

Indoor GNSS Signal Coverage

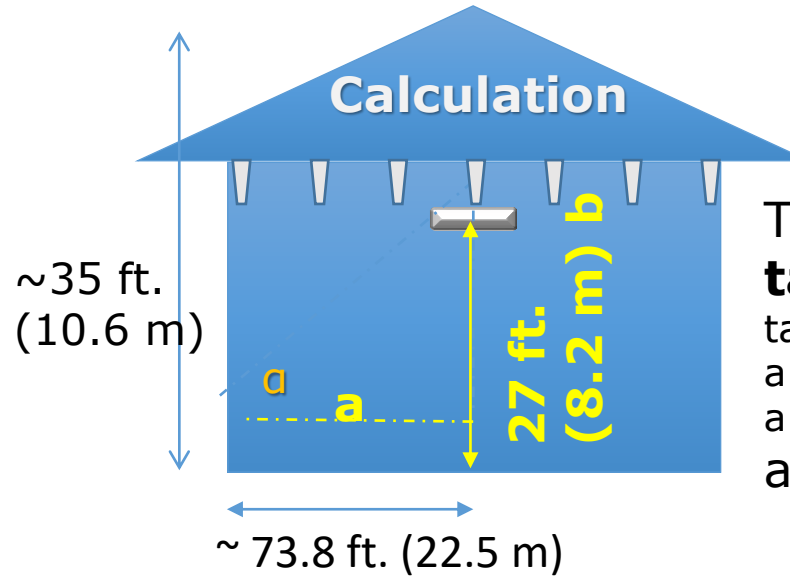
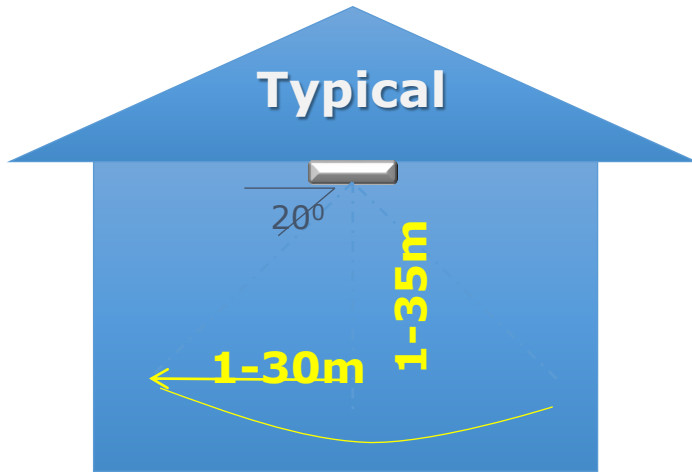


A Waypoint Aviation hangar at Cincinnati Municipal Lunken Airport need to have indoor GNSS signal coverage. Based on measurements with Google Earth we believe the dimensions are ~ 190 x 210 ft., and the free ceiling height that we have used in our coverage calculation is 27 ft. but may be higher as it is difficult to measure vertically with Google Earth.



If no roof penetration can be done or direct installation of the outdoor antenna to the roof is not allowed, a wall mounted tube can be used to raise the outdoor receiving antenna above the roof line (see picture). With metal roof it is recommended to have the outdoor receiving antenna at a min. of 6.5 ft. above the metal surface to avoid multipath effect.

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The formula
 $\tan(\alpha) = b/a$
 $\tan(20) = 8.2/a$
 $a = 8.2/\tan(20)$
 $a = 8.2/0,36397$
 $a = 22.5 \text{ m } (\sim 73.8 \text{ ft.})$

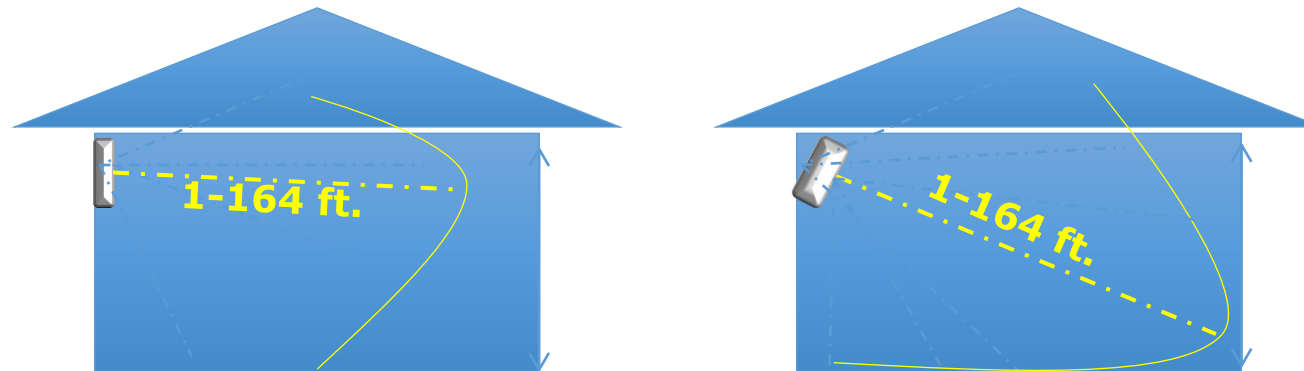
The area covered by one Roger-GPS repeater:

- The diameter is about 130 – 165 ft. depending on the construction material and the signal blocking obstacles
- The height to reach the coverage is up to 50 ft. depending on the construction material
- The material (cars, aircraft or other big metal particles) create reflecting waves that may influence the area coverage
- The GPS receiver sensitivity (up to -160dBm) and position has to be considered in the design
- The repeater has 40dB gain adjustment
- The repeater will have a delay of ~ 0.1μs / 30m of coaxial cable.
- The repeater provides the GPS clock as is, except the slight delay due to the cable connection to the outdoor antenna.

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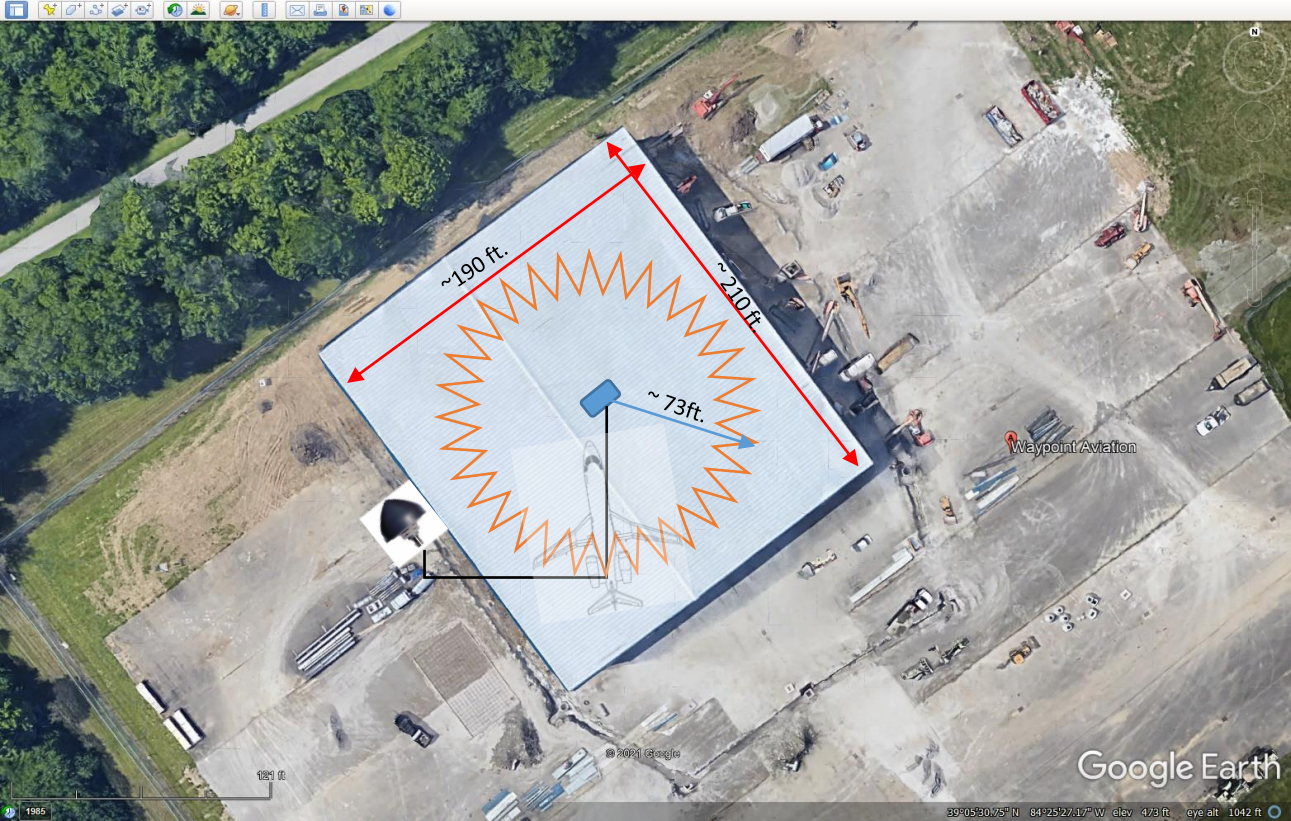
Coverage – repeater on side wall:



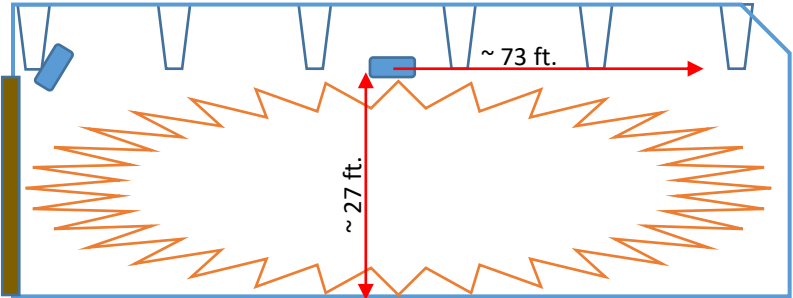
What size is the area that one Roger-GPS repeater covers?

- The diameter (sphere) is about 114-164 ft. depending on the construction material and the signal blocking obstacles
 - Signal strength is highest from the origin of the repeater
 - Tilting the repeater maximizes coverage as the origin points toward the utmost corner
- The material (ceiling, vehicles, other big metal particles) create reflecting waves that may influence the coverage area
- The GPS receiver sensitivity (up to -160dBm) and position must be considered in the design
- The repeater has ~ 40 dB gain adjustment

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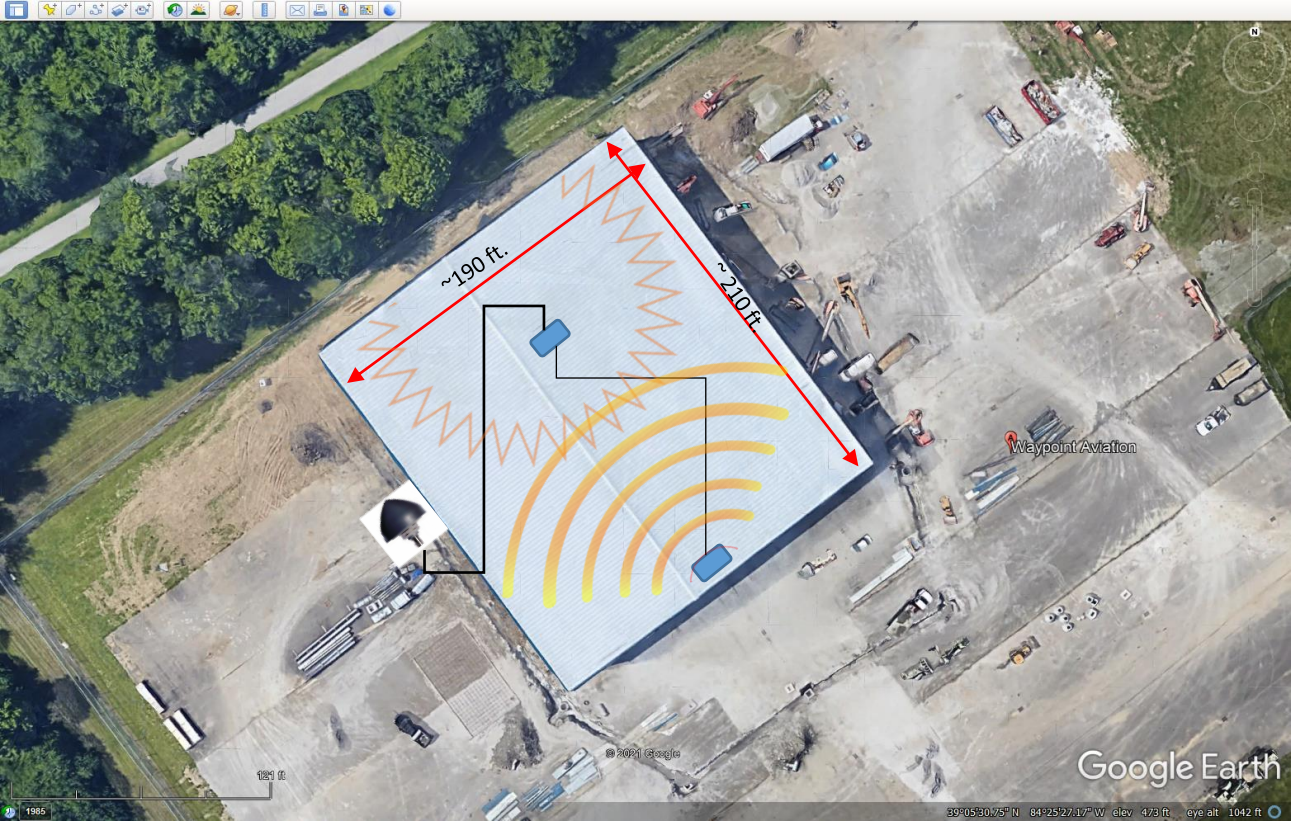


The indoor coverage is dependent on the free ceiling height in the hangar. We used the estimated figure of 27 ft. in our coverage calculations. With one repeater installed in the center of the hangar at this height you should expect to have a coverage with ~ 73 ft. radius from repeater center.

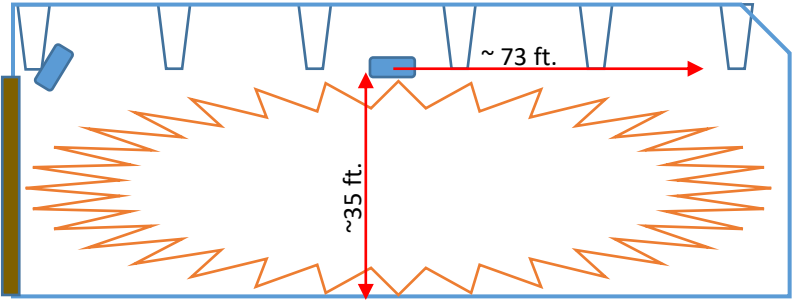


Repeaters need to be installed below any indoor ceiling support structures. If installed on the wall above the doors, they should be tilted on an angle and directed towards the aircraft.

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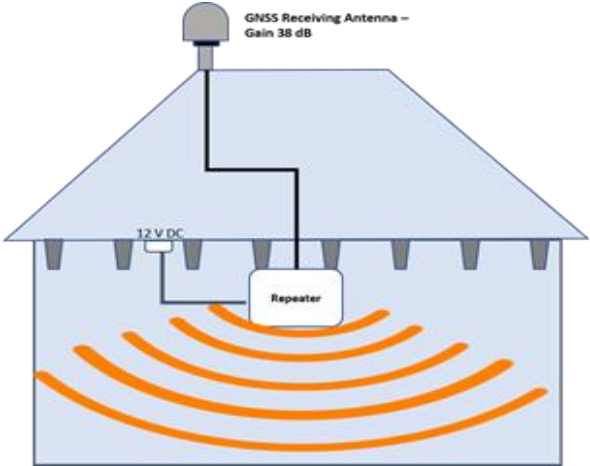


For a more complete hangar coverage one repeater can be added above the hangar doors pointing towards the center of the floor at an angle, and the other repeater can be installed further in the back of the hangar in the ceiling pointing straight down towards the floor.

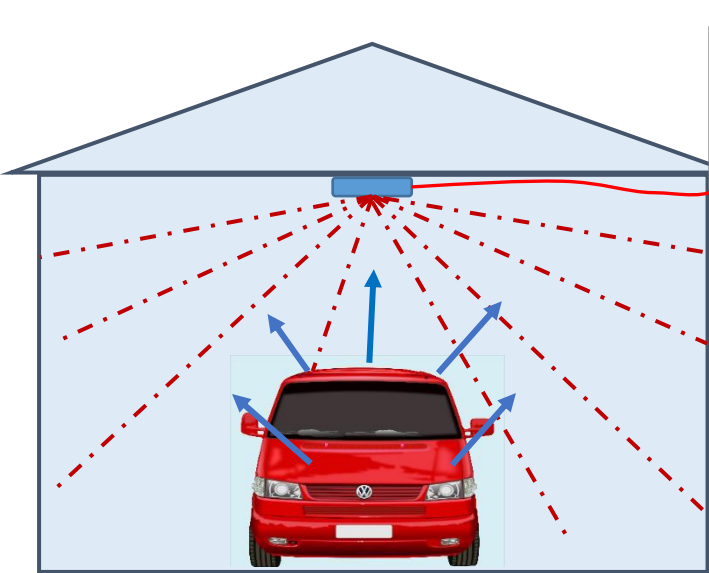


Repeaters need to be installed below any indoor ceiling support structures. If installed on the wall above the doors, they should be tilted on an angle and directed towards the aircraft.

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Bulky objects (cars, aircraft or other big metal objects) create reflecting waves that may influence the coverage area. The radiating angle of the repeater is ~ 180°.



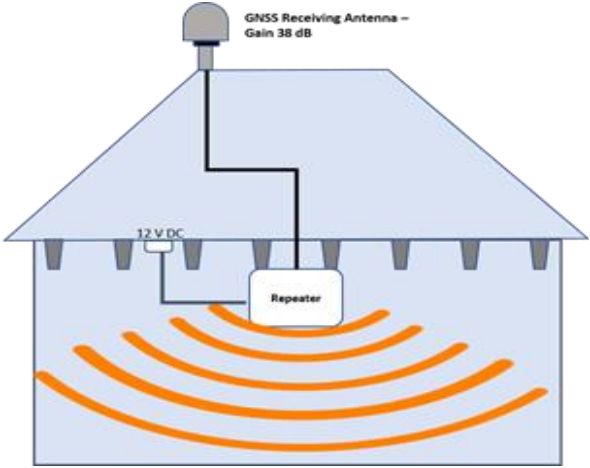
Location of Radiating antennas



Radiating angle ~ 180°

If no roof penetration can be done or direct installation of the outdoor antenna to the roof is not allowed, a wall mounted tube or pole can be used to raise the outdoor receiving antenna above the roof line (see picture) for maximizing visibility of satellites and to protect the antenna from being covered by eventual snow accumulation. Also, if the roof material is metal, the antenna should be installed at least 6.5 ft. above the surface in order to avoid multipathing.

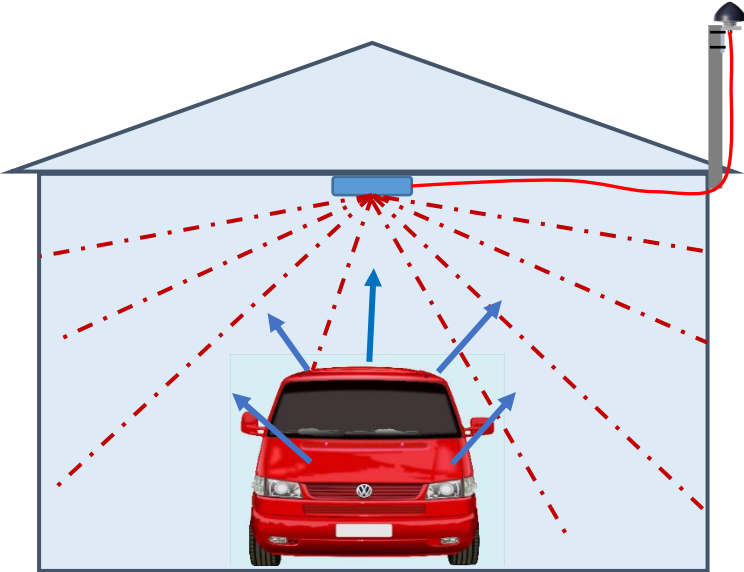
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The outdoor receiving antenna must be installed in a location with unobstructed view of the sky and the satellites, typically on the roof, or by mounting it to the top of a wall mounted pole or tube that sticks up clearly above the roof line.



The outdoor receiving antenna screws directly to the cable spacer and adjustable antenna mounting bracket. The cable spacer makes it easier to route the coaxial cable to the antenna.

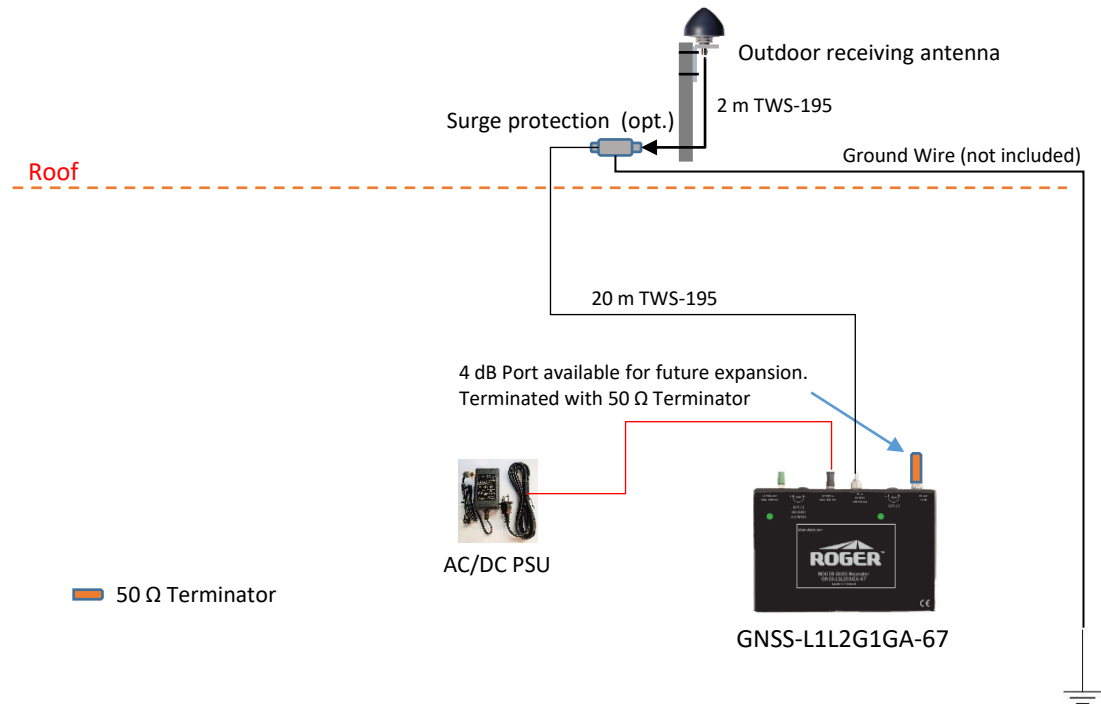


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The repeater requires a power outlet ~ 6 – 10 ft. from the repeater location as the PSU has a ~ 4.5 ft cable that attaches to the repeater and another ~ 6 ft. cable going from the PSU to the outlet.

Installation Instructions



Installation:

- Install the 35 dB Outdoor receiving antenna in a suitable location above the roofline.
- Install the optional Surge Protection kit and connect it to the outdoor receiving antenna using the short (2 m) jumper included in the kit. Connect the ground wire (not included in the delivery).
- Connect the 20 m TWS-195 coaxial cable to the other side of the Surge Protection device and route it inside the building .
- Install the repeater either in the center of the ceiling pointing straight down toward the floor, or on the wall pointing towards the area where signal coverage is most important. (using a bracket enabling tilting the repeaters on an angle is recommended)
- Connect the other end of the coaxial cable to the Antenna In (RF In) port of the repeater.
- Connect the Power Supply to a power outlet behind a switch and connect it to one of the repeaters PWR IN ports. (Make sure the switch is in the “OFF” position).
- We recommend testing the signal coverage with the repeater turned off and comparing the result to what you get when you turn it on after you have adjusted the gain per the instructions in the manual.