



**nu-metrics®**

A QUIXOTE COMPANY

**GROUNDHOG®  
HARDWARE  
INSTALLATION  
MANUAL**

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### DISCLAIMER OF LIABILITY

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### PURPOSE OF THIS MANUAL

This manual gives an overview of the equipment installation process and provides guidelines for installing your Groundhog Wireless System hardware. Read the entire manual carefully before you begin any of the installation procedures. You should also first read and be familiar with the Groundhog Wireless System Operation Manual and Groundhog and RRA 915 Programming Guide before proceeding.

## 1.0 INTRODUCTION

This manual provides instructions for Groundhog Hardware Installation. The manual will help you install your groundhog equipment, RFM-715 Radio Modules, Master Base Station, and any repeaters necessary. The manual assumes the user has basic computer and electrical knowledge. Read the entire manual before beginning any of these procedures. Before jumping into the hardware installation, you must complete a Site Survey and fill out the necessary planning and code forms. The equipment you will be installing is probably new to you as this section provides a brief description of each piece of equipment needed to set up your Groundhog Wireless Traffic Monitoring System.

### 0-1 AND 0-2

Your Groundhog Wireless Traffic Monitoring System includes several components or modules. The Groundhog Models 0-1, 0-2, and 0-2ws are permanent, in pavement, self contained, traffic detectors for wireless detection and transfer of multilane roadways data. The 0-1 is a basic traffic volume monitor, locally suited to highway construction management with capabilities that include volume, occupancy and roadway surface temperature. The 0-2 is for free stations, capabilities of speed, 1.5 minute clear length, 10 bins, occupancy, surface temperature and wet/dry pavement. The model 0-2ws provides channel storage for a maximum of 100 quantity of data being collected present.



Figure 1A - Model 0-1



Figure 1B - Model 0-2 and 0-2ws

### BASE STATION REPEATER (BSR-2)

The typical Base Station Repeater (BSR-2) consists of equipment cabinet (BSR-20), battery cells (UC-15), lightning arrester (LNC-4N), solar generator panel (SG-30), coax directional or yagi antenna, digital spread spectrum radio module (DPSM-25) transceiver, and optionally a weather data converter with precipitation, air temperature, humidity, and wind speed sensors. The BSR-2 equipment can be mounted on a fixed Top Pole Mount, Self Supporting Tower (SP-100 or 200), or it can be mounted on existing towers, poles, etc. A BSR-2 can function as a Fixed Base Unit (FBU), Repeater, or Master Data Collection Site.

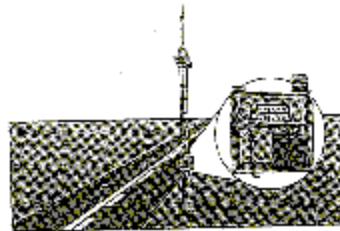


Figure 2 - BSR-2 Base Station Repeater

#### RFM-915

Go-Mo's Model RFM-915 is a compact stand alone digital spread spectrum radio modem that can be used in many applications that demand high performance communications. The RFM-915 has the capability to operate within a large network as a Master, Local or Slave Station.



Figure 3 - RFM 915 Radio Modem

#### MASTER COMPUTER DATA COLLECTION SITE

The Master Computer Data Collection Site generally consists of a 486-33 MHz operating at a Local Base Unit (LBU). The Radio Site in the LBU collects and transmits data from RFM Remote Data Sites or Dispersers. The data is then transferred by way of a (VFCB) cable to the Master CPU computer system at a central office location.

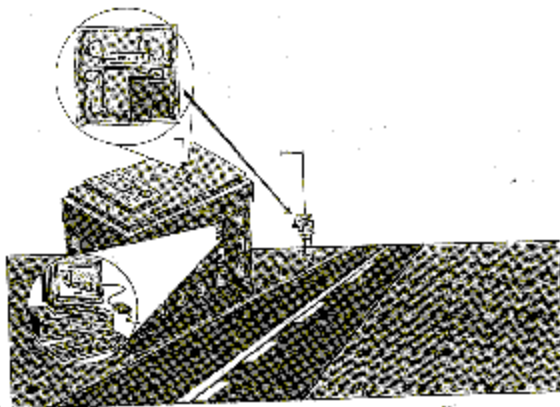


Figure 4 - Master Computer Data Collection Site

## 2.0 SAFETY INFORMATION

### ⚠ DANGER: AVOID POWER LINES

After following the instructions in this guide to install and connect or repair any equipment, like antennas, do not avoid contact with overhead power lines, lights and power circuits. Contact with power lines, lights and circuits may be fatal.

### COMPLIANCE WITH FCC PART 15 CLASS A

This equipment has been tested and found to comply with the limits for a Class B digital device pursuant to Part 15 of FCC Rules. These limits are designed to provide reasonable protection against harmful interference when this equipment is operated in a residential environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

### COMPLIANCE WITH NATIONAL ELECTRICAL CODE (NEC)

This manual contains some terms that are used to make the installation in compliance with the National Electrical Code (NEC). Any wiring should either be placed in a conduit that is sunlight resistant and conforms to Article 300 of the NEC, or the wiring should be type UF cable listed sunlight resistant. If additional local code/other codes apply, contact local inspection authorities. Before installing the Wireless System, check the electrical code guidelines in your area.

### OUTDOOR EQUIPMENT GROUNDING

The outdoor equipment used in the Wireless Grounding System is required to comply with local installation rules and the applicable sections of the National Electrical Code (NEC), especially Articles 250 and 430. These codes require proper grounding of the metal structure of the outdoor tower, tower antenna mast, and any connecting cable at a point where it enters a building. If you are having a professional make the installation, the installer must observe NEC and any local installation codes while proceeding with the installation.

### ANTENNA WARNINGS AND PRECAUTIONS

Plan your installation procedure carefully and completely before you begin. To determine a safe distance from wires, power lines and trees:

1. Measure the height of your antenna.
2. Add this length to the length of your tower or mast, and then:
3. Double this total for the minimum recommended safe distance.

If you are unable to maintain this safe distance, you will want to move the antenna to a safer location. When installing your antenna, DO NOT use a metal ladder. DO NOT work on a wet or windy day. DO climb properly, shoes with rubber soles and heels, rubber gloves, long sleeves and/or pants. If the antenna assembly starts to drop, get away from it and let it fall. Remember, the antenna, mast and cables are excellent conductors of electrical current. Even the slightest touch of any of these parts to a power line completes an electrical path through the antenna and the installer - THAT'S YOU! If any part of the antenna system should come in contact with a power line - DON'T TOUCH IT OR TRY TO REMOVE IT YOURSELF. CALL YOUR LOCAL POWER COMPANY. They will remove it safely.

#### SOLAR PANEL WARNINGS AND PRECAUTIONS

Photovoltaic (solar panel) modules generate direct current (DC) electricity when exposed to sunlight or other sources of light. Even though single modules produce low voltage and current, shocks and burns can still result from contact with panel output wiring. Never PV panels do not have to be connected (i.e., powering a load) to generate electricity. Since panels produce electricity whenever light is present, the panel front surface should be completely covered by an opaque cloth or other material before electrical connections to the panel or other system components are installed.

When using a storage battery with photovoltaic panels, battery manufacturer's safety recommendations should be followed. In some areas, local codes govern the installation and use of photovoltaic panels. In particular, these codes may specify requirements for panel installation on roofs and exterior walls. The United States National Electrical Code (NEC) addresses the installation of photovoltaic devices and should be consulted for recommendations.

#### RESTRICTIONS

Before installing your equipment, check the zoning codes, covenants and community restrictions in your area. Some rules prohibit installing towers, etc. There may be restrictions in your area that limit the mounting height of any equipment.

### 3.0 INSTALLATION PREPARATION

#### INSTALLATION PROCEDURES

If you are installing the equipment yourself, you should feel comfortable with the types of construction projects that may be necessary for your installation. These may include but are not limited to:

- Climbing ladders
- Climbing on a roof or tower
- Making holes & run flat, small power tools
- Working around power lines
- Working around cables
- Operating power equipment (saw, drill, generator, etc.)
- Removing traffic control & safety procedures
- Handling electronic devices
- Basic computer operation

If you do not feel comfortable performing these tasks, consult a professional contractor about having your system professionally installed.

#### PREINSTALLATION ACTIVITIES

Before installing any hardware, a site survey and survey should be conducted. Do not begin any hardware assembly or installation until this procedure is completed. First, carefully read and become familiar with all the manuals and documentation provided. Whenever you feel confident that you have a clear understanding of the theory and operation of the Wireless Data Collection System, you can conduct your site survey.

#### SITE SURVEY

Obtain as much information about your proposed site as possible, including maps, aerial views, contour maps, building plans, utility plans, etc. Make copies of relevant maps that you can mark or draw on. This will provide a good base for planning the locations of your Grounding Counters, Local Base Units (LBUs) and Master Data Collection Site.

Study the direction and flow of traffic to determine possible locations for your Grounding Traffic Counters. The counters must be installed in the center of a traffic lane so that vehicles pass directly over them. Locations will be determined differently depending on whether you are monitoring traffic on interstate highways, secondary roadways or in and out of shopping malls or parking lots. If the traffic is not channeled over the counters, some drivers will pass on either side and

may not be counted. Take advantage of bushes, dividers or other traffic restrictions. In extreme circumstances it may be necessary to install cameras or mirrors to channel the traffic over the counters. Keep in mind, you must have line of sight from the Grounding to the nearest LRU which can be no further than 200 meters (200 ft) away.

The LRUs may be installed on self-supporting or guyed towers, existing towers, new or existing poles or on existing base mounts. Regardless of the method, the LRU must be within 200 meters and have line of sight to the Groundings depending to it. The Grounding LRU must then have line of sight and be within 10 miles of the Master Data Collection LRU or equally to a Repeater LRU that then reports to the Master Data Collection Site. In some cases it may be many miles from the Groundings to the Master Data Collection Site. If this is the case it might require too many repeaters to be economically feasible. In this case, existing telephone lines or a cellular connection and a modem should be considered as workable alternatives. All LRU installations should be situated or protected to keep unauthorized persons from climbing on the equipment and also prevent vandalism.

Mark the proper location of all your Groundings, LRU's, Repeaters, Master Data Collection Site, etc. on a good map with a known scale. Verify the distance marked and double check for any site obstacles. The example shown will give you an idea of a typical Wireless Data Collection Site.



Figure 5

Select the appropriate antennas for your Master Data Collection and all Repeater or other LRU's. In most cases a 5' Wood Base Omnidirectional antenna with 4 dBi Gain will be adequate. For longer distances, or if outside RFL interference is present a yagi directional antenna may be required. Contact Nu-Merics if you are unsure which antenna is right for you.

Once you are confident of your site plan, you can proceed with the installation, beginning at your Master Data Collection LRU and working outward toward the Grounding counters.

#### TOOLS YOU WILL NEED DURING THE INSTALLATION

To save time and effort, make sure you have the tools you will need. This may include but may not be limited by:

- Portable Electric drill and drill bits
- Screwdrivers (Phillips and flat headed)
- Adjustable wrench or selection of open ended wrenches
- Hexwrench
- Chisel
- Crosscut Wrench
- Level (2 or 3 ft.)
- Black weatherproof tape for connections
- Ropes (various)

- Measuring Tape (25 ft. or longer)
- Ladders (Step and Extension)
- Heavy outdoor gloves
- Safety goggles
- Hard hat and safety shoes

## 4.0 MOUNTING THE ANTENNA

Be sure to take all precautions necessary before performing any installation. Please read through all of the steps provided and then perform the installation using the method given, or any variation of those methods given, any special warning notices that may arise. The instructions given in this manual assume you will be installing the antenna with a permanent installation of the antenna should be done on the ground, unless you can obtain a ladder break, or if the installation will be done on a roof. Once again, be sure to slightly modify these instructions to better suit your specific situation.

### 4.1 MOUNTING A YAGI ANTENNA



Using the U-bolts provided, place both of the U-bolts around the antenna mast and through the antenna mounting brackets. The top U-bolt should be positioned approximately 1" below the top of the antenna mast and the lower U-bolt should be spaced around 5" below the upper U-bolt. Be sure to place the lower side of the antenna base against the antenna mast using the bolts provided. Force the U-bolts into the brackets on the top to hold it in place.

1. Next, take the 1" antenna cable located at the bottom of the antenna and tighten this cable into the U-bolts antenna feed cable provided.
2. Once you have tightened the two cables together, the connection must be protected against moisture and corrosion. Use the specified corrosion resistant or self-sealing caulk to seal the connection and any cables from getting to the connection.
3. Next you need to make a loop with the 1" cable using the longer cable being fed. This will allow any water to collect in the bottom of the loop and drip off the wire.
4. You should run the antenna wire along the left side of the antenna mast. This wire will reach your RS232 control on the left side once it is installed.
5. Use the black wire ties provided to attach the cable wire to the antenna mast 1" below the wire connection and approximately every foot down the antenna mast until you reach the top of the solar panel.

### 4.2 MOUNTING AN OMNI-DIRECTIONAL ANTENNA

used only



1. Using the U-bolts provided, place both of the U-bolts around the antenna mast and through the antenna mounting brackets. The top U-bolt should be positioned approximately 1" below the top of the antenna mast. The lower U-bolt should be positioned approximately 5" below the upper U-bolt. After attaching the two brackets to the pole, slide the antenna through the brackets from the bottom to the top. Once the antenna is in position, tighten the bolts to hold the antenna in place.
2. Now you need to take the 1" antenna cable located at the bottom of the antenna and tighten this cable into the U-bolts antenna feed cable provided.

- Once you have tightened the two cables together, the connection must be protected against moisture and corrosion. Use the specified connector, welder or self-sealing rubber tape to seal out any moisture from getting to the connection.
- Next, you need to make a drip loop with the 1/2" cable letting the longer cable hang free. This will allow any water to collect at the bottom of the drip loop and drip off of the wire.
- You should run the antenna wire along the left side of the antenna mast. This wire will enter your B&B 2 cable on the left side once it is installed.
- Use the braid wire that is provided to attach the audio wire to the antenna mast 2" below the wire connection and approximately every 100" down the antenna mast until you reach the top of the outer panel.

## 5.0 MOUNTING SOLAR PANEL TO ANTENNA MAST

Note: When installing the solar panel, be aware that they generate maximum power when facing the sun directly. The fixed position which approximates this directly over the course of the year, thus maximizing annual energy production, is being due South (in the Northern Hemisphere) or due North (in the Southern Hemisphere) at the angle listed in Table 1. These orientations are true North and South, not magnetic North and South.

Table 1 shows the fixed angle above horizontal at which panels should be installed in order to maximize annual energy output. The panel's position for your specific location is a simple extrapolation of the figures in the table. As some users' systems may be less effective to adjust the tilt seasonally, at most latitudes, performance can be improved during the summer by using an angle flatter than the chart's recommendations. Conversely, a steeper angle can improve winter performance. If panels are not cleaned regularly, it is recommended that they not be mounted at an angle flatter than 12 degrees. Flatter angles reduce the full advantage of the cleaning action of rainfall. Dirt accumulation on the panel's front surface can reduce the light energy collected by the panel, decreasing its power output. If the panel surface becomes dirty, gently clean it with a soft cloth or sponge using water and a mild detergent. Do not use scrub brushes as they damage the panel surface. Wash rubber gromets to protect against possible electrical shock.

Locate the panel so that it is free of obstructions from shading during all seasons, particularly during the middle (the most unproductive) part of the day.

LATITUDES

| DATE                         | 0° | 5° | 15° | 24° | 32° | 42° | 48° | 58° | 64° | 72° | 80° |
|------------------------------|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| June 21                      | 23 | 15 | 7   | 0   | 8   | 16  | 24  | 32  | 41  | 49  | 57  |
| May 21<br>or July 21         | 20 | 12 | 4   | 4   | 12  | 20  | 28  | 36  | 44  | 51  | 60  |
| April 21<br>or August 21     | 12 | 4  | 4   | 12  | 20  | 28  | 36  | 44  | 52  | 60  | 68  |
| March 21<br>or September 21  | 0  | 8  | 16  | 24  | 32  | 40  | 48  | 56  | 64  | 72  | 80  |
| February 21<br>or October 21 | 11 | 19 | 27  | 35  | 43  | 51  | 59  | 67  | 75  | 83  | —   |
| January 21<br>or November 21 | 20 | 28 | 36  | 44  | 52  | 60  | 68  | 76  | 84  | —   | —   |
| December 21                  | 23 | 32 | 39  | 48  | 56  | 64  | 72  | 80  | 87  | —   | —   |

Table 1 - Solar Panel Position Angles (degrees above Horizontal)

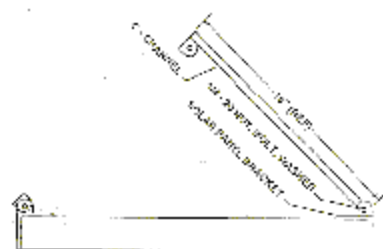
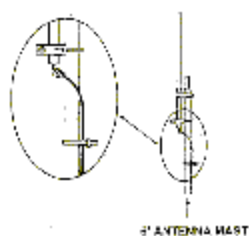


Figure 6 - Solar Bracket Arm on Mast

1. Fasten the lower solar bracket to the antenna mast (between the two 360° rot brackets). Note: This solar panel location is recommended as the most convenient. Antenna conditions may require alternate mounting due to shading, interference from solar voltage, cancellation, etc.
2. Insert the upper solar panel bracket on the antenna mast approximately 18 inches from the lower bracket using the 1/2x20 U-bolts and spacers. Do not tighten completely at this time.
3. Secure the Solar Panel to the lower and upper brackets using 1/2x20 bolts, nuts and washers and tighten securely.
4. Refer to Table 1 and adjust the solar panel by moving the upper bracket up or down the antenna mast until the face of the panel is on the correct degree angle as determined from the Table. Tighten the upper bracket securely.
5. Connect the antenna feed line cable in the connector on the down cable at the base of the antenna. Note: All external antenna connections must be protected against moisture and corrosion. Use specified connector sealant or self-sealing rubber tape.
6. Route the antenna feed line cable down the mast. Fasten to the mast with black vinyl ties. (Note: black vinyl ties are UV resistant. If other ties are used they will break down over time due to exposure to sunlight).



Figure 7 - Antenna Connection



3' ANTENNA MAST

Figure 8 - Antenna Feed Line Cable

7. Route the antenna feed line cable up through the opening on the bottom of the REC-02 equipment cabinet. Use the opening on the right if you are facing the front (door) side of the cabinet. Leave a "rain drip loop" on all feed line cables or wires.
8. Carefully connect the antenna feed-in cable to the connector on the LMC-4N Lightning Arrestor.
9. Ensure that the RFM-915 for this location is the proper one and has been preprogrammed according to the instructions in the Groundhog Wireless System Operation Manual and Groundhog and RFM-915 Programming Guide. Set the AIM-915 on the top small on the REC-02 Cabinet. Connect the cable from the other side of the LMC-4N Lightning Arrestor to the antenna connection on the RFM-915.
10. Plug the disc connector from the battery into the power jack on the RFM-915. The red Power LED on the Right should be illuminated, indicating the unit is on. When receiving data the green LED will flash and when transmitting data the Red Transmit LED will flash.
11. Make a final check to insure that the solar panel is facing in the correct position and angle for maximum exposure to the sun (Ref. Table 1) and correct if necessary. If using a sagi antenna, make a final check to insure the antenna is aligned with the Groundhogs or RSR-2 where your transmitter originates. Use additional wire ties to secure any wires or cables for a neat and secure installation. Once you have all the RSR-2 equipment installed, you are prepared for Groundhog installation.

## 6.0 MOUNTING SOLAR PANEL TO THE WALL

1. Make sure the solar panel is mounted so a permanent structure is facing due south.
2. Fasten the mounting bracket to the upper portion of the solar panel, making sure the mounting plate is facing down.
3. Fasten the other mounting bracket to the lower portion of the solar panel, making sure the mounting plate is facing down.
4. Bolt the top bracket to the mounting surface at least 5 feet above the ground.
5. Adjust the lower arm of the solar panel to the proper angle for your latitude.
6. Bolt the lower bracket to the wall making sure the bracket is flush to the wall.
7. Purchase the appropriate fasteners to attach the solar panel cable to the wall you are mounting your equipment on. Attach the cable to approximately 1 foot below the RSR-2 box, be sure to run your cable down the right side of the box.

## 7.0 MOUNTING THE RSR-2 BOX

You will want to mount the RSR-2 box after the antenna and solar panel installations are completed. Installation of the equipment should be done after the RSR-2 box is mounted to the antenna.

There are three methods of mounting the RSR-2 whiner. The RSR-2 can be mounted directly to the side of an existing structure using the brackets provided. The RSR-2 may also be bonded to an existing pole. This installation is used when you don't want any extra structures around the site. This manual will describe the most popular installation method, mounting the RSR-2 box to a LBL.

1. Locate the mounting plate. This thin piece of metal is approximately 1 foot square. Mount this plate to the back of the BSR-2 box using the shorter screws provided.
2. Once the plate is securely attached to the box, open the door of the cabinet and place the longer screws through the four outer holes in the back of the cabinet.
3. Attach the nuts to the bolts as they pass through the other side of the thin plate and tighten down.
4. Once all four screws are tightened, you will then want to proceed to the BSR-2 Box Equipment Installation (see 3.0).

#### MOUNTING BSR-2 BOX ON A WALL

1. Attach the four (4) mounting brackets provided to the sides of the BSR-2 in the holes provided.
2. Mount the BSR-2 box to the wall using any nails.
3. Refer to BSR-2 equipment installation steps.

### 3.0 BSR-2 BOX EQUIPMENT INSTALLATION

Refer to Figure 9 for BSR-2 Equipment Installation

1. Take the solar panel cable and strip the insulation off from the end of the cable. Separate the 3 conductors (white, green, red, and black) and strip the insulation off their ends to expose 1/2" of copper wire.
2. Looking on the inside of the BSR-2 box, you will find the terminal block. It consists of two rows of screw heads, six screws per row. Moving from left to right, attach the green wire to the bottom row, second screw from the left. The white wire will be attached to the first (left) row, fourth screw from the left. The black wire will be attached to the first (right) screw on the bottom row.
3. Place the batteries on the right side on the bottom shelf of the BSR-2 cabinet in front of the terminal block.
4. Connect the red and black wires that are tied together inside the box to the batteries. **BE SURE TO CONNECT THE RED WIRE TO THE POSITIVE TERMINAL ON THE BATTERY AND THE BLACK WIRE TO THE NEGATIVE TERMINAL.** The positive terminal is labeled with a red color and the negative terminal is labeled with a black color.
5. The cable from the lightning arrester will go from the lower shelf, through the divider and connect to the RFM. Connect this cable to the RFM at this time.
6. Take the power plug from the terminal block and attach it to the power port of the RFM.
7. Slide the RFM to the back of the BSR-2 cabinet and close the door. Be sure to use the key provided to lock the door. **DO NOT LOSE THIS KEY.** You will not be able to open your cabinet without one.

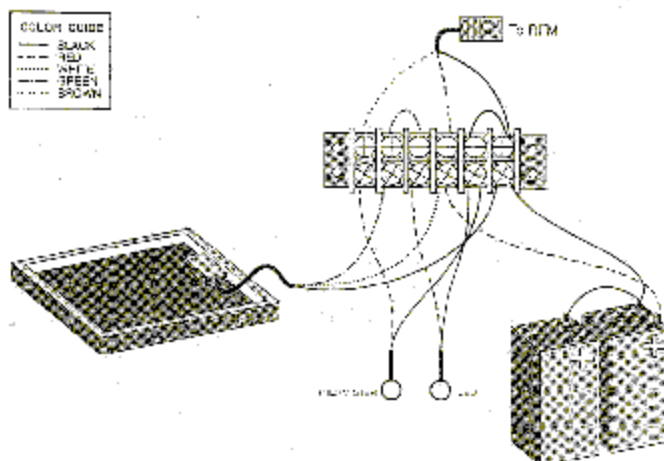


Figure 9

## 9.0 INSTALLING THE BASE STATION REPEATER

### 9.1 ROOFTOP BASE STATION MOUNT

**DANGER! Avoid Power Lines!**

When following the instructions in this guide to install and connect or repair any equipment, take extreme care to avoid contact with overhead power lines, lights and power circuits. Contact with power lines, lights, and circuits may be fatal.

Equipment needed:

1. 4"x4"x8' notched posts that fit together.
1. Lag screw to join the 3 posts.
2. Gulp of rubber to cover the bottom of the posts.
4. Lag screws to mount the base station antenna bracket.
1. 1/4"x1/4" bolt with nut and 2 washers to join antenna pole to bracket.
1. Antenna with bolts to attach to pole.
2. Removable brackets to attach RDR-2 Box to pole.

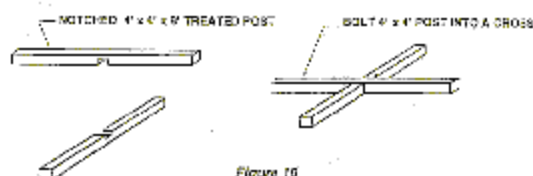


Figure 10

1. Prepare the 4" x 4" x 8' treated posts by cutting them according to the picture below.
2. Once your base is constructed, fasten the 3" or 5" tower base to the 4" x 4" post with the lag bolts provided.
3. Install the antenna mast into the tower base according to the instructions in Section 4.1.
4. Drill clearance for 7/8"-20 bolts into the antenna mast. Bolt the antenna mast to the tower base with a 2" 7/8"-20 bolt.
5. See Section 4.3 on Mounting the Antenna.
6. See Section 6.0 on Mounting the Solar Panel.
7. Fasten BSR-1 cable to antenna mast according to the instructions in Section 5.0.
8. See Section 8.0 on BSR-2 Box Equipment Installation.
9. Route the antenna feed line cable up through the opening on the bottom of the BSC-02 equipment cabinet. Use the opening on the right if you are facing the front (short) side of the cabinet. Leave a "rain drip loop" as all feed lines do when it rains.
10. Carefully connect the antenna feed line cable to the connector on the LAC-04 Lightning Arrester.
11. Ensure that the RJ-45 RJ-45 to RJ-45 patch cord is properly connected to the bottom of the Groundhog Wireless System Operation, Installation, Groundhog and RJ-45 RJ-45 Programming Guide. See the RJ-45 RJ-45 on the top of the BSC-02 Cabinet. Connect the cable from the other side of the LAC-04 Lightning Arrester to the antenna connector on the RJ-45 RJ-45.
12. Plug the RJ-45 connector from the antenna into the power jack on the RJ-45 RJ-45. The red Power LED on the RJ-45 RJ-45 should be illuminated, indicating the cable is on. When connecting, the green LED will flash and when your mating data, the Red Transmit LED will flash.
13. Make a final check to insure that the solar panel is facing in the correct direction and angle for maximum exposure to the sun (See Table 2) and period if necessary. If using a yard square, make a final check to insure the antenna is aligned with the Groundhog or BSR-2 where your transmissions originate. Use additional cable ties to secure any wires or cables for a neat and secure installation. Once you have all the BSR-2 equipment installed you can proceed with Groundhog installation.
14. Optional Grounding procedures.
15. Place 1 concrete block on each end of the base's legs.

## 9.2 SELF-SUPPORTING TOWER

When installing the tower, you will want the solar panel facing South (in the Northern Hemisphere). That may not be important now, but when you are finished with the installation, you will want the solar panel facing South.

**CAUTION:** Follow your installation procedure carefully and completely before you begin. Refer to "Safety Information" to determine how to carefully install this equipment.

1. Decide where you will put the tower. Make sure it will be installed away from trees.
2. Dig a hole 24 inches in diameter and at least 24 inches deep. 24 inches is deep enough for a tower installation, but if you feel uneasy about the depth, you can go lower. Remember, the lower you go in the ground, the lower the overall height of your tower will be.

5. Set the lower section of the tower in the hole with the flanged side sticking out of the ground. Make sure you have the proper section of the tower, the flanges should be sliding out of the ground.
6. Make enough cement to fill the entire hole, then fill the hole with cement.
7. Make sure the tower base is level in both the vertical and horizontal directions before continuing.
8. Once the tower base is level, allow 24 hours for the concrete to set before continuing with installation.
9. After waiting for the concrete to set, you will continue by placing the top section of the tower together with the middle section of the tower using 1/4 20 bolts. At this point, you will have one section embedded into the ground and the other two sections connected together laying on the ground.
10. See Section 4.0 on Mounting the Antenna.
11. From the middle section, located in the upper section in the hole section on TWO of the flanges using 1/4 20 bolts.
12. See Section 6.0 on Mounting the Solar Panel.
13. Mount the tower up. Be sure to put the main support pin into the section of the top pin using 1/4 20 bolts as shown in images.
14. Once the tower is in the upright position, tighten the three large bolts.
15. See Section 7.0 on Mounting the BSR-2 Base.
16. Go to BSR-2 Set for antenna installation.
17. Route the antenna feed line cable up through the opening in the bottom of the RBC-01 equipment cabinet. Use the opening on the right if you are facing the front (facing) side of the cabinet. Leave a "rain drop loop" over the top in cabinet or where.
18. Carefully connect the antenna feed line cable to the connector on the LAC-4N Lightning Arrester.
19. Ensure that the RFM-01S for this location is the proper one and has been pre-programmed according to the instructions in the Groundhog Wireless System Operation Manual and Groundhog and RFM-01S Programming Guide. See the RFM-01S on the top shelf on the RBC-01 Cabinet. Connect the cable from the other side of the LAC-4N Lightning Arrester to the antenna connection on the RFM-01S.
20. Plug the cin. connector from the batteries into the power jack on the RFM-01S. The red (Power LED) on the RFM should be illuminated, indicating the unit is on. When receiving data, the green LED will flash and when transmitting data, the Red Transmit LED will flash.
21. Make a final check to ensure that the solar panel is facing in the correct position and angle for maximum exposure to the sun (Ref. Table 1) and correct if necessary. If using a yagi antenna, make a final check to ensure the antenna is aligned with the Groundhogs or BSR-2 where your communications originate. Use additional cable ties to secure any wires or cables for a neat and secure installation. Once you have all the test-kit equipment installed you can proceed with Groundhog installations.
22. Go to page 12 for Grounding instructions.

### 9.3 TRIPOD INSTALLATION

NEVER use an antenna mast that exceeds a height of more than 10 feet above the rooftop.

1. Unfold the tripod legs until fully opened.
2. Fix the tripod securely to an appropriate permanent structure.
3. Slide the 5 foot section, tapered edge down, through the center of the tripod.
4. Tighten the 3 inch anti-rattle SQUARE nuts are tight against the inside of the mounting bracket and the round nuts are flush against the outside of the bracket.
5. Repeat step 4 for the lower bracket.
6. See Section 4.1 on Mounting the Antenna.
7. Slide the tapered end of the upper antenna mast into the tapered 5 foot antenna mast already secured to the base. Make sure the upper antenna mast "snaps" into the lower mast.
8. With black duct tape, be sure to fasten the microwave cable the rest of the way down to antenna mast.
9. Once the cable is tied to the antenna mast down to the tripod, do the same to one leg, preferably in the clearest of your BSR-2 box and Solar Panel.
10. See Section 7.1 on Mounting the Filter Panel.
11. See Section 7.2 on Mounting the BSR-2 Box.
12. See Section 8.1 on BSR-2 Box Equipment Installation.

### 10.0 GROUNDING THE BSR-2 INSTALLATION

#### GROUNDING THE BASE MOUNT

Drill one leg of the Metal base with clearance for a 1/4" - 20 x 2" zinc plated bolt. Insert the bolt through the metal leg, and then insert the 1/4" star washer and 1/4" nut loosely into the bolt. Use No. 10 AWG copper or No. 8 AWG or larger copper-clad steel or bronze wire as ground wire. Wrap the ground wire around the bolt between the star washer and the leg and securely tighten the nut. Route the ground wire to an appropriately grounded pipe or fixture in accordance with National Electrical Code.

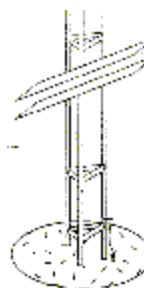


Figure 11 - Grounding the Base Mount Tower

#### GROUNDING THE SELF-SUPPORTING TOWER

Drill one leg of the tower, near the base, with clearance for a 1/4" - 20 x 2" zinc plated bolt. Insert the bolt through the metal leg, and then insert the 1/4" star washer and 1/4" nut loosely into the bolt. Use No. 10 AWG copper or No. 8 AWG or larger copper-clad steel or bronze wire as ground wire. Wrap the ground wire around the bolt between the star washer and the leg and securely tighten the nut.

About one foot away from the tower base, drive the ground rod into the ground. According to National Electrical Code, you must drive the ground rod eight feet into the ground. Attach the ground wire to the ground rod using the ground rod clamp.

## 11.0 GROUNDHOG HOUSING INSTALLATION

### PREPARATION

To prepare the Groundhog Casting for ready-to-use installation, first insure that the lid of the housing is secured tightly. If necessary, use the security tool provided and tighten the lid to a clockwise direction. The lid surface should be flush with the housing when completely tightened. Important Note: Do not remove the shield with the arrow from the lid until after the seal is installed in the casting.

In addition to the Groundhog Casting, you will need the following items for a proper installation:

- Core Drill Machine with a core drill bit (1/4" for G-1 or 7/16" for G-2)
- Generator for AC Power
- Water tank or water supply (if using wet core drill system)
- Air compressor or shop vac for blowing and drying
- Devcon #9300 2-part Epoxy Sealant
- Small bucket or container for mixing two part epoxy. Note: the epoxy is chemically active and becomes glass but when mixed and may melt some plastic containers
- Stirring rod or paddle & scraper or putty knife
- Paper towels or rags
- Hammer & chisel
- Measuring Tape
- Mask Tape Template (supplied with G-1 Casting)
- Chisel, screw or other sharp knife

If you intend to install the electronic module at the same time, you will also need:

- Electronic module (preprogrammed and setup per instructions)
- No-Markers Pen 4 (NE-G115 or On/Offogen Fill, Callahan)
- Lid Removal Tool

1. You should have already called on the desired site location for the Groundhog installation according to the requirements in the Operation Manual. Inspect the selected location again to insure you will not interfere with embedded items, underground cable, conduits, pipes, or other obstructions.

2. Clear the selected install hole to all traffic. Clear appropriate site and local entrances for proper procedures and requirements. Use appropriate safety devices, lights, signs, flags, arrows, cones, hard hats, safety goggles, etc.

3. Core drill the required hole (as shown in Section 14.0) in the center of the traffic lane.

4. The Groundhog casting is now ready for the Electronic Module installation.

## 12.0 ELECTRONIC MODULE INSTALLATION

### ACTIVATING THE GROUNDHOG BATTERIES

Carefully remove the electronic module from the cardboard shipping tube by sliding it out of the tube. Note: Avoid touching the sensor coil and metal strip at the top of the printed circuit board when handling the electronic module. Always grasp the printed circuit board on the edges to prevent any damage to the circuitry or sensors.

The Groundhog comes complete with two (G-1) or four (G-2) 3.6v Lithium batteries which are installed, but not connected to the circuit board. Locate the battery connectors indicated in Figure 12. Carefully plug the connectors from the batteries into the battery connection on the circuit board. Power is now applied and you are ready to program the Groundhog.

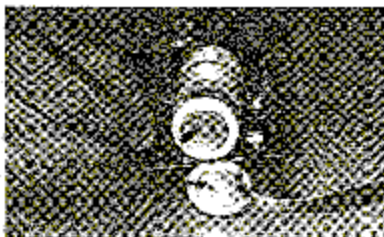


Figure 12 - Connecting the Battery

#### PROGRAMMING THE GROUNDHOG

Depending upon the situation you may want to install all of the Groundhog Loadings in the memory first and later program and install the elements. If this is the case you can follow the instructions in the Section II Chapter on Groundhog Housing Installation.

You should have already determined all of the necessary addresses and filled in the appropriate sheets on your site plan. It is time to program these addresses into the Groundhog's memory. The addresses will be stored in the unit's EEPROM (Electrically Erasable Programmable Read Only Memory) which, even if the battery runs dead, will be retained. The Groundhog Setup program will ask you to reply to a few simple questions and, through a Serial Interface (RS-485) connected to the unit, will store these addresses in the correct locations in the unit's memory.

#### USING THE GROUNDHOG SETUP PROGRAM

1. Make sure your computer clock is set to the correct time since the clock inside the Groundhog is set by your computer.
2. Next, connect the RS-485 to your computer using the Serial Interface Cable provided. If the only available COM port on your computer uses a 25 pin connector a 5 pin to 25 pin adapter is supplied with the Groundhog.
3. Connect the cable from the RS-485 Interface Adapter to the programming connector on the Groundhog Electronic module as indicated in Figure 3.

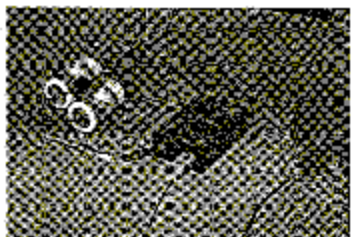


Figure 13

4. Insert the Grounding Setup Disk into your 3 1/2" drive, and type either ASCII or ASCII. This will load the setup software and scan the available communication ports on your computer to determine at which port the Grounding is connected. If you get an error stating "Grounding Not Found", check all of your cables and connections, making sure everything is connected correctly. If you are still unable to communicate with the unit, refer to the Troubleshooting section of this manual.
5. Once communication between your computer and the unit has been established, you must give the Grounding a Unit Code, or name on the network of other traffic counters and Base Stations. This number will be unique to this particular Grounding, and must not be used anywhere else in your system. Refer to Figure 5 for this address. You will then be asked to input the Destination Code. This address is also available in Figure 5, along with the Group Code and the System Code.

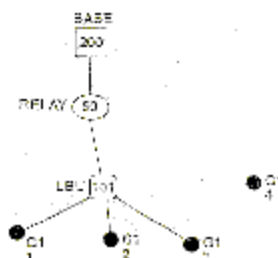


Figure 5

6. Next, you must decide how often this unit will report its data to the Base/Unit Station Receiver. This number should be between 1 and 10 (minutes).
7. Your Grounding electronic module is now programmed.
8. Slide the electronics module back into the Grounding's case, making sure the printed circuit board is positioned into each track of the inner housing. **IMPORTANT:** The Grounding Electronic Module PCB must be inserted into the Grounding case in proper alignment for traffic flow. Position yourself in front of the roadway installation, noting the direction that normal traffic would be flowing. The electronic module should then be inserted into the housing. The printed circuit board will be facing with traffic flow. The side of the printed circuit board, with all the components will be facing your left; and the side of the PCB with the copper patterns will be facing your right. The Printed Circuit Board should be inserted into the tracks so that the board is in direct alignment with traffic flow and direction.
9. Examine the lid to insure the rubber "O" rings are still positioned properly. Place the lid on the case and tighten by hand. Using the Lid Installation/Removal tool, tighten the lid securely; the lid surface should be flush with the rest of the case.
10. Should it ever become necessary to reopen the Grounding case, first clean the entire lid and area surrounding the Grounding so that no dirt or debris will fall into the opened case. The holes in the lid for the security removal tool may need cleaned out prior to attempting to remove the lid. Once the lid is removed, be sure to screw the lid back on the container so no debris falls into it.