

Maximizing UHF Radio Range for GNSS Base/Rover Pairs

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Thesis:

Your Base / Rover RTK pair used to have great radio range ... but something has changed and now you can only go a short distance from the base before the rover loses lock.

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Radio Range complaints are a big part of Base/Rover pair operation. This FAQ tries to address the things that can go wrong and reduce your radio range.

For the discussions below, we assume that your rover gets a FIXED solution when very close (15 feet) to the base and that the GREEN LED's are flashing once per second on the base and on the rover. However, when you move the rover more than 200 feet from the base, the radio signal is totally lost and the rover returns to DGPS or AUTONOMOUS mode.

FCC License is required

Important Note: Use of the UHF radio in GNSS equipment to **transmit** corrections requires a license from the FCC.

Here are some additional resources:

[[Sailing with the Pirate Surveyors](#)] an article about WHY you need a FCC license.

[[How to Get an FCC License](#)]

[[What happens if you program an unlicensed frequency into a radio?](#)]

Multiple Users on Same Radio Frequency

If there is someone or something else on the same frequency, voice or data it will greatly reduce the distance you can move from your Base. This the NUMBER ONE cause of bad radio range.

Use a Handheld UHF radio (like this one [[BauFeng](#)]) to check if the frequency is unused before you start. Carry the Handheld radio with you all day so that you can check if someone sets up on your frequency after your session begins.



Become familiar with what it sounds like if you are the only user on a frequency, if there are no users on a frequency and what it sounds like if there are more than one user on the same frequency.

Sources of interference include:

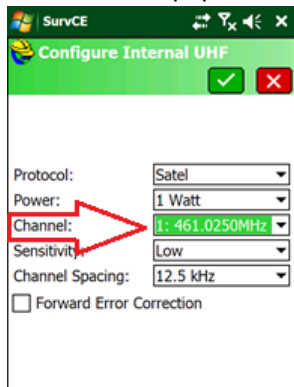
- other surveyors and engineers
- voice users (truckers, businesses, railroads, schools, service companies)
- wireless microphones
- SCADA equipment (like water or oil pipeline infrastructure)
- control backhails on com links
- nearby AM or FM radio transmitters
- nearby radar systems

The radio frequencies that are generally assigned (by the FCC in conjunction with frequency coordination) are not exclusive and are assigned to multiple users in the same area. For example, the frequency 461.025 MHz is assigned to 13 licensees in Salt Lake City, 68 users in Utah and 3,807 users in the United States who have legal authority to use this same frequency. Of the 3,807 licenses 67 have license to cover Salt Lake County. It is my belief that only 1 in 100 users is licensed, so there are probably thousands of possible users in our immediate area.

By FCC rules, even unlicensed voice transmissions have a higher priority than licensed data transmissions. Your radio (the radio built into your base) will wait for other users before it transmits (this is called CSMA: collision sense multiple avoidance.)

So it is always a great idea to check the frequency prior to starting work and during the work day.

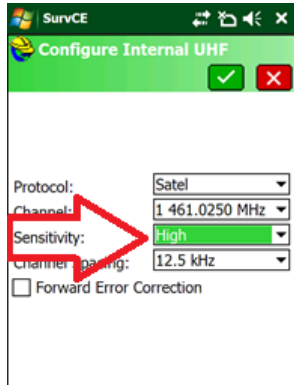
If you find that the frequency that you were going to transmit is busy, you can change the channel/frequency of your base and rover to an alternate frequency. The radio frequency is set on the Rover is under “Equip: GPS Rover: RTK (tab): Internal UHF Radio Settings”:



Receiver Sensitivity Setting

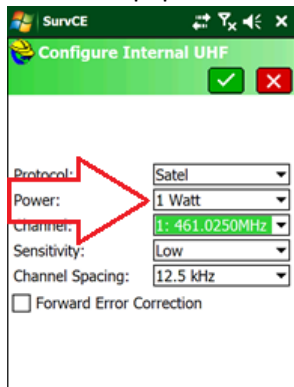
You want the radio in your rover to have the highest sensitivity possible so that it can hear your base when it is further away.

The receive sensitivity is set on the Rover is under “Equip: GPS Rover: RTK (tab): Internal UHF Radio Settings”:



Base Output Power Setting

You want the radio in your base to output as much power as possible. The setting for the base output power is under “Equip: GPS Base: RTK (tab): Internal UHF Radio Settings”:

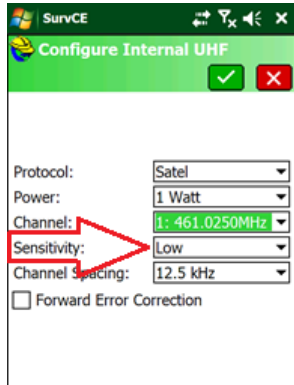


Minimize CSMA

Your base radio is required to not transmit when there are other users on the same frequency: Collision Sense Multiple Avoidance.

This is an FCC requirement and cannot be disabled. However, the FCC does not specify how carefully we need to listen for adjacent traffic. So we set the receive sensitivity on the base to 'Low'.

The setting for the base output power is under “Equip: GPS Base: RTK (tab): Internal UHF Radio Settings”:



Bad Antennas

The UHF antennas on most GNSS equipment get beat around quite a bit. The antennas on the base get whipped around in the wind a lot.

Unfortunately there is no easy way to test a UHF antenna (like with a voltmeter.) You would need a SWR meter like the \$1,000 [[RigExpert AA-1000](#)]:



If you suspect that you have a bad antenna, I recommend that you purchase two spare antennas and change out both your base and rover. If the problem goes away, then you know that one (or perhaps both) of your original antenna have failed.

We have spare ‘Original Equipment’ antennas (the black ones) for \$50. We have spare ‘Laird G450TN’ 10” base loaded antennas for \$28. Both antennas have 2.5 dBi gain and are nearly identical in performance and tuned center frequency.



We recommend that you not use $\frac{1}{4}$ wavelength antennas



because they require a ground plane at the base of the antenna and have significantly (about 1/2) the range of the ½ wavelength dipole antennas we supply.

External Antenna Extension (Top of Pole Extension)

If you are having range issues, remove the external antenna extension cable and mount the Base antennas directly on the bottom of the Base receiver. We expect at least 1-mile open range with the Base and Rover antenna mounted directly to the heads. (Assuming no other users are on the same frequency.)

The most common cause of external antenna extension wire failure is the termination on the pole side adapter due to excessive wind-whipping. The second most common failure is closing the wire in the hinge of the carry case which smashes the cable.

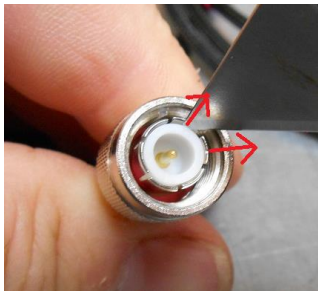
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Loose TNC Antenna Connections

The antenna connector can become intermittent and not make a solid connection. If antenna is over-tightened, then the connection points shown above can become 'sprung' and won't make good contact unless the antenna is screwed in even tighter.

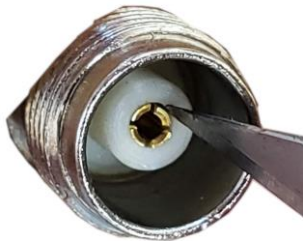
This issue is very difficult to diagnose, however it is very simple to fix.

On the antenna connector:



Bending out the ground contacts on the antenna connector.

On the TNC connector, attached to the GNSS receiver:



Bending in the center contact in towards the center.

If 'fixing' the issue fixes the antenna range, then this was probably the issue.

Internal Coax Failure

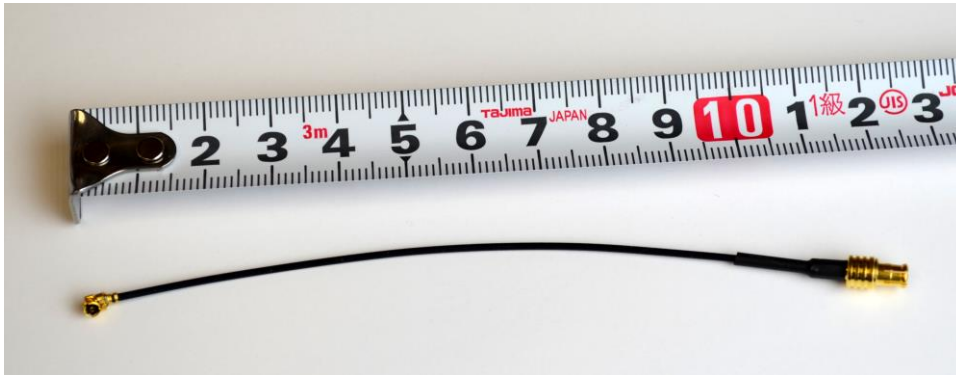
This coax issue and test is applicable to these receivers:

CHC X91+Satel, CHC X900+Satel, CHC i80, CHC i70, iGage iG8

It is not applicable to X91+CHC or X900+CHC devices with internal receive only CHC UHF radios.

Devices occasionally experience failures in the internal coaxial cable connection between the UHF TNC connector on the bottom of the receiver and the Satel radio SMA connector.

This 12 cm long cable connects the TNC UHF Antenna Connector to the SMA connector on the Satel radio:



You can easily verify that the cable is working by measuring the resistance between the outside and center of the TNC connector:



The resistance should be between 0.5 and 4.0 ohms. This [[video](#)] shows how to make the measurement and read the voltmeter.

If you find that the connection is open (infinite resistance or resistance over 4 ohms) call us and we will arrange to fix your receiver. The process does not take long however it is not a procedure that you should attempt, we replace the wire and provide additional strain relief for the cable where it connects to the Satel radio module.



We believe that this connector failure issue is exasperated by repeated vibrations on the cable termination to the SMA connector, perhaps from extended transport on vibrating platforms.