hills or tree blockage, the portable repeater can provide full property coverage from a single location. As hill or tree blockage and property size increases you may need to move the repeater around the property to several different locations to maintain good radio coverage.

When deploying the portable repeater, always ensure good received signal strength from the base station (see “Verifying Received Signal Strength” on page 15).

Verifying Received Signal Strength

After you deploy your repeater in the desired configuration (see “Deployment Overview” on page 10 and the sample configurations starting on page 11 for more information), you should verify the repeater is successfully receiving RTK messages from either from the base station or a repeater. The easiest way to do this is to monitor the signal LED (to the left of the power LED) on the repeater enclosure, as shown in Figure 2-2.

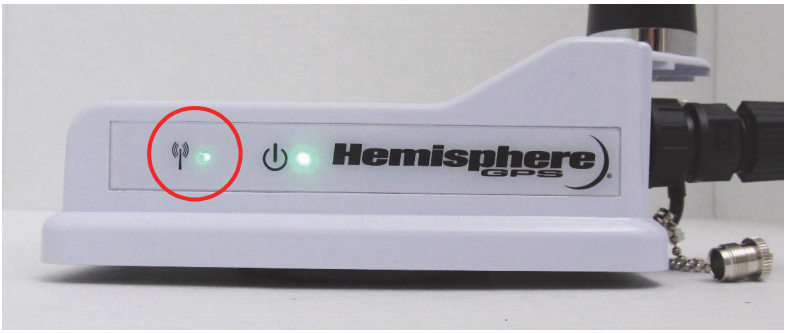


Figure 2-2: Signal LED on repeater

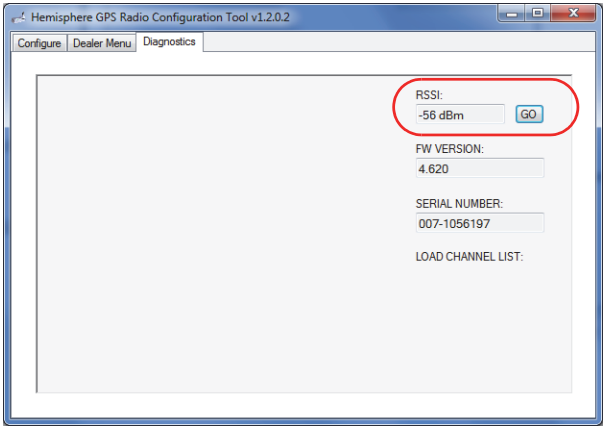
Table 2-1 describes each signal LED state.

Table 2-1: Signal LED states

LED State	Description
Off	Repeater is offline (currently in configuration mode), such as when you are connected to the Hemisphere GPS Radio Configuration Tool.
Slow blink	Repeater is online, but is out of range from the transmitter. Repeater is not successfully receiving RTK messages.
On solid	Repeater is successfully receiving RTK messages from a downstream repeater or base station with good signal strength.
Fast blink	Repeater is successfully receiving RTK messages from a downstream repeater or base station with weak signal strength. Try raising the antenna or moving the repeater to a different location to receive a stronger signal.

Received signal strength indicator (RSSI) is the actual power in a received radio signal. The Diagnostics tab of the Hemisphere GPS Radio Configuration Tool provides an RSSI value in dBm.

Note: See Chapter 3, "Connecting to Your Repeater" for instructions on connecting the repeater to your PC, powering the repeater, and starting the Hemisphere GPS Radio Configuration Tool.



To check the current RSSI value:

- On the *Diagnostics* tab click **GO** next to the RSSI field (see photo above). "Please wait" appears in the RSSI field followed by the RSSI value.

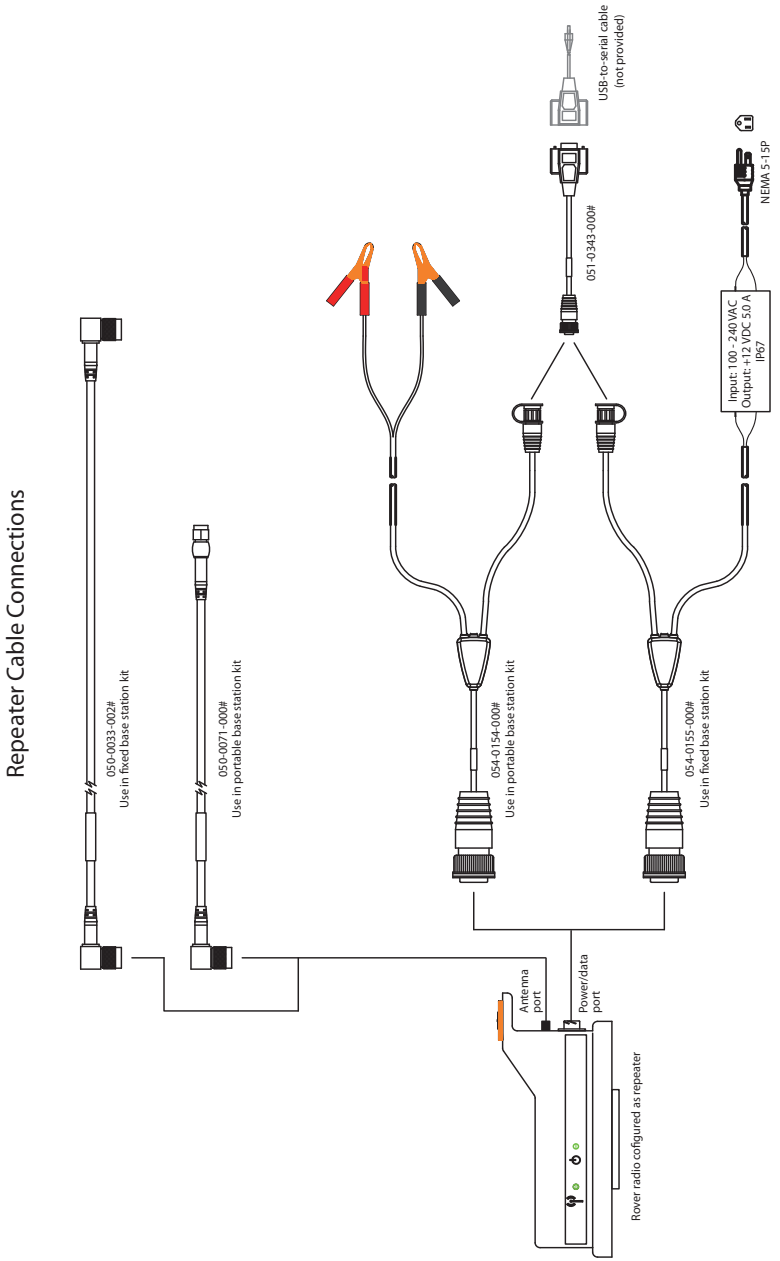
RSSI values are interpreted as follows:

- -120 dBm: No Signal
- -60 dBm or greater: Extremely good signal
- -100 dBm: Approximate signal strength threshold for reliably receiving 100% of RTK messages. This value may vary depending on if there are other interfering transmitters in the vicinity.

Chapter 3: Connecting to Your Repeater

After you determine the optimum configuration for your location (see Chapter 2, “Deployment Options”) you need to connect to your repeater. Review the parts in your kit (see Table 1-1 on page 3) before performing connecting your system.

Connection Diagram

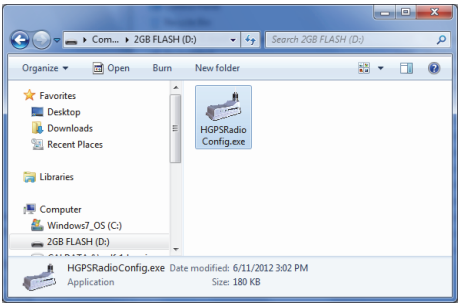


Connection Procedure

Note: The following steps assume you have a serial-to-USB cable.

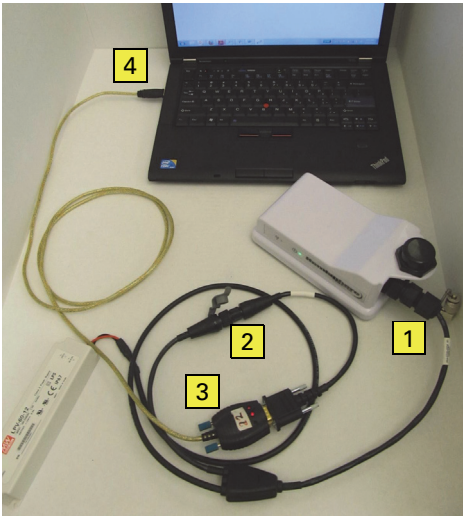
To connect to your repeater:

1. Copy the HGPSRadioConfig.exe file from the USB flash drive (shown below) to your computer (preferably to your desktop).

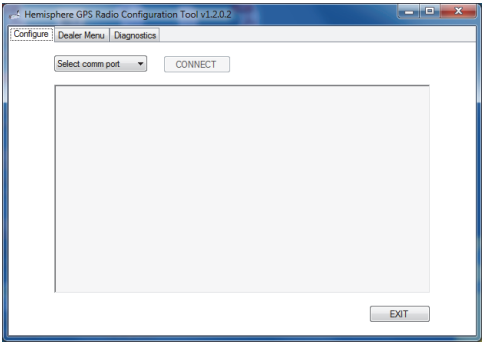


2. Connect the 18-pin connector of the power/data cable to the repeater (#1 in photo) and connect the 3-pin connector of the power/data cable to the serial adapter cable (#2 in photo).
3. Connect the serial end of a serial-to-USB cable to the serial adapter cable (#3 in photo) and connect the other (USB) end to an available USB port on your computer (#4 in photo).
4. Power up your repeater.
   - For the fixed kit, plug the power cable into a power outlet.
   - For the portable kit, connect the power cable alligator clips to the battery.

   The repeater's power LED illuminates and the repeater's signal LED blinks.



5. Double-click the HGPSRadioConfig.exe icon on your desktop (or where you copied the .exe file in step 1). The Hemisphere GPS Radio Configuration Tool starts and appears as below:

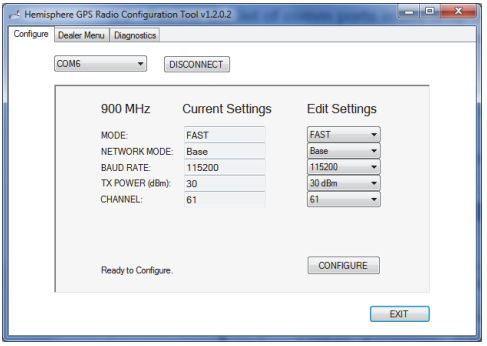


6. Click **Select comm port**, select the desired port, and then click **CONNECT**.

   Several comm ports may appear in the Select comm port drop-down. If you are not sure which one is correct, try the following:

   a. Write down a list of the comm ports available in the drop-down.
   b. Unplug the serial-to-USB cable from your computer.
   c. Close and then restart the application.
   d. Review the list of comm ports in the drop-down, making note of the comm port that no longer appears in the list.
   e. Close the application.
   f. Plug the serial-to-USB cable into the computer and restart the application. The comm port that has again become available is the one being used by your repeater.

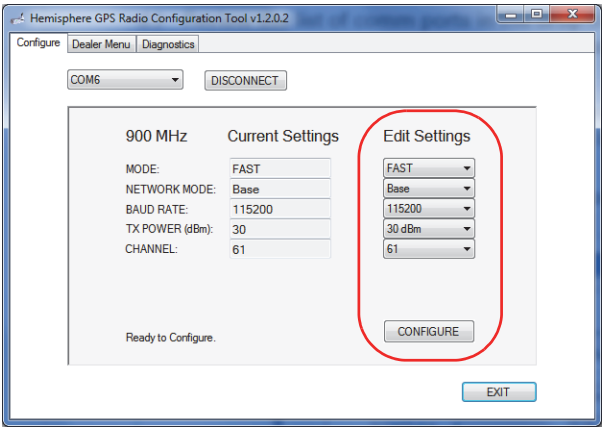
   Once successfully connected the application should appear similar to below. You are now ready to configure your repeater.



Chapter 4: Configuring Your Repeater

Configuration Overview

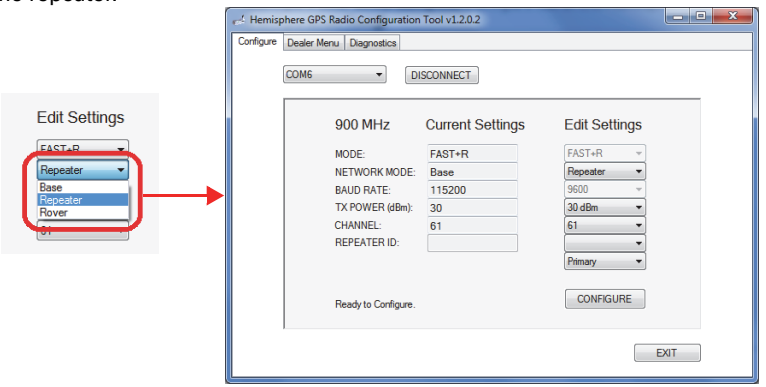
Configure your setup using the Configure tab of the Hemisphere GPS Radio Configuration Tool.



To configure the repeater:

1. In the Edit Settings column of the Configure tab, select Repeater from the drop-down (see figure at right).

   Upon selecting 'Repeater' the Configuration tab displays settings related to the repeater.



2. For repeaters, you can set the following:
   - Transmit (TX) power (up to 30 dBm maximum)
   - Channel
   - Repeater type (primary or secondary)

   See the following sections for more information on setting these parameters.

Configuring TX POWER (dBm)

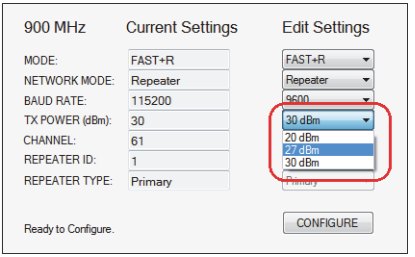
You can set the power to the maximum of 30 dBm. Refer to following conversion between power (dBm) and power (Watts), if necessary:

20 dBm = 0.1 W
27 dBm = 0.5 W
30 dBm = 1.0 W

To configure the TX (transmit) power:

- On the Configure tab of the Hemisphere GPS Radio Configuration Tool select the desired transmit power from the TX POWER drop-down in the Edit Settings column.

  The setting takes effect when you click CONFIGURE.



Configuring the Channel

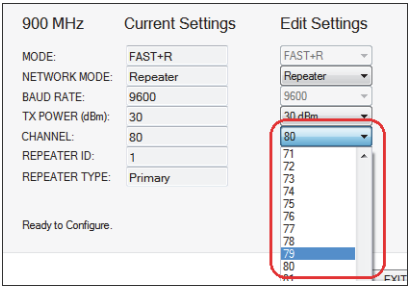
It is recommended that you select a channel other than Channel 1 (the default) to lessen the possibility of having the same channel as other nearby radios.

Note: The base, all repeaters, and all rovers must be set to the same channel.

To configure the channel:

- On the Configure tab of the Hemisphere GPS Radio Configuration Tool select the desired channel from the CHANNEL drop-down in the Edit Settings column.

  The setting takes effect when you click CONFIGURE.



Configuring the Repeater ID and Repeater Type

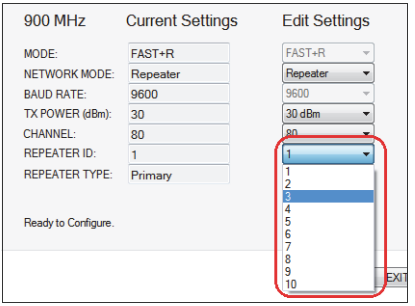
Each repeater in a network must have a unique repeater ID. ID 1 is always the primary repeater—if ID is 1, the REPEATER TYPE drop-down is unavailable (gray). IDs 2 through 10 can be primary or secondary.

For more information on primary and secondary repeater setup, see "Deployment Overview" on page 10 and the sample configurations starting on page 11.

To configure the repeater ID and type:

- In the Edit Setting column on the Configure tab, select the desired ID from the ID drop-down (shown at right) and then select the desired repeater type from the REPEATER TYPE drop-down.

  The setting takes effect when you click CONFIGURE.



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