A22X with Microhard L400 Radio

These Supplemental Release Notes apply to the following Hemisphere GPS products:

- A220 Smart Antenna
- A221 Smart Antenna

Both the A220 and the A221 (A22X when referred to together) offer a versatile, portable solution with centimeter-level accuracy powered by the Hemisphere GPS Eclipse™ dual-frequency GPS receiver in a rugged, all-in-one enclosure.

These Supplemental Release Notes provide information on using the Microhard L400 long-range radio in an RTK environment where the A221 is the base station and the A220 is a rover. The A221 base station with an integrated L400 radio is designed to broadcast RTK correction messages to compatibly-configured A220 rovers with an integrated L400 radio. Depending on the setup and installation environment you can achieve reliable RTK coverage over distances of up to 30 km (see “Typical Distance Performance” on page 13).

⚠WARNING: You must obtain a valid radio license for your jurisdiction before using the A22X with L400 radio. Only set the radio to the frequency and power you are licensed to use at your location. See “Obtaining a License” on page 17 for more information.

These Supplemental Release Notes cover the following topics:

What's Included in Your Kit

There are two kits available:

- A220 L400 kit
- A221 L400 kit

A220 L400 Kit

Figure 1 shows some of the parts included in the A220 L400 kit and Table 1 lists all the parts in the kit.

Figure 1: A220 L400 kit

Table 1: A220 kit parts list

Figure Item	Part No.	Description	Qty
A	804-0064-000#	Antenna, Outback A220	1
B	150-1008-000#	400 MHz whip antenna, shipped separately	1
Not shown	808-1010-000	L400 rover radio kit, pre-installed	1
C	051-0236-000#	Data/power cable with power switch	1
D	051-0067-005#	CAN/power adapter cable	1
Not shown	478-0013-000#	Mag mount, pre-installed	1
Not shown	601-1136	Antenna plate	1
Not shown	677-2002	Tie straps, 7"	6
E	875-0243-000	Outback A220 User Guide	1
Not shown	875-0244-000	Outback A220 Quick Reference Guide	1

A221 L400 Kit

Figure 2 shows some of the parts included in the A221 L400 kit and Table 2 lists all the parts in the kit.

Figure 2: A221 L400 kit

Table 2: A221 kit parts list

Figure Item	Part No.	Description	Qty
A	804-0065-000#	Antenna, Outback A221	1
B	602-1099-000	A221 fixed base mounting bracket	1
C	676-1071-000	5/8" nut	1
	676-0029-000#	5/8" mounting stem	1
D	675-0137-000	Pipe clamp 3 ½"	1
	675-0138-000	Pipe clamp 4 ½"	1
E	054-0136-000#	AC power adapter	1
F	150-0024-000#	450MHz omnidirectional antenna	1
Not shown	051-006x-xxx	Coax LMR400 cable, optional length	1
Not shown	054-0119-000#	12 VDC power adapter, battery clips	1
Not shown	808-1008-000	L400 3W radio kit, pre-installed	1
G	875-0245-000	Outback A221 User Guide	1
Not shown	875-0246-000	Outback A221 Quick Reference Guide	1

Installing the A22X

Installing the A220 Rover

For instructions on installing the A220 Rover on your vehicle, refer to the Outback A220 User Guide.

Note: For repeatable accuracy, the A220 must remain in the same position on the vehicle between operations. Any movement in physical installation location will result in an error.

Installing the A221 Base Station

Keep the following points in mind when installing the A221 base station:

- Install the A221 base station with a clear view of the sky. As a general rule a good location for the receiver antenna is 10 m (33.3 ft) horizontally from an obstruction for every 1 m (3.3 ft) of height the obstruction rises vertically above the top of the receiver.
- The A221 base station kit includes a mounting bracket and stem that you can clamp to a round pipe or bolt directly to the mounting structure of your choice. You must install the base station on a structure that cannot move over time with wind or other environmental conditions. Movements in the base station position will cause error in the rover accuracy.
- Consider your power source for your base station installation. You can power the A221 base station with the supplied AC adapter cable for household power access or with a 12 VDC power supply using the battery adapter cable.
- Although service needs for the A221 base station are minimal, there may be times when you will want to change a configuration or update software via one of the communication ports on the bottom of the unit. Consider access to these ports when installing the base station.
- You should install the radio antenna as high in the air as possible to achieve the best possible range (see “Typical Distance Performance” on page 13). The radio antenna is supplied with mounting brackets so you can attach it to a round tube or bolt it to the structure of your choice.
- Radio antenna cable length will gradually degrade range performance as the length increases. Striking a balance between GNSS receiver installation location and radio antenna location is an important part of optimizing your A221 base station installation.

Configuring the A22X Radio

You can configure the A22X through a simple user interface to set the following:

- Radio mode of operation
- Channel (frequency)
- Power

Note: The radio mode and channel of the A220 rover must match that of the A221 base station for the A220 rover to successfully receive the broadcasted RTK messages.

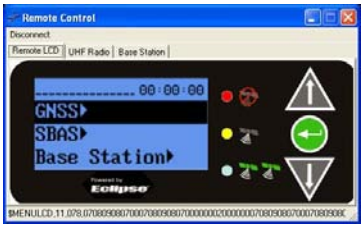
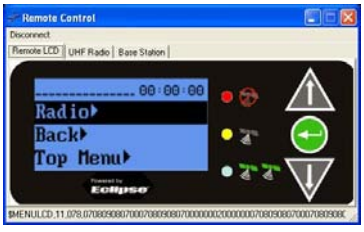
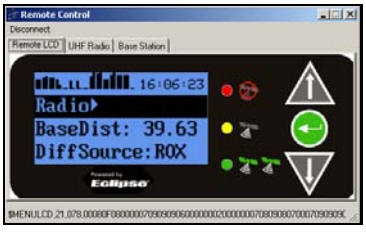
Additionally, you can encrypt RTK data using the Microhard radio static mask.

Setting the Radio Mode of Operation

The radio mode refers to a Hemisphere GPS-proprietary mode or a number of industry-standard compatible modes—see Table 3 on page 6 for more information on supported radio modes.

Note: The following procedure shows how to use the Remote Control software to set the mode. Follow the same procedure if using the actual menu on the A221 to set its mode.

Complete the following steps to set the radio mode:

Step	Base Station Screen Item	Rover Screen Item
Base Station 1. On the Top menu scroll to and select **Base Station**. Rover 1. On the Top menu scroll to and select **RTK**.	 	 
2. Scroll to (if necessary) and then select **Radio**.		

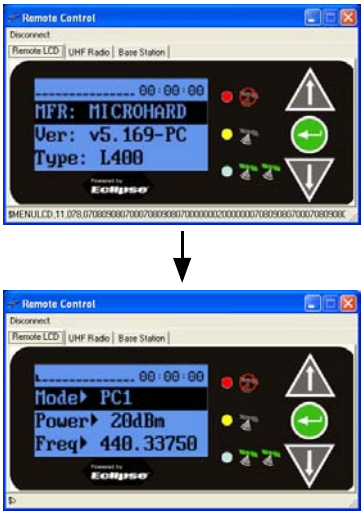
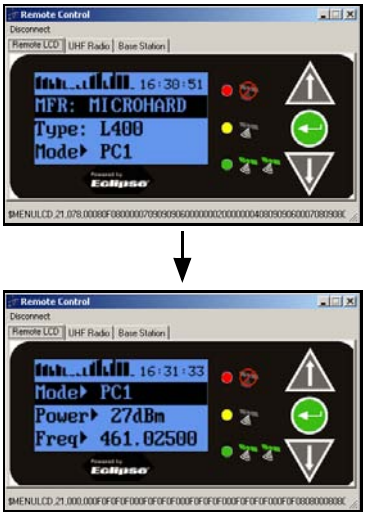
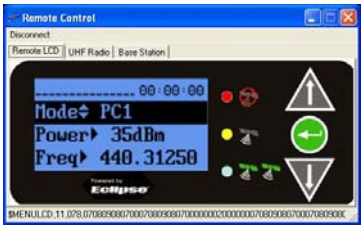
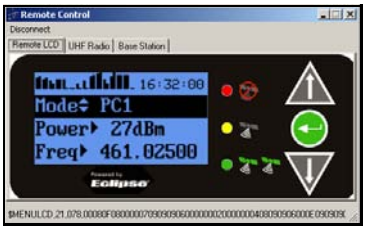
Step	Base Station Screen Item	Rover Screen Item
3. Scroll to and select **Mode**.		
4. Use the **Up Arrow** and **Down Arrow** buttons to display the desired mode and press **Enter** to select the mode.		

Table 3 describes the two available radio modes. Pac Crest provides configuration tool that allows you to view the parameters in the Description column; therefore, select the mode you need based on these parameters (PC1 and PC3 differ only by the FEC parameter: ON or OFF).

Note: Hemisphere GPS recommends PC1 for most applications. You should only use PC3 if your are trying to maintain compatibility with an existing Pac Crest network.

Table 3: Radio modes

Mode	Description	Comment
PC1	9600 bps link rate, GMSK, FEC ON, Scrambling ON	Compatible with Pac Crest and Satel. This is the most common mode of operation and generally provides best distance performance. Throughput is limited to about 5600 bits/second.
PC2	Future mode, currently not supported	
PC3	9600 bps link rate, GMSK, FEC OFF, Scrambling ON	Compatible with Pac Crest. This mode will give slightly inferior distance performance compared with PC1, but provides better throughput of roughly 8300 bits/second.
PC4	Future mode, currently not supported	
HGPS	Future mode, currently not supported	

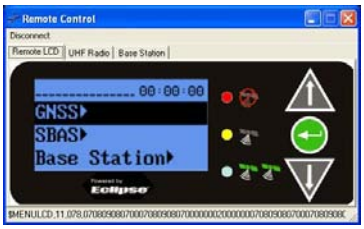
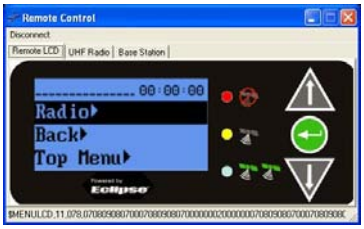
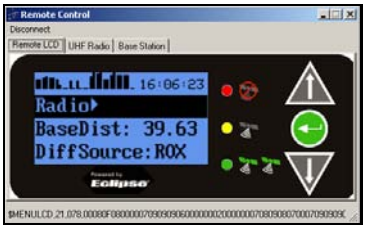
Setting the Channel (Frequency)

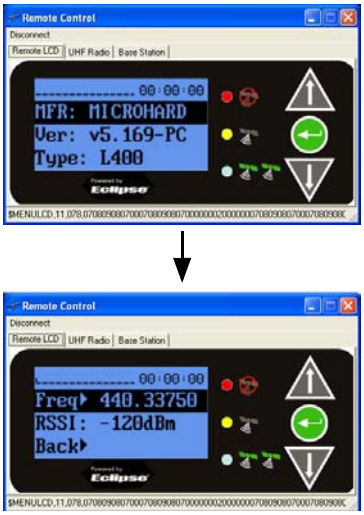
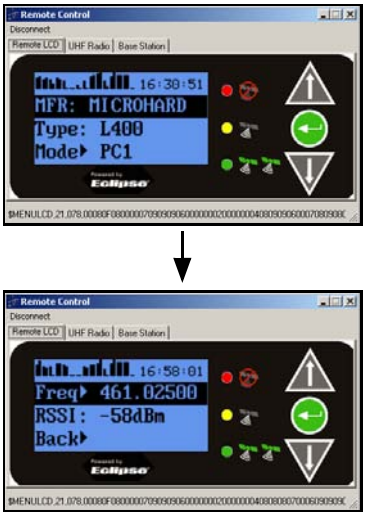
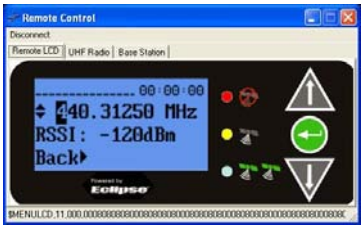
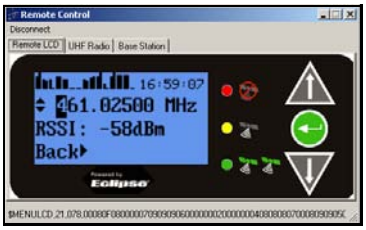
Each A221 base station and A220 rover in a network must be configured to operate on the same channel (frequency).

You can set the frequency to any value between 410 MHz and 480 MHz. The channel frequency must be a multiple of 0.0125 MHz (12.5 kHz). If you enter an invalid channel, it will be rejected with an “INVALID” error.

Note: The following procedure shows how to use the Remote Control software to set the channel (frequency). Follow the same procedure if using the actual menu on the A221 to set its channel.

Complete the following steps to set the channel (frequency):

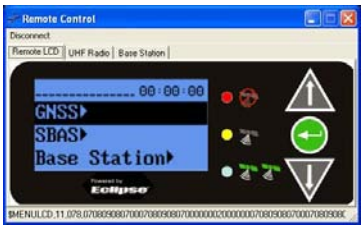
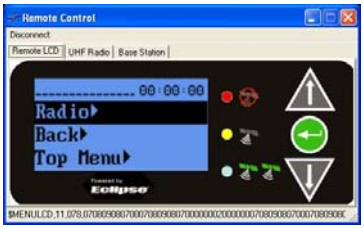
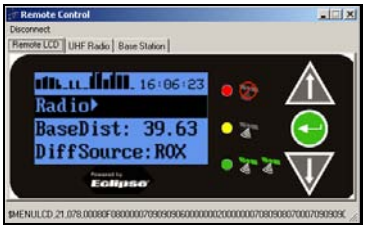
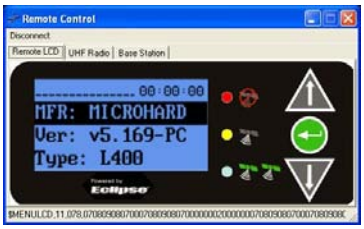
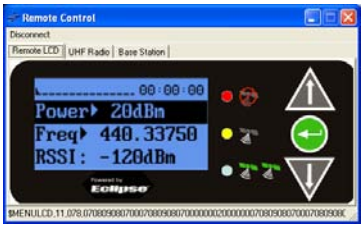
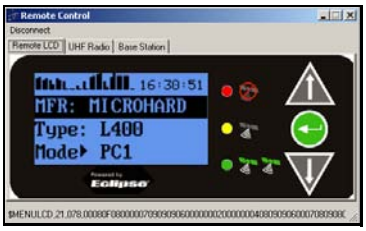
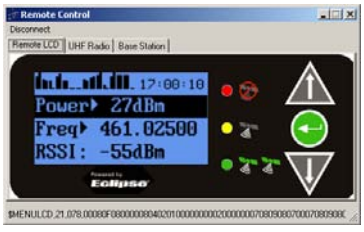
Step	Base Station Screen Item	Rover Screen Item
Base Station 1. On the Top menu scroll to and select **Base Station**. Rover 1. On the Top menu scroll to and select **RTK**.	 	 
2. Scroll to (if necessary) and then select **Radio**.		

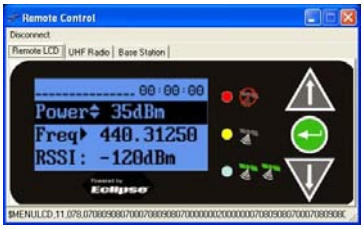
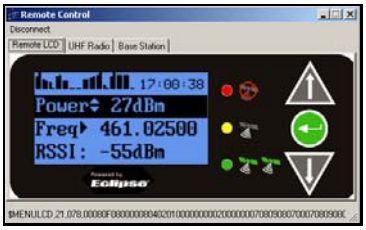
Step	Base Station Screen Item	Rover Screen Item
3. Scroll to and select **Freq**.		
4. To set the frequency: a. Use the **Up Arrow** and **Down Arrow** buttons to set the first digit and then press **Enter**. After pressing Enter the next digit to the right is highlighted. b. Repeat step **a** for each digit. When you press Enter to set the last digit, the frequency is set and the Up/Down Arrows change to the Right Arrow (you can now use the Up/Down Arrows to highlight other Radio options such as Type and RSSI).		

Setting the Power

Note: The following procedure shows how to use the Remote Control software to set the power. Follow the same procedure if using the actual menu on the A221 to set its power.

Complete the following steps to set the power:

Step	Base Station Screen Item	Rover Screen Item
Base Station 1. On the Top menu scroll to and select **Base Station**. Rover 1. On the Top menu scroll to and select **RTK**.	 	 
2. Scroll to (if necessary) and then select **Radio**.		
3. Scroll to and select **Power**.	 	 

Step	Base Station Screen Item	Rover Screen Item
4. Use the **Up Arrow** and **Down Arrow** buttons to display the desired power and press **Enter** to select the power.		

The A221 is capable transmitting at an output power ranging from 0.1 W (20 dBm) up to 5 W (37 dBm) in 1 dB increments. Hemisphere GPS recommends that you set the power to the highest level allowable by your license.

If battery life is a concern, you may want to start with the highest allowable power setting on the A221 base station and back it off to the lowest level that still provides adequate RF coverage for your location.

The radio is the main contributor to battery drain. Therefore, backing off on the transmit power allows for significantly longer discharge times. Table 4 lists typical A221 power consumption.

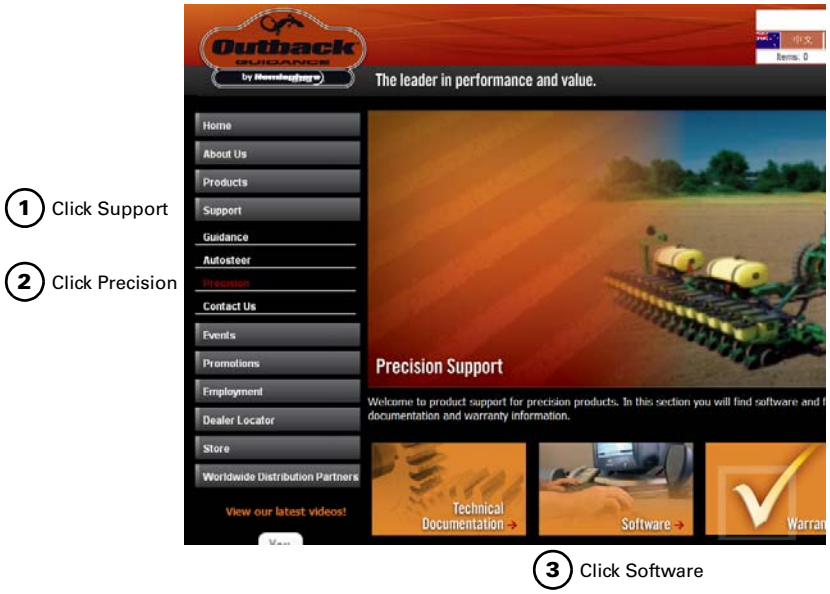
Table 4: Typical A221 power consumption

Radio TX Power Setting	Typical Total A221 Power Consumption	Typical Battery Discharge Time of 18Ah SLA Battery
20 dBm (0.1 W)	7.2 W	31 hours
27 dBm (0.5 W)	9.0 W	25.0 hours
30 dBm (1 W)	10.4 W	21.5 hours
33 dBm (2 W)	12.6 W	17.5 hours
35 dBm (3 W)	14.1 W	15.5 hours
Receive Mode Only	5.7 W	39 hours

Encrypting RTK Data Using the Microhard Radio Static Mask

When configuring a Microhard radio you can set the static mask to encrypt (require a password to access) RTK data. The default static mask for the 400 MHz L400 radio is blank (no static mask).

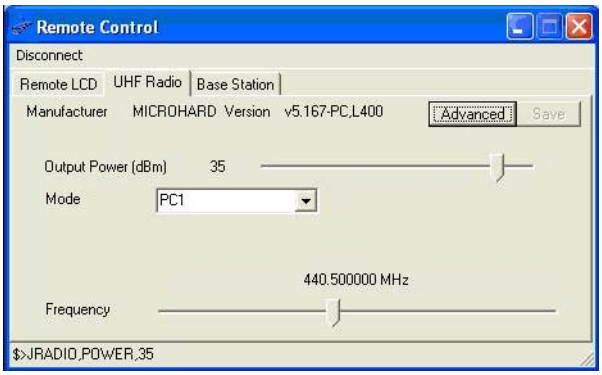
Before you set the static mask, make sure you are running the latest A-series controller software. To obtain the latest version of this software, visit www.outbackguidance.com and navigate to the Precision software downloads page (follows steps 1 - 3 below to display the software downloads page).



You can either connect to the A-series receiver with a terminal program or via the Remote Control application.

Setting the Static Mask Using Remote Control

1. Connect to the receiver on Port A.
2. Start Remote Control.



3. On the UHF Radio tab click the **Advanced** button. This takes the radio offline, passes through to the radio data port, and presents the current radio configuration (shown at right).

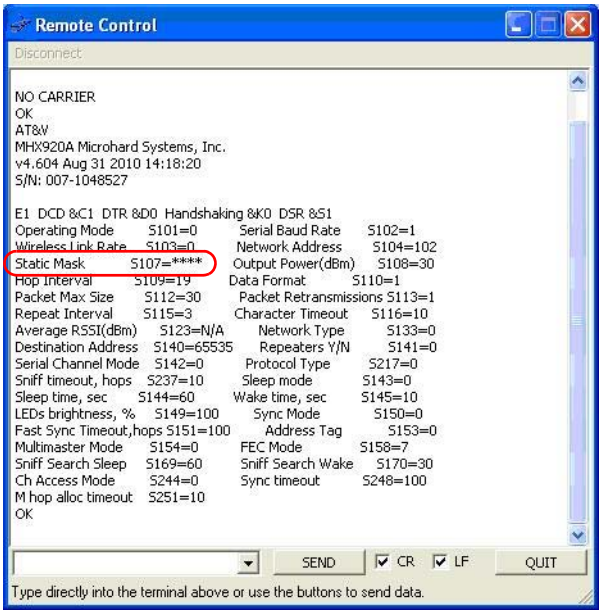
   The static mask is parameter S107 and is shown in the output as:

   Static Mask S107=****

4. Type `ATS107=xxxxxxxx` in the drop-down box and then press Enter (or click SEND) to change the static mask, where `xxxxxxxx` represents the static mask you want to use.

   If successfully set, the radio will reply with OK.

5. Send the command `AT&W` to save the settings.
6. Click QUIT to return to normal operating mode.



Setting the Static Mask Using a Terminal Window

1. Connect to the receiver on Port A.
2. Start the terminal program on your PC.
3. Send the command `$JRELAY,PORTC,$MENUREPLY,A`
4. Send the command `$JRELAY,PORC,$JRADIO,PROGRAMMODE` to take the radio offline, pass through to the radio data port, and present the current radio configuration.

   The static mask is parameter S107 and is shown in the output as:

   Static Mask S107=****

5. Type `ATS107=xxxxxxxx` to change the static mask:

   where `xxxxxxxx` represents the static mask you want to use. If successfully set, the radio will reply with `OK`.

6. Send the command `AT&W` to save the settings.
7. Type `QUIT` (uppercase) to return to normal operating mode.

Typical Distance Performance

Distance performance is dependent on several factors including:

- Base station antenna height
- Base station antenna gain
- Cable losses
- Base station transmit power
- Rover antenna gain
- Rover antenna height
- Receiver (rover) sensitivity
- Terrain

Hemisphere GPS provides a very high performance 400 MHz radio solution, which, when properly installed, can provide up to 30 km of RTK coverage from one base station location. Figure 3 provides a rough idea of what kind of distance performance the user can expect.

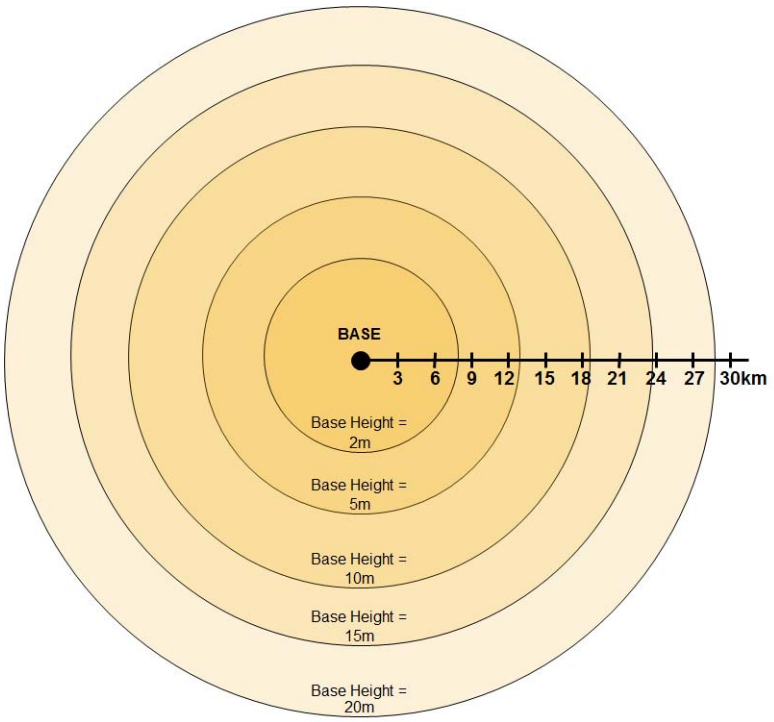


Figure 3: Typical RTK distance performance vs. base station antenna height above ground

The expected range is based on the following assumptions:

- Gently rolling hills
- Medium to low vegetation
- High quality, low loss RF cables at base station
- Base station uses Hemisphere-recommended 5 dBi antenna
- Base station Tx power is set to 3 W
- Rover antenna height is 3 m above ground level
- Frequency of operation is 450 MHz
- Mode of operation is PC1 (9600 bps GMSK, FEC ON)

As can be seen in Figure 3, Base Station antenna height is key to RTK performance. When installing your Base Station, find a location on a structure, preferably at the highest elevation available.

At 2m (6ft) base antenna height above ground, typical RTK distance performance is approximately 8 km (5 mi). However, as you raise the Base Station antenna, this range improves dramatically. At 20 m (65 ft) above ground level, Rovers can expect to typically receive RTK corrections at distances up to about 28 km (17 mi).

It is important to use high quality RF cable at the Base Station. Hemisphere GPS provides high-quality RF cables in standard lengths of 15, 30, and 45 m.

Normally, the A221 will be located close to ground level, while the 400 MHz UHF antenna will be mounted on a structure several meters above ground. This requires a fairly long run of cable. Figure 4 illustrates the typical degradation in distance performance (for four different Base Station antenna heights) as you use longer runs of RF cable.

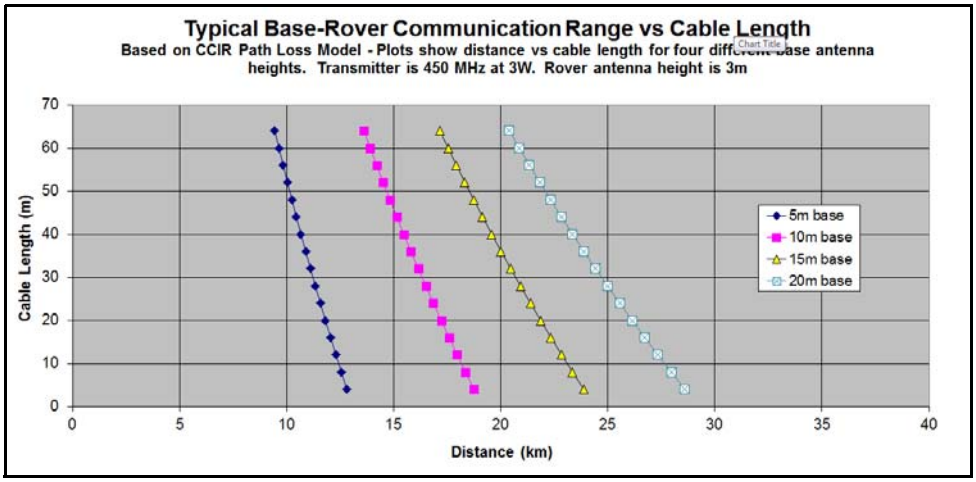
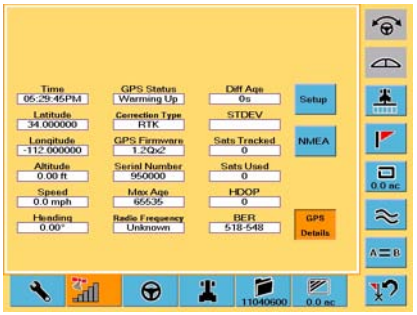
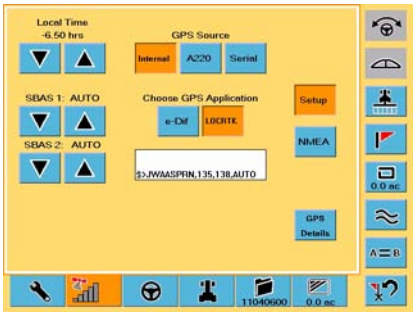
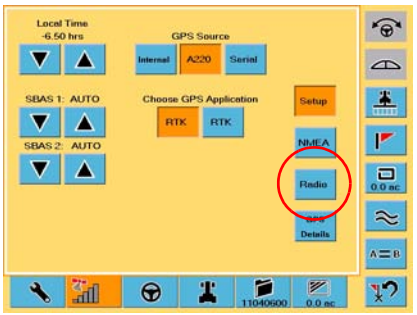


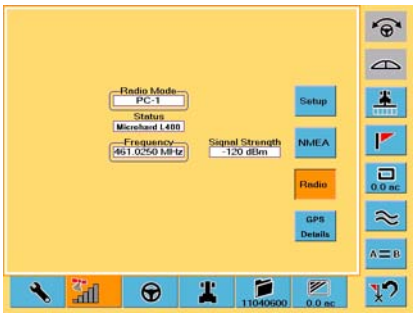
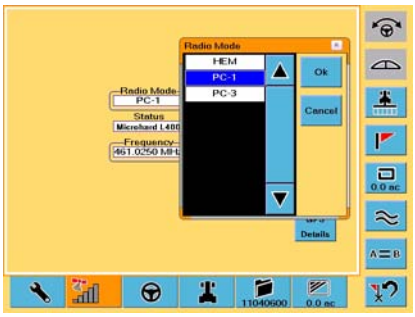
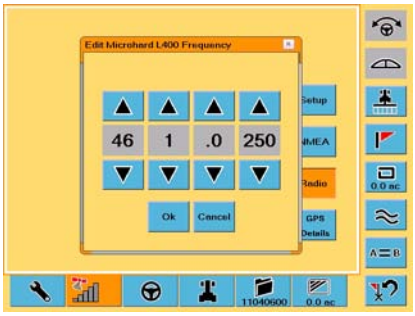
Figure 4: Typical RTK distance performance vs. RF cable length at base station for four base station antenna heights above ground

Displaying and Editing A220 L400 Information via the Outback S3

The Outback S3 provides an easy-to-use interface that allows you to select a radio within an A220 and set that radio's mode of operation and frequency.

Note: You must connect the A220 to the S3 and power on the A220 before accessing the setup menu within the S3.

Step	Screen Item (when applicable)
1. Power on the S3.	
2. On the main screen press the GPS screen tab. The GPS Details screen appears.	
	
3. Press **Setup**. The GPS Setup screen appears.	
	
4. Under GPS Sources press **A220**. The Radio button appears along the right side of the screen.	
	

Step	Screen Item (when applicable)
5. Press **Radio**. The Radio screen appears. Microhard L400 appears in the Status field (non-editable). The Display Mode and Frequency fields are editable.	A220
	
6. To set the radio mode:	
a. Press the **Radio Mode** field.	Radio Mode PC-1
	
b. In the Radio Mode window select the desired mode and press **OK**.	
7. To set the frequency:	
a. Press the **Frequency** field.	Frequency 461.0250 MHz
	
b. In the Edit Microhard L400 Frequency window use the Up and Down Arrow buttons to set each segment of the frequency value and press **OK**.	

Obtaining a License

Paperwork varies by country. The following sections provide basic instructions on obtaining and filling in the forms and include sample forms for the US, Canada, and Australia.

U.S. License

WARNING: You must obtain a valid radio license for your jurisdiction before using the A22X with L400 radio.

To obtain a U.S. license you must first register with the Federal Communications Commission (FCC). You can then login and file your application electronically.

For help on applying for a license, go to http://www.fcc.gov/Forms/Form601/601.html.

Use the following steps as a guideline to register.

Step	Screen Item (when applicable)
1. In a web browser navigate to the Federal Communications website at: http://wireless.fcc.gov/uls/index.htm The main Universal Licensing System page appears.	
	
2. Click **REGISTER**.	

Step	Screen Item (when applicable)
	
3. Click **REGISTER** to start the registration process and receive your FCC Registration Number (FRN).	
	
4. Select your registration type and location and then click **CONTINUE**.	

Step	Screen Item (when applicable)
	
5. Fill out the registration form and click **SUBMIT**. You are only required to fill out those fields that are noted with an red asterisk *****.	SUBMIT
You are issued an FCC Registration Number (FRN) at this point. You can now apply for your license.	

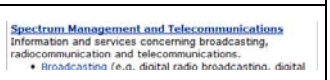
Canadian License

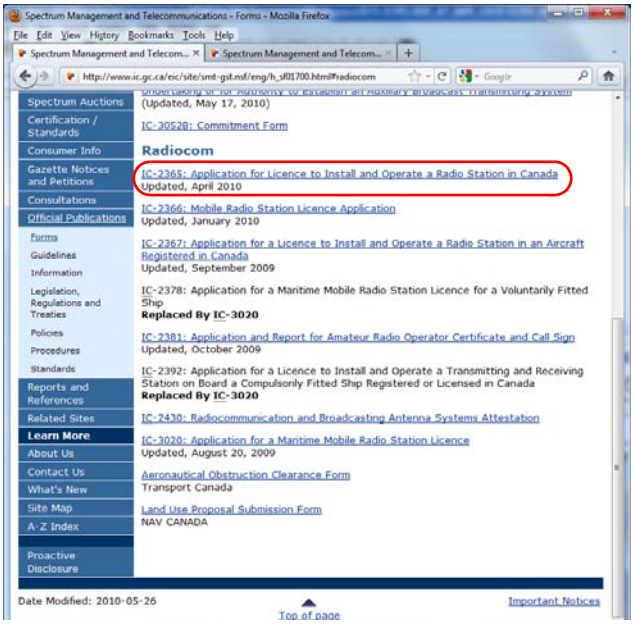
WARNING: You must obtain a valid radio license for your jurisdiction before using the A22X with L400 radio.

In Canada, licensing is administered by Industry Canada. A sample of the application is provided below. Contact Hemisphere GPS for assistance.

Use the following steps as a guideline to obtain a license.

Step	Screen Item (when applicable)
1. In a web browser navigate to the Industry Canada website at: http://www.ic.gc.ca/eic/site/ic1.nsf/eng/home The main Universal Licensing System page appears.	
	
2. Click **Programs and Services** and then from the expanded menu click **Radio, Spectrum and Telecommunications**. The Radio, Spectrum and Telecommunications page appears.	

Step	Screen Item (when applicable)
	
3. Scroll down and click **Spectrum Management and Telecommunications**. The Spectrum Management and Telecommunications page appears.	
	
4. Click **Official Publications**. The Official Publications page appears.	

Step	Screen Item (when applicable)
	
5. Under Forms click **Radiocom**. The Forms page appears with the Radiocom section visible.	
	
6. Click the **IC-2365** link (circled in previous step). The IC-2365 page appears.	

Step	Screen Item (when applicable)
	
7. Download the IC-2365 form. **Note:** For help on filling out and submitting the form, contact your Industry Canada Regional Office. For a Regional Office near you, visit: http://sd.ic.gc.ca/engdoc/help/about_contact.html	

Australian License

WARNING: You must obtain a valid radio license for your jurisdiction before using the A22X with L400 radio.

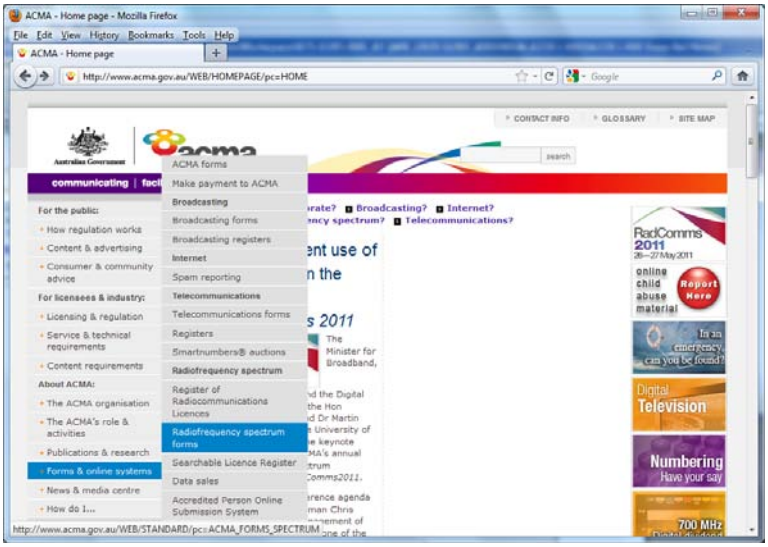
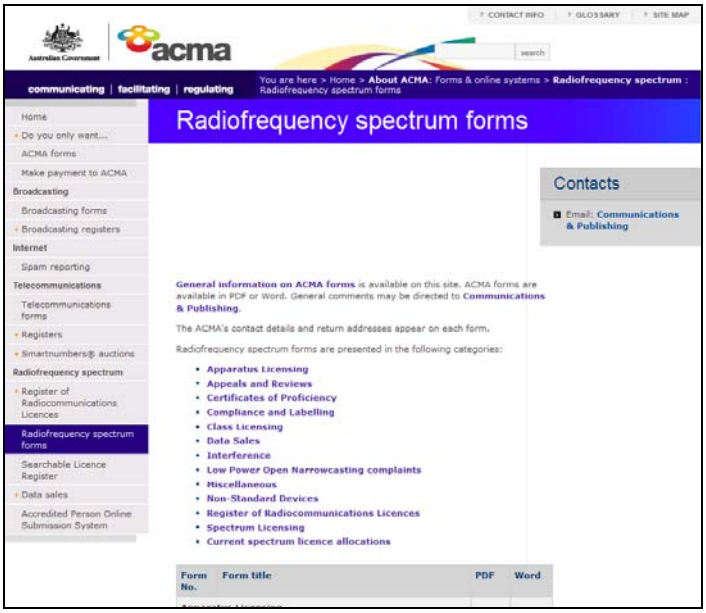
To obtain a license in Australia you must complete and submit the following forms:

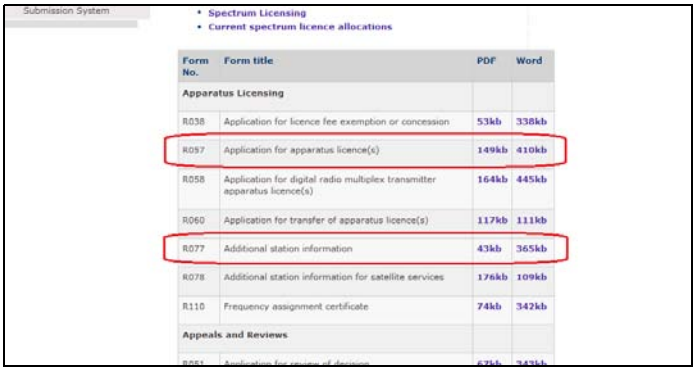
- ACMA form – R057 - Application for apparatus licence(s)
- ACMA form – R077 - Additional station information

Both forms are available from the Australian Communications and Media Authority (ACMA) website.

Use the following steps as a guideline to obtain a license:

Step	Screen Item (when applicable)
1. In a web browser navigate to the Australian Communications and Media Authority (ACMA) website at: http://www.acma.gov.au The main ACMA page appears.	
	

Step	Screen Item (when applicable)
2. On the left side of the page rest the mouse over **Forms and online systems** and then click **Radiofrequency spectrum forms**. 	
The Radiofrequency spectrum forms page appears. 	

Step	Screen Item (when applicable)
3. Scroll down the page and download the appropriate forms (R057 and R077) in either Microsoft Word or PDF. 	
4. After filling out the forms submit to the addresses listed on the forms.	