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RT System 2

Deployment Guide

April 15, 2014

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R01.i

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Overview

1.1 About this Guide

This document provides information on how to deploy the RT System 2 in the field. See the *RT System 2 Installation Guide* for instructions on setting up the recording truck equipment and software.

1.2 Who Should Use this Guide

The expected users of this document are as follows:

- Crew (Layout/Troubleshooters)
- Technician (LIU)
- Bosses (Line Crew)

1.3 Related Documents

RT System 2-related documents are as follows:

- **RT System 2 Documents Guide** (90-0026) – Lists all of the RT System 2 documents with a brief description of each.
- **RT System 2 Glossary** (90-0032) – Lists and defines RT System 2 terms and acronyms. Includes some general seismic and geologic terms and acronyms.
- **RT System 2 Installation Guide** (90-0028) – Provides instructions for setting up the recording truck hardware, and installing and updating software and firmware.
- **RT System 2 Troubleshooting Guide** (90-0039) – Provides instructions on how to solve common problems.

1.4 Getting Help

To get help on the RT System 2 Central Recording System, consult the online help. You can find the help documents by clicking the help icon in the user interface, or by navigating to the following directory:

`C:\wsi\rt\vx.y.z\server\help\index.htm`

Where `vx.y.z` is the version number (for example, v2.3).

To get help on the RT System 2 deployment, consult this document.

If you cannot find the answers you need, please contact Wireless Seismic, Inc. Customer Support at:

13100 Southwest Freeway, Suite 150
Sugar Land, TX 77478
(832) 532-5048

support@wirelessseismic.com

2

Layout

This chapter describes how to prepare (mobilization) and layout (install) the ground electronics. See the *RT System 2 Installation Guide* for instructions on setting up the recording truck equipment and software.

2.1 Prerequisites

In preparation for mobilization, define the following:

- Survey
- Backhaul plan

2.2 Getting Ready

Collect all of the following:

NOTE

Please refer to "Antenna Specifications" on page 145 for the list of supported antennas. Use of accessories other than those specified in this document is not supported or warrantied.

RT System 2 ground equipment (05-0007):

- WRUs (01-0001, 10-0017, 10-0023, 10-0027)
- LIUs (10-0016) (see also *"Backhaul Components" on page 31*)
- Antennas 5.5 dBi maximum (65-0204/65-0264)
- Geophones
- WRU Batteries (0400-001-01)
- WRU Dummy Batteries (55-0009)
- WRU Anchor Plates (10-0028)
- Antenna Extenders
  - 30 in (762 mm) antenna extender (65-00941) (standard)
  - 10 ft (3 m) M-to-F coax cable (65-0103)
  - 25 ft (7.6 m) M-to-F coax cable (65-0110)
- Backhaul Components (see *"Backhaul Components" on page 31*)
- Tools
- Manuals
- Consumables
- Spares (15-0003)
  - Mast Parts
  - Base Parts
  - Guy Lines
  - Antennas
  - Antenna Extenders
  - Batteries

- Cables
- Connectors

NOTE

The batteries (when fully discharged) require 8 hours of continuous charging in the battery charger connected to an AC source; therefore, the battery charger should be located at the staging area or in town.

2.3 Preparing the Equipment

Ensure that the Central Recording System has the latest available software installed. Ensure that the ground equipment has the latest available firmware installed. See the following for more information:

- See the *RT System 2 Release Notes* for version numbers.
- See the *RT System 2 Installation Guide* for installation and update instructions.

Ensure that the industry standard best practices are followed for securing the equipment for transport.

2.4 Laying Out the Equipment

Lay out the ground equipment while the central recording system hardware and software is being prepared to save time.

The WRU is shown in the following figure:

Figure 2–1 WRU

A WRU with a geophone attached is shown in the following figure

Figure 2–2 WRU with Geophone

The LIU is shown in the following figure:

Figure 2–3 LIU

2.4.1 Prerequisites

Attach the batteries, antennas, anchor plates, and geophones to the ground equipment prior to going into the field, or as each unit is placed. If you are assembling as you place the units, ensure that you have sufficient quantities for each unit, plus a few spares.

NOTE

Do not deploy (tip to power on) the WRUs until they are at the actual location where they will be placed.

Figure 2–4 Assembling WRUs

The RT System 2 shall be used with only the supplied antennas (*Table A–1 Antenna Specifications, on page 145*) attached to the WRU with an integrated type N male (threaded or HPQN) connector.

- The RT System 2 antennas shall be installed and handled by professionals specifically designated for this purpose.
- Changes or modifications not expressly approved by Wireless Seismic, Inc. can void the users's authority to operate the equipment.

CAUTION

In order to comply with radio frequency (RF) exposure requirements, the RT System 2 units must be installed so that a minimum separation distance of 20 cm is maintained between the antenna(s) and the body of all persons at all times during normal operation.

PRUDENCE

Afin de se conformer aux normes de la en matière d'exposition aux radiofréquences (RF), les unités RT System 2 doivent être installées de manière à garder en permanence une distance minimale de 20 cm entre la ou les antennes et le corps de toute personne en mode de fonctionnement normal.

VORSICHT

Um den Radiofrequenz-Strahlen-belastungsrichtlinien zu entsprechen, müssen die RT-System 2 Einheiten so eingebaut werden, dass ein Mindestabstand von 20 cm zwischen der/n Antenne/n und dem/n Körper/n aller Personen zu jeglicher Zeit während der üblichen Betriebszeiten gewährleistet ist.

PRZESTROGA

Aby zachować zgodność z wymogami dotyczącymi ekspozycji na promieniowanie o częstotliwości radiowej (RF), urządzenia RT System 2 należy instalować tak, aby podczas normalnej obsługi pomiędzy ciałem wszystkich osób a antenami przez cały czas było co najmniej 20 cm odstępu.

2.4.2 Assembling the Ground Equipment

This section describes the process to assemble the ground equipment prior to deployment.

To assemble the ground equipment:

1 Gather the equipment:
- WRU
- Antenna
- Antenna Extender
- Geophone
- Batteries
- Anchor plates

2 Gather any special tools and equipment:
- Optional: Nylon grip pliers
- Optional: Loctite® 222
- Safety gear such as vests, hard hat, and gloves.

CAUTION

The metal ground equipment can become hot while exposed to the sun. Wear gloves to handle hot equipment.

PRUDENCE

Les équipements terrestres en métal peuvent devenir chauds lorsqu'ils sont exposés au soleil. Portez des gants lorsque vous manipulez un équipement chaud.

VORSICHT

Die Metallbodenausrüstung kann heiß werden, wenn sie der Sonneneinstrahlung ausgesetzt wird. Tragen Sie Handschuhe, wenn Sie mit erhitzter Ausrüstung umgehen.

PRZESTROGA

Metalowe elementy urządzeń w terenie mogą nagrzać się w przypadku wystawienia na słońce. Nagrzane urządzenia należy obsługiwać w rękawicach.

3 Attach one or more batteries to the WRU.
- Press the battery into the connector.
- Flip the bail over the molded area on the end of the battery.
- Press the lever until the catch snaps to lock it in place.

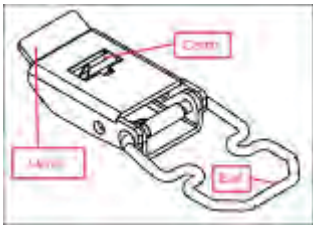


Figure 2–5 Battery Latch

Figure 2–6 Installing the Battery

4 Optional: Attach the anchor plate. See *"WRU Anchor Plate" on page 22* for instructions.

5 Attach the geophone to the WRU.

TIP

To record three components of seismic data with the multiple-channel WRU, connect three separate arrays of one-component geophones to the same WRU, or connect a multiple-component geophone to the WRU

Figure 2–7 Installing the Geophone

6 Attach the antenna with extender to the WRU. Ensure that the antenna connection is clean, and the antenna is snug and does not wobble.

NOTE

The antenna screws on to the WRU in a clockwise direction. It should twist on easily; do not use force. To ensure that the threads are properly aligned, turn the connector counter-clockwise until you hear a click indicating that the threads are aligned, then turn clockwise to tighten.

Figure 2–8 Antenna Extender (65-0091)

Figure 2–9 Antenna with Spring Relief

2.4.3 Placing the WRU in the Field

This section describes the process to ready the ground equipment for interaction with the central recording system (deployment).

NOTE

Do not deploy (tip to power on) the WRUs until they are at the actual location where they will be placed.

To deploy the WRU:

1 Prerequisites:

- The WRU is assembled with battery, geophone, and antenna
- Optional: The anchor plate is attached to the WRU

NOTE

When using a WRU as a Repeater, the deployment instructions are the same, except a geophone is not required. Repeaters are added to the line segment in the Spread Manager. See the RT System 2 Operator Guide for more information.

If a geophone is not connected, you can skip the geophone test. See "D. LED Indicators" on page 163 for more information on skipping the test and the relevant LED status indicators.

2 Pick up the WRU and point the geophone connector end towards the ground as shown in the following figure. After a few seconds, all of the LEDs illuminate:

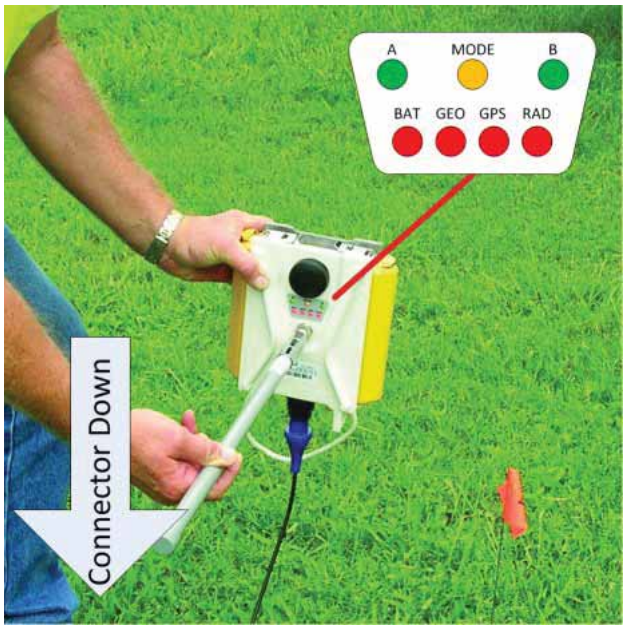


Figure 2–10 Power on the Unit

3 Place the unit flat on the ground as shown in the following figure:

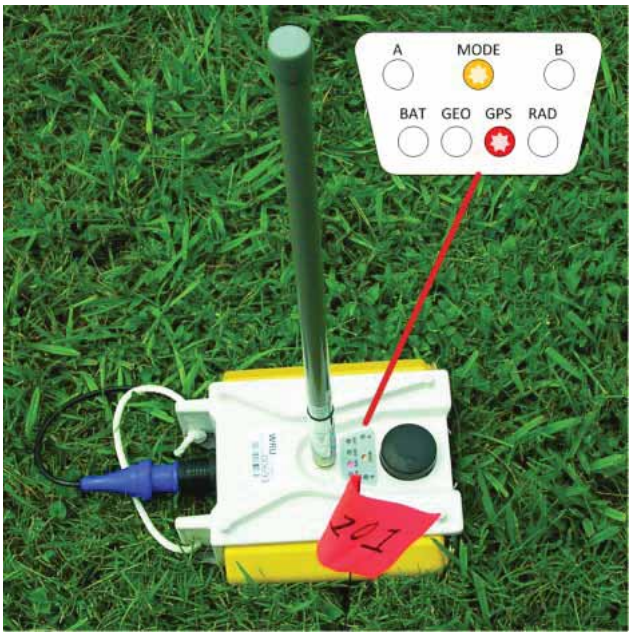


Figure 2–11 Place the Unit

4 The unit first turns on its GPS and acquires a new position. Then it will begin a series of internal and external tests. The LEDs on the top of the unit indicate the current test and whether the unit passes or fails each test.

NOTE

The WRU will attempt to get a 3-meter GPS lock for up to 15 minutes. During this time, the GPS LED flashes. The WRU will not form until the GPS lock is achieved. If the GPS lock cannot be achieved, form by serial number.

5 Press or stomp the geophone into the ground. If you stomp the geophone while the geophone test is running, the test will fail and the WRU will not deploy.

Verify that the WRU does not show a GEO self-test failure (see the following figure) after placing the geophone. If the WRU does show a self-test failure, pick up the WRU, point the geophone connector end towards the ground until all of the LEDs illuminate, and then place the unit flat on the ground to re-run the self-test.

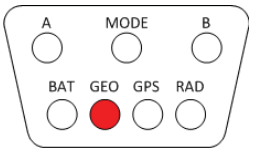


Figure 2–12 Geophone Self-Test Failure

NOTE

See *"D. LED Indicators" on page 163* for an explanation of the LED status and error conditions.

If a WRU self test fails, the WRU will continue to the next test.

Skip a self-test by tipping the WRU geophone down and then returning it to the upright position (flat on the ground).

6 Optional: If the WRU has an anchor plate attached, attach the WRU and anchor plate to the ground with three large nails or stakes; two at the geophone end and one at the end opposite of the geophone.

2.4.4 Placing the LIU in the Field

The LIU is part of the backhaul configuration. See *"3. Backhaul" on page 26* for more information.

2.5 WRU Anchor Plate

This WRU Anchor Plate (10-0028) is designed to reduce downtime due to tipped units and to reduce losing units as a result of theft. The shape maintains the WRU stacking ability while providing three solid anchor points. Constructed of light-weight and durable thermoplastic polyurethane, it attaches to the bottom of the WRU with minimal effort while maintaining the integrity of the WRU seal.

The anchor plate is compatible with the temperature range of the WRU which is -40°C to +75°C (-40°F to +167°F).

Figure 2–13 Attaching the Anchor Plate to the WRU

To use the anchor plate:

1 Attach the anchor plate to the WRU as shown in the following figures:

a Place the anchor plate on the geophone end of the WRU. The wide end of the anchor plate slides on to the to the geophone end of the WRU.

Figure 2–14 Anchor Plate and WRU Alignment

b Verify that the anchor plate is placed snugly against the WRU as shown in the following figure:

Figure 2–15 Anchor Plate at WRU Geophone End

c Hold the bracket at the edge of the WRU base as shown in the following figure:

Figure 2–16 Anchor Plate Bracket

d Secure the bracket to the anchor plate with two screws.

Figure 2–17 Anchor Bracket Screws

Figure 2–18 Anchor Plate Attached to WRU

2 Attach the WRU and anchor plate to the ground with three large nails or stakes; two at the geophone end and one at the end opposite of the geophone.

Figure 2–19 WRU Anchored with Anchor Plate

3

Backhaul

3.1 Overview

In network communications, the *backhaul* is the part of the network that contains the links and equipment between the core network and the sub networks. The following table defines concepts associated with backhaul communications:

Table 3–1 Backhaul Communication Concepts

Term	Definition	Reference
Point-to-Point	A method where each radio node in the network captures and disseminates its own data as well as serves as a relay for other radio nodes in the network sending data along a path, *hopping* from one node to the next. This is how the RT System 2 WRUs send information to the LIU and how LIUs communicate with each other in a point-to-point configuration. Also called Bucket Brigade or String-of-Pearls.	• *"Point-to-Point Single Backhaul Data Direction" on page 28* • *"Point-to-Point Dual Backhaul Data Direction" on page 29* • *"4. Point-to-Point Backhaul" on page 65*
Point-to-Multipoint	A method where each line station LIU communicates directly with the recorder LIU. The backhaul is composed of a number of line station mast/radio/LIUs pointing to a recording truck mast/radio/LIU. The following list describes the most common configurations: • **Point-to-Multipoint** – A single recording truck radio and multiple line station radios • **Point-to-Multipoint (redundant)** – A single active recording truck radio, a backup (redundant) recording truck radio, and multiple line station radios • **Point-to-Multipoint (custom)** – A combination of recording truck radios and line station radios Also called Star Configuration.	• *"Point-to-Multipoint Backhaul Data Direction" on page 30* • *"5. Point-to-Multipoint Backhaul" on page 98*

Table 3–1 Backhaul Communication Concepts

Term	Definition	Reference
Power over Ethernet (PoE)	A technology that passes electrical power along an Ethernet cable. PoE is used where DC power is not available and USB unsuitable. Power can be supplied at the end of a network span or somewhere in the middle. PoE *switches* supply power at the end of a span. The RT System 2 Line Interface Unit (LIU) acts as a switch with PoE. PoE *injectors* supply power somewhere between the PoE switch and the powered device. They inject power and do not affect the data. A discrete PoE injector is used when configuring the backhaul radios.	• *"Ubiquiti Rocket/Bullet Private Network Connection" on page 107* • *"Ubiquiti NanoStation Private Network Connection" on page 72*

In the RT System 2 system, the LIU communicates with the Central Software System (CSS) computer in the central recording truck along a backhaul on the 5.8 GHz Industrial, Scientific, and Medical (ISM) radio band. Some smaller systems may not require a backhaul.

The following figure illustrates the components and data flow for a four-line, single-backhaul, point-to-point line:

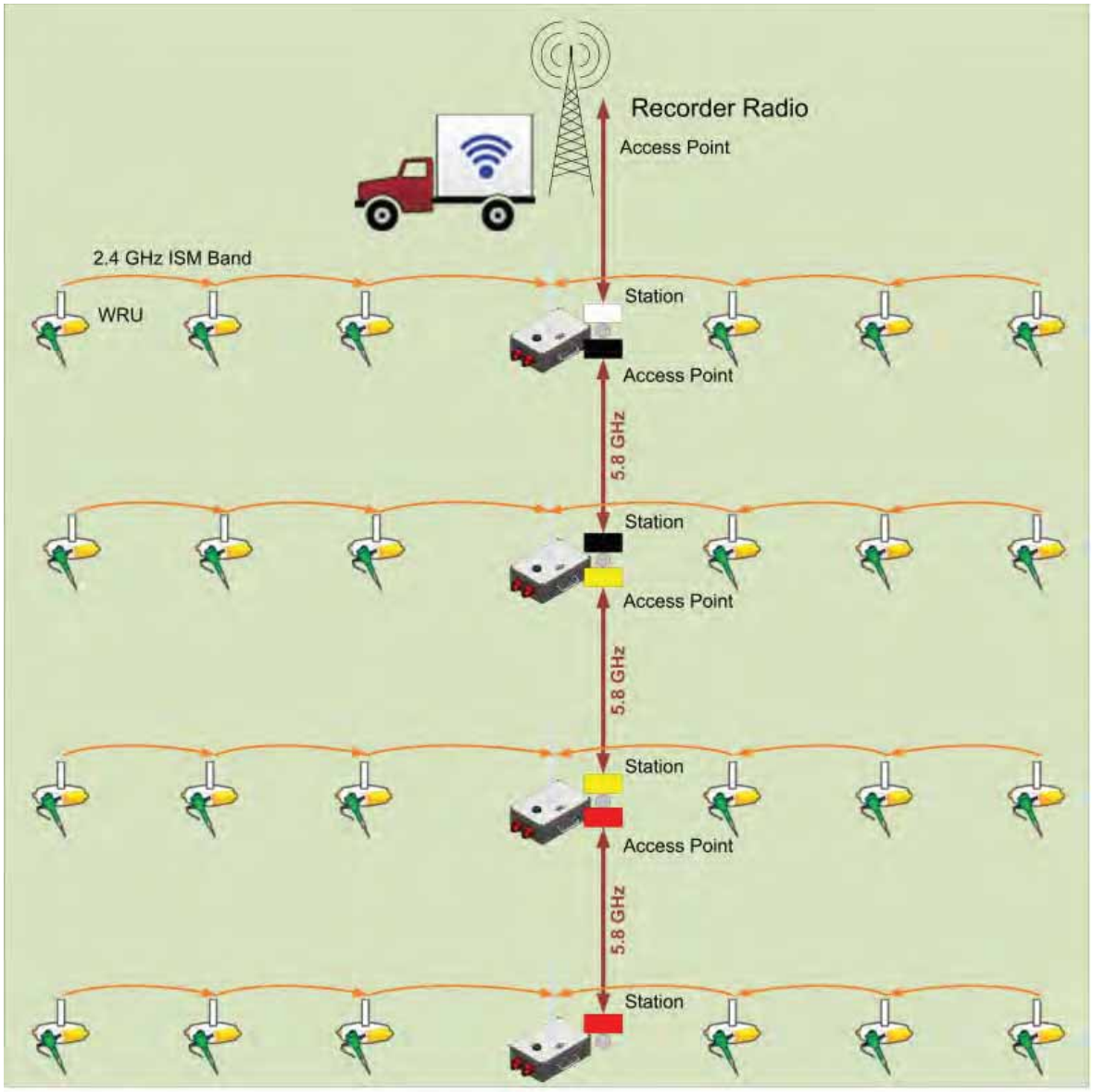


Figure 3–1 Point-to-Point Single Backhaul Data Direction

The following figure illustrates the components and data flow for a four-line, dual-backhaul, point-to-point line:

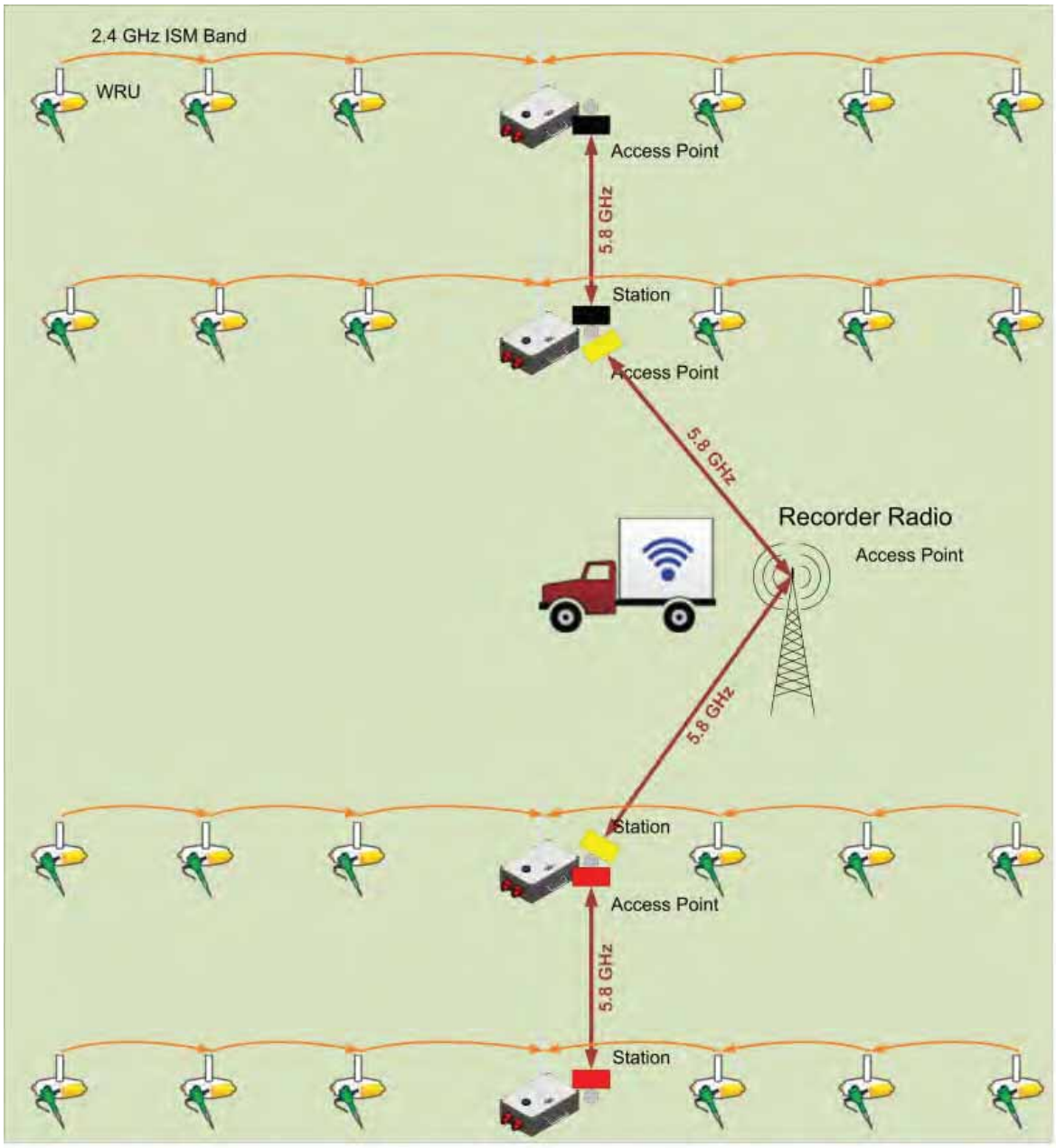


Figure 3–2 Point-to-Point Dual Backhaul Data Direction

The following figure illustrates the components and data flow for a point-to-multipoint, star configuration:

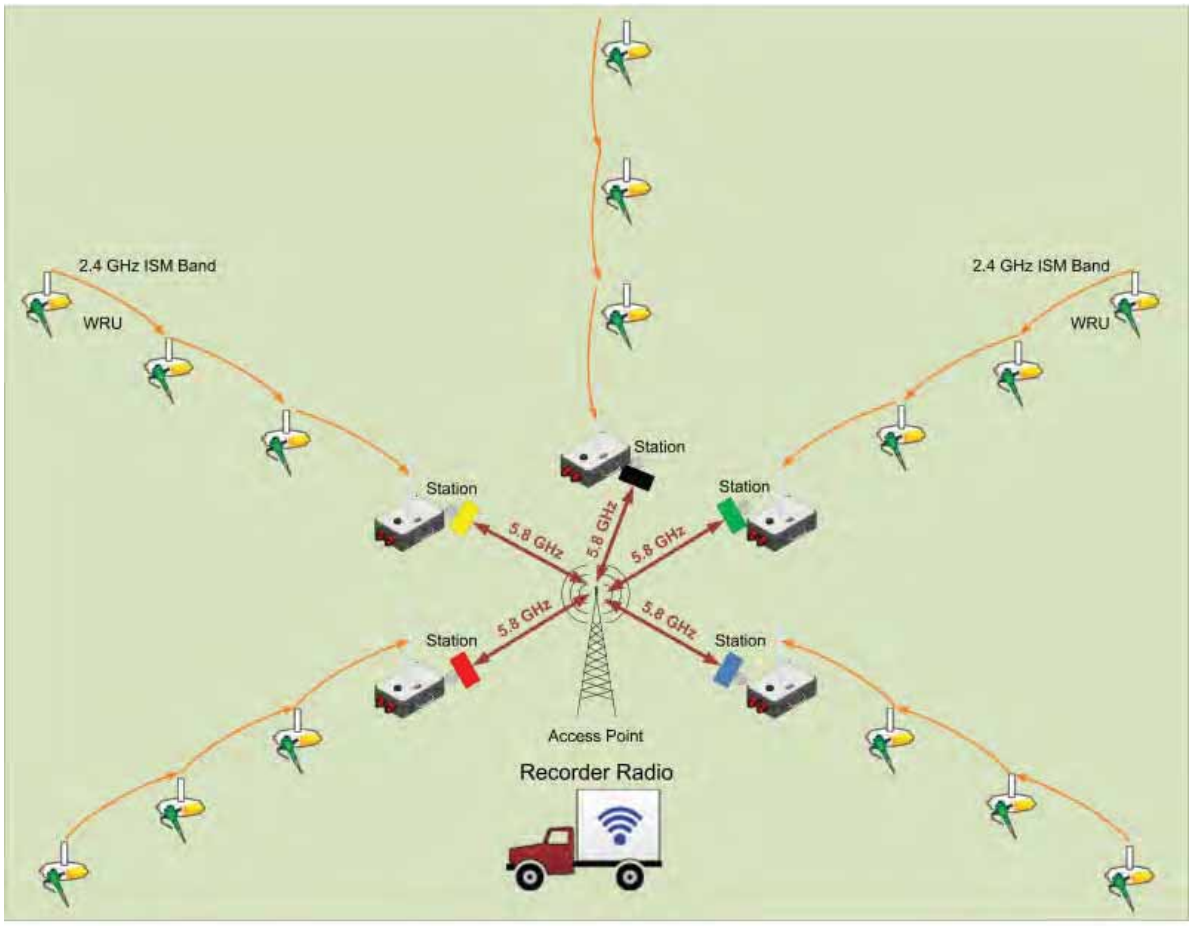


Figure 3–3 Point-to-Multipoint Backhaul Data Direction

3.2 Backhaul Components

The backhaul components are either *line station* (remote) backhaul components or *recorder* (central) backhaul components. Line station components are the components that are not physically located next to the recording truck. Recorder components are physically located at the recording truck.

The following tables and figures illustrate the backhaul components.

Table 3–2 Backhaul Components, LIU, Mast, and Fiber

#	EA	Item	Line	Recorder	Reference
L-1	1	LIU Kit (15-0041)	Y	Y	—
L-2	1	• LIU (10-0016)	Y	Y	*"LIU" on page 38*
L-3	1	• Cable, LIU to Battery, yellow (60-0034)	Y	Y	*"Cable Assemblies" on page 45*
L-4	—	• An antenna is required to communicate with the WRUs.	Y	Y	*"LIU and WRU Antennas" on page 39*
L-5	—	• A 12 V DC Battery is required, but not included.	Y	Y	*"LIU and WRU Antennas" on page 39*
M-1	1	Mast Kit (15-0046)	Y	Y	—
M-2	1	• Mast (15-0051)	Y	Y	*"Mast and Base" on page 49*
M-3	1	– 20 ft Telescoping Mast (70-0130)	Y	Y	—
M-4	1	– Mast Guy Ring (70-0133)	Y	Y	—
M-5	1	– Bracket, Omni Antenna (70-0136)	Y	Y	—
B-1	1	• Base (55-0050)	Y	Y	*"Mast and Base" on page 49*
B-2	2	– Knob, 10-32 x 1/2 inch Threaded Stud (70-0137)	Y	Y	—
BK-1	1	• Backpack Kit (15-0014)	Y	Y	*"Setting up the Backhaul" on page 50*
BK-2	1	– Backpack, Red/Grey (70-0059)	Y	Y	—
BK-3	4	– Antenna Mast Guy Line, 4 mm, 15.25 m, Orange (70-0057)	Y	Y	—
BK-4	4	– Tent Stake, Steel, 12 in (70-0061) (hard ground stakes)	Y	Y	—
BK-5	4	– Tent Stake, Plastic, 16 in, Orange (70-0060) (soft ground stakes)	Y	Y	—
BK-6	5	– Nail, 12 in (70-0062)	Y	Y	—
BK-7	4	– Guy Line Holder (70-0063)	Y	Y	—

Table 3–2 Backhaul Components, LIU, Mast, and Fiber (cont.)

#	EA	Item	Line	Recorder	Reference
BK-8	1	– Hammer, 2.5 lb (70-0064)	Y	Y	—
BK-9	1	– Pry Bar, 15 in (70-0065)	Y	Y	—
BK-10	2	– Flagging Roll, Orange (70-0066)	Y	Y	—
BK-11	1	– Compass Sighting (70-0067)	Y	Y	*“F. Using a Compass” on page 184*
BK-12	5	– Hose Clamp, 2 in (70-0142)	Y	Y	—
BK-13	2	– Hose Clamp, 0.5 in (70-0084)	Y	Y	—
BK-14	15 ft	– Wire, 18AWG Green (65-0077)	Y	Y	—
F-1	1	• Fiber Backhaul Kit, 250 m (15-0037) – OR – • Fiber Backhaul Kit, 500 m (15-0038)	Y	Y	—
F-2	1	– Media Converter (60-0017)	Y	Y	*“Cable Assemblies” on page 45*
F-3	1	– Cable, Backhaul Jumper (60-0033)	Y	Y	*“Cable Assemblies” on page 45*
F-4	1	– Cable, Fiber Optic, Armored, 250 m (60-0026) – OR – – Cable, Fiber Optic, Armored, 500 m (60-0023)	Y	Y	*“Cable Assemblies” on page 45*

Table 3–3 Backhaul Components, Radios

#	EA	Item	Line	Recorder	Reference
LB-1	1 1	Ubiquiti Bullet Radio Line Radio Kit (US) (15-0044) – OR – Line Radio Kit (Intl) (15-0053)	Y	—	—
LB-2	2	• 5 GHz Radio (US) (56-0019 US) – OR – • 5 GHz Radio (Intl) (56-0024)	Y	—	*“Bullet Line Station Radios” on page 157*
LB-3	1	• 5.8 GHz 6 dBi Omni Antenna (65-0179)	Y	—	*“Bullet Line Station Antenna” on page 149*

Table 3–3 Backhaul Components, Radios (cont.)

#	EA	Item	Line	Recorder	Reference
LB-4	1	• 5.8 GHz 19 dBi Panel Antenna, W Polarization (56-0020)	Y	—	*"Bullet Line Station Antenna" on page 149*
LB-5	1	• 5.8 GHz 19 dBi Panel Antenna, G Polarization (56-0021)	Y	—	*"Bullet Line Station Antenna" on page 149*
LB-6	1	• Bracket, Line Radio (55-0047)	Y	—	—
LB-7	2	• Cable, Armored Ethernet, 10 ft, White (60-0053)	Y	—	*"Cable Assemblies" on page 45*
LB-8	1	• Cable, Armored Ethernet, 15 ft, Green (60-0055)	Y	—	*"Cable Assemblies" on page 45*
LB-9	2	• Cable, Shielded Ethernet, 15 ft, Black (60-0054)	Y	—	*"Cable Assemblies" on page 45*
LB-10	1	• Carrying Case (70-0138)	Y	—	—
LB-11	1	• Hose Clamp, 4 in (70-0140)	Y	—	—
LB-12	1	• Hose Clamp, 2 in (70-0142)	Y	—	—
LB-13	1	• Nut Driver, 5/16 in (70-0147)	Y	—	—
LB-14	2	• Elbow connector (comes with 15-0044 and 15-0053)	Y	—	—
RR-1	1 – OR – 1	Ubiquiti Rocket Radio Recorder Radio Kit (US) (15-0045) – OR – Recorder Radio Kit (Intl) (15-0055)	—	Y	—
RR-2	1 – OR – 1	• Recorder Radio and Antenna (US) (15-0052) • Recorder Radio and Antenna (Intl) (15-0054)	—	Y	—
RR-3	1 – OR – 1	– 5 GHz Radio (US) (75-0031 US) – 5 GHz Radio (Intl) (75-0038)	—	Y	*"Rocket Recorder Radios" on page 159*
RR-4	1	– 5 GHz 13 dBI Dual Polarity Omni Antenna (65-0178)	—	Y	*"Rocket Recorder Antenna" on page 152*
RR-5	1	– Shield, Recorder Radio Omni (70-0129)	—	Y	*"Cable Assemblies" on page 45*
RR-6	1	– Bracket GPS Antenna Holder (70-0148)	—	Y	—
RR-7		– GPS Antenna (comes with 15-0045 and 15-0055)	—	Y	—

Table 3–3 Backhaul Components, Radios (cont.)

#	EA	Item	Line	Recorder	Reference
RR-8	1	– Cable, Shielded Ethernet, 3 ft, Black (65-0104)	—	Y	*"Cable Assemblies" on page 45*
—	1	– PoE Injector (75-0023)	—	—	• *"Ubiquiti Rocket/Bullet Private Network Connection" on page 107* • *"Ubiquiti NanoStation Private Network Connection" on page 72*
RR-9	1	• Surge Protector (75-0021)	—	Y	*"Surge Protector Box" on page 44*
RR-10	1	• Cable, Shielded Ethernet, 120 ft, Black (60-0038)	—	Y	*"Cable Assemblies" on page 45*
RR-11	60 ft	• Wire, 18AWG Green (65-0077)	—	Y	—
RR-12	1	• Case, Recorder Radio Kit (70-0139)	—	Y	—
RR-13	1	• Nut Driver, 5/16 in (70-0147)	—	Y	—
RN-1	2 2	Ubiquiti NanoStation Radio Kit • Recorder Radio Kit (US) (15-0068) – OR – • Recorder Radio Kit (Intl) (15-0067)	—	Y	—
RN-2	2	– 5 GHz Radio Assembly (US) (56-0035 US) – OR – – 5 GHz Radio Assembly (Intl) (56-0032)	—	Y	—
RN-3	2	– Cable, Shielded Ethernet, 120 ft, Black with Red shrink tube (60-0036)	—	Y	—
RN-4	3	– Strain Relief, Wedge Clamp .160/.330 DIA. (70-0171)	—	Y	—
RN-5	1	– Case, NanoStation Line Radio (70-0176)	—	Y	—
RN-6	1	– Nut driver, 7/16 in, Brown (70-0178)	—	Y	—
RN-7	1	– Wrench, Double Open-end, 7/16 in - 1/2 in (70-0179)	—	Y	—

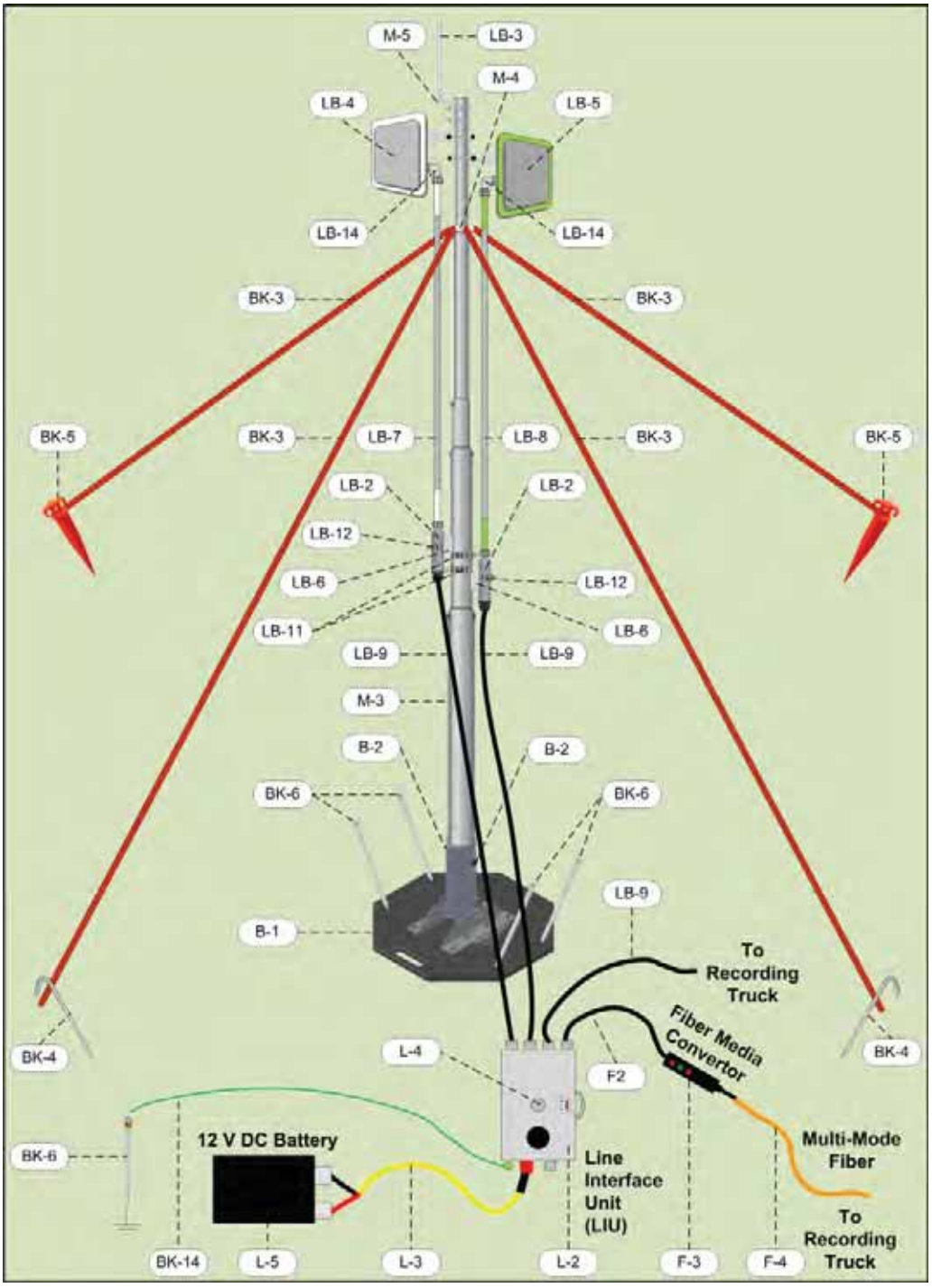


Figure 3–4 Line Station Backhaul Components

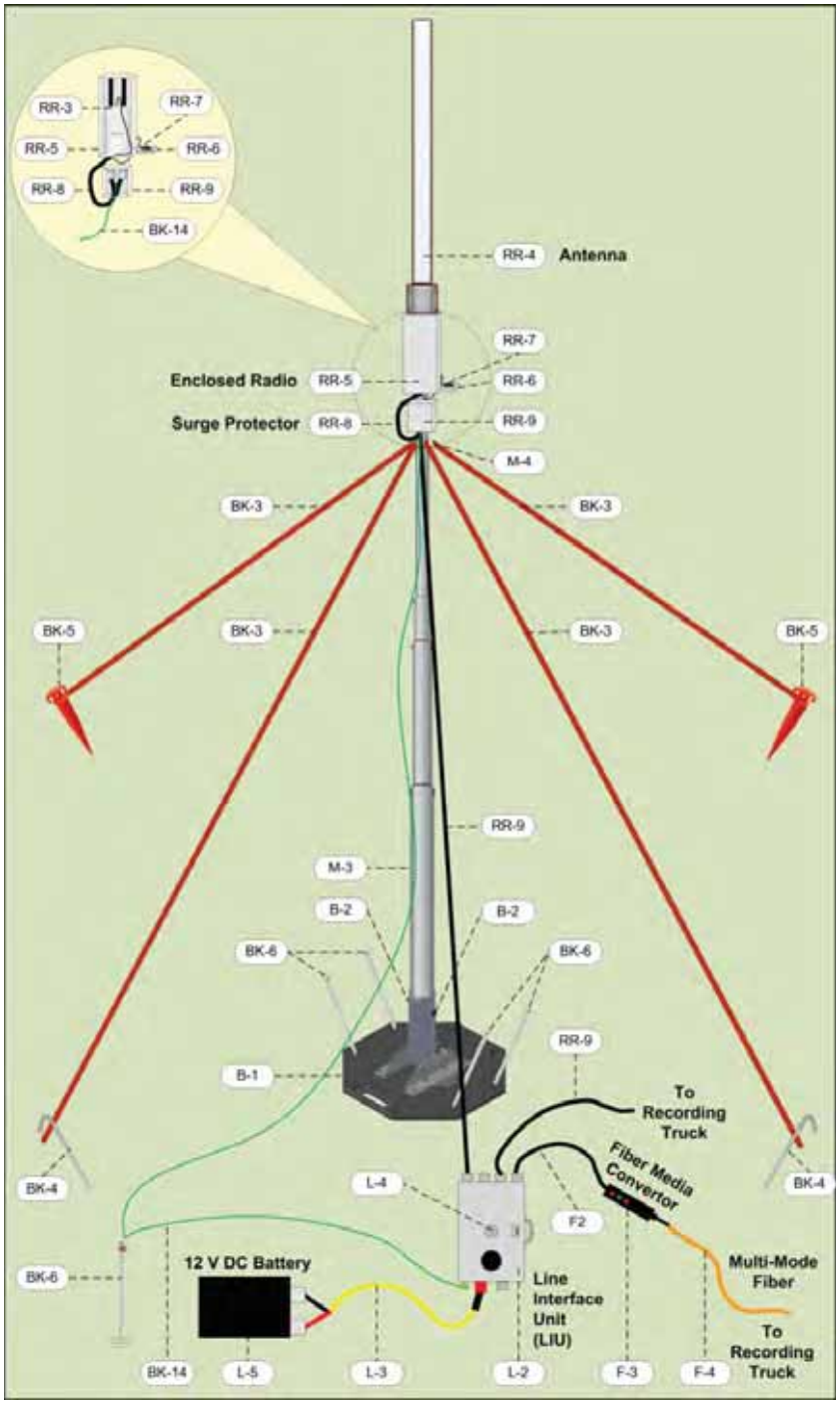


Figure 3–5 Recorder Backhaul Components

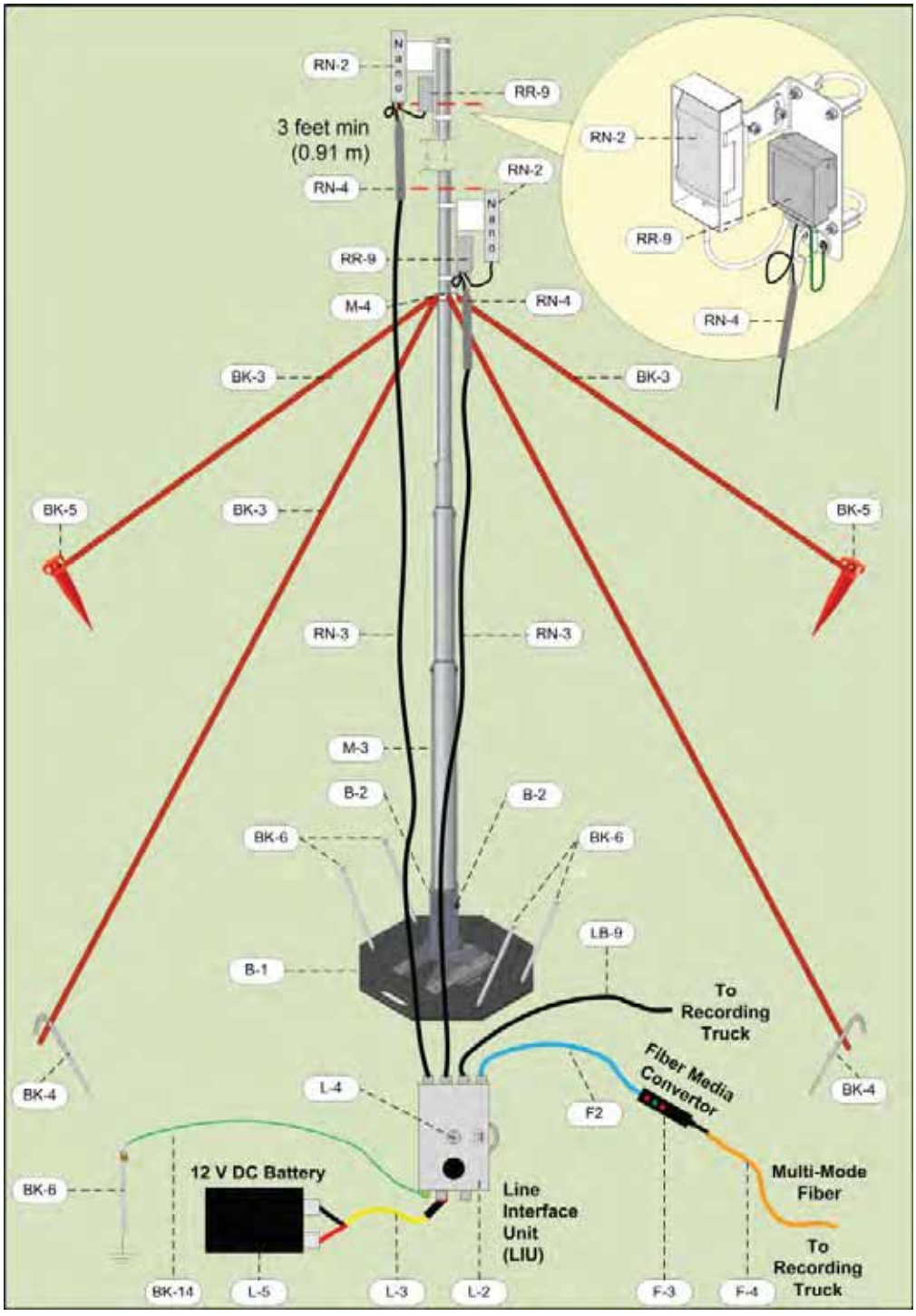


Figure 3–6 Recorder/Line NanoStation Backhaul Components

3.2.1 LIU

The data transmitted by the WRUs is collected by the Line Interface Unit (LIU). The LIU acts as the interface between the network of WRUs and the backhaul equipment. The LIU has an Ethernet port that can be connected directly to a computer, or more commonly, to an armored fiber optic cable or a backhaul radio. Backhaul radios operate in the 5.8 GHz band. A second array of WRUs can be deployed on the other side of the LIU, symmetrically or asymmetrically around the LIU. The LIU is shown in the following figure:

Figure 3–7 Line Interface Unit (LIU)

Before the Central Software System can communicate with the LIU, you must set up the backhaul.

NOTE

See "D. LED Indicators" on page 163 for an explanation of the LED status and error conditions.

3.2.2 LIU Battery

Power is supplied to the LIU components by way of a 12 V DC battery. The external battery is not supplied as part of the backhaul system.

TIP

The backhaul power requirements vary depending on the hardware in use and period of use. For example, you may be using one or two radios. Supply enough power to ensure there is enough power for the entire duration of the time you are using the backhaul.

See the *Troubleshooting Guide, Best Practices chapter, LIU Batteries section* for instructions on how to hot-swap the LIU battery.

3.2.3 LIU and WRU Antennas

The following table lists the supported antennas for the LIUs and the WRUs (all models). The remote and central backhauls use the same antennas:

Table 3–4 Antenna Specifications, WRU/LIU

Model	Frequency (MHz)	Maximum Gain	Vertical Beam Width	Weight	Dimension (Length x Diameter)
WSI 65-0204/65-0264 (antenna-standard)	2400	5.5 dBi (50 ohm)	25°	0.4 lbs 0.2 kg	32 x 0.6 in 810.5 x 15 mm
WSI 65-0091 (extender-standard)	2400	0 dBi	N/A	0.6 lbs 0.3 kg	30 x 0.7 in 762 x 18.5 mm

There is an *auto-power-leveling* feature built into the firmware. It works in conjunction with the RSSI parameters to keep the power at a defined level. If the **Unit Thresholds** → **Command** (or **Data**) **RSSI** parameter is set to any number greater than zero, power-leveling is enabled.

3.2.4 Line Radios

There are two line radio options provided as follows:

- **Ubiquiti Bullet** – Currently supported for point-to-point (string-of-pearls) backhauls:
  - 5 GHz Radio (US) (56-0019 US)
  - 5 GHz Radio (Intl) (56-0024)
- **Ubiquiti NanoStation M5** – Currently supported for point-to-multi-point (star) backhauls:
  - 5 GHz Radio Assembly (US) (56-0035 US)
  - 5 GHz Radio Assembly (Intl) (56-0032)

The Ubiquiti Bullet line radio is normally used with a directional antenna; however an omnidirectional antenna is also included. The antennas are attached at the top of the mast and the radio is attached to the mast at eye level as shown in the following figure.

Figure 3–8 Line Radio and Antennas, Bullet

The Ubiquiti NanoStation M5 radio has an integrated (internal) antenna. The radio is attached at the top of the mast with a surge protector as shown in the following figure:

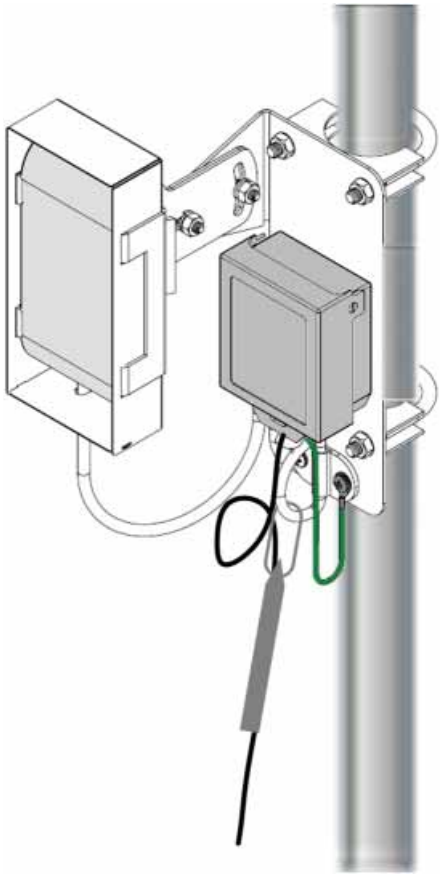


Figure 3–9 Line Radio, NanoStation

The line radios and antennas can be stored in their protective case when not in use:

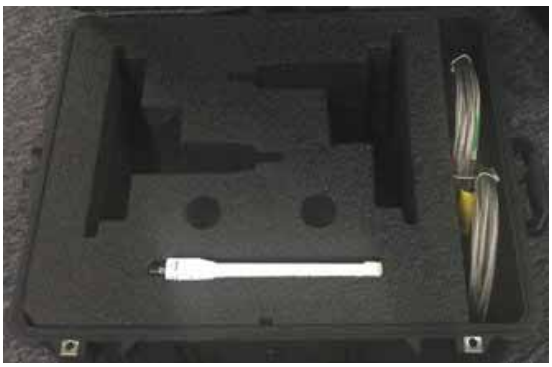


Figure 3–10 Bullet Radio Case (70-0138)

Figure 3–11 NanoStation Radio Case (70-0176)

See *"C. Radio Specifications" on page 149* for FCC information and other technical specifications.

3.2.5 Recorder Radio

There are two recorder radio options provided as follows:

- **Ubiquiti Rocket** – Currently supported for point-to-point (string-of-pearls) backhauls:
  - Recorder Radio and Antenna (US) (15-0052)
  - Recorder Radio and Antenna (Intl) (15-0054)
- **Ubiquiti NanoStation M5** – Currently supported for point-to-multi-point (star) backhauls
  - 5 GHz Radio Assembly (US) (56-0035 US)
  - 5 GHz Radio Assembly (Intl) (56-0032)

The Ubiquiti Rocket recorder radio is used with an omnidirectional antenna. It is attached to the top of the mast and is shown in the following figure. The Rocket radio is completely enclosed in a protective metal case when installed.

Figure 3–12 Recorder Radio

The Ubiquiti NanoStation M5 radio has an integrated (internal) antenna. The radio is attached at the top of the mast with a surge protector as shown in *"Line Radio, NanoStation" on page 41*.

See *"C. Radio Specifications" on page 149* for FCC information and other technical specifications.

3.2.6 Radio Antennas

The following table lists the supported antennas for the radios:

Table 3–5 Antenna Specifications, Radios

Model	Frequency (MHz)	Gain	Dimension (Length x Diameter)	See
WSI 65-0178 2x2 Dual Polarity MIMO Omni	5450 - 5850	13 dBi	6.2x3.8x32.8 in 158x98x834 mm	*"Rocket Recorder Antenna" on page 152*
WSI 65-0179 Omni	5275 - 5850	6 dBi	10.6 in 269 mm	*"Bullet Line Station Antenna" on page 149*
WSI 65-0177 Antenna Panel	5150 - 5825	19 dBi	7.5 x 7.5 x 0.8 in 190 x 190 x 20 mm	*"Bullet Line Station Antenna" on page 149*

3.2.7 Surge Protector Box

The following figure illustrates the inside of the Surge Protector Use a surge protector on each mast between the Rocket radio or the NanoStation radio and the LIU.

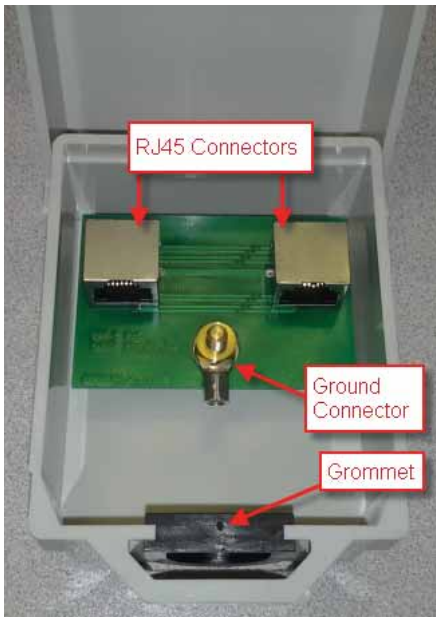


Figure 3–13 Surge Protector Connections

3.2.8 Cable Assemblies

The following cables are used in the backhaul:

- Cable, LIU to Battery (60-0034)
- Cable, LIU to NanoStation Radio (60-0036)
- Cable, Ethernet, 120 ft Shielded, Black with Red shrink tube (60-0036)
- Cable, LIU-to-PC (60-0039)
- Cable, Ethernet, 3 ft Shielded (65-0104)
- Cable, Armored Ethernet, 10 ft (60-0053)
- Cable, Shielded Ethernet, 15 ft (60-0054)
- Cable, Armored Ethernet, 15 ft (60-0055)
- Cable, Shielded Ethernet, 120 ft (60-0038)
- Cable, RF Extender, 10 ft (65-0103)
- Cable, RF Extender, 25 ft (65-0110)
- Fiber Backhaul Kit, 250 m (15-0037)
  - Media Converter (60-0017)
  - Cable, Backhaul Jumper (60-0033)
  - Cable, Fiber Optic, Armored, 250 m (60-0026)
- Fiber Backhaul Kit, 500 m (15-0038)
  - Media Converter (60-0017)
  - Cable, Backhaul Jumper (60-0033)
  - Cable, Fiber Optic, Armored, 500 m (60-0023)

Figure 3–14 Cable, LIU to Battery (60-0034)

Table 3–6 Cable Pinout, LIU to Battery (60-0034)

5-Pin Connector	2-Terminal End	Signal Name
A	NC	—
B	WHT	+V
C	BLK5	-V
D	NC	—
E	NC	—

Figure 3–15 Cable, LIU to NanoStation Radio (60-0036)

CAUTION

The LIU to Radio cable is a powered Ethernet Cable. Do not plug it into the Ethernet port on a Laptop computer when troubleshooting the radios. Use a non-powered Ethernet cable to avoid damaging the computer.

PRUDENCE

Le câble interface de ligne (LIU) à radio est un câble Ethernet alimenté. Ne le branchez pas au port Ethernet d'un ordinateur portable lors du dépannage des radios. Afin de ne pas endommager l'ordinateur, utilisez un câble Ethernet non alimenté.

VORSICHT

Das LIU-Radiokabel ist ein mit Strom versorgtes Ethernetkabel. Stecken Sie es nicht in den Ethernetanschluss in Ihrem Laptop, wenn Sie Störungen Ihrer Radiosender beseitigen. Benutzen Sie ein nicht mit Strom versorgtes Ethernetkabel, um eine Beschädigung Ihres Computers zu vermeiden.

PRZESTROGA

Kabel LIU-radio to zasilany kabel Ethernet. Podczas rozwiązywania problemów z działaniem urządzeń radiowych nie należy podłączać go do portu Ethernet w laptopie. Aby uniknąć uszkodzenia komputera, należy użyć niezasilanego kabla Ethernet.

Table 3–7 Cable Pinout, to NanoStation Radio(60-0036)

14-Pin Connector	RJ-45 Connector	Signal Name
B	1	TX+
A	2	TX-
C	3	RX+
H	4	POSITIVE
F	5	POSITIVE
D	6	RX-
E	7	RETURN
L	8	RETURN
P	—	SHIELD DRAIN
R*	NC	—
M*	NC	—
* Jumper R and M together.		

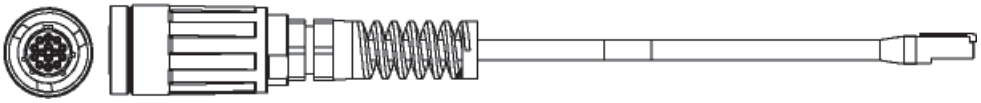


Figure 3–16 Cable, LIU-to-PC (60-0039)

Table 3–8 Cable Pinout, LIU-to-PC (60-0039)

14-Pin Connector	RJ-45 Connector	Signal Name
B	1	TX +
A	2	TX -
C	3	RX +
NC	4	POSITIVE
NC	5	POSITIVE
D	6	RX -
NC	7	RETURN
NC	8	RETURN
P	—	SHIELD DRAIN

Figure 3–17 Cable, Ethernet, 3 ft Shielded (65-0104)

Figure 3–18 Cable, Armored Ethernet, 10 ft (60-0053)

Figure 3–19 Cable, RF Extender, 10 ft (65-0103)

Figure 3–20 Media Converter (60-0017)

Figure 3–21 Cable, Backhaul Jumper (60-0033)

Table 3–9 Cable Pinout, Backhaul Jumper (60-0033)

14-Pin Connector	Wire Color	8-Pin Connector	Signal Name
B	WHT/ORG	A	TX +
A	ORG	B	TX -
C	WHT/GRN	C	RX +
H	BLU	D	PWR +
F	WHT/BLU	E	PWR +
D	GRN	F	RX -
E	WHT/BRN	G	GND
L	BRN	H	GND

Table 3–9 Cable Pinout, Backhaul Jumper (60-0033)

14-Pin Connector	Wire Color	8-Pin Connector	Signal Name
R*	RED	NC	—
M*		NC	—
* Install a 1.5 inch long jumper wire between pins R and M WHT = White, ORG = Orange, GRN = Green, BLU = Blue, BRN = Brown, BLK= Black, YEL = Yellow			

Figure 3–22 Cable, Fiber Optic, Armored, 250 m (60-0026)

3.2.9 Mast and Base

The line and recorder backhauls use the same mast kit components.

3.2.9.1 Telescoping Mast

Telescoping backhaul masts are used to elevate the backhaul components above obstructions and to enable radio communications to accommodate typical cross-line distances. The mast is stabilized with guy ropes. The following figure shows the mast:

Figure 3–23 Mast (55-0050)

3.2.9.2 Base

The base (shown in the following figure) stabilizes the mast that is attached to the hinged mast sleeve. The base is staked into the ground for added stability.

Figure 3–24 Base (55-0050)

The Weighted Base (70-0070) is another option for use when staking is impractical (see *"E. Weighted Base" on page 182*).

3.3 Setting up the Backhaul

This section provides instructions on how to assemble the backhaul components.

Table 3–10 How to Set Up the Backhaul

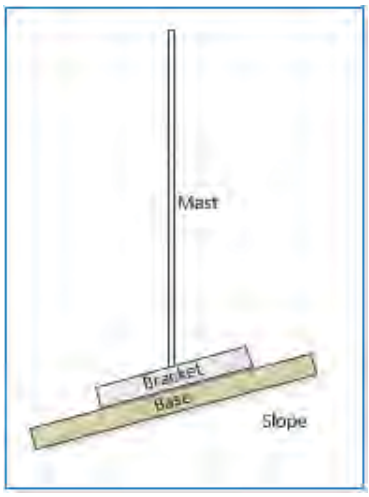
Step	Image
1 Gather all of the backhaul components. **2** Refer to the deployment instructions to determine the location and compass heading to the next back haul site closer to central. **3** Use the compass to determine and mark that direction. **4** Use the following considerations while positioning the base: • Locate the base such that the guy lines and the mast clear obstructions during erection and while in operation. • If the ground is sloped, position the base such that when the base is flush to the ground, the bracket orientation allows the mast to remain perpendicular to the ground.	

Table 3–10 How to Set Up the Backhaul

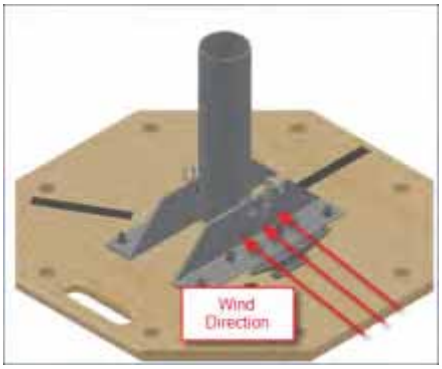
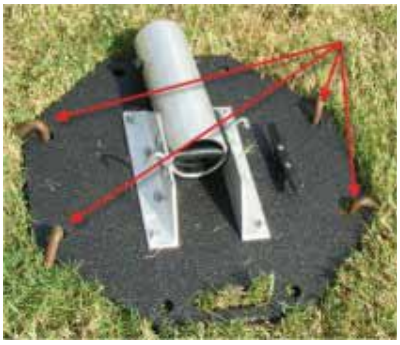
Step	Image
• If the wind is blowing, the mast is more stable when the brackets are perpendicular to the wind.	
5 Secure the base [B-1] to the ground with stakes [BK-4] or nails [BK-6].	
6 Attach the mast [M-3] to the base [B-1]. Tighten both knobs [B-2].	

Table 3–10 How to Set Up the Backhaul

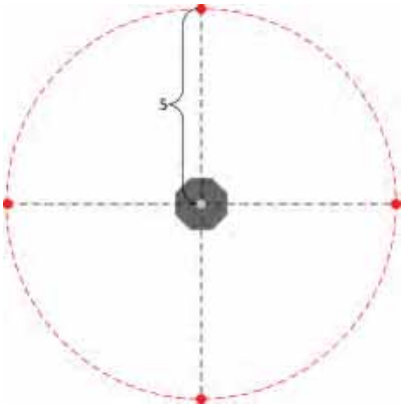
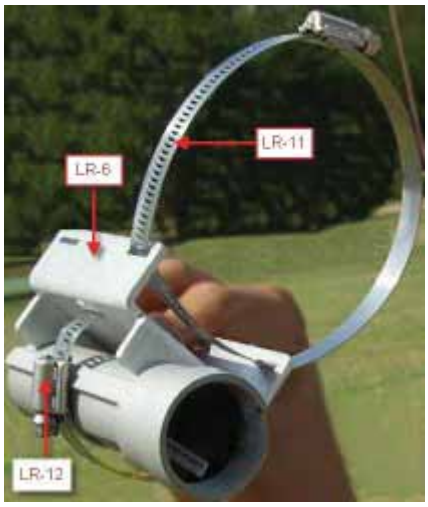
Step	Image
7 Position four stakes equal distances apart at approximately 20 ft (6 m) from the base. Pound them into the ground.	 
8 Assemble the radios and brackets: • Bullet line radio installation – Assemble the Bullet radios and brackets. ► Insert the 4 in hose clamp [LR-11] in the side slots of the bracket [LR-6]. ► Insert the 2 in hose clamp [LR-12] in the center slots of the bracket [LR-6]. ► Insert the line radio between the bracket [LR-6] and the 2 in hose clamp [LR-12]. ► Tighten the 2 in hose clamp [LR-12]around the radio.	Line radio in bracket: 

Table 3–10 How to Set Up the Backhaul

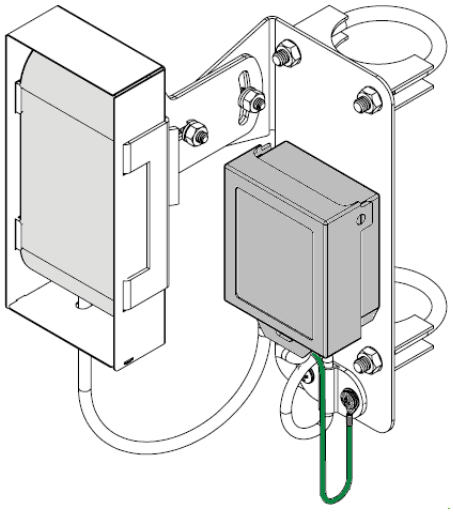
Step	Image
• Rocket radio installation – The Rocket radio, antennas, and bracket are already assembled.	Recorder radio in bracket: 
• NanoStation radio installation – The NanoStation radio, surge protector, and bracket are already assembled.	

Table 3–10 How to Set Up the Backhaul

Step	Image
9 Assemble the mast: • Bullet radio installation – While the mast is resting on the ground, slide the following on the mast: ► Bullet radios and clamps (*do not tighten*) ► Mast guy ring [M-4]	

Table 3–10 How to Set Up the Backhaul

Step	Image
• Rocket radio installation – While the mast is resting on the ground, slide the following on the mast: ► Mast guy ring [M-4] ► Surge Protector cable clamp (*do not tighten*)	

Table 3–10 How to Set Up the Backhaul

Step	Image
• NanoStation radio installation – While the mast is resting on the ground, slide the following on the mast: ► Mast guy ring [M-4]	
10 Attach and tighten the following: • Bullet radio installation: ► Bullet radio antenna brackets and antennas [LR-4, LR-5] ► Omni antenna bracket [M-5] and antenna [LR-3]	

Table 3–10 How to Set Up the Backhaul

Step	Image
• Rocket radio installation – Attach the Rocket radio antenna and bracket [R-2] to the mast.	

Table 3–10 How to Set Up the Backhaul

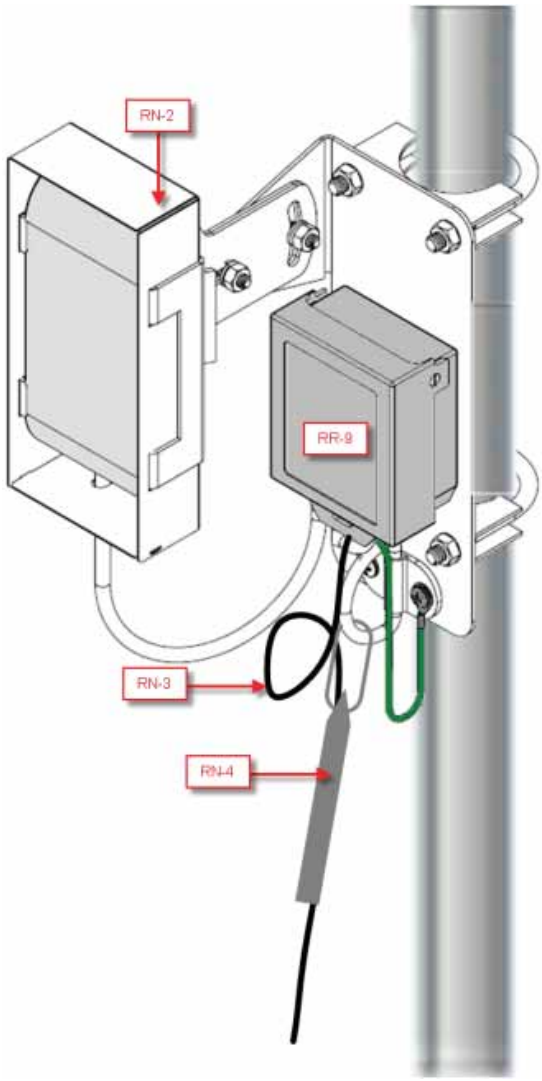
Step	Image
• NanoStation radio installation – Attach the NanoStation radio bracket assembly [RN-2] to the mast.	

Table 3–10 How to Set Up the Backhaul

Step	Image
11 Attach the cables: • Bullet radio installation – Attach an elbow connector [LR-14] to the antenna and then an armored cable [LR-7, LR-8] to the elbow connector. Match white-to-white and green-to-green if your panels are color-coded.	
• Rocket radio installation: ► Open the protective metal case if the Ethernet cable is not already attached. ► Connect the GPS antenna if it is not already connected. ► Connect a short Ethernet cable [R-8] to the radio [R-3]. ► Close the protective metal case. ► Open the surge protector case [R-9]. ► Remove the rubber grommet from the surge protector case and cut some slots in it. ► Thread two Ethernet cables [R-8, R-10] and a ground wire [BK-14] through the grommet and place the grommet back in the case. ► Plug the Ethernet cables into the shielded RJ45 jacks. It does not matter which cable goes to which jack; the unit provides bidirectional protection. ► Attach the ground wire to the ground lug. ► Close the surge protector case and secure it to the mast with the hose clamp.	

Table 3–10 How to Set Up the Backhaul

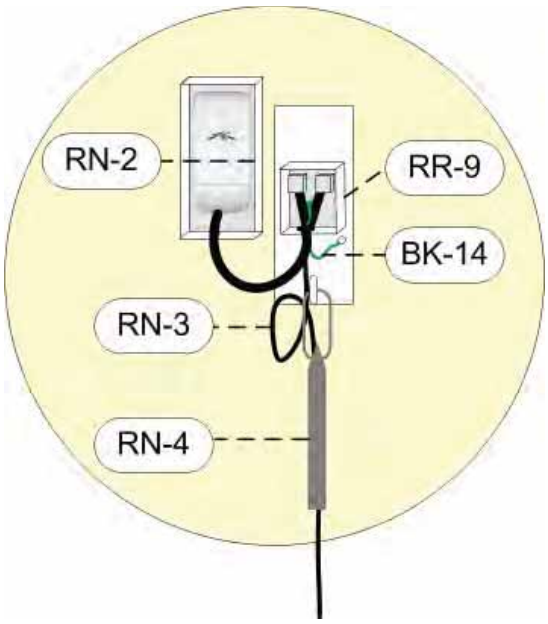
Step	Image
• NanoStation radio installation: ► Open the surge protector case [R-9]. ► Remove the grommet from the case. ► Thread the Ethernet cable [RN-3], through the grommet with the short Ethernet cable (that is attached to the redound the ground wire [BK-14]. Place the grommet back in the case. ► Plug the Ethernet cable into the shielded RJ45 jacks. It does not matter which cable goes to which jack; the unit provides bidirectional protection. ► Close the surge protector case. ► Attache the strain relief [RN-4] to the D-ring on the bracket. ► Loop the Ethernet Cable [RN-3] through the strain relief [RN-4].	
12 Attach the guy lines to the mast collar. **NOTE:** Use a taut-line-hitch knot for best results (see *"G. Rope Knot" on page 188*).	

Table 3–10 How to Set Up the Backhaul

Step	Image
13 Lay out the four guy lines close to the stakes.	
14 Extend the mast, clicking the segments into place.	
15 Attach the guy lines to the stakes. **NOTE:** Use a taut-line-hitch knot for best results (see *"G. Rope Knot" on page 188*).	

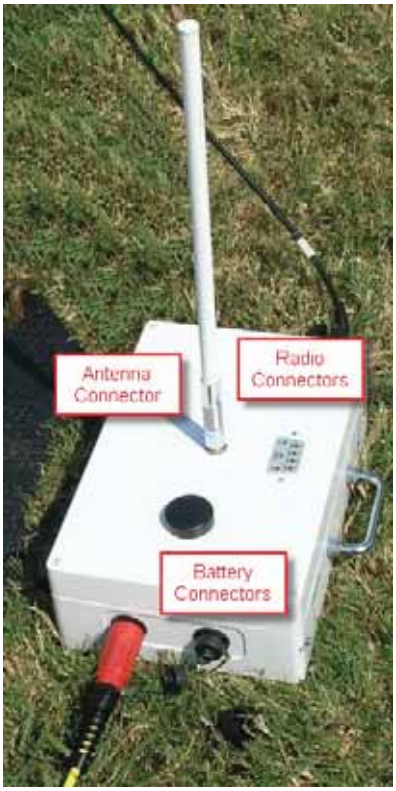
Table 3–10 How to Set Up the Backhaul

Step	Image
16 Walk the mast to an upright position.	
17 While one person holds the mast, a second person tightens the guy lines evenly. Keep the mast level/vertical (use the level included with the kit).	
18 If assembling the Bullet radio backhaul: **a** Attach the cables from the antennas to the top of the Bullet radios.	

Table 3–10 How to Set Up the Backhaul

Step	Image
b Attach the cables to the bottom end of the Bullet radios. ► Assemble the connector for the radio as shown in the image to the right: ► Plug the Ethernet connector into the radio. ► Screw the large coupler into the base of the radio. Hand-tighten only. ► Push the rubber grommet into the base of the large coupler. ► Screw the end cap on the large coupler. Hand-tighten only.	
c Tighten the clamps on the Bullet radios. ► Verify that the armored cables attached to the antennas are straight and not twisted. ► Position the line radio so the armored cable is not pulling on the antenna. ► Tighten the cable clamp.	
19 Set up the LIU: ● Ground the LIU – Verify that the LIU is grounded. Attach a ground wire to the case, and to a nail that is driven into the ground. Attach the LIU ground wire and the Surge Protector ground wire to the same nail.	

Table 3–10 How to Set Up the Backhaul

Step	Image
• Attach the radio cables to the LIU. • Attach the antenna to LIU. • Attach the battery to the LIU.	

4

Point-to-Point Backhaul

4.1 Overview

The backhaul is composed of a number of line station mast/radio/LIUs. The number of poles pole (masts/towers) in your point-to-point spread must be a multiple of the number of channels used.

A channel is an 80 MHz wide frequency band with 40 MHz on either side of the center frequency. For example, if the center frequency is 2.412 GHz, the frequency range for that channel is 2.372 to 2.452 GHz.

Figure 4–1 Channel – 80 MHz Wide Frequency Band

When using a system with six possible channels, the backhaul could have just 6 poles, or a multiple of 6 poles: 6, 12, 18, 24, and so on.

This section uses an example of six possible channels, and 18 line station mast/radio/LIUs. Each pole (mast/tower) has two radios and one LIU as shown in the following figure.

NOTE

If using the mast at the recording truck, connect the LIU with an Ethernet or Fiber cable to the recording truck. If the mast is not used at the recording truck, the connections shown in the figure to the recording truck are not used.

See "Connecting to the Recording Truck" on page 92 for a radio link (pendant) option).

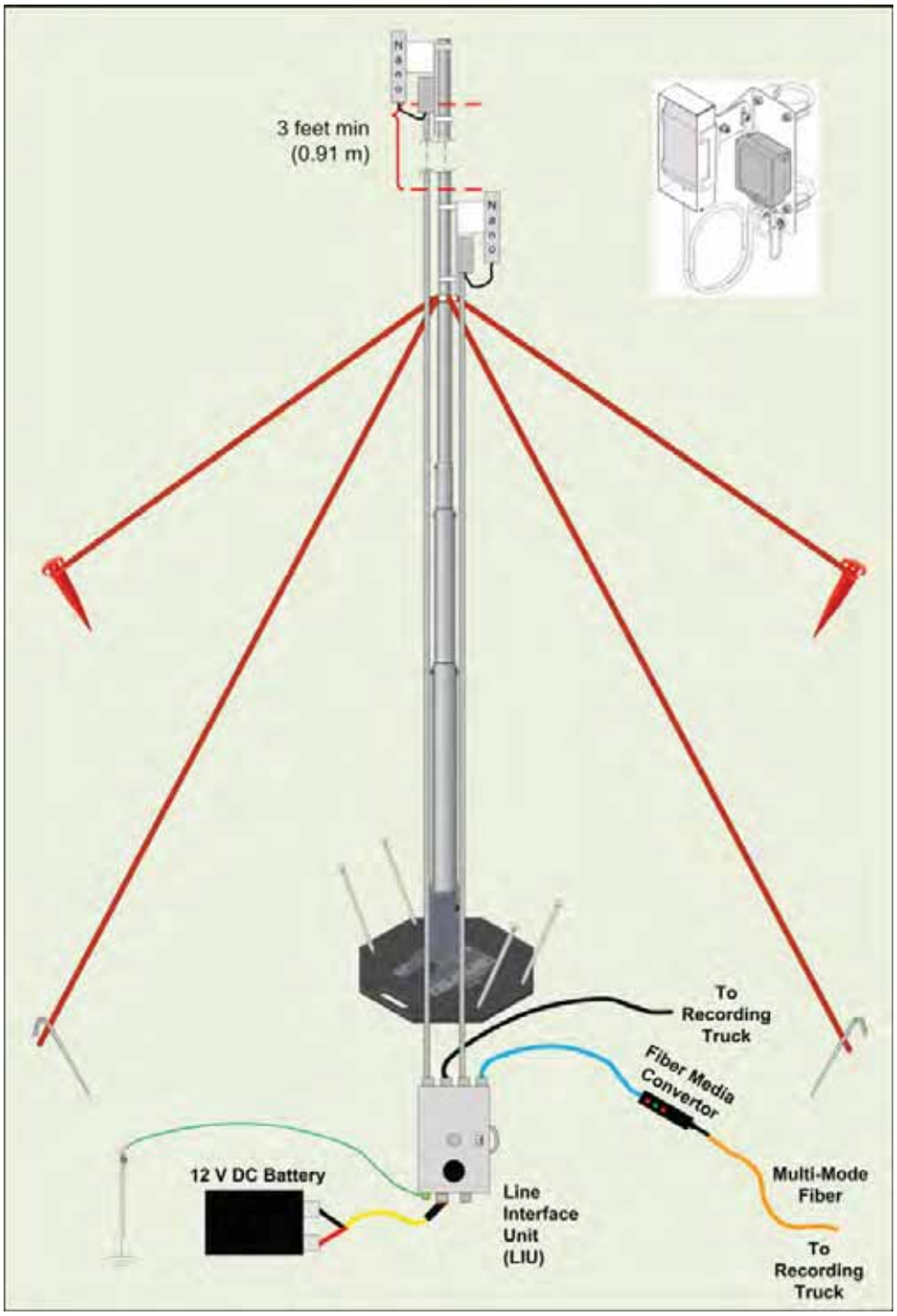


Figure 4–2 Line Station Backhaul

The radios are configured as pairs and are either an Access Point (A) or a Station (S).

An Access Point communicates only with a Station. An Access Point cannot communicate with an Access Point, and a Station cannot communicate with a Station.

The poles (masts) and radios for a six-channel system are labeled and color-coded as follows. The number of colors used should match the number of channels used.

Pole	Radio	Color
Pole 1	18:S-P1	White
	1:A-P1	Black
Pole 2	1:S-P2	Black
	2:A-P2	Yellow
Pole 3	2:S-P3	Yellow
	3:A-P3	Red
Pole 4	3:S-P4	Red
	4:A-P4	Green
Pole 5	4:S-P5	Green
	5:A-P5	Blue
Pole 6	5:S-P6	Blue
	6:A-P6	White
Pole 7	6:S-P7	White
	7:A-P7	Black
Pole 8	7:S-P8	Black
	8:A-P8	Yellow
Pole 9	8:S-P9	Yellow
	9:A-P9	Red

Pole	Radio	Color
Pole 10	9:S-P10	Red
	10:A-P10	Green
Pole 11	10:S-P11	Green
	11:A- P11	Blue
Pole 12	11:S-P12	Blue
	12:A-P12	White
Pole 13	12:S-P13	White
	13:A-P13	Black
Pole 14	13:S-P14	Black
	14:A-P14	Yellow
Pole 15	14:S-P15	Yellow
	15:A-P15	Red
Pole 16	15:S-P16	Red
	16:A-P16	Green
Pole 17	16:S-P17	Green
	17:A-P17	Blue
Pole 18	17:S-P18	Blue
	18:A-P18	White

Where:

- Label Nomenclature:

Table 4–1 Label Nomenclature

Pair #	:	A or S	-	Pole #
2	:	A	-	P2
2	:	S	-	P3

- S = Station
- A = Access Point
- The pole pairs must remain in sequential order:
  - Radio 1:A-P1 communicates only with Radio 1:S-P2
  - Radio 2:A-P2 communicates only with Radio 2:S-P3
  - And so on until pole 18, where Radio 18:A-P18 communicates only with Radio 18:S-P1

NOTE

The primary indicator for radio-to-radio communication is the alpha-numeric label. The colored label is provided as a visual indicator to ensure that the pole is pointed correctly to the next radio. For example, a yellow radio cannot communicate with all yellow radios.

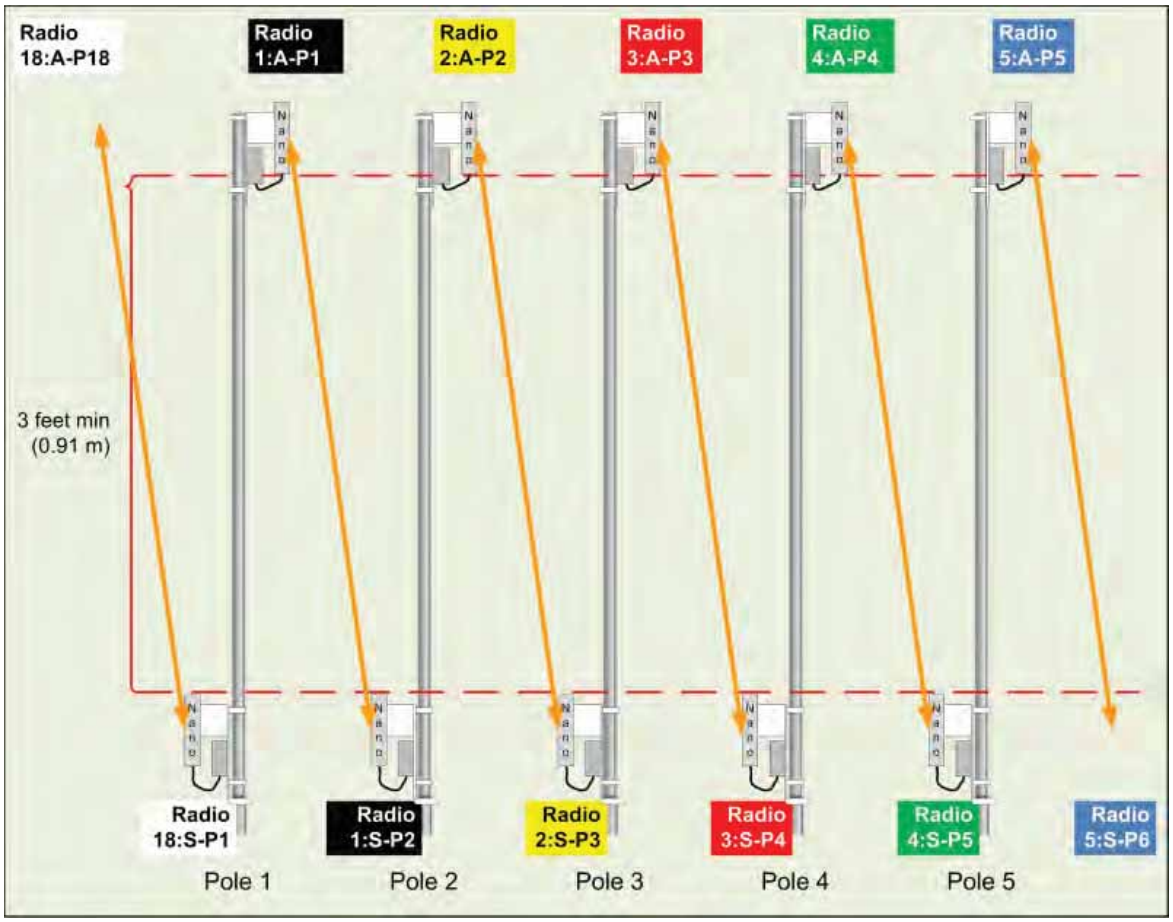


Figure 4–3 Radio-to-Radio Communication

In some cases—such as when line-of-sight cannot be established—using fiber cables can improve communication. Install the radios and poles using the same labels and positioning; however, only the odd *or* even pairings are used for radio communication. The other pairings are linked together with fiber cable as shown in the following figure.

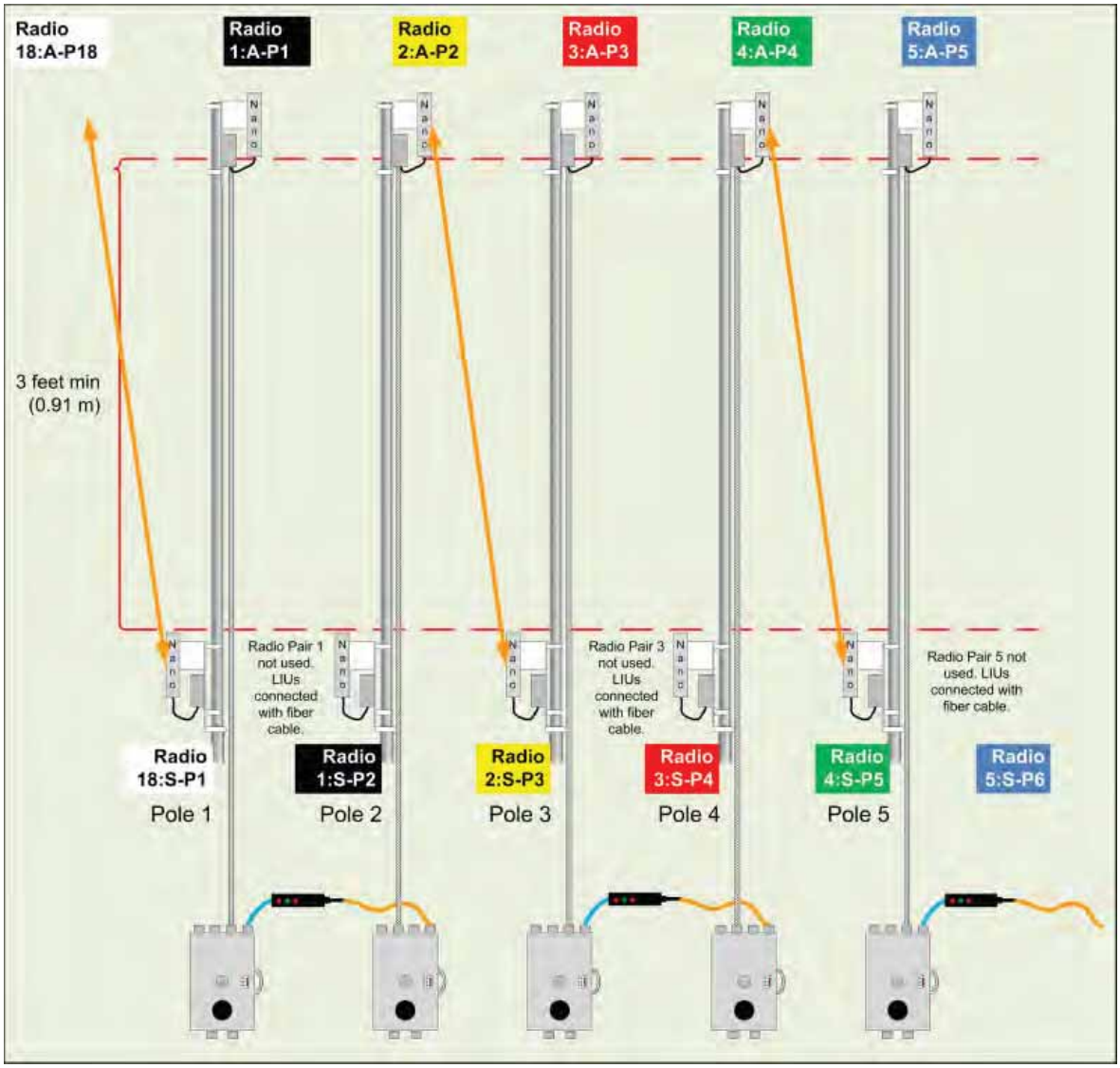


Figure 4–4 Radio-to-Fiber Communication

4.2 Preparation

This section provides the steps required to prepare the radios for placement in the field.

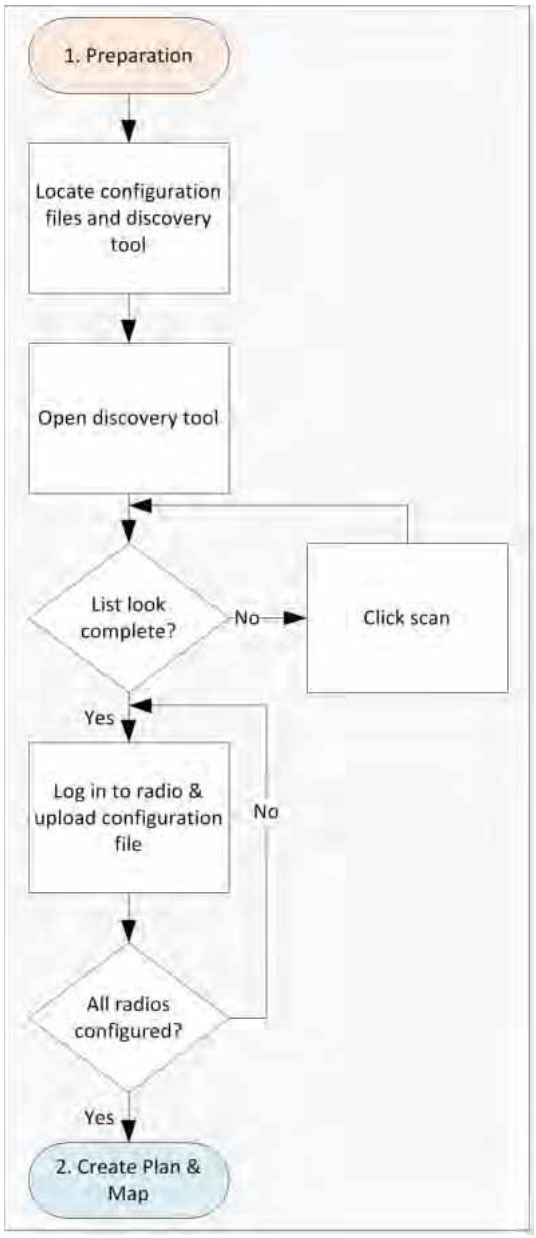


Figure 4–5 Preparation Troubleshooting Flow

There are two versions of the NanoStation M5 radio. Verify that you are using the correct radio and configuration files for your location. Wireless Seismic, Inc. recommends using only the following radios in a point-to-point network.

- **United States frequencies** (56-0035 US) – Operating frequency 5745 – 5825 MHz
- **International frequencies** (56-0032 INTL) – Operating frequency 5470 – 5825 MHz

NOTE

Operating outside of the allowed frequency range could result in sanctions by governmental regulatory agencies. Verify that all radios are correct for the market in which they will be used.

If you use an international configuration file with a United States radio, or a United States configuration file with an international radio, an error message is displayed:

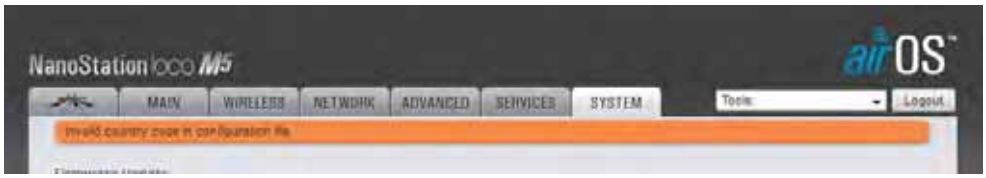


Figure 4–6 Invalid Country Code Error Message

The ability to modify the Country Code is disabled for radios that are configured for use in the United States and Canada.

TIP

Country codes are three-digit codes defined in ISO 3166-1. See the following for more information:

- *http://www.iso.org/iso/home/standards/country_codes.htm*
- *"H. Country Codes" on page 189*

To discover and configure the radios:

→ **RT System 2 Windows computer**

1 Verify that the configuration files for the radios and the discovery tool are on the RT System 2 Windows computer. The configuration files and the **Ubiquiti Discovery Tool** files are provided as a ZIP file. Extract the files if necessary.

The file names are as follows:

- ubnt-discovery-v2.3.bat
- ubnt-discovery-v2.3.jar

- 1-AP.cfg
- 1-S.cfg
- 2-AP.cfg
- 2-S.cfg
- 7-AP.cfg
- 7-S.cfg
- 8-AP.cfg
- 8-S.cfg
- 13-AP.cfg
- 13-S.cfg
- 14-AP.cfg
- 14-S.cfg

- 3-AP.cfg
- 3-S.cfg
- 4-AP.cfg
- 4-S.cfg
- 5-AP.cfg
- 5-S.cfg
- 6-AP.cfg
- 6-S.cfg
- 9-AP.cfg
- 9-S.cfg
- 10-AP.cfg
- 10-S.cfg
- 11-A P.cfg
- 11-S.cfg
- 12-AP.cfg
- 12-S.cfg
- 15-AP.cfg
- 15-S.cfg
- 16-AP.cfg
- 16-S.cfg
- 17-AP.cfg
- 17-S.cfg
- 18-AP.cfg
- 18-S.cfg

NOTE

When using a radio link (pendant) to the recording truck, the following configuration files are also required:

- *Recorder-AP.cfg*
- *Recorder-S.cfg*

See “Connecting to the Recording Truck” on page 92 for more information on using a pendant radio link.

2 Configure the computer to be a private network with a static IP address of 192.168.1.100. See the *Troubleshooting Guide, Additional Information chapter*, Setting a Static IP Address section if you need instructions on setting the IP address.

3 Connect a single radio to the computer.

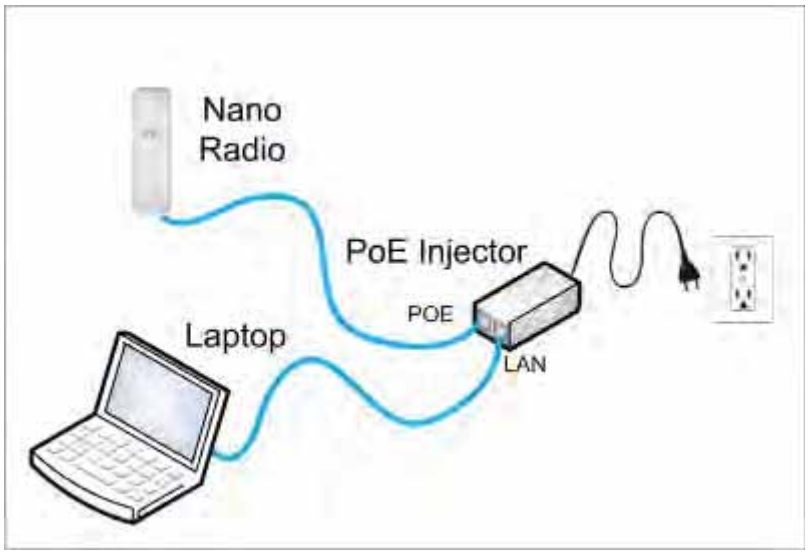


Figure 4–7 Ubiquiti NanoStation Private Network Connection

4 Open the **Ubiquiti Discovery Tool** by double-clicking the shortcut on the desktop.

Figure 4–8 Ubiquiti Discovery Tool Icon

NOTE

Ensure that the .bat file and the .jar file are in the same directory.

TIP

The discovery tool can also be downloaded from the following location:

http://www.ubnt.com/download#app

Extract the files from the downloaded ZIP file to the desktop.

5 The **Discovery** window opens and displays a list of all **Discovered Devices**:

NOTE

The factory default IP address for the radios is 192.168.1.20. Configure the radios one at a time.

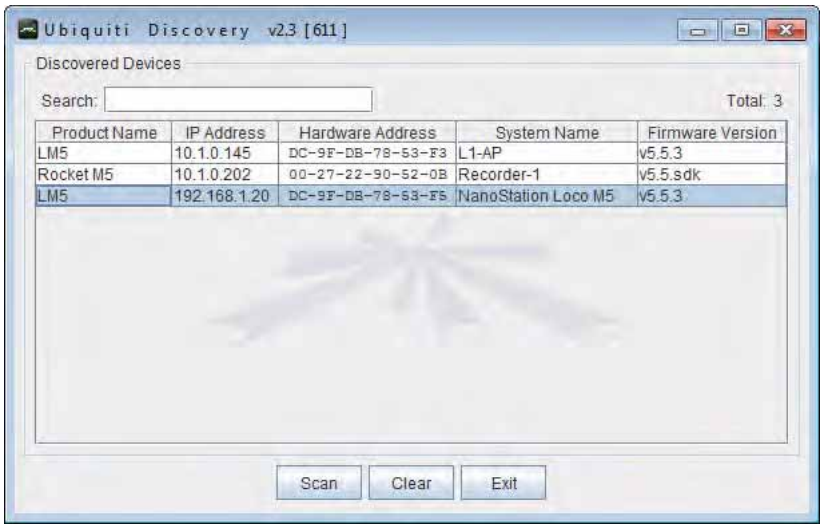


Figure 4–9 Ubiquiti Discovery Window

6 If the list does not look correct, click **Scan**.

7 Right-click one of the radios and then click **Web UI**. For example, right-click the following row:

`L M5 | 192.168.1.20 | DC-9F-DB-78-53-F3 | NanoStation Loco M5`

and then click **Web UI**. The **airOS** login window opens:

Figure 4–10 Ubiquiti airOS Login Window

8 Type the following credentials and click **Login**:

- Username: `ubnt`
- Password: `ubnt`

9 The radio configuration window opens. Click the **System** tab.

Figure 4–11 Ubiquiti airOS Window, System Tab

10 In the **Configuration Management** → **Upload Configuration** area, click **Browse**. Browse to the configuration file (for example `1-AP.cfg`), and then click **Upload**.

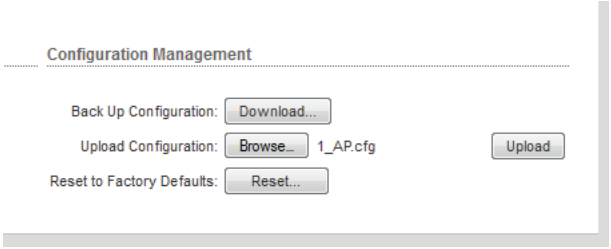


Figure 4–12 Ubiquiti, Upload Configuration File

11 Click **Apply**.

Figure 4–13 Ubiquiti, Apply Configuration Changes

12 The radio reboots and obtains a new IP address if a DHCP server is active. The current session of airOS is no longer valid since the IP address of the radio has changed.

13 Close the browser window.

14 Disconnect the radio. It is now ready for deployment.

15 Continue connecting radios and uploading configuration files until they are all configured.

NOTE

Radios were labeled prior to shipment and there should be a 1:1 correlation between radios and configuration files. Make sure the correct configuration file is loaded onto the corresponding radio.

4.3 Create Plan and Map

Using the documents provided for the job (survey, planned LIU locations, and so on), create a plan to plot radio locations and map the layout of AP and S radios.

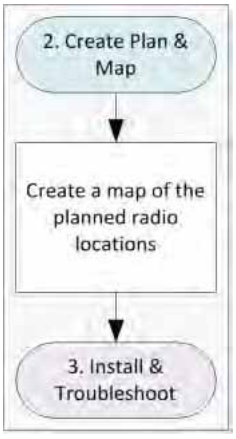


Figure 4–14 Create Plan and Map Troubleshooting Flow

Keep the following in mind as you create the layout plan:

- Point the radio pairs directly at each other whenever possible maintaining line-of-sight around obstructions (see *“Maintain Line-of-Sight” on page 77*).

- Use a tool such as Google Earth or Global Mapper to create an Elevation Profile to assist with determining the best locations for radio towers. See *"Creating a Google Earth Elevation Profile" on page 113* for an example.
- An Access Point communicates only with a Station. An Access Point cannot communicate with an Access Point, and a Station cannot communicate with a Station.

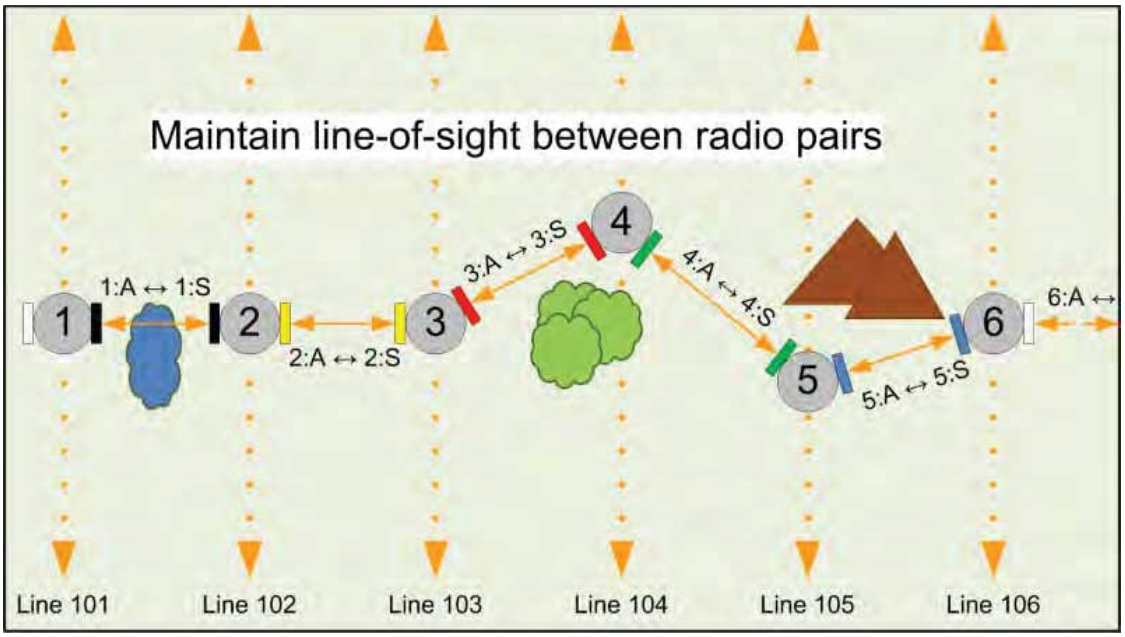


Figure 4–15 Maintain Line-of-Sight

4.4 Install and Troubleshoot

This section describes how to install the radios and troubleshoot the radio communications.

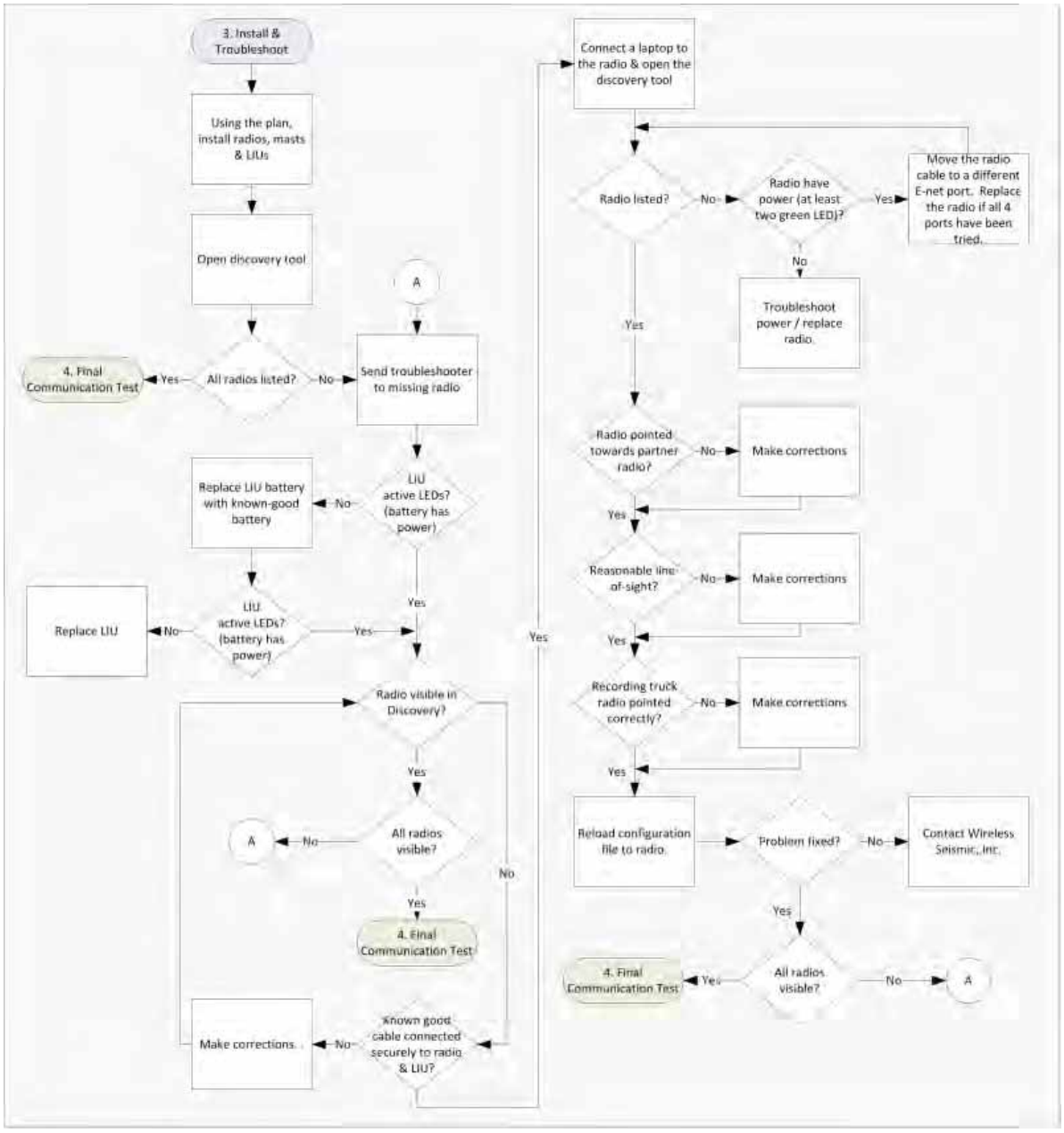


Figure 4–16 Install and Troubleshoot the Radios Flow

To install and troubleshoot the radios:

1 Using the plan created in section *"Create Plan and Map" on page 76*. install all of the radios, masts, and LIUs. Keep the following in mind as you proceed through the installation:

- Use labels to ensure that the correct radios are in the correct positions.
- Install the Access Point (A) radios are at the top of the pole, and the Station (S) radios on the same pole are at least three feet below the Access Point radios as shown in *"Radio-to-Radio Communication" on page 68*.
- Point radio pairs directly at each other where possible (see *"Maintain Line-of-Sight" on page 77*). Some inaccuracy is tolerable; however, align the radios as close as possible using binoculars or compass bearing.

2 From the recording truck, open the **Ubiquiti Discovery Tool.** Verify that all of the radios are listed, and verify that each of the radios has a valid IP Address. Note the following:

- If a radio is listed, that means there is an Ethernet path to the radio.
- If a radio has a valid IP address that means the DHCP is active, DHCP is being accepted by the radios, and DHCP is being passed from radio link to radio link.
  - DHCP server-assigned IP addresses are 10.xxx.xxx.xxx
  - Non-DHCP server-assigned IP addresses are 192.168.1.xxx

3 If a radio is not listed, send a troubleshooter to the first radio that is not listed (the radio closest to the recording truck) and perform the following steps:

a Verify that the LIU has active LED lights (the battery has power).

b Verify that the radio is visible in Discovery.

c Verify that the radio is securely connected to the LIU with a known-good cable.

d Connect a laptop to the LIU.

IMPORTANT: The Ethernet ports on the LIU are PoE enabled. When connecting a laptop computer to the LIU, use a non-powered cable (60-0039) to protect the computer's Ethernet port. Do not use a powered Ethernet cable (60-0054). See *"Ethernet Cable Connections Comparison" on page 80* for more information.

e Open the discovery tool and verify that the radio is listed. If the radio is not listed, perform the following steps.

1) Verify that the radio has power by visually inspecting the LEDs.

2) If the radio has power but is not visible to the laptop, try a different Ethernet port.

3) If the radio does not have power, troubleshoot the power and/or replace the radio.

f Verify that the radio is pointed in the direction of its partner (pair) radio and has reasonable line-of-sight to its partner (pair) (see *"Maintain Line-of-Sight" on page 77*).

g Verify that the last radio visible from the doghouse is pointed in the correct direction.

h Reload the configuration file to the radio.

i If the above steps fail, contact Wireless Seismic, Inc. for assistance.

The following table compares the powered Ethernet cable and the non-powered Ethernet cable:

Table 4–2 Ethernet Cable Connections Comparison

60-0039 LIU to Computer		Signal Name	60-0054 LIU to Radio PoE	
14-Pin Connector	RJ-45 Connector		RJ-45 Connector	11-Pin Connector
B	1	TX+	1	B
A	2	TX-	2	A
C	3	RX+	3	C
NC	4	POSITIVE	4	H
NC	5	POSITIVE	5	F
D	6	RX-	6	D
NC	7	RETURN	7	E
NC	8	RETURN	8	L
P	—	SHIELD DRAIN	—	P
—	—	—	NC	R*
—	—	—	NC	M*
—			*Jumper pins R and M together.	

4.5 Final Communication Test

This section describes how to run the final speed test to verify good communication throughout the backhaul.

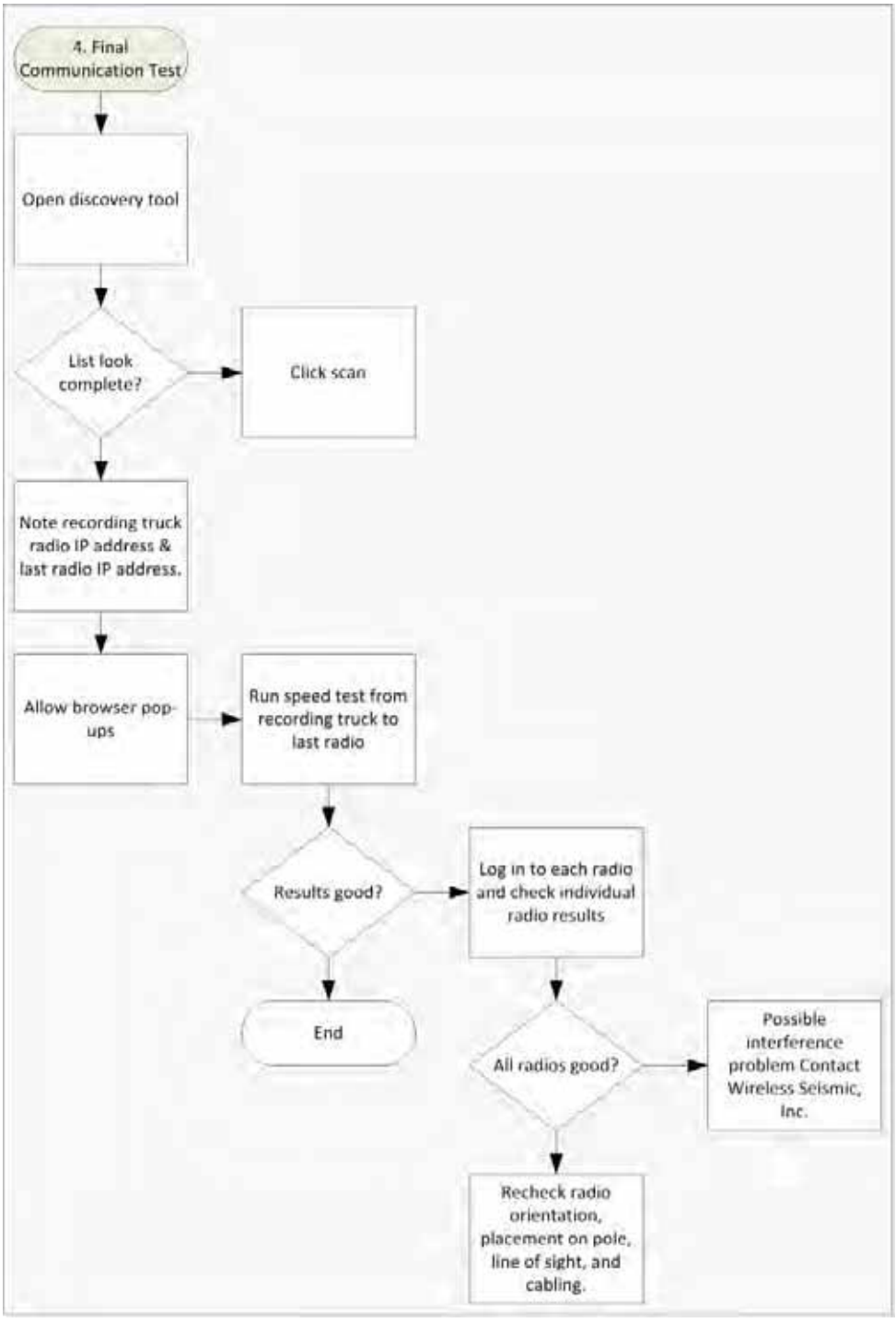


Figure 4–17 Final Communication Test Flow

To run the speed test:

1. Verify that all radios are listed in the **Ubiquiti Discovery Tool** as described in *step 4 on page 73 through step 6 on page 74.*
2. Make a note of the following IP addresses:
   - The last radio in the line segment, that is, the radio farthest away from the recording truck:

     _____.____.____.____
   - The radio at the recording truck:

     _____.____.____.____
3. The speed test should be run from the recording truck radio to the radio farthest from the recording truck. Log in to the recording truck radio as described in *step 4 on page 73 through step 8 on page 74.*
4. Verify that browser pop-ups are allowed:
   - **Firefox** – **Tools** ⟶ **Options** ⟶ **Content** ⟶ clear the **Block pop-up windows** check box ⟶ click **OK**
   - **Internet Explorer** – **Tools** ⟶ **Internet Options** ⟶ **Privacy** ⟶ clear the **Turn on Pop-up Blocker** check box ⟶ click **OK**
   - **Chrome** – **Settings button** ⟶ **Settings** ⟶ **Show Advanced Settings** ⟶ **Privacy area** ⟶ **Content Settings** ⟶ **Pop-ups area** ⟶ **Allow all sites to show pop-ups** ⟶ **click Done**
5. Click **Tools** ⟶ **Speed Test**.

Figure 4–18 Ubiquiti airOS Tools

6. In the **Speed Test** window, perform the following steps:
   a. Click the IP address for the radio farthest from the recording truck in the **Select Destination IP** list:

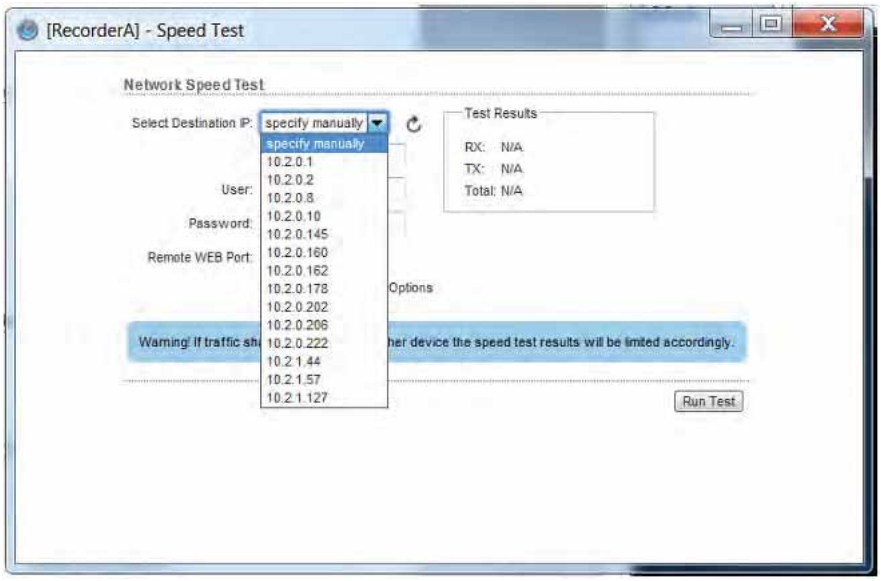


Figure 4–19 Speed Test Window

b Type ubnt in the **User** text box.

c Type ubnt in the **Password** text box.

d Type 443 in the **Remote WEB Port** text box.

e The default test **Direction** is **duplex**; the test is performed for both transmit and receive. If you want to run the test in only one direction, perform the following steps:

1) Select the **Show Advanced Options** check box.

2) Select **transmit** or **receive**.

f Click **Run Test**.

g Good **Test Results** are as follows:

- RX (receive) only = 70+ Mbps
- TX (transmit) only = 70+ Mbps
- Total (duplex) = 90+ Mbps
  - RX = 40+ Mbps
  - TX = 40+ Mbps

7 If **Speed Test** results are low, use a systematic approach of testing links to identify the offending radio pairs:

a Log in to a Station (S) radio.

b Click the **Main** tab and verify the following values:

- Signal Strength < -75 dBm
- Either the Vertical or Horizontal (Main Tab, Stations only) < -80 (between -65 and -75 is ideal)
- Transmit CCQ < 90% (100% is ideal)
- Click **AP Information** in the **Monitor** area. Verify that the Access Point **Signal Strength** < -75 dBm

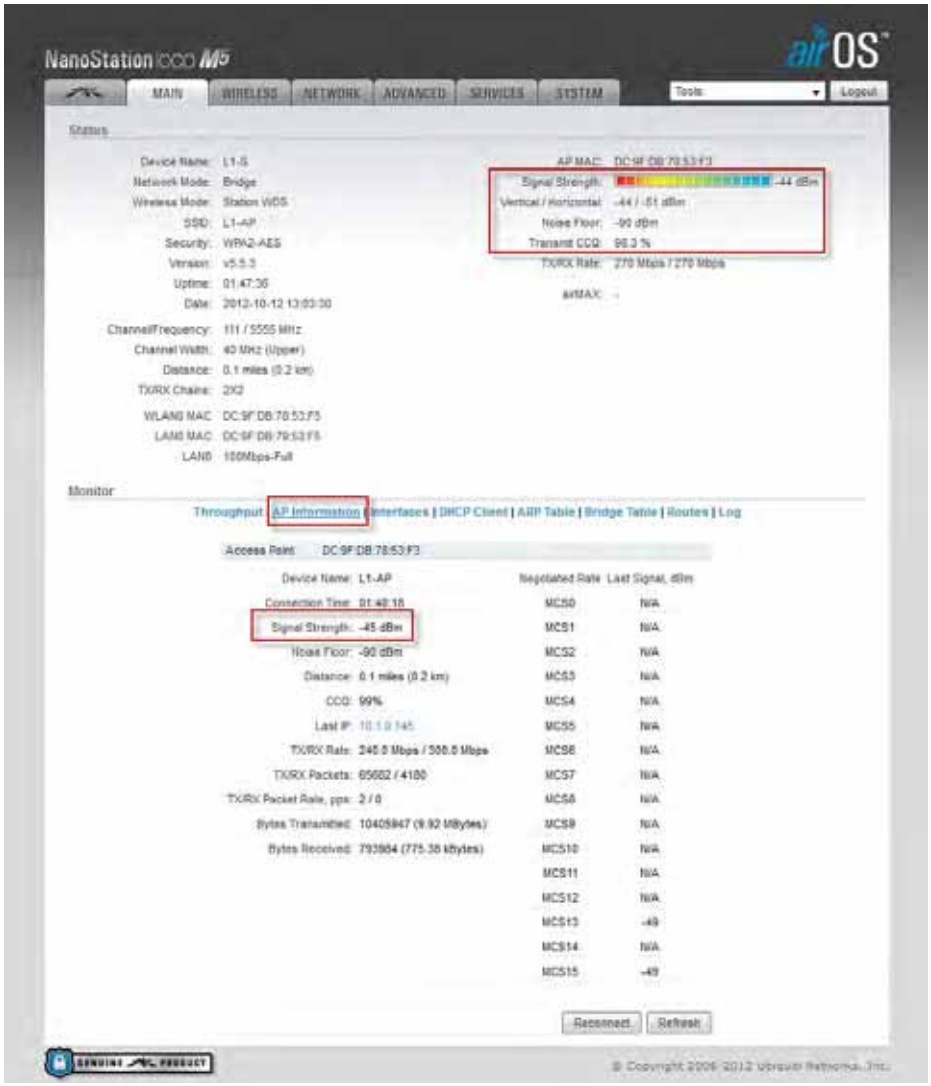


Figure 4–20 NanoStation Main Tab

c Repeat *step a on page 83 and step b on page 83* for all of the radios.

8 If the individual links are all good but the backhaul as a whole does not deliver the appropriate throughput, it indicates that there is an interference problem.

Contact Andy Prokop, Jerry Stair, or Mike Shilts for project-specific recommendations.

9 If there are individual links with low numbers, perform the following steps to fix them:

a Verify that the radios are pointing in the correct directions.

b Verify that shielding is properly installed. The following figure shows the NanoStation radio shielding and surge suppressor assembly (56-0032):

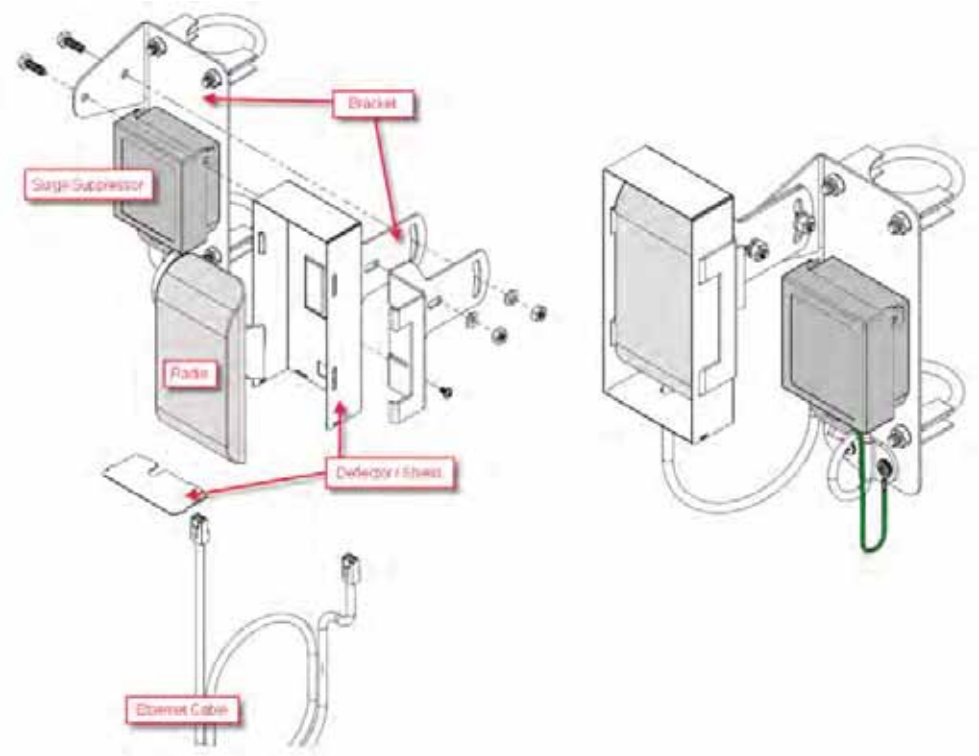


Figure 4–21 NanoStation Radio Shielding and Surge Suppressor

c Check for misaligned or improperly installed shielding.

d Verify that the radios on the same pole are at least three feet apart.

e Verify that the Access Point (A) radio is three feet higher on the pole than the Station (S) radio.

f If possible, raise the poles (masts) to provide the least-obstructed view to the partner radio as is reasonable.

g Verify that there are no frayed cables or cables with water intrusion.

4.6 Rolling the Backhaul

As production rolls away from the lines, radios, and towers farthest from the recording truck, these lines, radios, and towers become available to be used on the other side of the recording truck.

As you move the equipment, note the following:

- Maintain the A-to-S configuration throughout the survey.
- The poles must stay in sequential order as you roll the spread.

NOTE

The recording truck radio can be any one of the poles; in an ideal case the recording truck starts at pole farthest from the recording truck, for example Pole 18. When you roll Pole 18, you will also need to move the recording truck.

The following figure shows the movement of the poles and recording truck:

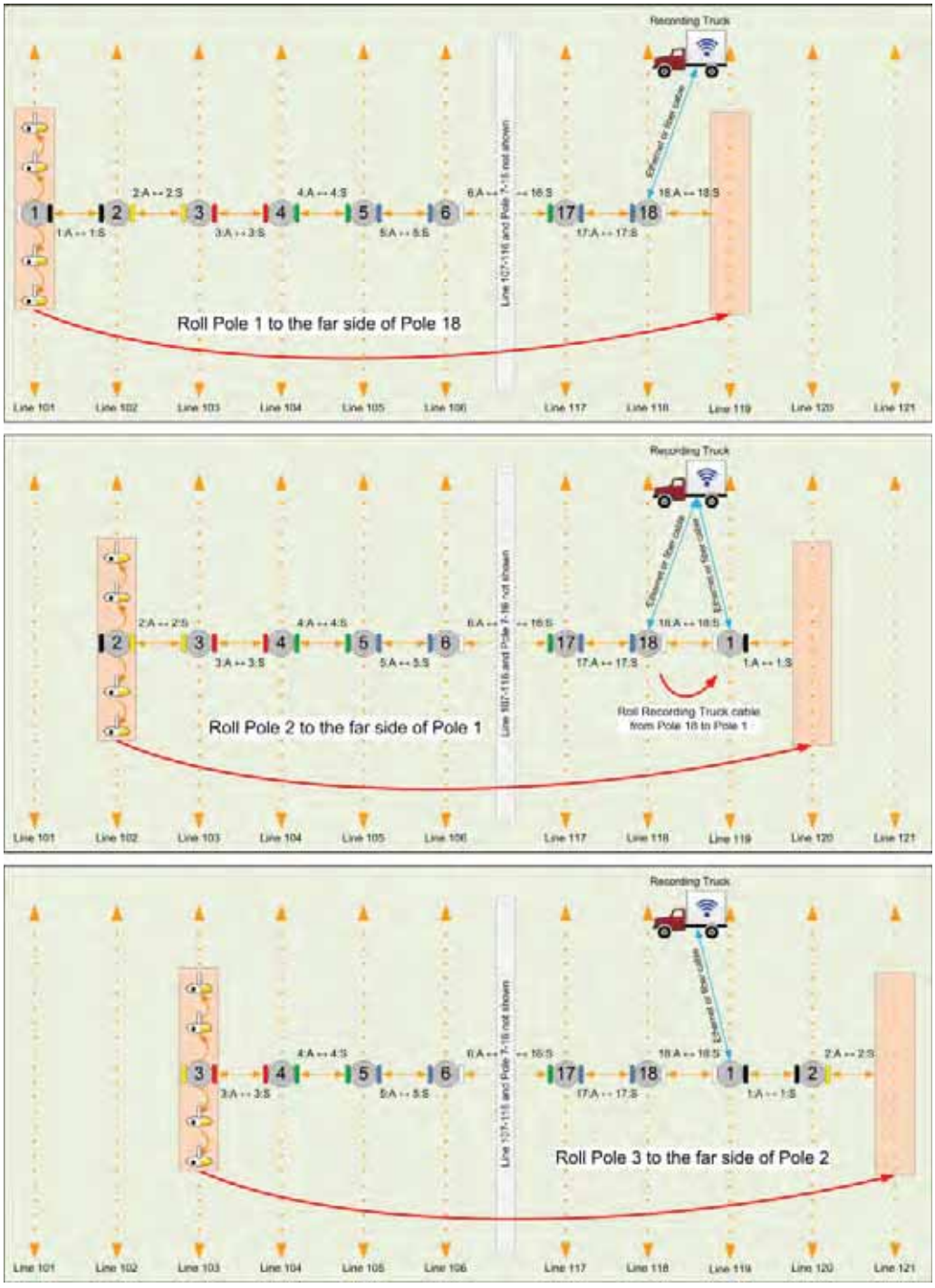


Figure 4–22 Rolling the Poles Example for 18 Total Poles

The following figure shows the movement of the poles when using 18 total poles:

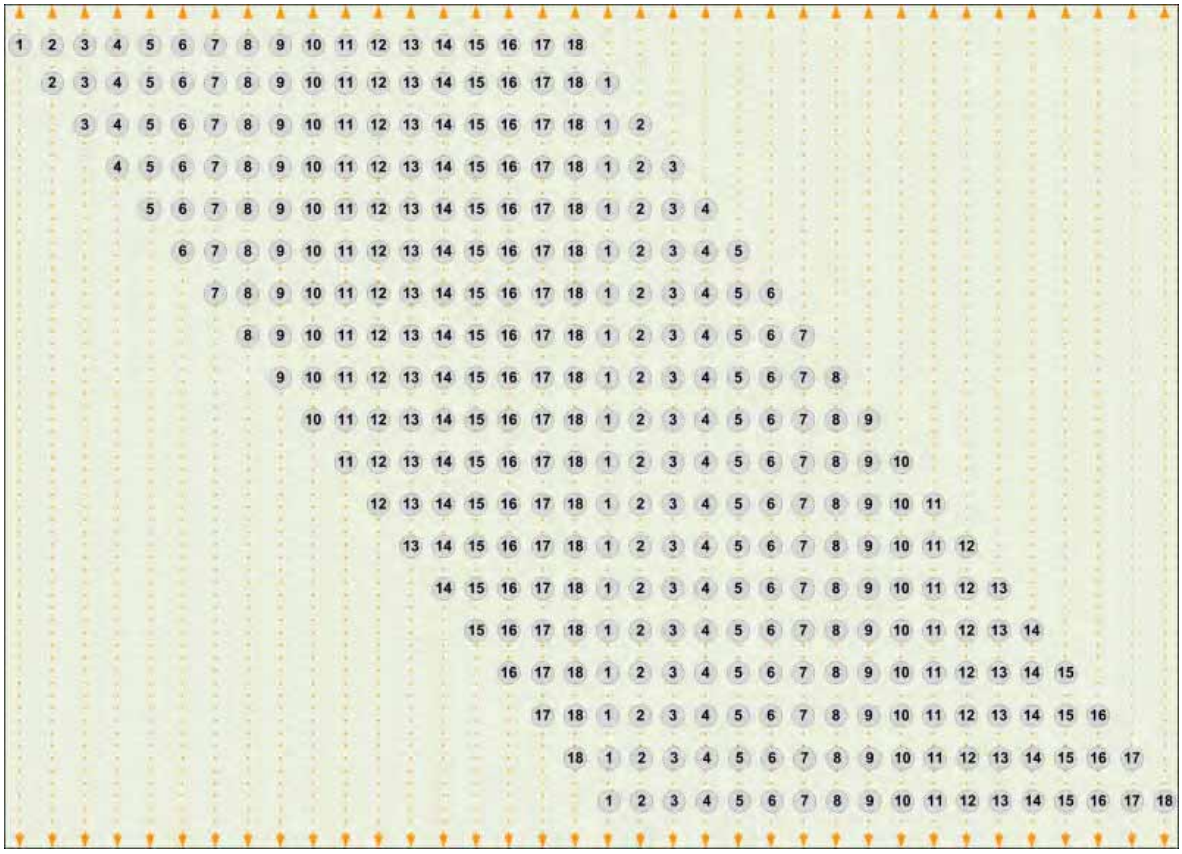


Figure 4–23 Rolling Scheme, 18 Total Poles Example

For a backhaul using 18 poles, even if you do not have all 18 lines set up at the same time, the rolling scheme must be followed using all 18 poles as shown in the following figure:

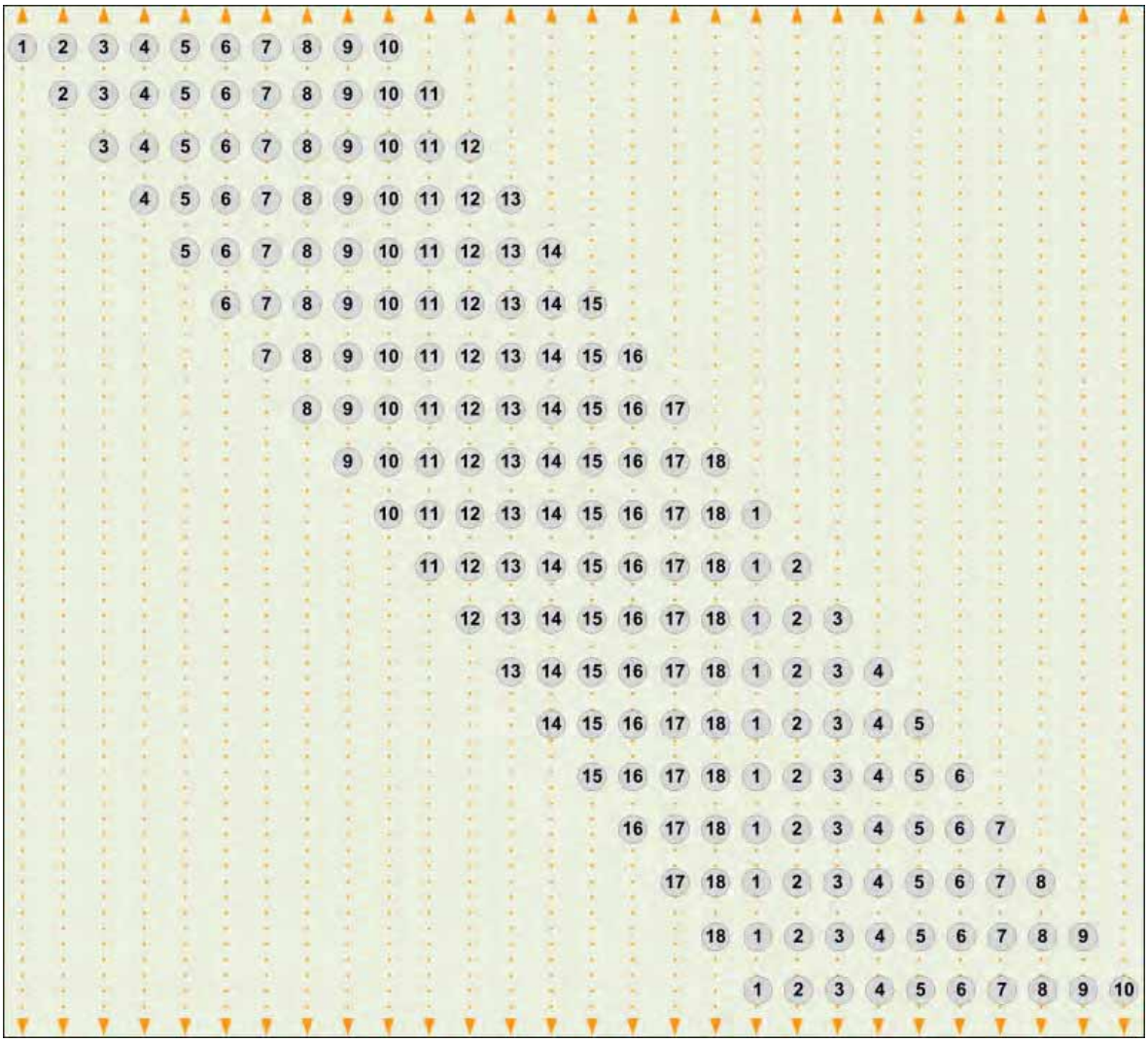


Figure 4–24 Rolling Scheme, 18 Pole Backhaul, 10 Poles in Use

4.7 Replacing a Radio

Any number of environmental hazards could destroy an existing radio. When this happens, replace it using the following instructions:

1. Identify the radio that needs to be replaced.
2. When the radio was initially configured for the point-to-point backhaul, a label was attached to the radio indicating which configuration file was used. Make a note of the configuration label (for example, 12:A-P12).
3. Duplicate the configuration label and attach it to the replacement radio using the same information and color.

   The following example label indicates a radio configured for the following:

   - Radio pair 12
   - Access Point
   - Pole 12

12:A-P12	**White**

4. Locate the corresponding configuration file (for example, 12-AP.cfg) and upload it to the replacement radio according to *step 4 on page 73* through *step 13 on page 76*.
5. Mark the faulty radio is so that it does not work its way back into the spread.
6. Replace the radio on the pole.

4.8 Upload New Firmware

This section describes how to upload new firmware into the radio.

To upload new firmware:

→ **Windows computer** → **Radio Configuration, System tab**

1. Click **Browse** next to **Upload Firmware** and navigate to the supplied BIN file.
2. Select the file and click **Open**.
3. Click **Upload**.
4. Click **Update**.
5. Do not power off the radio until the firmware is updated.

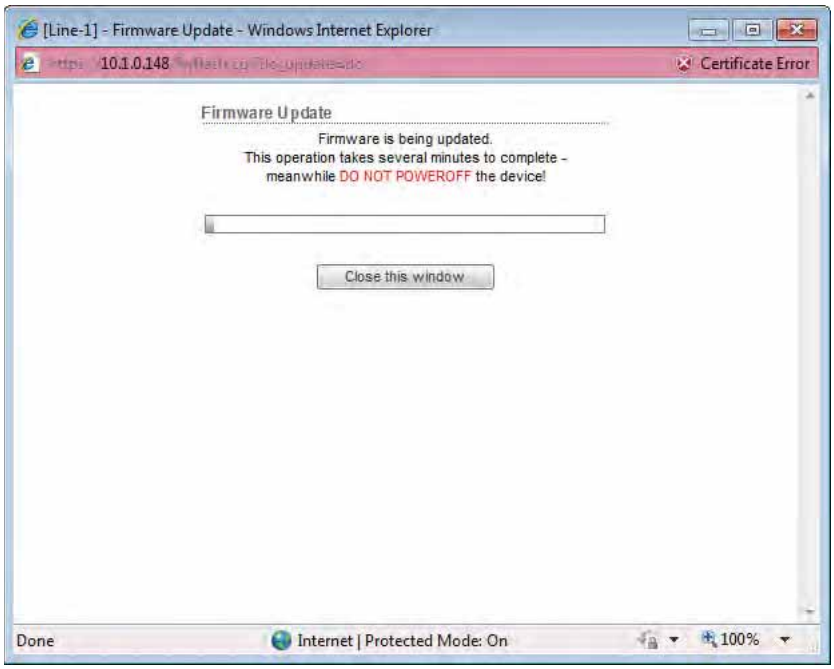


Figure 4–25 Radio Configuration, Updating Firmware

4.9 Unzipping the Configuration Files

The configuration files are delivered combined into one compressed file (config.zip).

To extract the files, use the built-in Windows 7 extraction process, or you can use a third-party tool such as 7-Zip.

To use the Windows 7 process:

1. Locate the ZIP file in Windows Explorer.
2. Right-click the ZIP file name and then click **Extract All**.
3. Browse to and select a folder.
4. Click **Extract**.

To use 7-Zip:

1. Download and install 7-Zip if it is not already installed:

http://www.7-zip.org/download.html

2. Locate the ZIP file in Windows Explorer.
3. Right-click the ZIP file name and then click **7-zip** → **Extract Files**.
4. Browse to and select a folder.

5 Click **OK**.

4.10 Connecting to the Recording Truck

The line communicates to the recording truck through an LIU using one of the following methods:

- Fiber cable
- Radio link (pendant)

The following figure shows a fiber cable connection example:

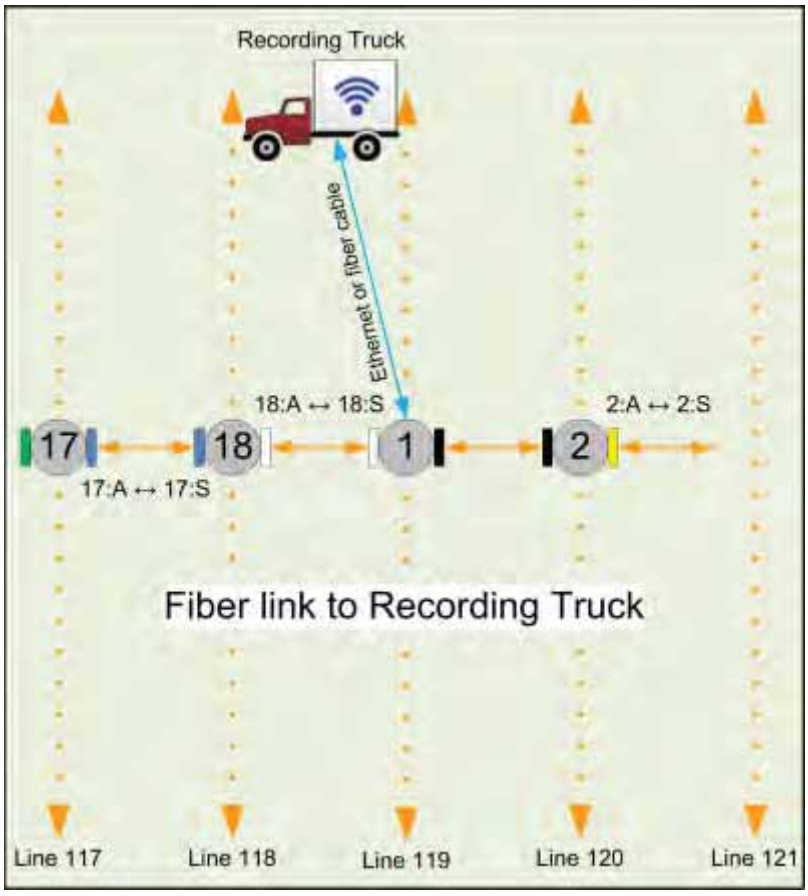


Figure 4–26 Connecting the Recording Truck with Fiber

The following figure shows a radio link (pendant) connection example.

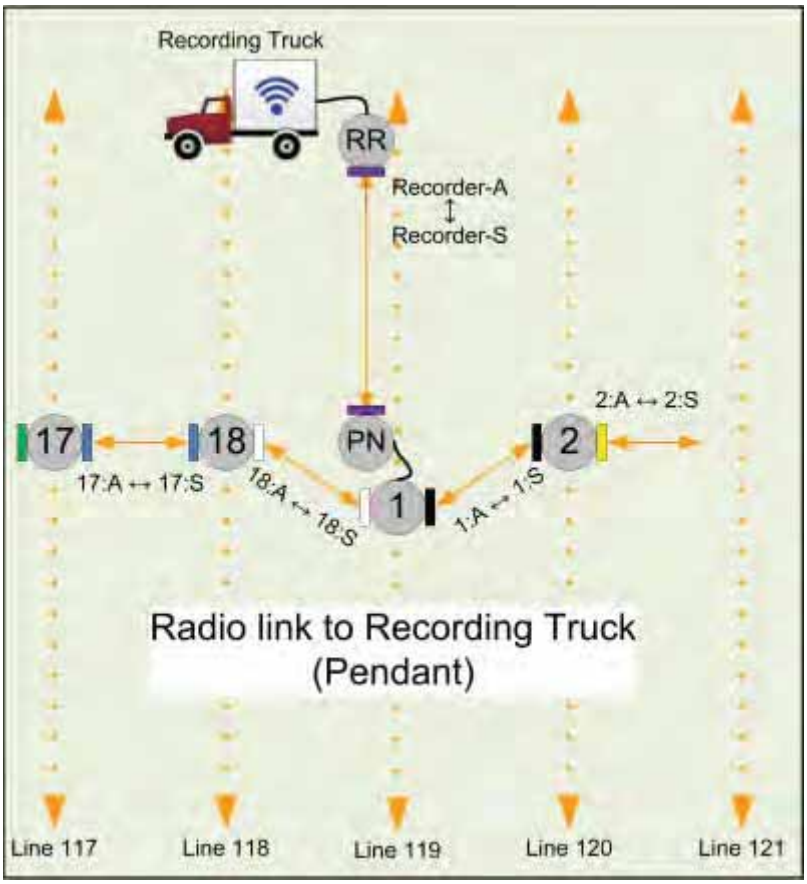


Figure 4–27 Connecting the Recording Truck with a Pendant Radio Link

The following figure shows the optimal angle between the pendent and the line.

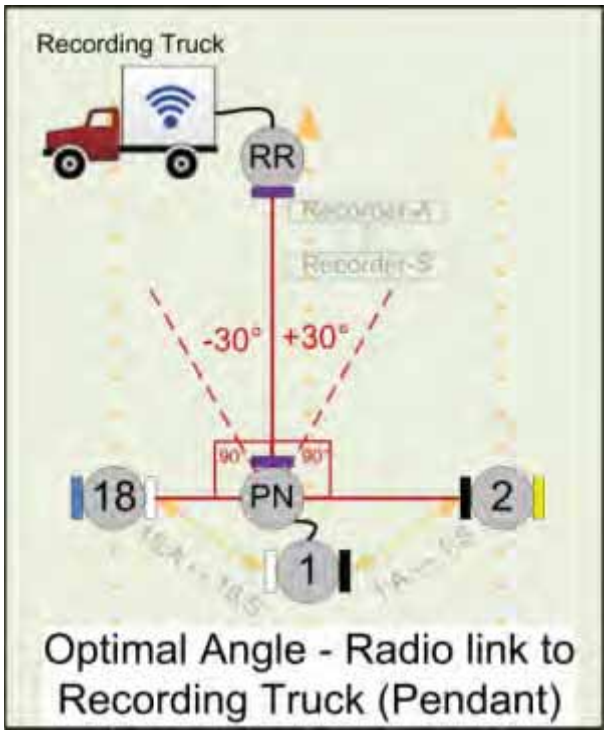


Figure 4–28 Optimal Angle, Radio Link to Recording Truck

The following figure shows the connections for the pendant radio link example.

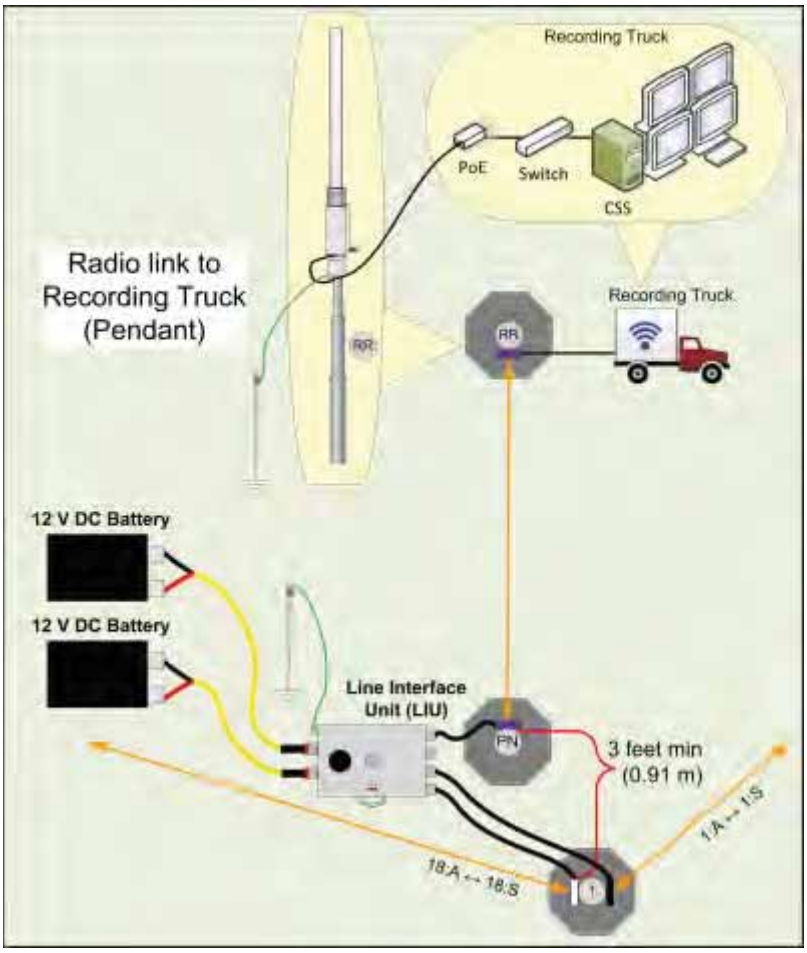


Figure 4–29 Connecting the Pendant Radio Link

The following table lists information about the pendant radio connection.

Table 4–3 Pendant Radio Link Elements

Item	Description
Configuration	The following additional configuration files are provided: • • Recorder-AP.cfg • • Recorder-S.cfg
RR	• The radio at the recording truck is a Rocket radio with an Omni antenna and is indicated in the drawings as RR (Recorder/ Rocket). • Use the Recorder-AP.cfg file with this radio. • The RR radio should be installed at the top of the pole, pointing directly at the pendant radio (PN).
PN	• The radio at the line is a NanoStation radio with a built-in antenna and is indicated in the drawings as PN (Pendant/Nano). • Use the Recorder-S.cfg file with this radio. • The PN radio should be installed at the top of the pole, pointing directly at the recording truck radio antenna (RR). • The optimal angle between the pendant radio link (RR to PN) and the next LIU in the line segment (pearl) is 90° as shown in *"Optimal Angle, Radio Link to Recording Truck" on page 94*. If necessary, ±30° off of perpendicular should also work. • The PN radio should be at least 3 ft (0.91 m) from the line pole (Pole 1 in the example shown in *"Connecting the Recording Truck with a Pendant Radio Link" on page 93).* Use as much distance as you can as allowed by your cable lengths. • The PN radio and pole should be between the line and the recording truck as shown in *"Connecting the Recording Truck with a Pendant Radio Link" on page 93.*
Batteries	• Adding a third radio to the LIU increases the battery usage at this position. To ensure that the LIU does not reset due to a low or depleted battery, keep two batteries connected to the LIU at all times. • The battery with the lowest voltage is used until the voltage falls below the Unit Thresholds ? LIU Voltage Warning number (usually about 11V). At this point, the LIU auto-swaps to the battery with the higher voltage. Monitor the battery status in the Ground Equipment Table. Replace the low-voltage battery with a fully-charged battery as soon as possible after the battery auto-swap occurs.

After the pendant radio link radios are configured and installed, log in to the PN radio and set the power level to the minimum amount required to achieve communication with the RR.

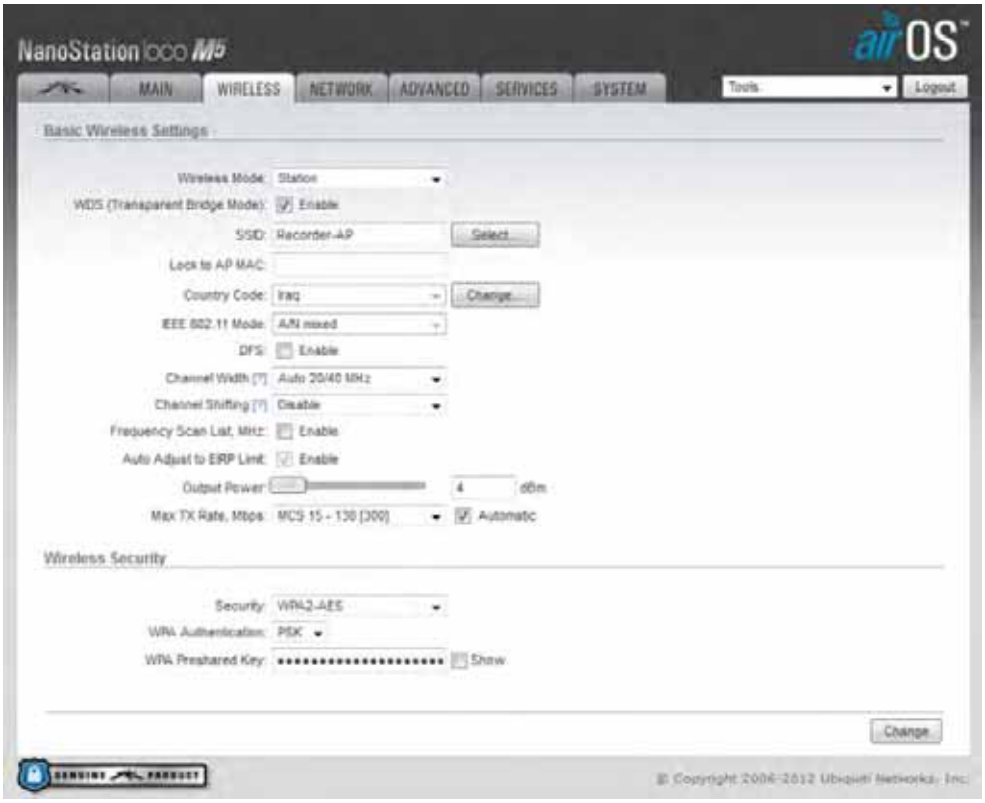


Figure 4–30 Wireless Tab

To set the PN radio power level:

1. Click the **Wireless** tab.
2. Move the **Output Power** slider bar to the desired power level.
3. Click **Change** at the bottom of the window.
4. Click **Apply Command** at the top of the window.
5. Wait 30 – 60 seconds.

5

Point-to-Multipoint Backhaul

5.1 Overview

A channel is a frequency band of a specified width. For example, if the center frequency is 2.412 GHz, and the frequency band is 80 MHz wide, there are 40 MHz on either side of the center frequency, and the frequency range for that channel is 2.372 to 2.452 GHz.

Figure 5–1 Channel, 80 MHz Wide Frequency Band

Some custom configurations will require multiple channels operating at the same time. Verify that channel ranges do not overlap to avoid interference.

The recording truck radios are configured Access Points (A) and the line station radios are configured as Stations (S).

An Access Point communicates only with a Station. An Access Point cannot communicate with an Access Point, and a Station cannot communicate with a Station.

NOTE

A line station mast requires an LIU to communicate with the recording truck. A mast located at the recording truck can communicate using an LIU or a PoE connected directly to the recording truck computer. See the following figures for examples.

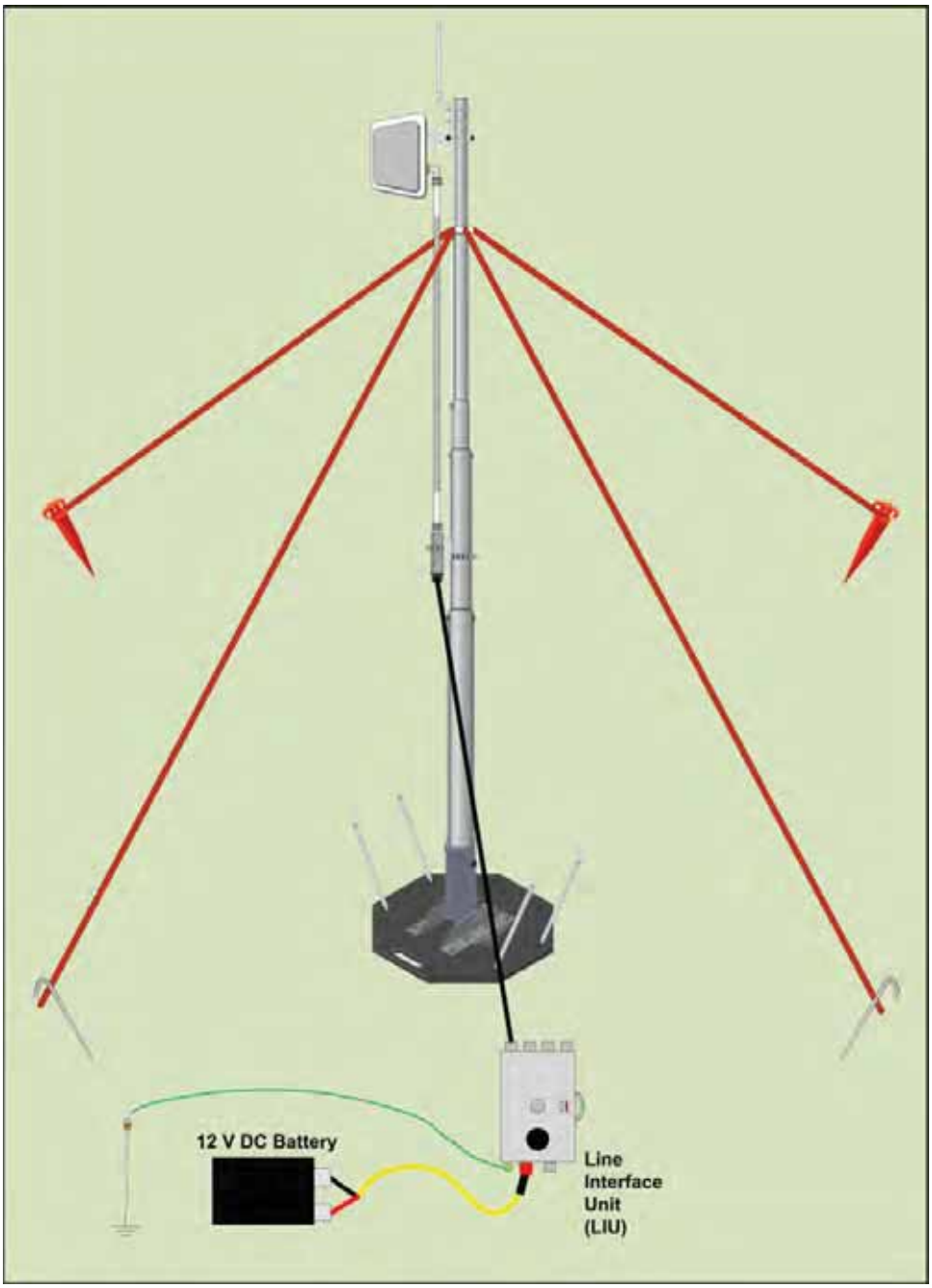


Figure 5–2 Line Station Mast (Bullet Radio)

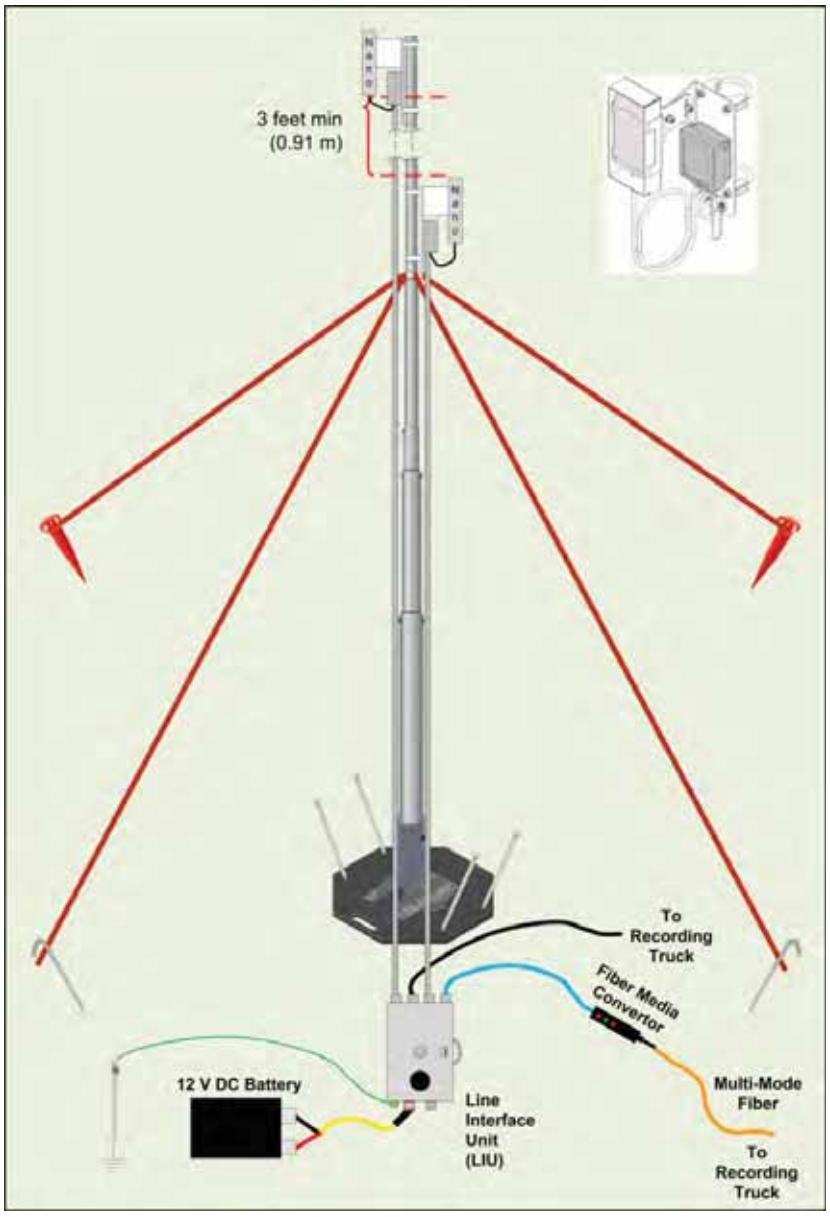


Figure 5–3 Recording Truck or Line Station Mast (NanoStation Radio)

NOTE

If using the mast at the recording truck, connect the LIU with an Ethernet or Fiber cable to the recording truck. If the mast is not used at the recording truck, the connections shown in the figure to the recording truck are not used.

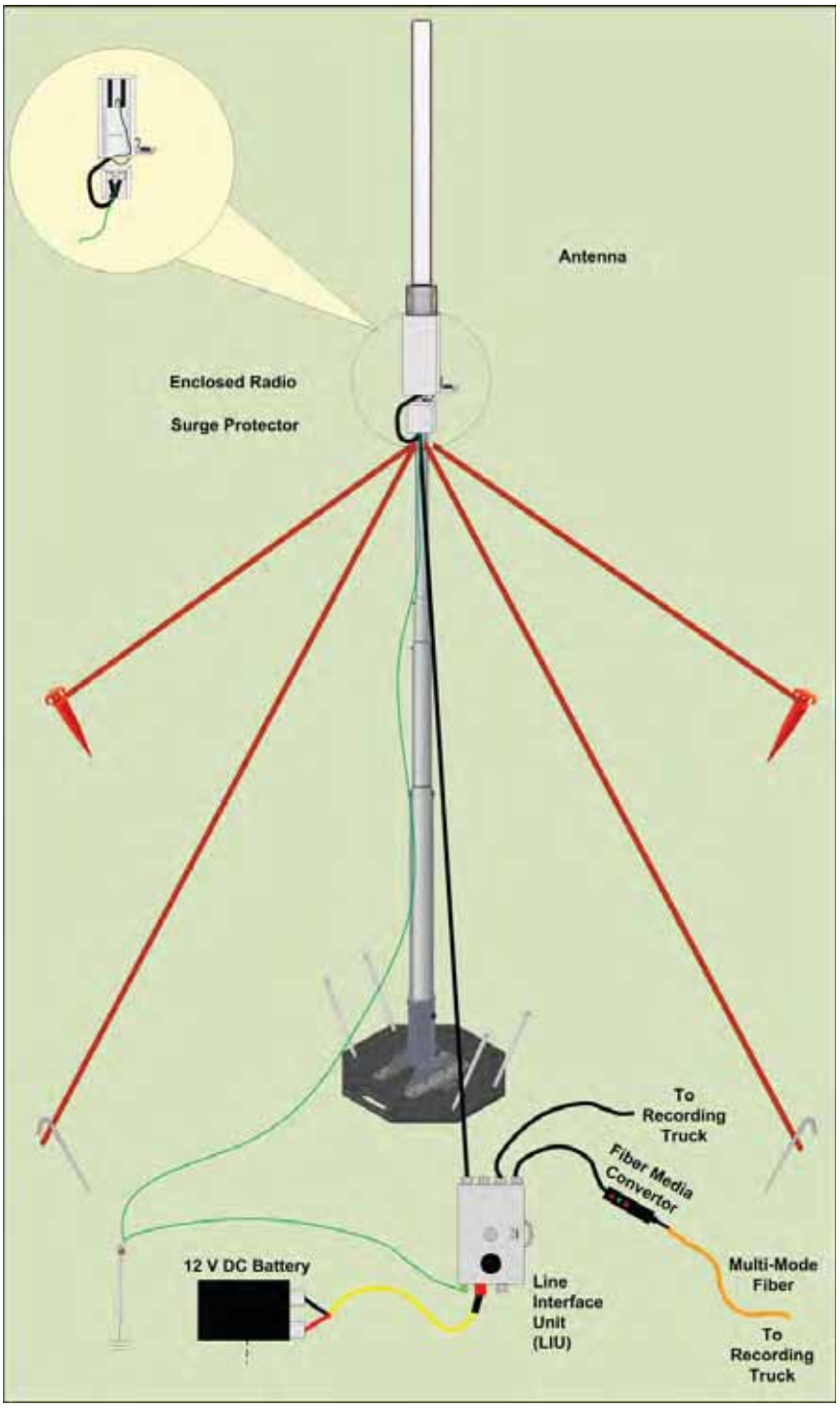


Figure 5–4 Recording Truck Mast with LIU (Rocket Radio)

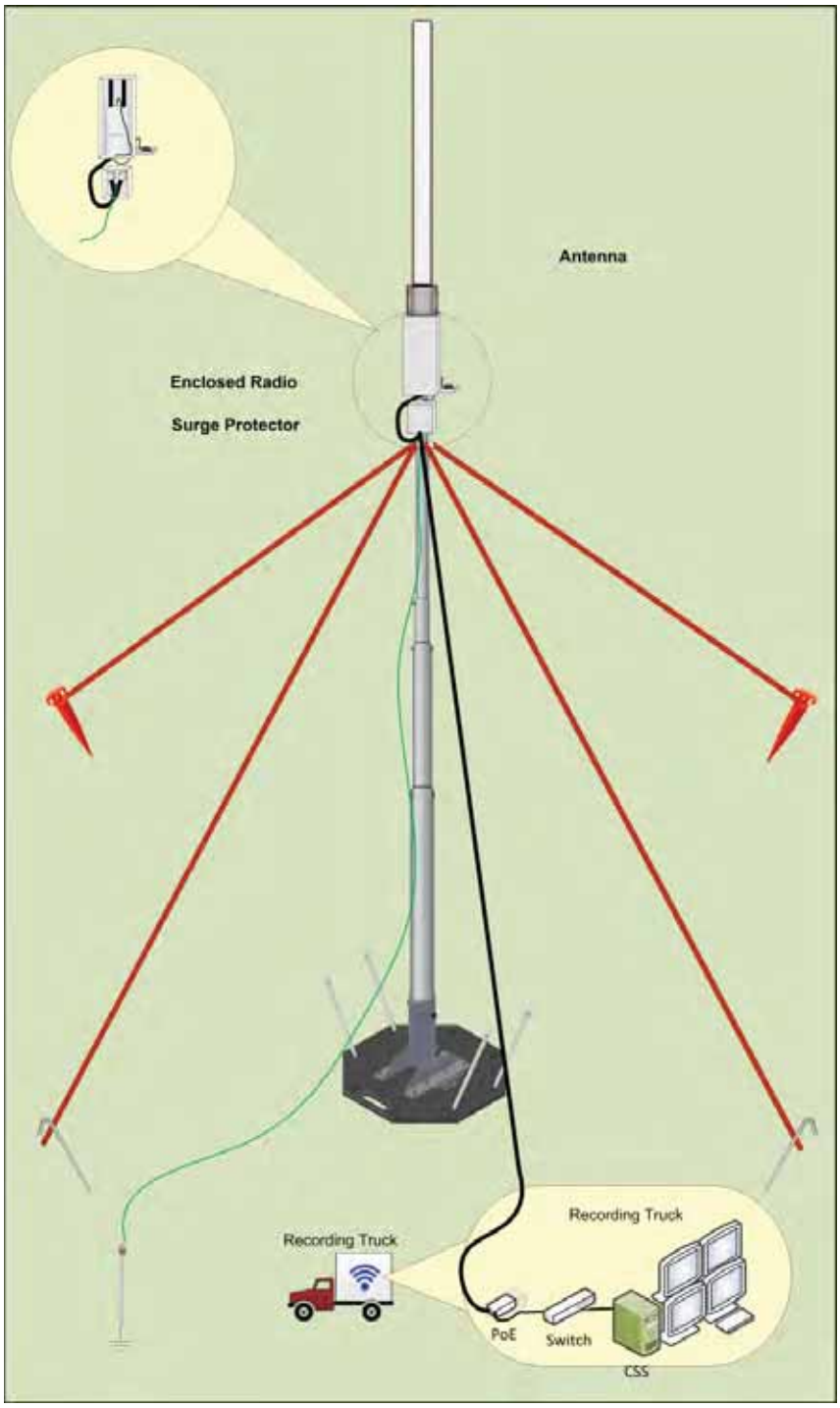


Figure 5–5 Recording Truck Mast without LIU (Rocket Radio)

NOTE

You can use a NanoStation radio instead of the Rocket Radio on the mast at the Recording Truck without an LIU.

TIP

If you have multiple radios at the recording truck, and enough PoE devices, Ethernet cables, Ethernet ports, and AC power receptacles, all of the recording truck radios can be used without an LIU unit.

5.2 Preparation

This section provides the steps required to prepare the radios for placement in the field.

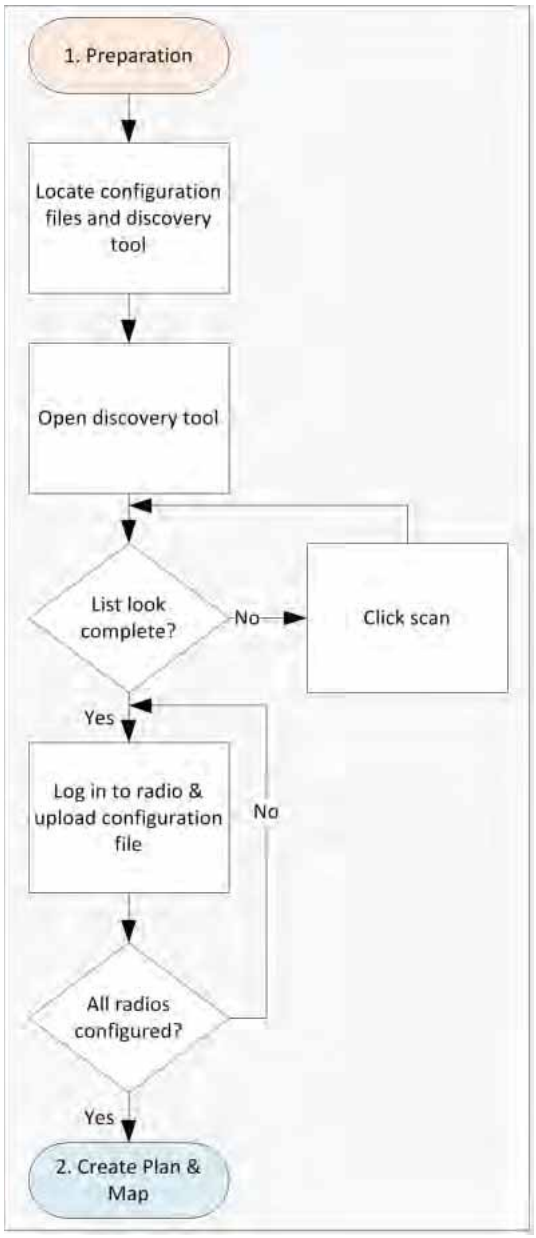


Figure 5–6 Preparation Troubleshooting Flow

There are two versions of the radios. one for use in the United States of America and Canada, and one for use internationally. Verify that you are using the correct radio and configuration files for your location.

Table 5–1 Supported Backhaul Radios

Radio	Antenna	Use For	US 5745 - 5825 MHz	INTL 5470 - 5825 MHz
Rocket	External Omni	Recorder	15-0052	15-0054
Bullet	External Directional	Line Station	56-0019	56-0024
NanoStation	Internal Directional	Recorder -or- Line Station	56-0035	56-0032

NOTE

Operating outside of the allowed frequency range could result in sanctions by governmental regulatory agencies. Verify that all radios are correct for the market in which they will be used.

If you use an international configuration file with a United States radio, or a United States configuration file with an international radio, an error message is displayed:

Figure 5–7 Invalid Country Code Error Message

TIP

Country codes are three-digit codes defined in ISO 3166-1. See the following link for more information:

http://www.iso.org/iso/home/standards/country_codes.htm

See “H. Country Codes” on page 189 for a list of codes.

TIP

Use a Rocket radio at the recording truck in the following cases:

- *You need an omni-directional antenna*

–or–

- *Bullet radios are used at the line stations*

Use a NanoStation radio at the recording truck when you need a directional antenna.

To discover and configure the radios:

→ **RT System 2 Windows computer**

1 Verify that the configuration files for the radios and the discovery tool are on the RT System 2 Windows computer. The configuration files and the **Ubiquiti Discovery Tool** files are provided as a ZIP file. Extract the files if necessary.

The following table provides example file names for the common installation configurations. The files provided to you may have a different naming convention based on the specific job requirements; however, there will be one or more configuration files for the recorder radios and one or more configuration files for the line station radios:

Table 5–2 Example File Names

Standard Configuration	Redundant Configuration	Custom Configuration
RECORDER_A.cfg	RECORDER_A.cfg	RECORDER_A.cfg
LINE_RADIO_1.cfg	RECORDER_B.cfg	RECORDER_B.cfg
LINE_RADIO_2.cfg	LINE_RADIO_1.cfg	RECORDER_C.cfg
LINE_RADIO_3.cfg	LINE_RADIO_2.cfg	LINE_RADIO_1_RECORDER_A.cfg
LINE_RADIO_4.cfg	LINE_RADIO_3.cfg	LINE_RADIO_2_RECORDER_B.cfg
LINE_RADIO_5.cfg	LINE_RADIO_4.cfg	LINE_RADIO_3_RECORDER_C.cfg
LINE_RADIO_6.cfg	LINE_RADIO_5.cfg	LINE_RADIO_4_RECORDER_A.cfg
LINE_RADIO_7.cfg	LINE_RADIO_6.cfg	LINE_RADIO_5_RECORDER_B.cfg
LINE_RADIO_8.cfg	LINE_RADIO_7.cfg	LINE_RADIO_6_RECORDER_C.cfg
LINE_RADIO_9.cfg	LINE_RADIO_8.cfg	LINE_RADIO_7_RECORDER_A.cfg
LINE_RADIO_10.cfg	LINE_RADIO_9.cfg	LINE_RADIO_8_RECORDER_B.cfg
LINE_RADIO_11.cfg	LINE_RADIO_10.cfg	LINE_RADIO_9_RECORDER_C.cfg

NOTE

When using a radio link (pendant) to the recording truck, the following configuration files are also required:

- *Recorder-AP.cfg*
- *Recorder-S.cfg*

2 Configure the computer to be a private network with a static IP address of `192.168.1.100`. See the *Troubleshooting Guide, Additional Information chapter, Setting a Static IP Address section* if you need instructions on setting the IP address (**Control Panel** ⟶ **Network and Internet** ⟶ **Network and Sharing** ⟶ **Change adapter settings** ⟶ **LAN** ⟶ **Properties** ⟶ **IPv4** ⟶ **Properties**).

3 Connect a single radio to the computer.

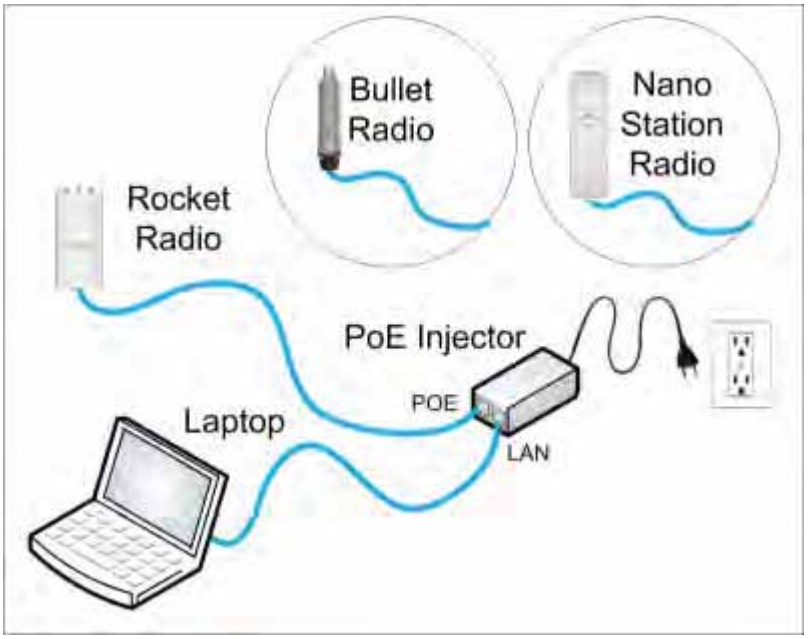


Figure 5–8 Ubiquiti Rocket/Bullet Private Network Connection

4 Open the **Ubiquiti Discovery Tool** by double-clicking the shortcut on the desktop.

Figure 5–9 Ubiquiti Discovery Tool Icon

NOTE

Ensure that the .bat file and the .jar file are in the same directory.

TIP

The discovery tool can also be downloaded from the following location:

http://www.ubnt.com/download#app

Extract the files from the downloaded ZIP file to the desktop.

5 The **Discovery** window opens and displays a list of all **Discovered Devices**:

NOTE

The factory default IP address for the radios is 192.168.1.20. Configure the radios one at a time.

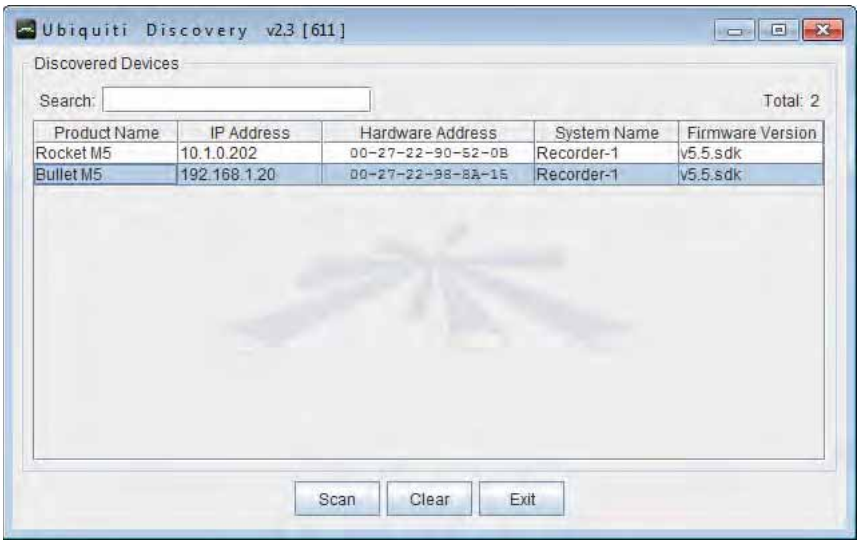


Figure 5–10 Ubiquiti Discovery Window

6 If the list does not look correct, click Scan.

7 Right-click one of the radios and then click **Web UI**. For example, right-click the following row:

`Bullet M5 | 192.168.1.20 | 00-27-22-98-8A-15 | Recorder-1`

and then click **Web UI**. The **airOS** login window opens:

Figure 5–11 Ubiquiti Login Window

8 Type the following credentials and click **Login**:

- Username: `ubnt`
- Password: `ubnt`

9 The radio configuration window opens. Click the **System** tab.

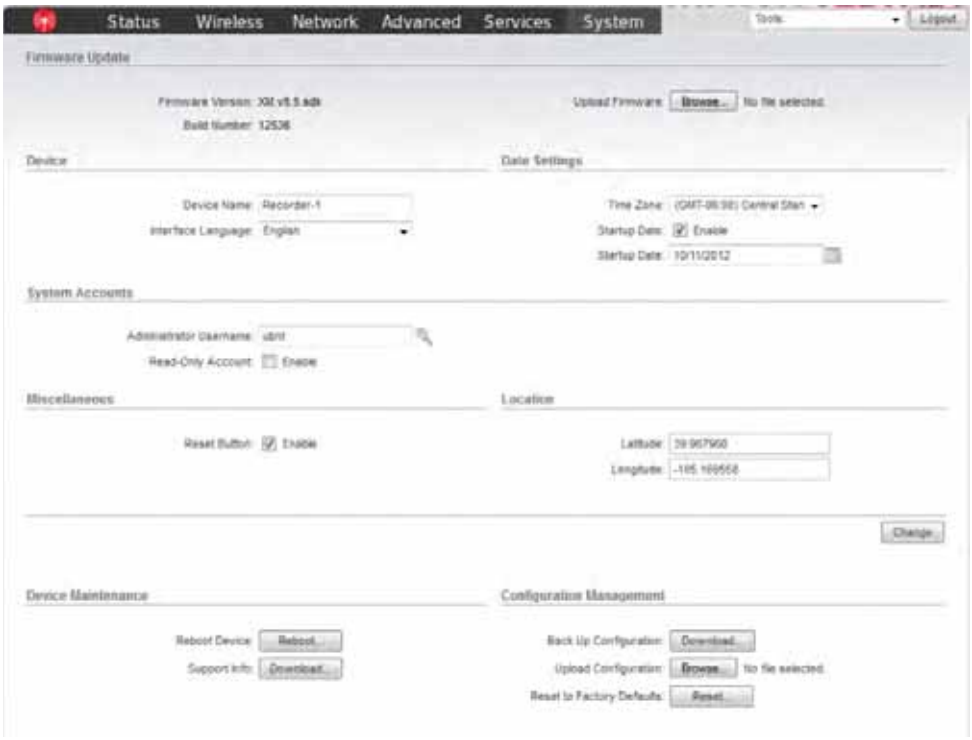


Figure 5–12 Ubiquiti Rocket/Bullet Window, System Tab

10 In the **Device Maintenance** → **Upload Configuration** area, click **Browse**. Browse to the configuration file (for example `LINE_RADIO_1.cfg`), and then click **Upload**.

Figure 5–13 Upload Configuration File

11 Click **Apply**.

Figure 5–14 System Tab, Apply Changes

12 The radio reboots and obtains a new IP address if a DHCP server is active. The current session of airOS is no longer valid since the IP address of the radio has changed.

13 Close the browser window.

14 Disconnect the radio. It is now ready for deployment.

15 Continue connecting radios and uploading configuration files until they are all configured.

16 Configure a second recorder radio (RECORDER_B) if you are creating a redundant setup.

17 Configure any backup recorder radios if required.

5.3 Create Plan and Map

Using the documents provided for the job (survey, planned LIU locations, and so on), create a plan to plot radio locations and map the layout of the radios.

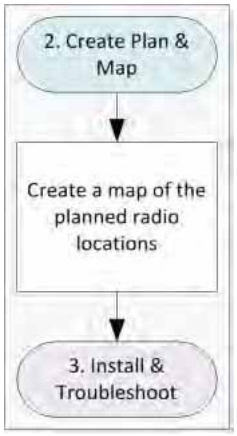


Figure 5–15 Create Plan and Map Troubleshooting Flow

Keep the following in mind as you create the layout plan:

- Point the radio pairs directly at each other whenever possible maintaining line-of-sight around obstructions (see *"Maintain Line-of-Sight" on page 112*).
- Use a tool such as Google Earth or Global Mapper to create an Elevation Profile to assist with determining the best locations for radio towers. See *"Creating a Google Earth Elevation Profile" on page 113* for an example.

- An Access Point communicates only with a Station. An Access Point cannot communicate with an Access Point, and a Station cannot communicate with a Station.

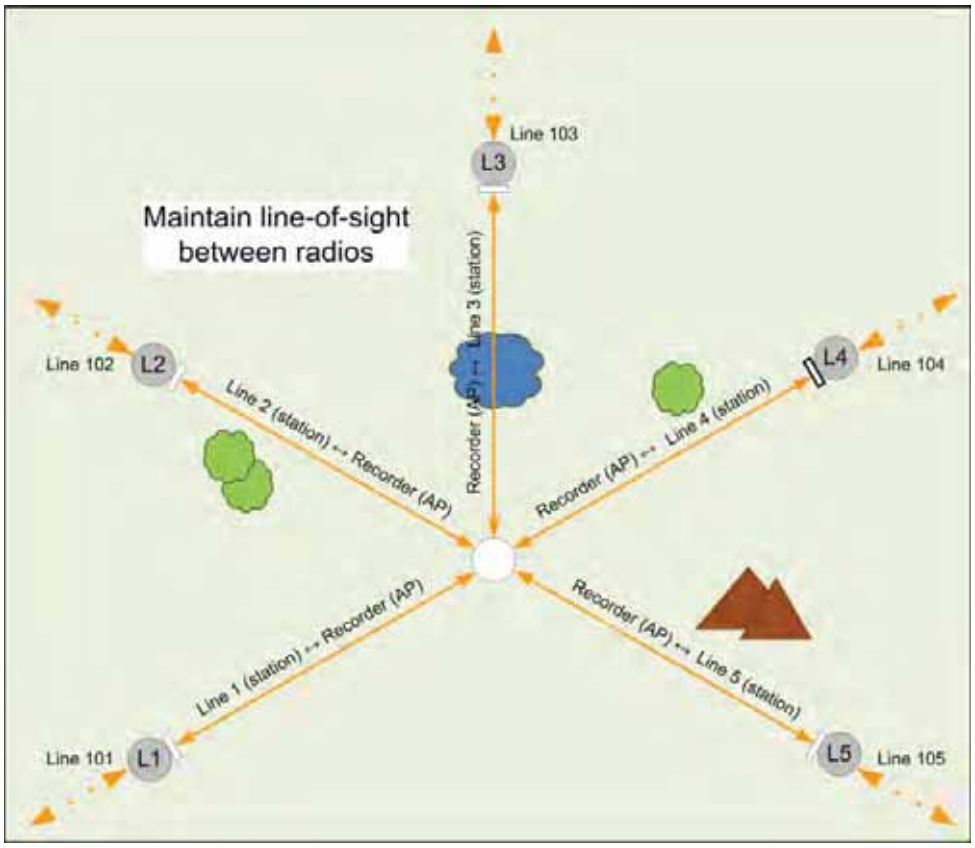


Figure 5–16 Maintain Line-of-Sight

Table 5–3 Creating a Google Earth Elevation Profile

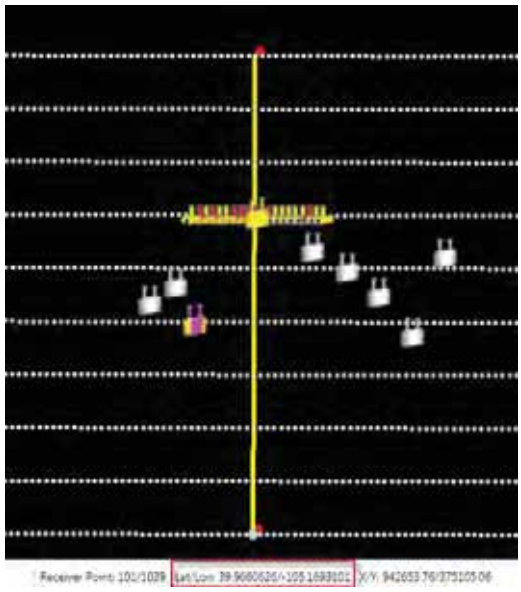
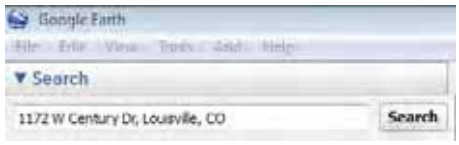
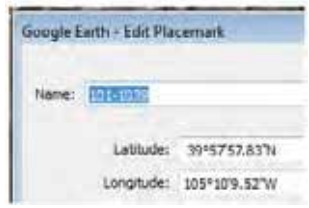
Step	Instructions	Example Image
1	In the RT System 2 Spread Manager, make a note of the Lat/Lon coordinates for the starting and ending point of the planned backhaul. For example: • Line101, Receiver Point 1030 Lat/Lon = 39.9660626/-105.1693101 • Line 110, Receiver Point 1030 Lat/Lon = 39.9701155/-105.1692904	
2	Open Google Earth and navigate to your survey location. For example, type an address or Lat/Lon coordinates in the text box and then click Search.	
3	Add a placemark for the beginning and ending points of the planned backhaul. • Click **Add Placemark**. • Type a **Name**, **Latitude**, and **Longitude**. The decimal value entered is automatically converted to degrees/minutes/seconds. • Click **OK**.	 

Table 5–3 Creating a Google Earth Elevation Profile (cont.)

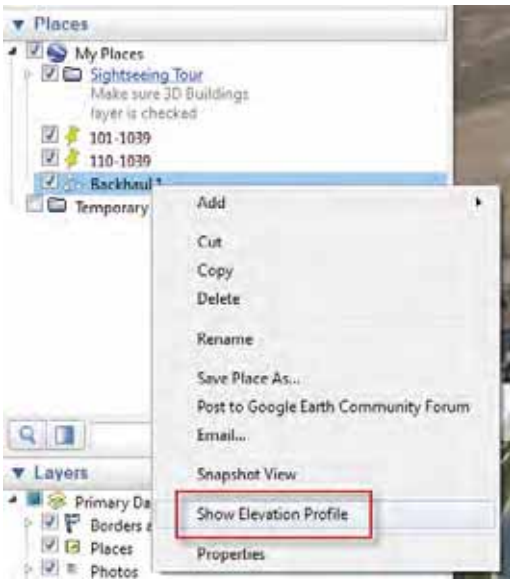
Step	Instructions	Example Image
4	Add a path between the placemarks. • Click **Add Path** • Click the first placemark. • Click the second placemark. A line is drawn between the two placemarks. • Type a **Name** and then click **OK**.	
5	Right-click the saved path and then click **Show Elevation Profile**.	

Table 5–3 Creating a Google Earth Elevation Profile (cont.)

Step	Instructions	Example Image
6	Refer to the elevations and numbers displayed when planning the tower locations and heights. See the following link for more assistance in creating and using Google Earth Elevation Profiles. https://support.google.com/earth/answer/181393?hl=en&ref_topic=2376 756	

5.4 Install and Troubleshoot

This section describes how to install the radios and troubleshoot the radio communications.

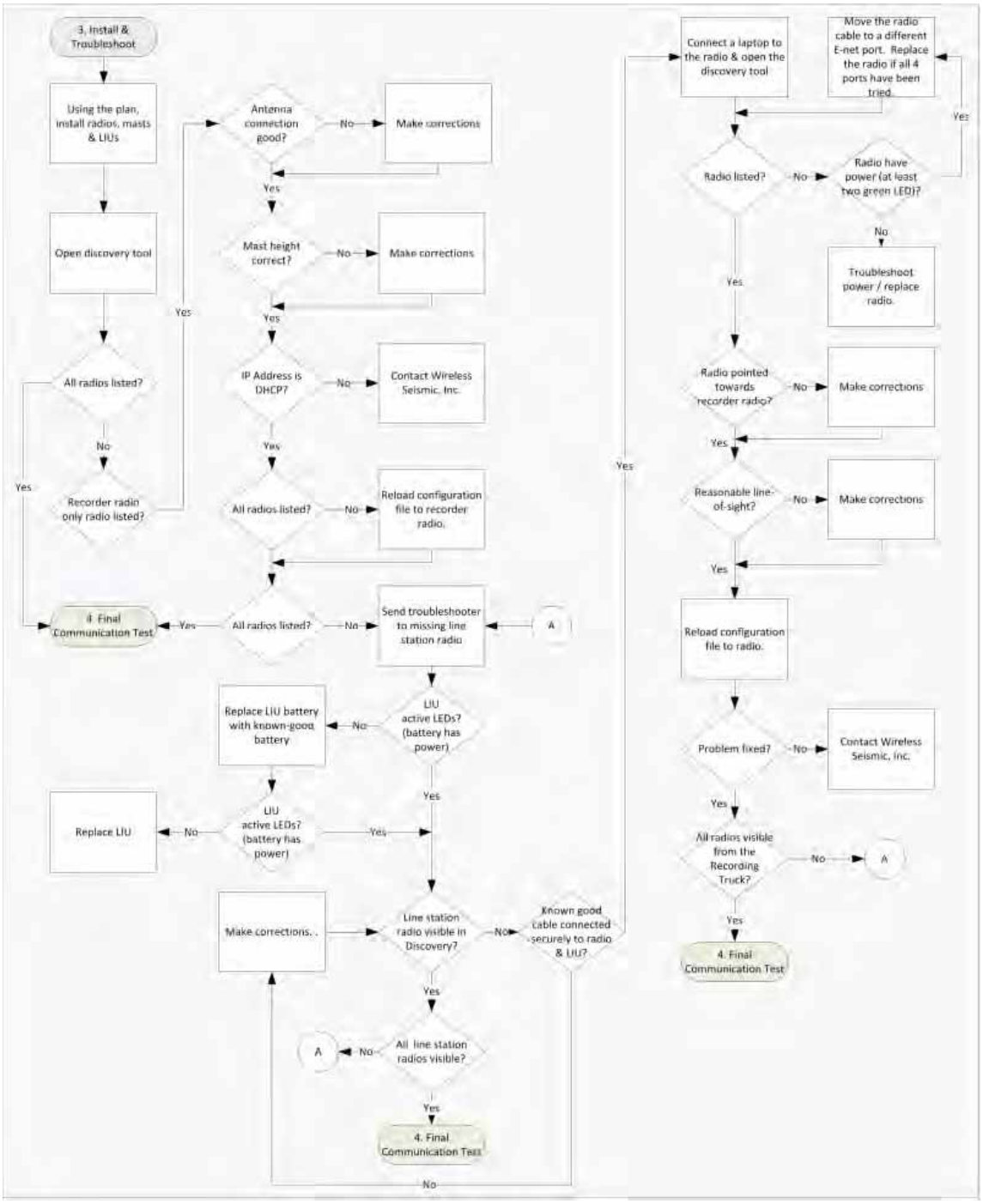


Figure 5–17 Install and Troubleshoot the Radios Flow

5.4.1 Using one Recorder Radio

This section describes how the steps to configure one recorder radio, and multiple line station radios.

To install and troubleshoot the radios:

1. Using the plan created in *"Create Plan and Map" on page 111*, install all of the radios, masts, and LIUs. Point radio pairs directly at each other where possible (see *"Maintain Line-of-Sight" on page 112*). Some inaccuracy is tolerable; however, align the radios as close as possible using binoculars or compass bearing.
2. If your configuration includes a redundant recorder radio, do not supply power to it yet (RECORDER_B).
3. From the recording truck, open the Ubiquiti Discovery Tool. Verify that all of the radios are listed, and verify that each of the radios has a valid IP Address. Note the following:
   - If a radio is listed, that means there is an Ethernet path to the radio.
   - If a line station radio has a valid IP address that means the DHCP is active, DHCP is being accepted by the radios, and DHCP is being passed from the recorder radio.
     - DHCP server-assigned IP addresses are 10.xxx.xxx.xxx
     - Non-DHCP server-assigned IP addresses are 192.168.1.xxx
4. If the recorder radio is the only radio listed, the problem is probably at the recorder radio. Perform the following steps:
   - **a** Verify that the recorder radio is connected to the antenna.
   - **b** Verify that the antenna mast is elevated to the correct height
   - **c** Verify that the recorder radio has DHCP by validating the IP address displayed in the Ubiquiti Discovery tool. It should not be 192.168.1.20 (factory default). If it is 192.168.1.20, contact Wireless Seismic for DHCP support.
   - **d** Reload the configuration file on the recorder radio.
   - **e** If the recorder radio is still the only radio listed, proceed to the line station radios.
5. If a line station radio is not listed, send a troubleshooter to the radio that is not listed and perform the following steps:
   - **a** Verify that the line station radio is securely connected to the LIU with a known-good cable.
   - **b** Verify that the LIU has active LED lights (the battery has power).
   - **c** Verify that the LIU has a flashing LNK LED. Note the following:
     - A flashing LNK LED confirms that the LIU can communicate over the network and obtain an IP address through DHCP.
     - This step helps identify the exact location in the network where communications are broken by proving the network is active between the two radios on a specific pole.
     - If the LNK LED is not flashing, replace the Ethernet cable.
     - If the LNK LED is still not flashing, replace the battery.
     - If the LNK LED is still not flashing, reload the radio configuration file.
     - If the LNK LED is still not flashing, replace the LIU.
   - **d** Verify that a known-good Ethernet cable is securely attached to the radio.
   - **e** Connect a laptop to the LIU.

     IMPORTANT: The Ethernet ports on the LIU are PoE enabled. When connecting a laptop computer to the LIU, use a non-powered cable (60-0039) to protect the computer's Ethernet port. Do not use a powered Ethernet cable (60-0054). See *"Ethernet Cable Connections Comparison" on page 118* for more information.

f Open the discovery tool and verify that the radio is listed. If the radio is not listed, perform the following steps.

1) Verify that the radio has power by visually inspecting the LEDs.

2) If the radio has power but is not visible to the laptop, replace the radio.

3) If the radio does not have power, replace the cable and/or the radio.

g Verify that the line station radio is pointed in the direction of the recorder radio and has reasonable line-of-sight (see *"Maintain Line-of-Sight" on page 112*).

h If the line station radio still cannot be seen, replace the radio.

The following table compares the powered Ethernet cable and the non-powered Ethernet cable:

Table 5–4 Ethernet Cable Connections Comparison

60-0039 LIU to Computer		Signal Name	60-0054 LIU to Radio PoE	
14-Pin Connector	RJ-45 Connector		RJ-45 Connector	11-Pin Connector
B	1	TX+	1	B
A	2	TX-	2	A
C	3	RX+	3	C
NC	4	POSITIVE	4	H
NC	5	POSITIVE	5	F
D	6	RX-	6	D
NC	7	RETURN	7	E
NC	8	RETURN	8	L
P	—	SHIELD DRAIN	—	P
—	—	—	NC	R*
—	—	—	NC	M*
—			*Jumper pins R and M together.	

5.4.2 Using a Redundant Recorder Radio

This section describes the additional steps required to configure a redundant recorder radio.

To install and troubleshoot the redundant recorder radio:

1 Correctly configure the backhaul for RECORDER_A as detailed in *"Using one Recorder Radio" on page 117*.

2 Supply power to the RECORDER_B radio.

3 Wait 2 minutes to confirm that RECORDER_B completes its boot cycle.
4 Disconnect RECORDER_A.
5 Verify that all line station radios are listed in the Discovery window through RECORDER_B within 2 minutes. The typical switch over takes 30 seconds but it can take longer.
6 Supply power to RECORDER_A and disconnect power from RECORDER_B.
7 Verify that all line station radios are listed in the Discovery window through RECORDER_A.
8 Supply power to RECORDER_B.
9 Verify that all line station radios are listed in the Discovery window.
10 Verify that both recorder radios are listed in the Discovery window.

5.4.3 Using a Custom Configuration

Custom configurations may have a number of recorder radios and line station radios.

Correctly configure the backhaul for one of the recorders, for example, RECORDER_A, as detailed in *"Using one Recorder Radio" on page 117*.

Then, configure the backhaul for each additional recorder, for example, RECORDER_B, until the backhaul configuration is complete.

NOTE

Remove power from competing recorder radios during the configuration process. During production is the only time more than one recorder radio should have power applied.

5.5 Final Communication Test

This section describes how to run the final speed test to verify good communication throughout the backhaul. The final communication test should be run from each recorder radio that will be communicating to line radios during production.

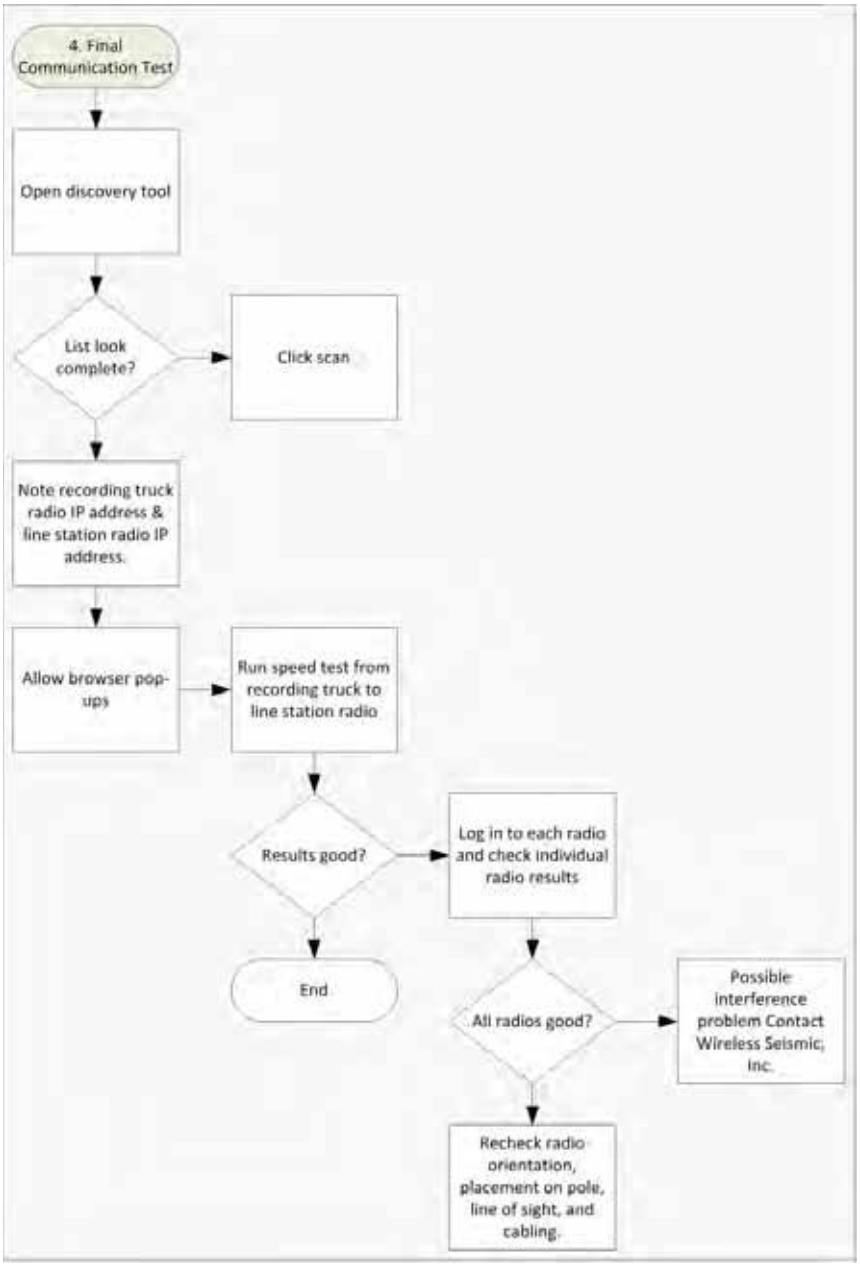


Figure 5–18 Final Communication Test Flow

To run the speed test:

1 Verify that all radios are listed in the **Ubiquiti Discovery Tool** as described in *step 3 on page 117* through *step 5 on page 117*

2 Make a note of the line segment radio IP addresses, or keep the Discovery window open for easy reference:

_____.____.____.____

_____.____.____.____

_____.____.____.____

_____.____.____.____

3 The speed test should be run from the recording truck radio to the line segment radios. Log in to the recording truck radio as described in *step 2 on page 107* through *step 8 on page 109*.

4 Verify that browser pop-ups are allowed:

- **Firefox** – **Tools** ⟶ **Options** ⟶ **Content** ⟶ clear the **Block pop-up windows** check box ⟶click **OK**
- **Internet Explorer** – **Tools** ⟶ **Internet Options** ⟶ **Privacy** ⟶ clear the **Turn on Pop-up Blocker** check box ⟶ click **OK**
- **Chrome** – **Settings button** ⟶ **Settings** ⟶ **Show Advanced Settings** ⟶ **Privacy area** ⟶ **Content Settings** ⟶ **Pop-ups area** ⟶ **Allow all sites to show pop-ups** ⟶ **click Done**

5 Click **Tools** ⟶ **Speed Test**.

Figure 5–19 Tools, Speed Test

6 In the **Speed Test** window, perform the following steps:

a Click the IP address for a line segment radio in the **Select Destination IP** list:

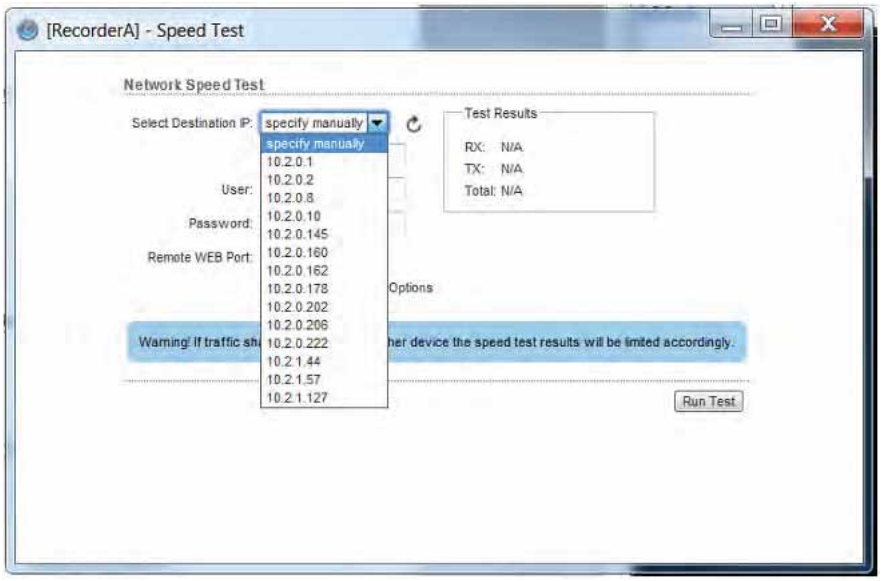


Figure 5–20 Speed Test Window

b Type `ubnt` in the **User** text box.

c Type `ubnt` in the **Password** text box.

d Type `80` in the **Remote WEB Port** text box.

e The default test **Direction** is duplex; the test is performed for both transmit and receive. If you want to run the test in only one direction, perform the following steps:

1) Select the **Show Advanced Options** check box.

2) Select transmit or receive.

f Click **Run Test**.

g If the following error is displayed, type **443** in the **Remote WEB Port** text box and click **Run Test**.

Error: Invalid remote port or web server is not running.

h Good **Test Results** are as follows:

- **RX** (receive) only = 70+ Mbps
- **TX** (transmit) only = 70+ Mbps
- **Total** (duplex) = 90+ Mbps
  - RX = 40+ Mbps
  - TX = 40+ Mbps

7 Click another line segment radio IP address in the **Select Destination IP** list, click **Run Test**, and then check results. Repeat for all line station radios.

8 If **Speed Test** results are low, perform the following steps for a Bullet radio. (Go to *step 9 on page 124*):

a Log in to the line station radio that displayed low **Speed Test** results.

b Click the **Status** tab and verify the following values:

- **WSI-MAX (AirMax) Quality** > 80%. If the value is < 80%, check the following:

- Poor line-of-sight
- Bad antenna connection
- Faulty hardware (cable and/or antenna)

► **WSI-MAX (AirMax) Capacity** >40%. If the value is < 40%, note the following:

- The maximum capacity for the titanium bullet is 50%
- Capacity is a reflection of quality. If the quality improves, the capacity should also improve.
- Poor capacity is typically the result of a misaligned antenna.

► Click AP Information in the **Monitor** area. Verify that the **Access Point Signal Strength** is between -80 dBm and -65 dBm.

c Verify that line station radios are pointing in the correct direction.

d Raise the mast towers to provide the least obstructed view as is reasonable.

e Check the condition of the antenna panels.

f Check for frayed cables or water intrusion.

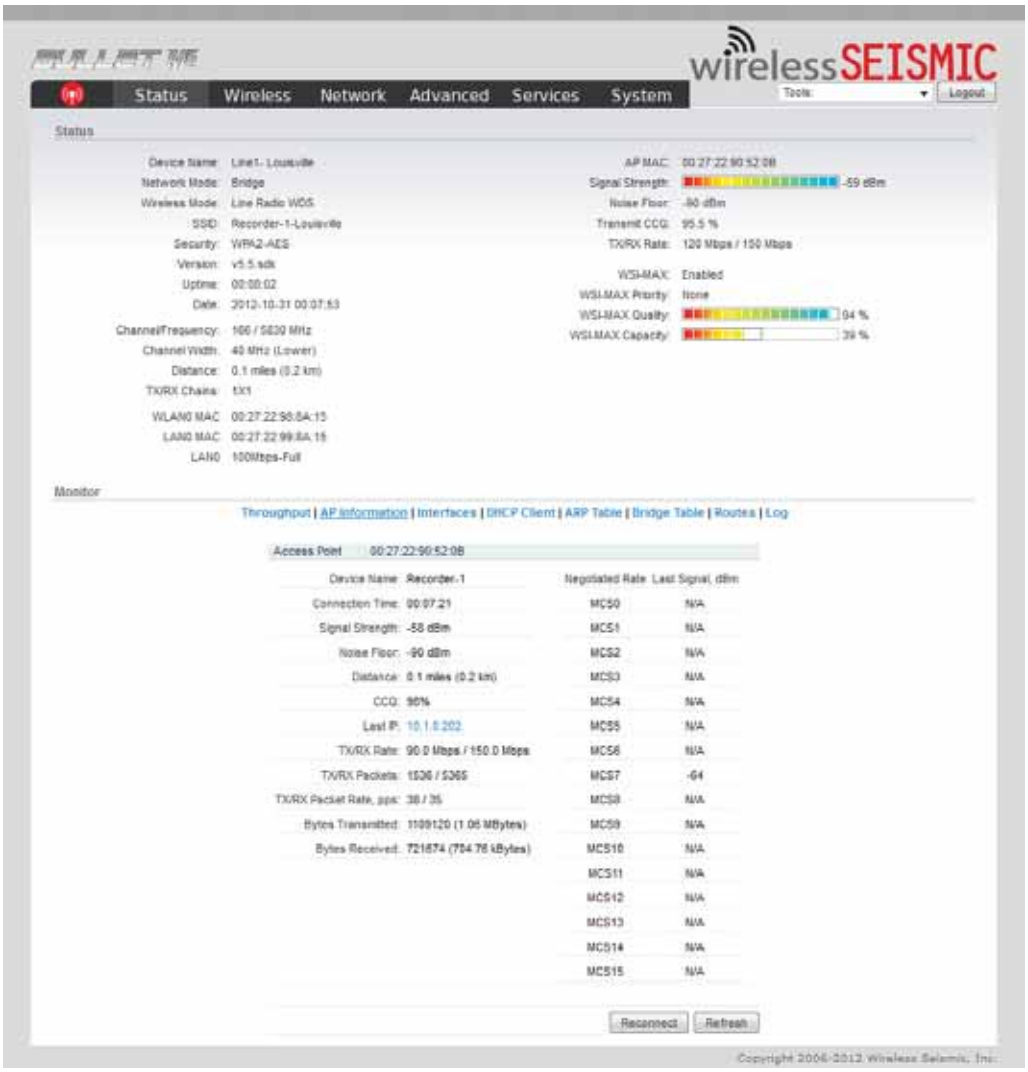


Figure 5–21 Bullet Radio Status Tab

9 If **Speed Test** results are low, perform the following steps for a NanoStation radio. Use a systematic approach of testing links to identify the offending radio pairs:

a Log in to a Station (S) radio.

b Click the **Main** tab and verify the following values:

- Signal Strength < -75 dBm
- Either the **Vertical** or **Horizontal** (Main Tab, Stations only) < -80 (between -65 and -75 is ideal)
- **Transmit CCQ** < 90% (100% is ideal)
- Click **AP Information** in the **Monitor** area. Verify that the **Access Point Signal Strength** < -75 dBm

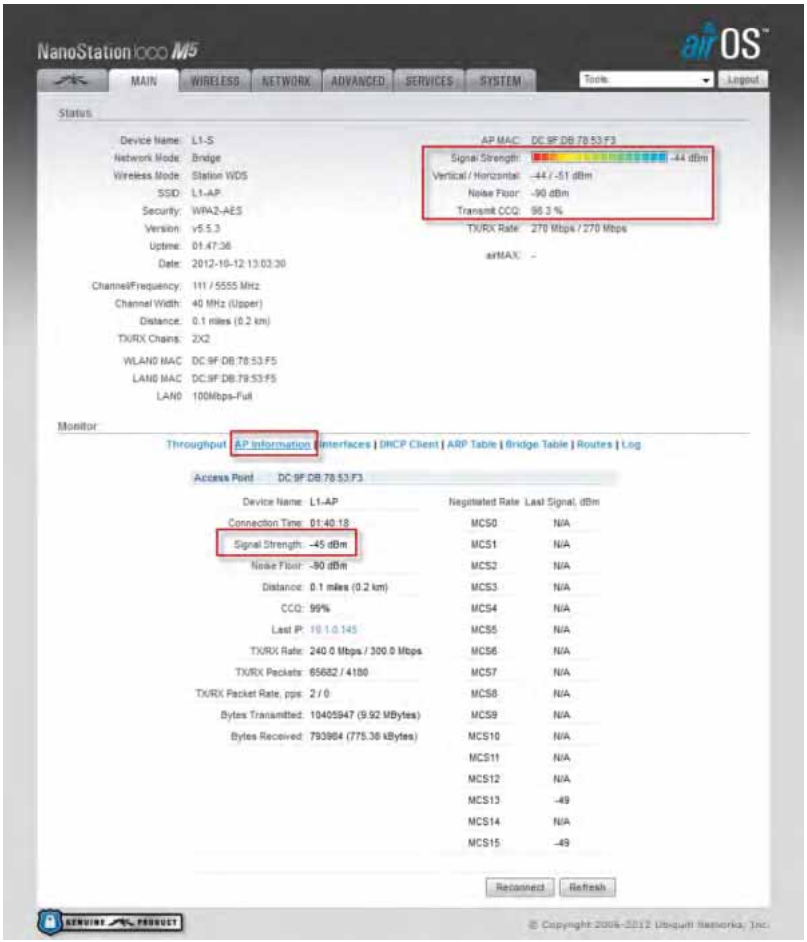


Figure 5–22 NanoStation Main Tab

c Repeat step a and step b for all of the radios.

10 If the individual links are all good but the backhaul as a whole does not deliver the appropriate throughput, it indicates that there is an interference problem.

Contact Andy Prokop, Jerry Stair, or Mike Shilts for project-specific recommendations.

11 If there are individual links with low numbers, perform the following steps to fix them:

a Verify that the radios are pointing in the correct directions.

b Verify that there are no frayed cables or cables with water intrusion.

c Verify that shielding is properly installed. The following figure shows the radio/ antenna shielding:

Figure 5–23 Radio/Antenna Shielding

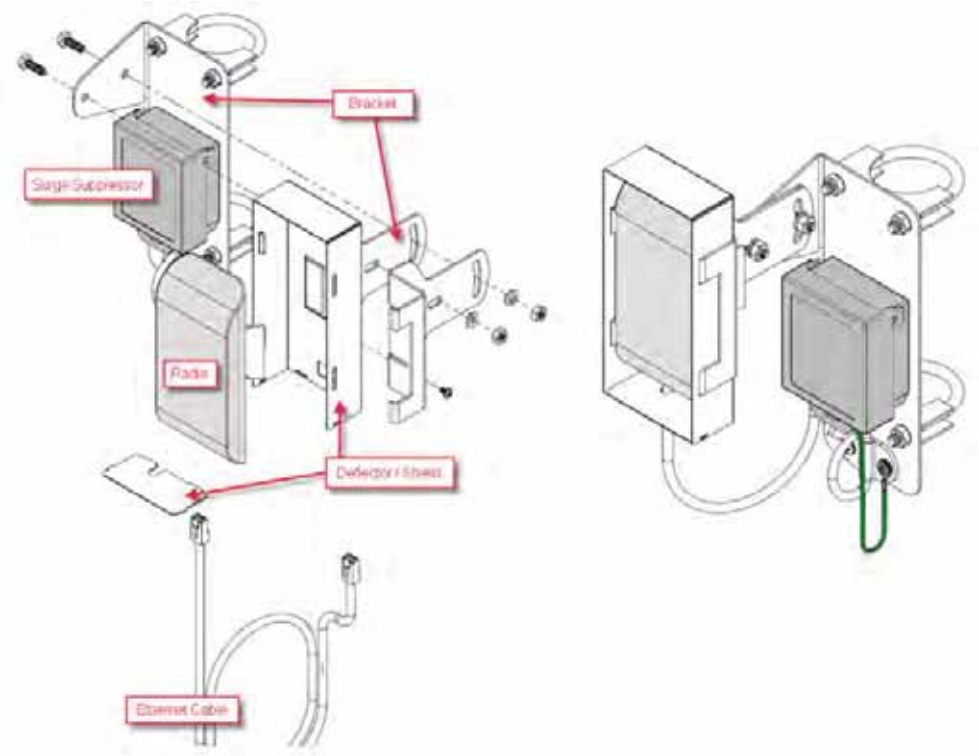


Figure 5–24 NanoStation Radio Shielding and Surge Suppressor

d For the NanoStation radios:

1) Verify that the radios on the same pole are at least three feet apart.

2) Verify that the Access Point (A) radio is three feet higher on the pole than the Station (S) radio.

3) If possible, raise the poles (masts) to provide the least-obstructed view to the partner radio as is reasonable.

5.6 Replacing a Radio

Any number of environmental hazards could destroy an existing radio. When this happens, replace it using the following instructions:

1 Identify the radio that needs to be replaced.

2 When the radio was initially configured for the point-to-multipoint backhaul, a label was attached to the radio indicating which configuration file was used. Make a note of the configuration label (for example, Line_1_Recorder_A).

3 Duplicate the configuration label and attach it to the replacement radio using the same information.

4 Locate the corresponding configuration file (for example, `Line_1_Recorder_A.cfg`) and upload it to the replacement radio according to *step 2 on page 107* through *step 13 on page 111*.

5 Mark the faulty radio is so that it does not work its way back into the spread.
6 Replace the radio on the pole.

5.7 Upload New Firmware

This section describes how to upload new firmware into the radio.

To upload new firmware:

→ **Windows computer** → **Radio Configuration, System tab**

1 Click **Browse** next to **Upload Firmware** and navigate to the supplied BIN file.
2 Select the file and click **Open**.
3 Click **Upload**.
4 Click **Update**.
5 Do not power off the radio until the firmware is updated.

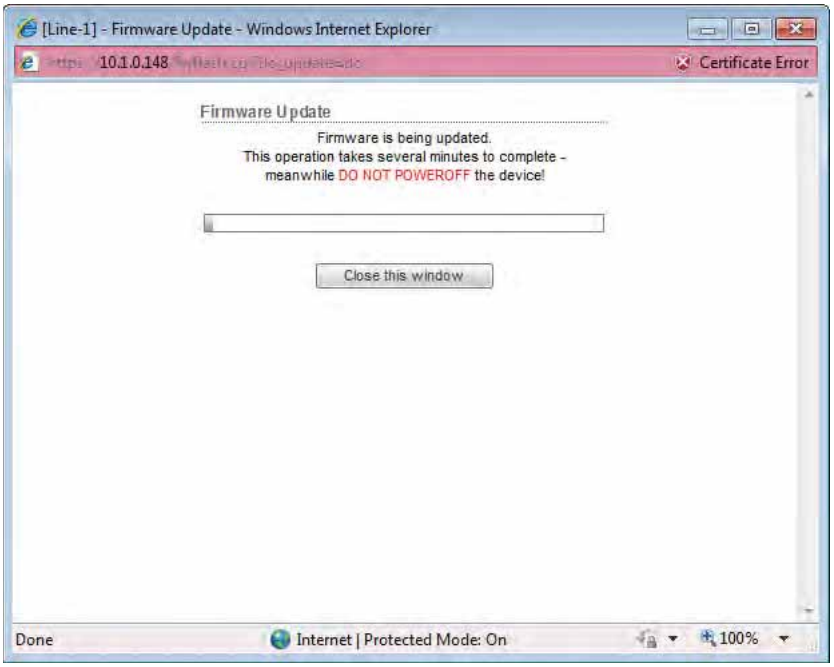


Figure 5–25 Radio Configuration, Updating Firmware

5.8 Unzipping the Configuration Files

The configuration files are delivered combined into one compressed file (config.zip).

To extract the files, use the built-in Windows 7 extraction process, or you can use a third-party tool such as 7-Zip.

To use the Windows 7 process:

1. Locate the ZIP file in Windows Explorer.
2. Right-click the ZIP file name and then click **Extract All**.
3. Browse to and select a folder.
4. Click **Extract**.

To use 7-Zip:

1. Download and install 7-Zip if it is not already installed:

http://www.7-zip.org/download.html

2. Locate the ZIP file in Windows Explorer.
3. Right-click the ZIP file name and then click **7-zip** → **Extract Files**.
4. Browse to and select a folder.
5. Click **OK**.

5.9 Connecting to the Recording Truck

The line communicates to the recording truck through an LIU using one of the following methods:

- Fiber cable
- Radio link (pendant)

The following figure shows a fiber cable connection example:

Figure 5–26 Connecting the Recording Truck with Fiber

The following figure shows a radio link (pendant) connection example.

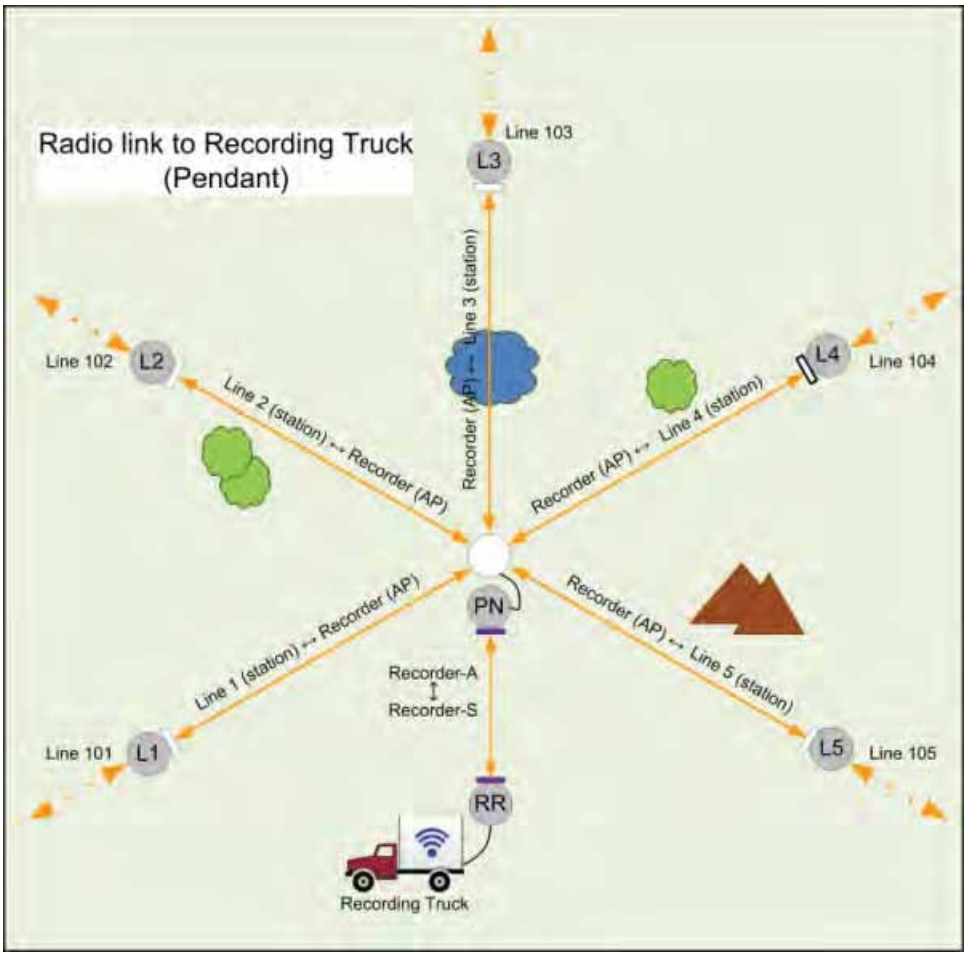


Figure 5–27 Connecting the Recording Truck with a Pendant Radio Link

The following figure shows the connections for the pendant radio link example.

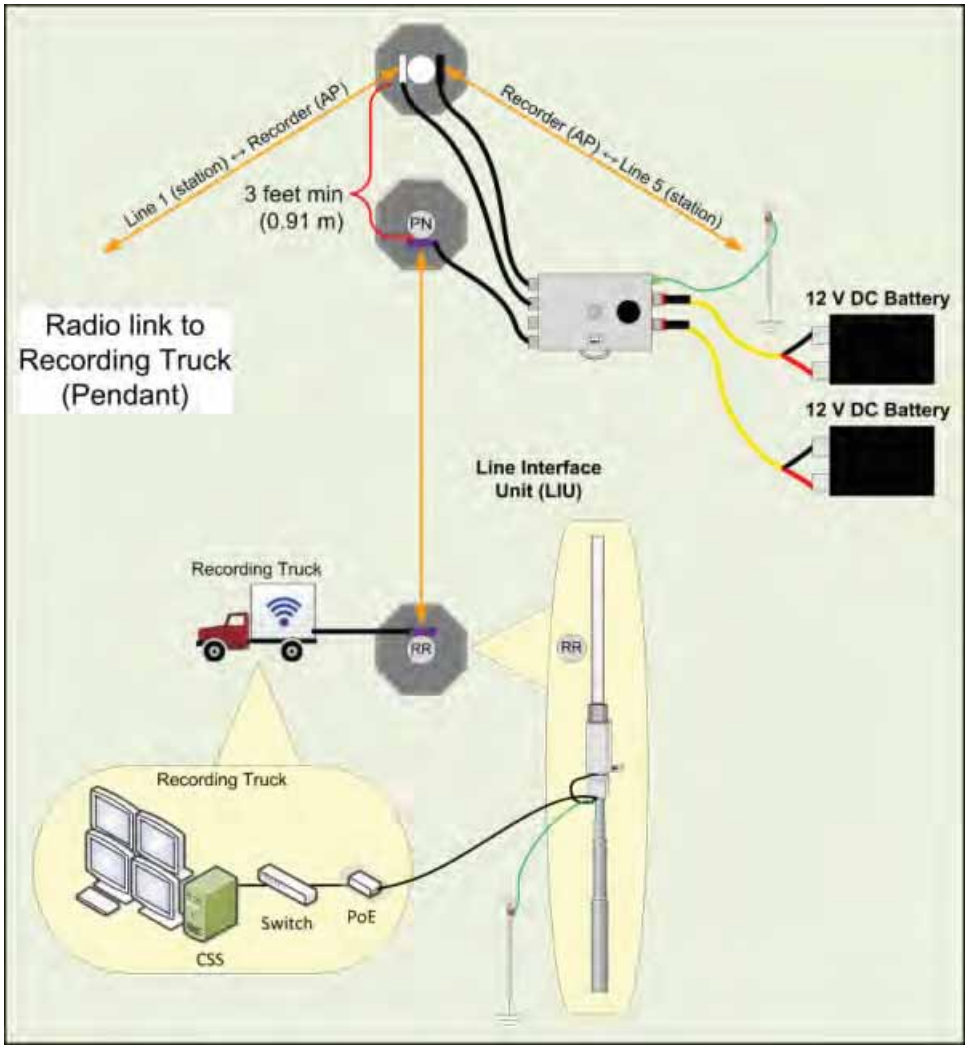


Figure 5–28 Connecting the Pendant Radio Link

The following table lists information about the pendant radio connection.

Table 5–5 Pendant Radio Link Elements

Item	Description
Configuration	The following additional configuration files are provided: • • Recorder-AP.cfg • • Recorder-S.cfg
RR	• The radio at the recording truck is a Rocket radio with an Omni antenna and is indicated in the drawings as RR (Recorder/ Rocket). • Use the Recorder-AP.cfg file with this radio. • The RR radio should be installed at the top of the pole, pointing directly at the pendant radio (PN).
PN	• The radio at the line is a NanoStation radio with a built-in antenna and is indicated in the drawings as PN (Pendant/Nano). • Use the Recorder-S.cfg file with this radio. • The PN radio should be installed at the top of the pole, pointing directly at the recording truck radio antenna (RR). • The PN radio should be at least 3 ft (0.91 m) from the line pole (Pole 1 in the example shown in *"Connecting the Recording Truck with a Pendant Radio Link" on page 131*). Use as much distance as you can as allowed by your cable lengths. • The PN radio and pole should be between the line and the recording truck as shown in *"Connecting the Recording Truck with a Pendant Radio Link" on page 131*.
Batteries	• Adding a third radio to the LIU increases the battery usage at this position. To ensure that the LIU does not reset due to a low or depleted battery, keep two batteries connected to the LIU at all times. • The battery with the lowest voltage is used until the voltage falls below the Unit Thresholds ? LIU Voltage Warning number (usually about 11V). At this point, the LIU auto-swaps to the battery with the higher voltage. Monitor the battery status in the Ground Equipment Table. Replace the low-voltage battery with a fully-charged battery as soon as possible after the battery auto-swap occurs.

After the pendant radio link radios are configured and installed, log in to the PN radio and set the power level to the minimum amount required to achieve communication with the RR.

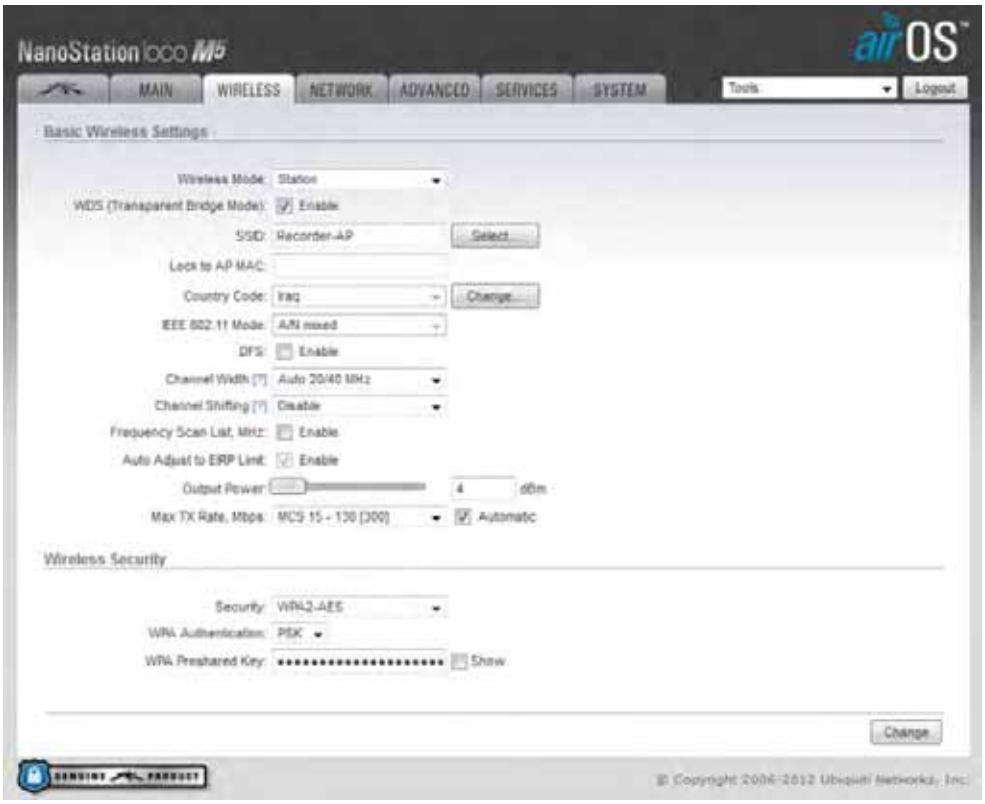


Figure 5–29 Wireless Tab

To set the PN radio power level:

1. Click the **Wireless** tab.
2. Move the **Output Power** slider bar to the desired power level.
3. Click **Change** at the bottom of the window.
4. Click **Apply Command** at the top of the window.
5. Wait 30 – 60 seconds.

6

Demobilization

6.1 Overview

This chapter describes how to prepare (undeploy) the ground electronics for transport at the end of a project (demobilization).

6.2 Removing the WRU from the Field

This section describes the process to ready the WRU for movement to a new physical location or to remove it in preparation for demobilization.

To undeploy the WRU:

1 Prerequisites:

- The WRU is assembled with battery, geophone, optional anchor plate, and antenna (and extender)
- The WRU is in an active, transitional, or ready state

2 Optional: If the anchor plate is attached, remove the nails or stakes anchoring it to the ground.

3 Pick up the WRU and point the geophone connector end towards the sky as shown in the following figure. Within a few seconds, all of the LEDs illuminate:

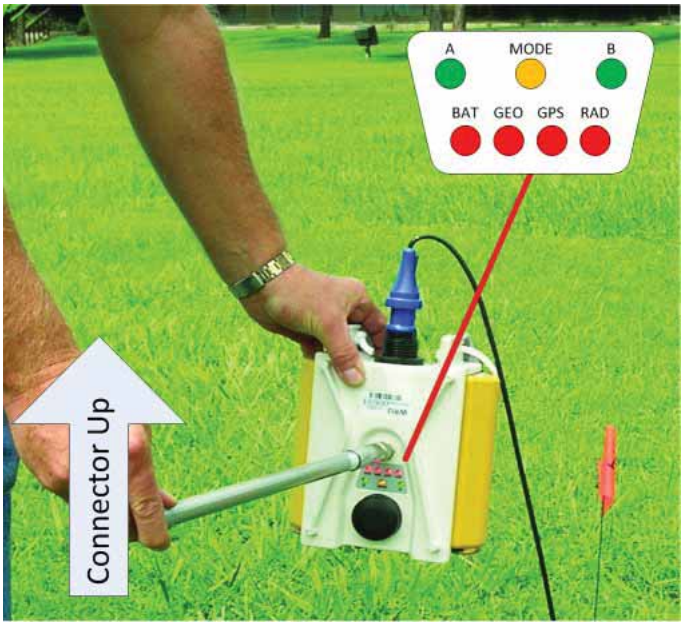


Figure 6–1 Power Off the Unit

4 Within 5 seconds, place the unit flat in the transportation vehicle as shown in the following figure. The LEDs on the top of the unit turn off and then flash on briefly to indicate the WRU is undeployed and the unit shuts down.

Figure 6–2 Undeployed Unit

5 Optional: Remove batteries, antenna, or geophone as described in *"Disassemble the WRU" on page 136*.

6.3 Disassemble the WRU

This section describes the process to disassemble the WRU prior to demobilization.

To disassemble the WRU:

1 Undeploy the equipment as described in *"Removing the WRU from the Field" on page 135*.
2 Remove the antenna (and extender) from the unit.
3 Remove the geophone from the unit.
4 Remove the batteries from the unit.
   - Press the catch on the battery latch.
   - Lift the lever, but do not lift the bail from the molded area on the battery.

- Continue to lift the lever using the bail to push the battery out of the connector.

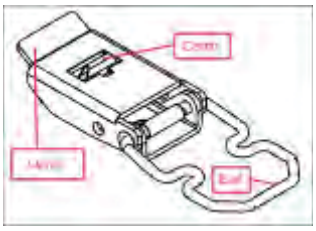


Figure 6–3 Removing the Battery

5 It is not necessary to remove the anchor plate. The WRU will stack with the anchor plate attached.

6 Secure the equipment in the transport vehicle.

7

Batteries

See *"Batteries" on page 194* for the French translation of this chapter.

Voir *"Batteries" sur la page 194* pour la traduction française de ce chapitre.

This chapter provides information about the batteries and battery requirements used in the Wireless Seismic, Inc. RT System 2.

7.1 Lithium Ion Batteries

This section provides information regarding the characteristics, use, and handling of lithium ion batteries. See the following sections for details:

- *"Specifications" on page 138*
- *"Handling and Safety Guidelines" on page 139*
- *"Transportation" on page 140*
- *"Storage" on page 141*

7.1.1 Specifications

The RT System 2 uses one or two custom intelligent lithium-ion batteries with self-contained charging circuitry that protects the batteries from overcharge, discharge, short circuits, or extreme temperature charging.

Battery specifications are shown in the following table:

Table 7–1 Lithium Ion Battery Specifications

Item	Description	Value
Voltage	Nominal	3.7 VDC
	Shut-off	2.8 VDC
	Full (90%) charge	4.1 VDC
	Overcharge Voltage	4.28 VDC
	Over Discharge Voltage	2.80 VDC
Current	Maximum Charge Current	2 A
	Consumption Active Mode	4.2 mA maximum
	Consumption Sleep Mode	66 μA maximum
Full (90%) charge mAh	Approximately 12,000 mAh at nominal voltage	—
Full (90%) charge mWh	Approximately 44,400 mWh at nominal voltage	—
Capacity		48.8 Watt hours

Table 7–1 Lithium Ion Battery Specifications (cont.)

Item	Description	Value
Connector	5-pin	—
LED	One LED that indicates charging status when connected to the charging station as follows	• Green – Charged • Red – Charging • Amber – Transitional phase between charging and charged, or charge temperature limits exceeded
Label	One bar code serial number label	—
Temperature	Operating	From -40°C to +85°C
	Charging	From -5°C to +45°C
	Ambient Storage	• From -20°C to +45°C for a maximum period of one month • From -20°C to +35°C for a maximum of 6 months, after which time the battery packs will need to be recharged to above 50% capacity

7.1.2 Handling and Safety Guidelines

Observe the following handling and safety guidelines:

- If a battery pack has leaking fluids, do not touch any fluids. Dispose of a leaking battery pack. In case of eye contact with fluid, do not rub eyes. Immediately flush eyes thoroughly with water for at least 15 minutes, lifting upper and lower lids until no evidence of the fluid remains. Seek medical attention.
- Do not disassemble, crush, or puncture a battery
- Do not short the external contacts on a battery
- Do not dispose of a battery in fire or water
- Do not expose a battery to temperatures above 60 °C (140 °F)
- Keep the battery away from children
- Avoid exposing the battery to excessive shock or vibration
- Do not use a damaged battery
- Lithium Ion battery packs MUST be completely discharged before disposal
- Although there may be local or state restrictions, lithium ion batteries are considered by the Federal Government as “non-hazardous universal waste”. There are restrictions for large quantity handlers of universal waste that define labeling, containment, and so on. Whenever possible the batteries must be discharged before disposal. Battery leads/ contacts should be taped off to prevent accidental shorting. Each battery pack should be placed in a plastic bag.
- Recycling is encouraged when practical and applicable. The batteries contain recyclable material and are accepted by several battery recycling companies. Refer to one of the following for more information on recycling and disposal:
  - http://www.swe.com

- http://www.rbrc.org
- http://www.call2recycle.org
- 1-800-8-BATTERY
- 1-877-2-RECYCLE

7.1.3 Transportation

In the United States, large lithium ion battery shipments (more than 24 cells or 12 batteries per package) are regulated as hazardous material (Class 9) by the Federal Government and are subject to the regulations described in the following:

- Code of Federal Regulations, Title 49 Transportation
  http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?sid=92868a82add6feba6afa796572133179&c=ecfr&tpl=/ecfrbrowse/Title49/49tab_02.tpl
- International Air Transport Association (IATA)
  http://www.iata.org/whatwedo/cargo/dangerous_goods/pages/lithium_batteries.aspx

Batteries can be ground shipped only if all of the following conditions are met:

- Box used meets the 1.2 m drop test box (“UN” rated box) for packaging
- Battery pack terminals are protected to prevent a short circuit
- Gross weight does not exceed 30 kg (66 pounds)
- Outer package is labeled with the current required label. An example is shown in the following figure.

Figure 7–1 Example Battery Shipping Label

Batteries can be air shipped only if all of the following conditions are met:

- Box used meets the 1.2 m drop test box (“UN” rated box) for packaging
- Maximum weight of each package does not exceed 10 kg (22 lbs)
- Battery pack terminals are protected to prevent a short circuit

- Outer package is labeled with the current required label. An example is shown in the previous figure (*"Example Battery Shipping Label" on page 140*).

NOTE

The information contained in this document is intended to provide general awareness of battery regulations; it is not comprehensive, and the requirements referenced herein may have changed. Nothing in this chapter or the Deployment Guide constitutes legal advice or is intended to address any specific legal, compliance, or regulatory issues that may arise in particular circumstances. This chapter and the Deployment Guide are not intended to replace current, official regulations regarding the packaging and shipment of hazardous materials or independent legal counsel on these issues. You are solely responsible for compliance with all applicable laws, regulations, and other requirements. Please refer to an official copy of the current version of these documents for the latest information.

7.1.4 Storage

Proper storage and maintenance of Lithium Ion batteries is essential to maximize their useful life and avoid catastrophic failure. Observe the following storage precautions:

- Remove the batteries from the WRU for storage
- The recommended storage temperature for Lithium ion batteries is as follows:
  - From -20°C to +45°C for a maximum period of one month
  - From -20°C to +35°C for a maximum of 6 months, after which time the battery packs will need to be recharged to above 50% capacity
  - Storing at cooler temperatures slows down self discharge and capacity loss over time. Store the batteries at 25°C or less if possible
- The recommended storage charge levels are as follows:
  - Charge (or discharge) batteries to a 30% to 50% charge level before placing into storage. Higher or lower charge levels can reduce the battery life.
  - Never store the battery completely depleted of charge unless for disposal.
  - Periodic charging is necessary to maintain 30% to 50% charge when stored for a long period of time
- Store batteries in a well ventilated area
- Do not leave batteries unused for extended periods of time, either in the product or in storage. When a battery has been unused for 6 months, check the charge status and charge or dispose of the battery as appropriate.
- Routinely check the battery's charge status
- Consider replacing the battery with a new one if you note either of the following conditions:
  - The battery run time drops below about 80% of the original run time
  - The battery charge time increases significantly

7.2 Charging Lithium Ion Batteries

7.2.1 Charging Precautions

Observe the following charging precautions:

- Prior to charging, inspect the battery for any visible damage to the case or connector that could create an electrical shortage.
- The temperature range over which the battery can be charged is 0°C to +45°C. Charging the battery outside of this temperature can cause the battery to become hot or to break.
- Be absolutely sure that only a 5 V source is used when charging the battery.
- Care should be taken to charge batteries on a fireproof surface.
- Do not charge batteries near flammable items or liquids.
- Keep a Class C Dry Chemical fire extinguisher nearby.
- Do not continue recharging the battery if it does not recharge within the specified charging time.
- A lithium ion battery should NEVER be left unattended while charging.

7.2.2 Battery Charger

The lithium ion battery charger is designed to operate from a single 10 A, 120 VAC service line.

The power supply to charge the battery pack is a 5VDC regulated voltage supply.

Figure 7–2 Battery Charger

Figure 7–3 Serial Number Label and LED Indicator

CAUTION	*Risk of explosion if battery is replaced by an incorrect type. Dispose of used batteries according to the instructions.*
PRUDENCE	*Une explosion risque de se produire si vous remplacez la batterie par un type de batterie inapproprié. Suivez les instructions pour vous débarrasser de la batterie.*
VORSICHT	*Es besteht das Risiko einer Explosion, wenn die Batterie nicht mit dem korrekten Batterietyp ersetzt wird. Entsorgen Sie benutzte Batterien den Anweisungen entsprechend.*
PRZESTROGA	*W przypadku wymiany baterii na niewłaściwy typ zachodzi ryzyko wybuchu. Zużyte baterie należy zutylizować zgodnie z instrukcjami.*

A

Legal Information

See *"l'information juridique" on page 200* for the French translation of this chapter.

Voir *"l'information juridique" sur la page 200* pour la traduction française de ce chapitre.

A.1 FCC Rules and Regulations Compliance

The Federal Communications Commission (FCC) regulates the use of antennas in the "*Code of Federal Regulations – Title 47, Part 15 – Radio Frequency Devices, Subpart C – Intentional Radiators, Section 15.203 Antenna Requirement*."

NOTE

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

NOTE

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

REMARQUE

En vertu des règlementations d'Industrie Canada, cet émetteur radio peut être utilisé uniquement à l'aide d'une antenne de type et de gain maximum (ou inférieur) approuvés pour l'émetteur par Industrie Canada. Pour réduire les interférences radio éventuelles avec d'autres utilisateurs, le type et le gain de l'antenne doivent être choisis de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas la valeur nécessaire pour établir une communication réussie.

When used as intended, the RT System 2 complies with FCC Section 15.203 and Industry Canada RSS-Gen 7.1.2 requirements as follows:

- The RT System 2 antennas shall be installed and handled by professionals specifically designated for this purpose.
- Changes or modifications not expressly approved by Wireless Seismic, Inc. can void the users's authority to operate the equipment.
- The RT System 2 shall be used with only the supplied antennas (*Table A–1*) attached to the WRU (all models) or LIU (all models) with an integrated type N male (threaded or HPQN) connector.

NOTE

This radio transmitter has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

REMARQUE

Cet émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés ci-dessous. Le gain maximum permis et l'impédance d'antenne requise pour chaque antenne sont indiqués. Les types d'antenne non inclus dans cette liste, ayant un gain supérieur au gain maximum indiqué pour le type en question, sont strictement interdits pour ce dispositif.

Table A–1 Antenna Specifications

Model	Frequency (MHz)	Maximum Gain	Vertical Bandwidth	Weight	Dimension (Length x Diameter)
WSI 65-0204/65-0264 (antenna-standard)	2400	5.5 dBi (50 ohm)	25°	0.4 lbs 0.2 kg	32 x 0.6 in 810.5 x 15 mm
WSI 65-0091 (extender-standard)	2400	0 dBi	N/A	0.6 lbs 0.3 kg	30 x 0.7 in 762 x 18.5 mm

CAUTION

In order to comply with radio frequency (RF) exposure requirements, the RT System 2 units must be installed so that a minimum separation distance of 20 cm is maintained between the antenna(s) and the body of all persons at all times during normal operation.

PRUDENCE

Afin de se conformer aux normes de la matière d'exposition aux radiofréquences (RF), les unités RT System 2 doivent être installées de manière à garder en permanence une distance minimale de 20 cm entre la ou les antennes et le corps de toute personne en mode de fonctionnement normal.

VORSICHT

Um den Radiofrequenz-Strahlen-belastungsrichtlinien zu entsprechen, müssen die RT-System 2 Einheiten so eingebaut werden, dass ein Mindestabstand von 20 cm zwischen der/n Antenne/n und dem/n Körper/n aller Personen zu jeglicher Zeit während der üblichen Betriebszeiten gewährleistet ist.

PRZESTROGA

Aby zachować zgodność z wymogami dotyczącymi ekspozycji na promieniowanie o częstotliwości radiowej (RF), urządzenia RT System 2 należy instalować tak, aby podczas normalnej obsługi pomiędzy ciałem wszystkich osób a antenami przez cały czas było co najmniej 20 cm odstępu.

FCC equipment authorization has been granted as follows:

- The 5Mbps Line Interface Unit has been granted FCC equipment authorization.
- The 5Mbps Wireless Remote Unit has been granted FCC equipment authorization.

A.2 Industry Canada Compliance

The Wireless Remote Unit (WRU) provided with this guide has been granted Industry Canada (IC) approval and certification per RSS-210 Issue8 and RSS-102 Issue 4.

This Class A digital apparatus complies with Canadian ICES-003.

The Line Interface Unit (LIU) provided with this guide has been granted Industry Canada (IC) approval and certification per RSS-210 Issue 8 and RSS-102 Issue 4.

This Class A digital apparatus complies with Canadian ICES-003.

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions:

- This device may not cause harmful interference, and
- This device must accept any interference received, including interference that may cause undesired operation.

A.3 CE Compliance

The Wireless Remote Unit (WRU) and Line Interface Unit (LIU) provided with this guide comply with applicable EU directives for the Conformité Européene (CE) mark. The following mark is affixed to each unit.

Figure A–1 CE Mark

A.4 Australian Compliance

This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

B

WRU and LIU Specifications

This section provides the WRU and LIU specifications. See the following sections for more information:

B.1 WRU Specifications

The following table provides the WRU Specifications:

Table B–1 WRU Specifications

Item	Description
Power source	3.7Vdc nominal – accessory battery voltage
Operating temperature	-40°C to +75°C
Humidity	0 to 100%
Environmental Rating	IP67
Operating Frequency Range	2403 MHz to 2475 MHz
Dimensions	1C WRU: 5.79 W x 2.83 H x 9.01 L in. (14.7 W x 7.2 H x 22.9 L cm) 3C WRU: 5.79 W x 3.35 H x 9.01 L in. (14.7 W x 8.5 H x 22.9 L cm)
Dimensions with 2 batteries	1C WRU: Standard – 7.71 W in. (19.58 W cm) High capacity – 9.17 W in. (26.66 W cm) 3C WRU: Standard – 7.71 W in. (19.58 W cm) High capacity – 9.17 W in. (26.66 W cm)
Weight	1C WRU: Stand-alone – 4.02 lbs. (1.83 kg) 3C WRU: Stand-alone – 4.64 lbs. (2.10 kg)

Table B–1 WRU Specifications (cont.)

Item	Description
Weight with 2 batteries and antenna	1C WRU: Standard – 6.5 lbs. (2.95 Kg) High capacity – 7.71 lbs. (3.50 kg) 3C WRU: High capacity – 8.33 lbs. (3.78 kg)

B.2 LIU Specifications

The following table provides the LIU Specifications:

Table B–2 LIU Specifications

Item	Description
Maximum PoE output power	40W
Power source	12V DC (+20% tolerance) battery
Operating temperature	-40°C to +75°C
Humidity	0 to 100%
Environmental Rating	IP67
Dimensions	5.42 W x 9.44 H x 14.21 L inches (24 W x 14 H x 36 L centimeters)
Weight	13 lbs. (5.9 Kg)
Current Rating	5 A
Operating Frequency Range	2403 MHz to 2475 MHz

C

Radio Specifications

This section provides the backhaul radio and antenna specifications. See the following sections for more information:

- *"Antenna Specifications" on page 149*
- *"Radio Specifications" on page 156*

C.1 Antenna Specifications

This section provides the antenna specifications. See the following sections for more information:

- *"Bullet Line Station Antenna" on page 149*
- *"Rocket Recorder Antenna" on page 152*
- *"NanoStation Recorder/Line Station Antenna" on page 155*

C.1.1 Bullet Line Station Antenna

The remote (line) station backhauls using the Ubiquiti Bullet radios support the following antennas:

- **6 dBi antenna** (65-0179) – This antenna is a UV stable, omnidirectional vented radome that can sustain extreme weather conditions such as heat, wind, and rain, and can be mounted to a mast, ceiling, or wall.
- **19 dBi directional antenna** (65-0177) – This antenna is a UV-resistant, directional flat-panel ABS plastic radome antenna with an aluminum back plate. It can be surface or pole mounted and adjusted 45 degrees up or down.

Figure C–1 19 dBi Antenna (65-0177)

Figure C–2 6 dBi Antenna (65-0179)

The supported line station antenna specifications are as follows:

Table C–1 Antenna Specifications, 6 dBi (65-0179)

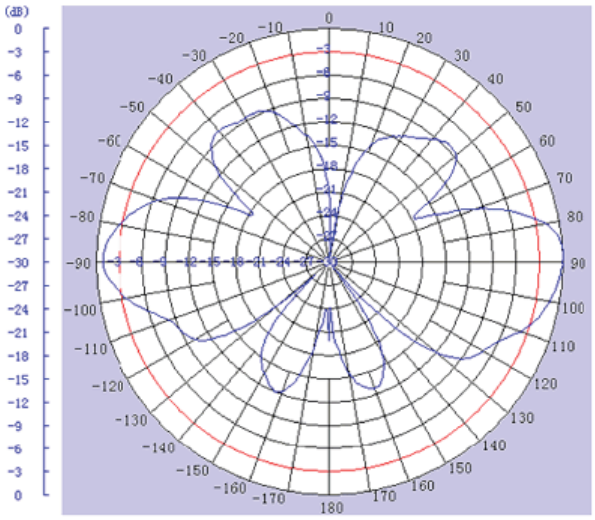
Item	Description	Radiation Patterns
Model	T58060O10006	 Vertical Radiation Pattern
Frequency Range	5725 to 5850 MHz	
Bandwidth	125 MHz	
Gain	6 dBi	
Vertical Beamwidth	25°	
VSWR	-/= 1.5	
Impedance	50 Ohms	
Polarization	Vertical	

Table C–1 Antenna Specifications, 6 dBi (65-0179) (cont.)

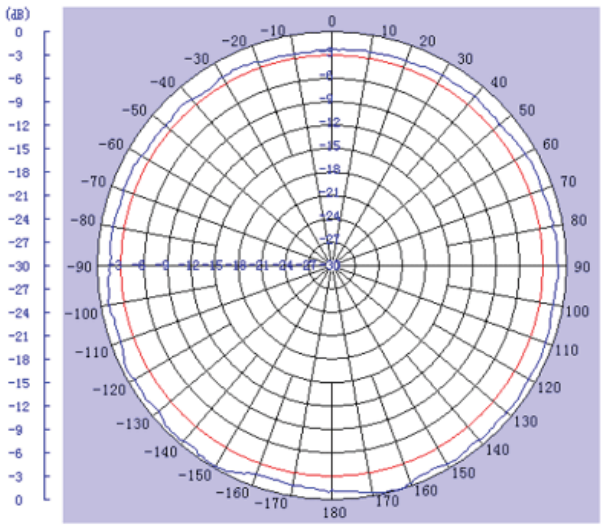
Item	Description	Radiation Patterns
Maximum Power	100 Watts	 Horizontal Radiation Pattern
Connector	N-Style Jack	
Height	10.6"	
Weight	0.5 lbs	
Horizontal Beamwidth	360°	
Rated Wind Velocity	135 mph	
Operating Temperature	-22°F to 158 °F -30 to 70 °C	

Table C–2 Antenna Specifications, 13 dBi (65-0177)

Parameter	Min	Typ	Max
Frequency Range	5150 MHz		5825 MHz
Gain		19 dBi	
Horizontal Beamwidth		16 Deg	
Vertical Beamwidth		16 Deg	
Front to Back	30 dB		
Cross Polarization	25 dB		
VSWR • 5150-5350MHz • 5470-5825MHz	 2.0:1 1.5:1		
Impedance		50 OHM	
Input Power			100W
Operating Temperature	-40 ºF -40 °C		158 °F 70 °C
Pole Size	1 in 25 mm		2.5 in 64 mm

Table C–2 Antenna Specifications, 13 dBi (65-0177) (cont.)

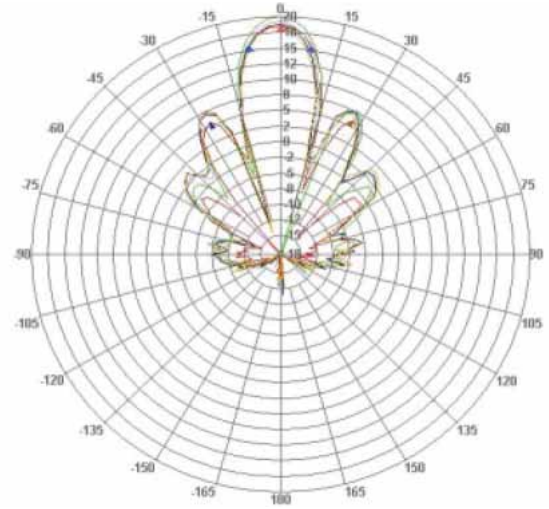
Parameter	Min	Typ	Max
Weight		17.6 oz 0.5 kg	
Dimension (L x W x Thick)	7.5 x 7.5 x 0.8 in 190 x 190 x 20 mm		
Bracket Tilt	45 Deg		
Radiation Pattern			

Table C–3 Antenna Wind Loading, 13 dBi (65-0177)

Parameter	Area	100 mph 161 kph	125 mph 201 kph
Wind Loading	56 sq in 0.04 sq m	14 lbs 6.4 kg	22 lbs 10 kg

C.1.2 Rocket Recorder Antenna

The recorder station backhaul using the Ubiquiti Rocket radio supports a 13 dBi antenna. This antenna is a 2x2 Dual Polarity MIMO Omnidirectional Antenna that provides 360 degree coverage.

Figure C–3 13 dBi Antenna (65-0178)

The supported recorder antenna specifications are as follows:

Table C–4 Antenna Specifications, 13 dBi (65-0178)

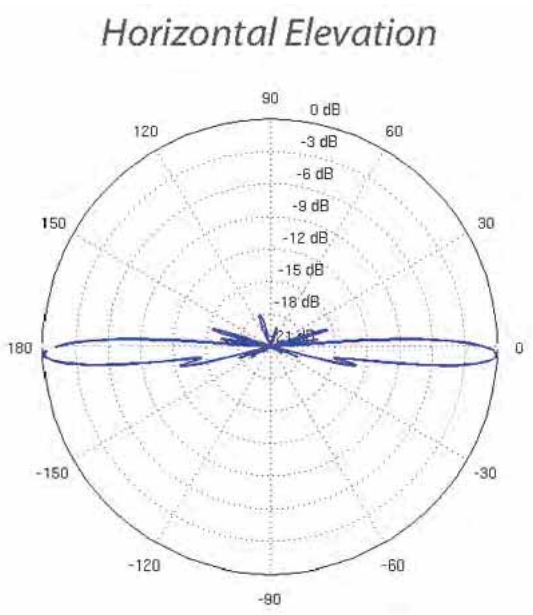
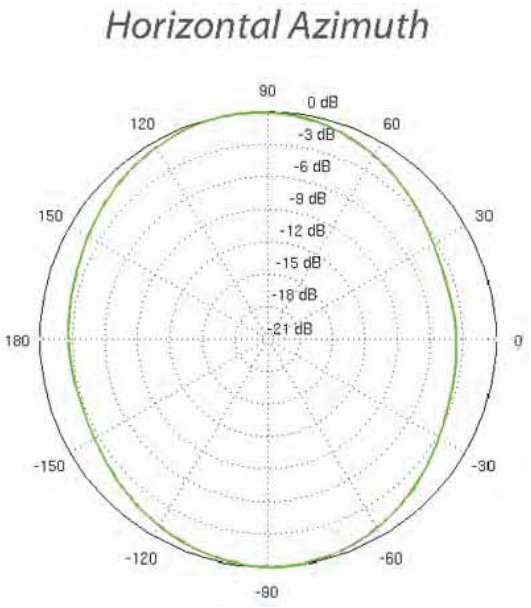
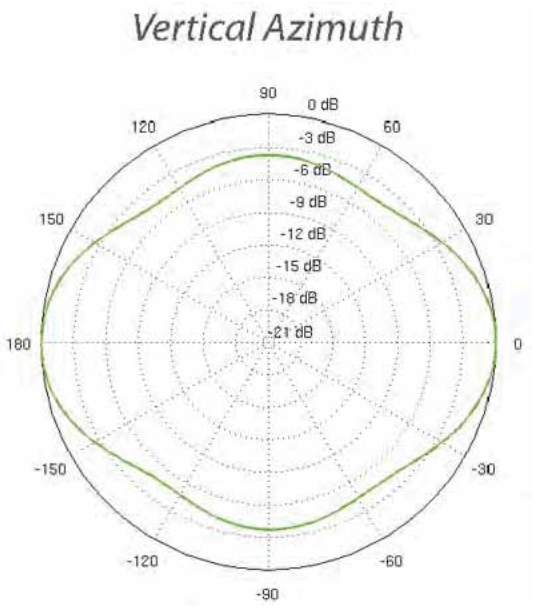
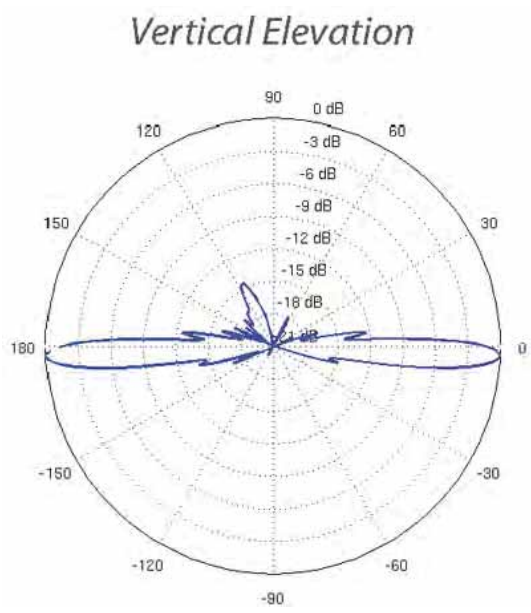
Item	Description	Radiation Patterns
Frequency Range	5.45 to 5.85 GHz	
Gain	13 dBi	
Elevation Beamwidth	7 deg	
Max VSWR	1.5:1	
Downtilt	2 deg	
Dimensions L x W x H	6.2 x 3.8 x 32.8 in 158 x 98 x 834 mm	
Weight (including pole mount)	1 lb 13 oz 820 g	
Wind Survivability	125 mph 201 kph	

Table C–4 Antenna Specifications, 13 dBi (65-0178) (cont.)

Item	Description	Radiation Patterns
Wind Loading	10 lb @ 100 mph 4.5 kg @ 161 kph	
Polarization	Dual Linear	
Cross-pol Isolation	25 Db min	
ETSI Specification	EN 302 326 DN2	
Mounting	Universal pole mount	
	

C.1.3 NanoStation Recorder/Line Station Antenna

The recorder or line station backhaul using the Ubiquiti NanoStation M5 radios do not use an external antenna; the NanoStation M5 has an integrated 14 dBi dual-polarity antenna.

The NanoStation integrated antenna specifications are as follows:

Table C–5 NanoStation Integrated Antenna Specifications

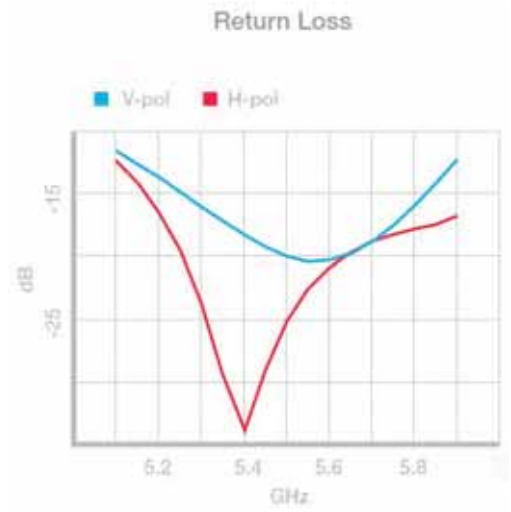
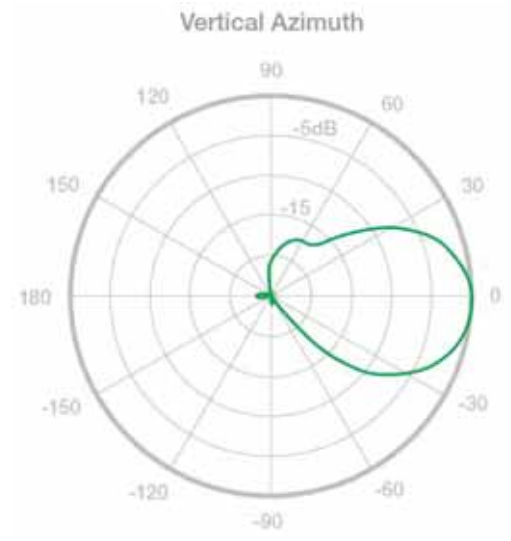
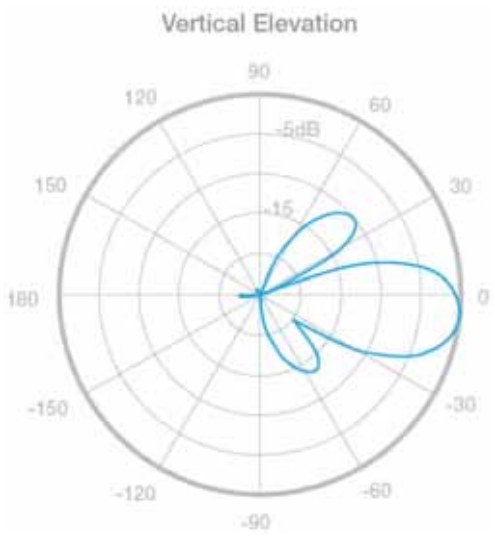
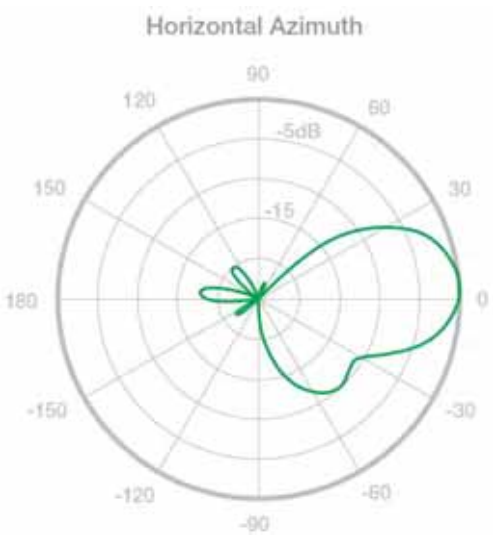
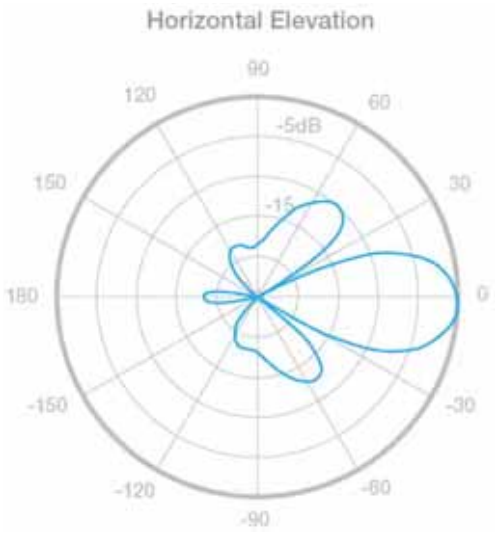
Item	Description	Radiation Patterns
Model	NSM5/+locoM5 integrated	
Frequency Range	5745 to 5825 MHz (US) 5170 to 5875 MHz (INTL)	
Cross Pol Isolation	20 dB Minimum	
Gain	13 dBi	
Beamwidth	45° (H-pol) 45° (V-pol) 45° (Elevation)	
Max VSWR	1.4:1	
Polarization	Dual Linear	
Maximum Power	5.5 Watts	
Maximum Power	5.5 Watts	
Connector	N-Style Jack	
Height	10.6"	
Weight	0.5 lbs	
Horizontal Beamwidth	360°	
Rated Wind Velocity	135 mph	
Operating Temperature	-22°F to 158 °F -30 to 70 °C	

Table C–5 NanoStation Integrated Antenna Specifications (cont.)

Item	Description	Radiation Patterns
		
		

C.2 Radio Specifications

This section provides radio specifications. The following radios are used in the backhaul:

- **Bullet** – 2.4 GHz High Power 802.11N Outdoor Radio System
  See *"Bullet Line Station Radios" on page 157*

- **Rocket** – 900 MHz High Power 2x2 MIMO AirMax TDMA BaseStation
  See *"Rocket Recorder Radios" on page 159*
- **NanoStation M5** – 5.8 GHz, High power, 2x2 MIMO AirMax TDMA PoE station with integrated 14 dBi dual-polarity antenna.
  See *"NanoStation Recorder/Line Station Radios" on page 160*

C.2.1 Bullet Line Station Radios

The specifications for the Ubiquiti Bullet line station radio are as follows:

Table C–6 Bullet Line Station Radio Specifications (56-0019 US, 56-0024 Intl)

Item	Description
System Information	
Processor Specs	Atheros MIPS 24KC, 400 MHz
Memory Information	32 MB SDRAM, 8 MB Flash
Networking Interface	(1) 10/100 Ethernet Port
Regulatory / Compliance Information	
Wireless Approvals	FCC Part 15.247, IC RS210, CE
RoHS Compliance	Yes
Physical / Electrical / Environmental	
Dimensions (length x width)	7.5 x 1.8 in 190 x 46 mm
Weight	6.9 oz 196 g
Enclosure Characteristics	Powder Coated Aluminum
Antenna Connector	N-Type Connector (male)
Power Supply	24V, 0.5A PoE Adapter (included)
Power Method	Passive Power over Ethernet (pairs 4, 5+; 7, 8 return)
Max. Power Consumption	6 Watts
Operating Temperature	-40 to 176 °F -40 to 80 °C
Operating Humidity	5 to 95% Condensing
Shock and Vibration	ETSI300-019-1.4
Software Information	
Modes	Station, Access Point, AP Repeater
Services	SNMP, DHCP, NAT
Utilities	Site Survey with Preferred SSID, Antenna Alignment Tool, Discovery Utility

Table C–6 Bullet Line Station Radio Specifications (56-0019 US, 56-0024 Intl) (cont.)

Item	Description
Security	WEP/WPA/WPA2
QoS	802.11e / WMM Support
Statistical Reporting	Ethernet Activity, Uptime, Packet Success/Errors
Operating Frequency	5725 to 5850 (USA) 5170 to 5825 (International)
Output Power	25 dBm
Range Performance	31+ mi 50+ km (Outdoor - Antenna Dependent)

The power specifications for the Ubiquiti Bullet line station radio are as follows:

Table C–7 Bullet Line Station Radio Power Specifications (56-0019 US, 56-0024 Intl)

TX Power Specifications				RX Power Specifications			
	Data Rate	Avg. TX	Tolerance		Data Rate	Sensitivity	Tolerance
11a	1-24 Mbps	25 dBm	+/-2 dB	11a	24 Mbps	-83 dBm	+/-2 dB
	36 Mbps	23 dBm	+/-2 dB		36 Mbps	-80 dBm	+/-2 dB
	48 Mbps	21 dBm	+/-2 dB		48 Mbps	-77 dBm	+/-2 dB
	54 Mbps	20 dBm	+/-2 dB		54 Mbps	-75 dBm	+/-2 dB
11n / airMAX	MCS0	25 dBm	+/-2 dB	11n / airMAX	MCS0	-96 dBm	+/-2 dB
	MCS1	25 dBm	+/-2 dB		MCS1	-95 dBm	+/-2 dB
	MCS2	25 dBm	+/-2 dB		MCS2	-92 dBm	+/-2 dB
	MCS3	25 dBm	+/-2 dB		MCS3	-90 dBm	+/-2 dB
	MCS4	24 dBm	+/-2 dB		MCS4	-86 dBm	+/-2 dB
	MCS5	22 dBm	+/-2 dB		MCS5	-83 dBm	+/-2 dB
	MCS6	20 dBm	+/-2 dB		MCS6	-77 dBm	+/-2 dB
	MCS7	19 dBm	+/-2 dB		MCS7	-74 dBm	+/-2 dB

C.2.2 Rocket Recorder Radios

The specifications for the Ubiquiti Rocket recorder radio are as follows:

Table C–8 Rocket Recorder Radio Specifications (15-0052 US, 15-0054 Intl)

Item	Description
System Information	
Processor Specs	Atheros MIPS 24KC, 400MHz
Memory Information	64MB SDRAM, 8MB Flash
Networking Interface	2 X 10/100 BASE-TX (Cat. 5, RJ-45) Ethernet
Regulatory / Compliance Information	
Wireless Approvals	FCC Part 15.247, IC RS210, CE
RoHS Compliance	YES
Physical / Electrical / Environmental	
Dimensions (length, width, height)	6.7 x 3.1 x 1.2 in 17 x 8 x 3cm
Weight	1.6 lb 0.5kg
Enclosure Characteristics	Outdoor UV Stabilized Plastic
RF Connector	2x RP-SMA and 1x SMA (Waterproof)
Mounting Kit	Pole Mounting Kit included
Power Supply	24V, 1A POE Supply included
Power Method	Passive Power over Ethernet (pairs 4, 5+; 7, 8 return)
Max Power Consumption	8 Watts
Operating Temperature	-22 to 167 °F -30 to 75 °C
Operating Humidity	5 to 95% Condensing
Shock and Vibration	ETSI300-019-1.4
Operating Frequency	5745 to 5825 (USA) 5470 to 5825 (International)
Output Power	27 dBm
Range Performance	up to 9.3 miles up to 15 km

The power specifications for the Ubiquiti Rocket radio are as follows:

Table C–9 Rocket Recorder Radio Power Specifications (15-0052 US, 15-0054 Intl)

TX Power Specifications				RX Power Specifications			
	Data Rate	Avg. TX	Tolerance		Data Rate	Ave. TX	Tolerance
11a	6-24 Mbps	27 dBm	+/-2 dB	11a	6-24 Mbps	-94 dBm min	+/-2 dB
	36 Mbps	25 dBm	+/-2 dB		36 Mbps	-80 dBm	+/-2 dB
	48 Mbps	23 dBm	+/-2 dB		48 Mbps	-77 dBm	+/-2 dB
	54 Mbps	22 dBm	+/-2 dB		54 Mbps	-75 dBm	+/-2 dB
11n / airMAX	MCS0	27 dBm	+/- 2 dB	11n / airMAX	MCS0	-96 dBm	+/- 2 dB
	MCS1	27 dBm	+/- 2 dB		MCS1	-95 dBm	+/- 2 dB
	MCS2	27 dBm	+/- 2 dB		MCS2	-92 dBm	+/- 2 dB
	MCS3	27 dBm	+/- 2 dB		MCS3	-90 dBm	+/- 2 dB
	MCS4	26 dBm	+/- 2 dB		MCS4	-86 dBm	+/- 2 dB
	MCS5	24 dBm	+/- 2 dB		MCS5	-83 dBm	+/- 2 dB
	MCS6	22 dBm	+/- 2 dB		MCS6	-77 dBm	+/- 2 dB
	MCS7	21 dBm	+/- 2 dB		MCS7	-74 dBm	+/- 2 dB
	MCS8	27 dBm	+/- 2 dB		MCS8	-95 dBm	+/- 2 dB
	MCS9	27 dBm	+/- 2 dB		MCS9	-93 dBm	+/- 2 dB
	MCS10	27 dBm	+/- 2 dB		MCS10	-90 dBm	+/- 2 dB
	MCS11	27 dBm	+/- 2 dB		MCS11	-87 dBm	+/- 2 dB
	MCS12	26 dBm	+/- 2 dB		MCS12	-84 dBm	+/- 2 dB
	MCS13	24 dBm	+/- 2 dB		MCS13	-79 dBm	+/- 2 dB
	MCS14	22 dBm	+/- 2 dB		MCS14	-78 dBm	+/- 2 dB
	MCS15	21 dBm	+/- 2 dB		MCS15	-75 dBm	+/- 2 dB

C.2.3 NanoStation Recorder/Line Station Radios

The specifications for the Ubiquiti NanoStation™ radio are as follows:

Table C–10 NanoStation Radio Specifications (56-0035 US, 56-0032 Intl)

Item	Description
System Information	
Processor Specs	Atheros MIPS 24KC, 400MHz
Memory Information	32MB SDRAM, 8MB Flash
Networking Interface	1 X 10/100 BASE-TX (Cat. 5, RJ-45) Ethernet
Regulatory / Compliance Information	

Table C–10 NanoStation Radio Specifications (56-0035 US, 56-0032 Intl) (cont.)

Item	Description
Wireless Approvals	FCC Part 15.247, IC RS210, CE
RoHS Compliance	YES
Physical / Electrical / Environmental	
Dimensions (length, width, height)	6.42 x 1.22 x 3.15 in 163 x 31 x 80mm
Weight	0.40 lb 0.18kg
Enclosure Characteristics	Outdoor UV Stabilized Plastic
Mounting Kit	Pole Mounting Kit included
Power Supply	24V, 0.5A POE Supply included
Power Method	Passive Power over Ethernet (pairs 4, 5+; 7, 8 return)
Max Power Consumption	5.5 Watts
Operating Temperature	-22 to 167 °F -30 to 75 °C
Operating Humidity	5 to 95% Condensing
Shock and Vibration	ETSI300-019-1.4
Operating Frequency	5745 to 5825 (USA) 5170 to 5875 (International)
Output Power	27 dBm
Range Performance	31+ mile 50+ km

The power specifications for the Ubiquiti NanoStation M5 radio are as follows:

Table C–11 NanoStation Radio Power Specifications (56-0035 US, 56-0032 Intl)

TX Power Specifications				RX Power Specifications			
	Data Rate	Avg. TX	Tolerance		Data Rate	Ave. TX	Tolerance
11a	6-24Mbps	23 dBm	+/-2 dB	11a	6-24Mbps	-83 dBm min	+/-2 dB
	36 Mbps	21 dBm	+/-2 dB		36 Mbps	-80 dBm	+/-2 dB
	48 Mbps	19 dBm	+/-2 dB		48 Mbps	-77 dBm	+/-2 dB
	54 Mbps	18 dBm	+/-2 dB		54 Mbps	-75 dBm	+/-2 dB

Table C–11 NanoStation Radio Power Specifications (56-0035 US, 56-0032 Intl) (cont.)

TX Power Specifications				RX Power Specifications			
11n / airMAX	MCS0	23 dBm	+/- 2 dB	11n / airMAX	MCS0	-96 dBm	+/- 2 dB
	MCS1	23 dBm	+/- 2 dB		MCS1	-95 dBm	+/- 2 dB
	MCS2	23 dBm	+/- 2 dB		MCS2	-92 dBm	+/- 2 dB
	MCS3	23 dBm	+/- 2 dB		MCS3	-90 dBm	+/- 2 dB
	MCS4	22 dBm	+/- 2 dB		MCS4	-86 dBm	+/- 2 dB
	MCS5	20 dBm	+/- 2 dB		MCS5	-83 dBm	+/- 2 dB
	MCS6	18 dBm	+/- 2 dB		MCS6	-77 dBm	+/- 2 dB
	MCS7	17 dBm	+/- 2 dB		MCS7	-74 dBm	+/- 2 dB
	MCS8	23 dBm	+/- 2 dB		MCS8	-95 dBm	+/- 2 dB
	MCS9	23 dBm	+/- 2 dB		MCS9	-93 dBm	+/- 2 dB
	MCS10	23 dBm	+/- 2 dB		MCS10	-90 dBm	+/- 2 dB
	MCS11	23 dBm	+/- 2 dB		MCS11	-87 dBm	+/- 2 dB
	MCS12	22 dBm	+/- 2 dB		MCS12	-84 dBm	+/- 2 dB
	MCS13	20 dBm	+/- 2 dB		MCS13	-79 dBm	+/- 2 dB
	MCS14	18 dBm	+/- 2 dB		MCS14	-78 dBm	+/- 2 dB
	MCS15	17 dBm	+/- 2 dB		MCS15	-75 dBm	+/- 2 dB

D

LED Indicators

This chapter provides the possible LED status and error indicators for WRUs and LIUs.

The WRU has three possible states; undeployed, deploying, and deployed.

When tilting the WRU to deploy, re-acquire GPS, or check status, tilt the WRU geophone down until the LEDs light, and then return the WRU to the horizontal position as shown in the following figure:

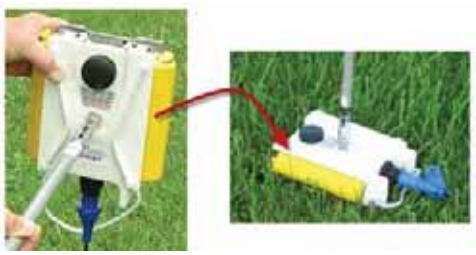


Figure D–1 WRU Down-Tilt Action

When tilting the WRU to undeploy, tilt the WRU geophone up until the LEDs light, and then return the WRU to the horizontal position as shown in the following figure:

Figure D–2 WRU Up-Tilt Action

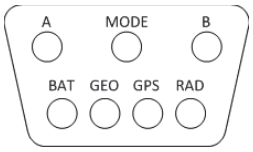
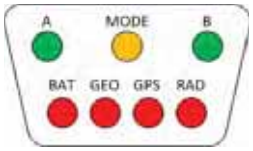
D.1 WRU Undeployed

When the WRU is undeployed, all of the LEDs are off. A vertical tilt has the following effect:

- **Geophone Down** – WRU deployment
- **Geophone Up** – No effect; nothing happens

WRU Undeployed

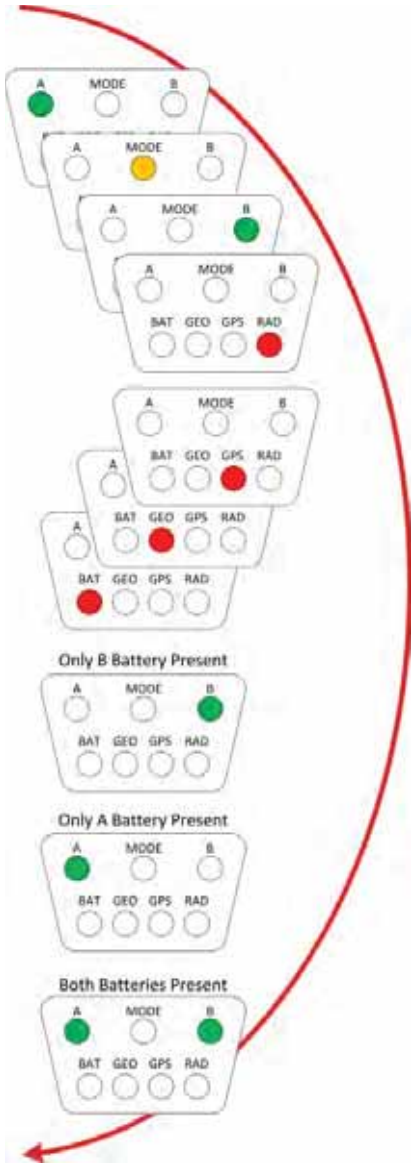
Table D–1 WRU LED Indications, Undeployed

LED Indicators	Summary	Description
	Undeployed Dead batteries	If no LEDs are on (lit up) on an undeployed WRU, it can be one of the following scenarios: • Unit undeployed • Batteries dead When you do a tilt test (geophone down) on an undeployed WRU with no LEDs on, the following may occur: • An Undeployed WRU deploys and begins the self tests • A WRU with dead batteries will continue to display no lit LEDs • A WRU is defective if no LEDs turn on after battery replacement. **NOTE:** Battery state is shown in the RT System 2 user interface tables. For example, the Ground Equipment Table.
	Geo down tilt detected Deploy	Tilt the WRU with the geophone pointing down. After a few seconds, all of the LEDs light up solid. Place the WRU flat on the ground to within five seconds to begin the deployment process: • Battery fuse self-test • Battery test • THD test • Geophone test • GPS fix • Radio test

After removing both batteries from an undeployed WRU, and then replacing BAT A, BAT B, or both, when the first battery is connected, the WRU goes through the power on LED sequence and then remains in the undeployed state.

The following table shows the LED power-on sequence for an undeployed WRU:

Table D–2 WRU LED Indications, Undeployed Power-On Sequence

LED Indicators	Summary	Description
	Hard reset (power on)	The LEDs light up in clockwise rotation starting with the A battery LED and ending with the A battery LED, B battery LED, or both.

D.2 WRU Deploying

When the WRU begins deploying, the following tests are executed:

- BAT A and BAT B connected
  - Battery fuse test
  - Battery test
  - THD test
  - Geophone Test
  - GPS test
  - Radio Test
- BAT A *or* BAT B connected
  - Battery test
  - THD test
  - Geophone Test
  - GPS test
  - Radio Test

The following table shows the possible LED indicators for a WRU that is deploying:

Table D–3 WRU LED Indications, Deploying Sequence

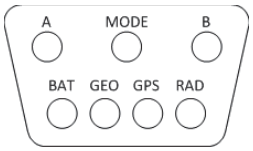
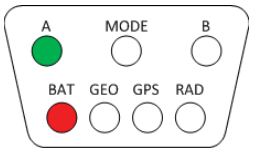
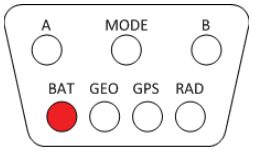
LED Indicators	Summary	Description
	Dead batteries Defective Unit	If no LEDs are on (lit up) during the deploying state, it can be one of the following scenarios: • Batteries dead • Defective Unit When you do a tilt test (geophone down) on a WRU with no LEDs on, the following may occur: • A WRU with dead batteries will continue to display no lit LEDs • A WRU is defective if no LEDs turn on after battery replacement. **NOTE:** Battery state is shown in the RT System 2 user interface tables. For example, the Ground Equipment Table.
 A is solid for 5 seconds  BAT remains solid	Battery fuse test failure (A)	When both batteries are installed, the battery fuse test is performed. A Solid for 5 seconds BAT Solid A solid BAT LED indicates that the WRU detected a bad fuse during deployment and returned to the undeployed state. When a battery fuse test fails, the WRU will not deploy. Both batteries must be present for the battery fuse test to execute. This allows you to deploy a WRU by removing the battery connected to the bad fuse prior to the deployment tilt action.

Table D–3 WRU LED Indications, Deploying Sequence (cont.)

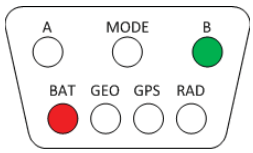
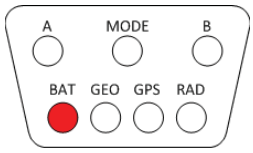
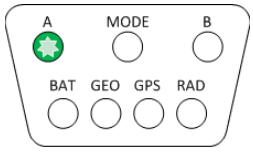
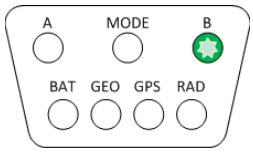
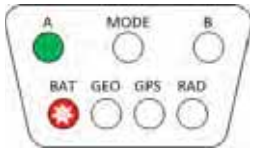
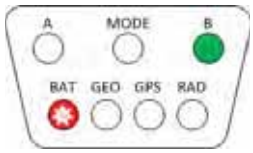
LED Indicators	Summary	Description
 B is solid for 5 seconds  BAT remains solid	Battery fuse test failure (B)	When both batteries are installed, the battery fuse test is performed. B Solid for 5 seconds BAT Solid A solid BAT LED indicates that the WRU detected a bad fuse during deployment and returned to the undeployed state. When a battery fuse test fails, the WRU will not deploy. Both batteries must be present for the battery fuse test to execute. This allows you to deploy a WRU by removing the battery connected to the bad fuse prior to the deployment tilt action.
 	Battery test	If both batteries are installed and their capacities are above 9000 mAh, the following occurs: • Battery in use LED (A or B) Flashes • The THD, GEO, GPS, and RAD self-tests are performed **NOTE:** The general battery test provides a visual indication if the WRU has one or more missing, malfunctioning, or low capacity batteries and provides 45 seconds to correct the problem before proceeding to the remainder of the deployment self-tests.
 	Battery failure	If one or both batteries have sub-9000mAh capacities or are not installed, the following occurs: • Solid – A and or B • Flashing – BAT LED flashes for 45 seconds Install one or two batteries with capacities above 9000 mAh during the 45 second window. The following occurs: • Flashing BAT LED turns off • Battery in use LED (A or B) flashes for approximately 2 seconds • The THD, GEO, GPS, and RAD self-tests are performed

Table D–3 WRU LED Indications, Deploying Sequence (cont.)

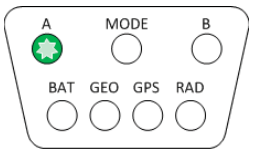
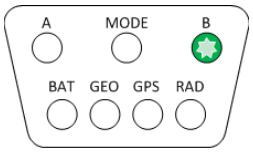
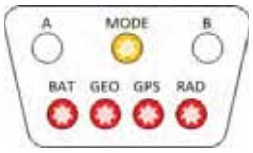
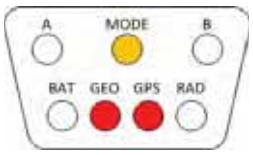
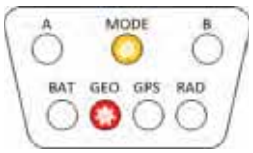
LED Indicators	Summary	Description
 		If no changes are made to the batteries within the 45 second window, The following occurs: • Flashing BAT LED turns off • Battery in use LED (A or B) flashes for approximately 2 seconds • The THD, GEO, GPS, and RAD self-tests are executed
	Self-test starting	If a WRU self-test fails, the WRU will continue to the next test. Flashing: • MODE • BAT • GEO • GPS • RAD **NOTE:** Error LEDs remain persistent throughout the self-discovery process and are turned off upon completion.
	Continue (lay flat to move to next test)	To skip a test during the self-test process, tilt the WRU geophone down until you see this triangle of LEDs. Tilt the WRU back to horizontal to continue. Solid: • MODE • GEO • GPS **NOTE:** The GPS test cannot be skipped.
	Geophone test in progress	Flashing: • MODE • GEO **NOTE:** Performing a vertical geophone down tilt during the geophone test causes the WRU to go into the communications repeater mode. WRU repeaters are used to solve terrain or distance related communication problems between WRUs.

Table D–3 WRU LED Indications, Deploying Sequence (cont.)

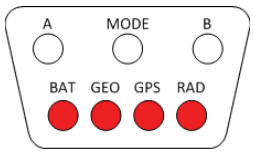
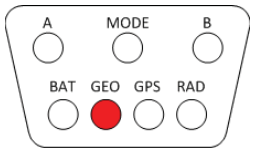
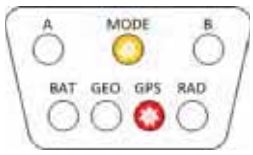
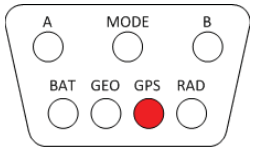
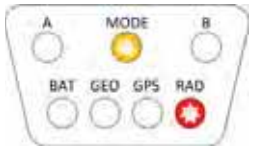
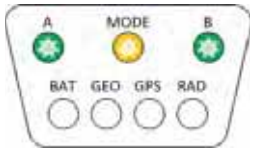
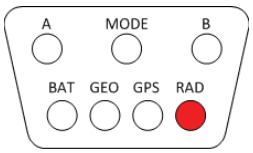
LED Indicators	Summary	Description
	THD test failure	Solid: • BAT • GEO • GPS • RAD **NOTE:** No LEDs are affected when the THD test starts or when it passes.
	Geophone test failure	GEO Solid **NOTE:** For a multiple-channel geophone, tests the first channel only.
	Acquiring GPS fix	Flashing: • MODE • GPS **NOTE:** The WRU will attempt to get a 3-meter GPS lock for up to 15 minutes. During this time, the GPS LED flashes. The WRU will not form until the GPS lock is achieved. If the GPS lock cannot be achieved, form by serial number.
	GPS test failure	GPS Solid GPS fix not found For a multiple-channel geophone, tests the first channel only.
	Neighbor discovery in progress	Flashing: • MODE • RAD
	Neighbor discovered	Flashing: • A • MODE • B

Table D–3 WRU LED Indications, Deploying Sequence (cont.)

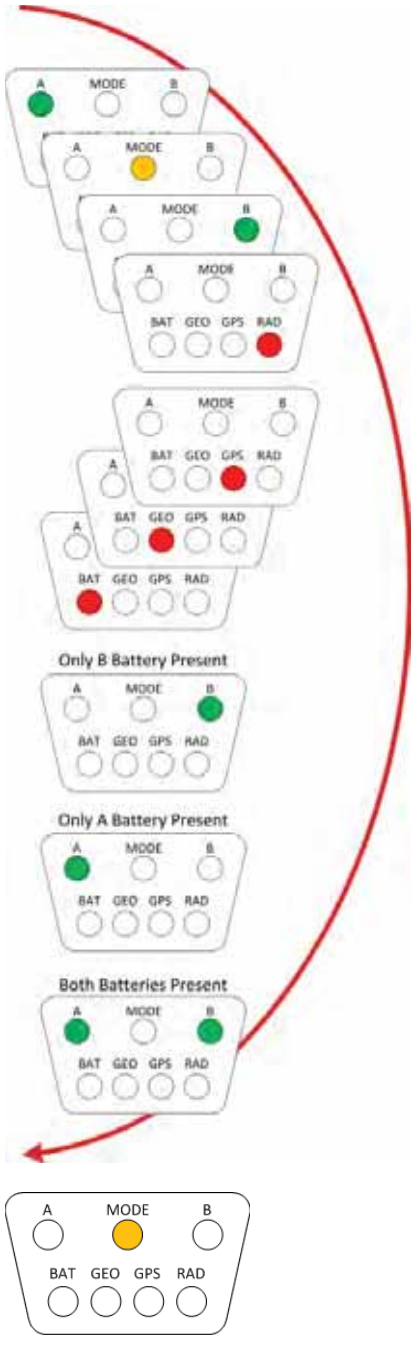
LED Indicators	Summary	Description
	No neighbor detected	RAD Solid If this is the first WRU deployed, this is the expected condition.

If power is removed from a WRU in the deploying state, the WRU stays in the deploying state and restarts the deploying process when power is restored.

After removing both batteries from a deploying WRU, and then replacing BAT A, BAT B, or both, when the first battery is connected, the WRU goes through the power on LED sequence. If both batteries are connected, the battery fuse test is executed. If only one battery is connected, the battery fuse test is skipped. The remainder of the self-tests are then executed.

The following table shows the LED power-on sequence for an deploying WRU:

Table D–4 WRU LED Indications, Deploying Power-On Sequence

LED Indicators	Summary	Description
	Hard reset (power on)	The LEDs light up in clockwise rotation starting with the A battery LED and ending with the A battery LED, B battery LED, or both for 2 seconds. The A and B battery LEDs at the end of the rotation indicate that one or both batteries are above the minimum threshold of 9000mAh. Finally, the MODE LED lights up for approximately 5 seconds indicating that the WRU is verifying its firmware integrity.

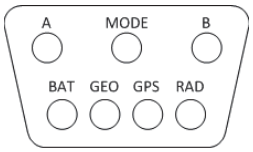
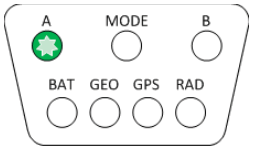
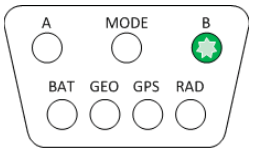
D.3 WRU Deployed

If the WRU is already deployed, a vertical tilt has the following effect:

- **Geophone Down** – If Sleeping, takes three to four seconds to wake up. If in Standby or Armed displays the battery status, deployment self-test status, and re-acquires the GPS position.
- **Geophone Up** – All lights light. If placed flat within 5 seconds, the WRU undeploys.

The following table shows how the LEDs light up during normal operation with no vertical tilt for a deployed WRU.

Table D–5 WRU LED Indications, Deployed WRU, No Geophone Tilt

LED Indicators	Summary	Description
	Undeployed Dead Batteries Sleeping	If no LEDs are on (lit up), it can be one of the following scenarios: • WRU undeployed • Batteries dead • WRU Sleeping • WRU Awake, but unformed **NOTE:** Battery state is shown in the RT System 2 user interface tables. For example, the Ground Equipment Table.
	Battery A in use	A Flashing: • Battery A in use • WRU formed or Armed
	Battery B in use	B Flashing: • Battery B in use • WRU formed or Armed

The following table shows how the LEDs light up during a vertical tilt (geophone down) for a deployed WRU.

Table D–6 WRU LED Indications, Deployed WRU, Geophone Down Tilt

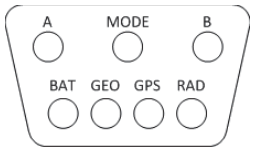
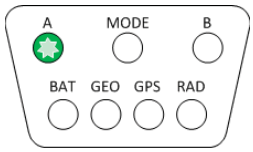
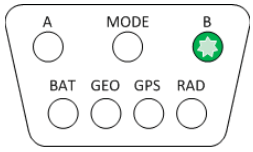
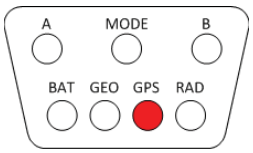
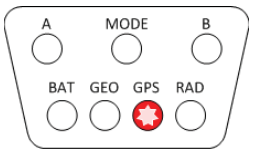
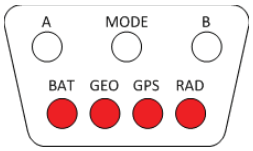
LED Indicators	Summary	Description
	Undeployed Dead Batteries Sleeping	If no LEDs are on (lit up) before tilting the WRU, it can be one of the following scenarios: • WRU undeployed • Batteries dead • WRU Sleeping • WRU Awake, but unformed When you do a tilt test (geophone down) on a WRU with no LEDs on, the following may occur: • An Undeployed WRU deploys and begins the self tests • A WRU with dead batteries will continue to display no lit LEDs • A Sleeping WRU goes back to the deployed, unformed state and displays the battery status and any self-tests that failed during deployment (BAT, THD, GEO, GPS, or RAD). • A WRU in the Awake unformed state displays the battery status and any self-tests that failed during deployment (BAT, THD, GEO,GPS, or RAD). **NOTE:** Battery state is shown in the RT System 2 user interface tables. For example, the Ground Equipment Table.
	Battery A in use	A Flashing: • Battery A in use • WRU formed or Armed **NOTE:** Only when GPS position occurs at the same time the battery status is displayed.
	Battery B in use	B Flashing: • Battery B in use • WRU formed or Armed **NOTE:** Only when no self-test failures. Re-acquire GPS position occurs at the same time the battery status is displayed.

Table D–6 WRU LED Indications, Deployed WRU, Geophone Down Tilt (cont.)

LED Indicators	Summary	Description
	Re-acquire GPS position	GPS Solid for up to 15 minutes The deployed WRU can be in any of the following states: • Unformed • Formed **NOTE:** The battery status is displayed at the same time the GPS position is re-acquiring.
	GPS position acquired	GPS Flashing The Deployed WRU is in Standby
	Self test failure	The LED associated with the failed self-test is solid. All four LEDs are solid only if all four self-tests failed, or the THD self-test fails. The LEDs are visible only during the deployment process, and when the WRU is tilted (geophone down) to check status after the WRU is deployed. Solid: • BAT • GEO • GPS • RAD

The following table shows how the LEDs light up during a vertical tilt (geophone up) for a deployed WRU.

Table D–7 WRU LED Indications, Deployed WRU, Geophone Up Tilt

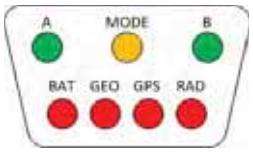
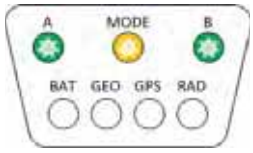
LED Indicators	Summary	Description
	Geo tilt detected Undeploy	Tilt the WRU with the geophone pointing up. After a few seconds, all of the LEDs light up solid. Place the WRU flat on the ground within five seconds to undeploy the WRU.

Table D–7 WRU LED Indications, Deployed WRU, Geophone Up Tilt (cont.)

LED Indicators	Summary	Description
	Undeploy successful	Flashing: • A • MODE • B

After removing both batteries from a deployed WRU, and then replacing BAT A, BAT B, or both, when the first battery is connected, the WRU goes through the power on LED sequence. The WRU transitions to the Awake, unformed state. If the WRU is not formed within 30 minutes, the WRU transitions to the Sleep state.

D.4 LIU Power-On

The LIU LEDs function independently from each other, and there can be a number of combinations of LEDs that are on, off, or flashing. The following list shows the LEDs used to indicate status:

- **Battery** – A, B, BAT
- **Power, Mode** – MODE
- **Discipline** – MODE
- **Check Link Status** – MODE, 1, 2, 3, and 4
- **Connection to Central** – LNK
- **GPS Lock** – GPS
- **Radio connection, communication with neighbor** – RAD

The following table shows the LED power-on sequence for an LIU:

Table D–8 LIU LED Indications, Power-On Sequence

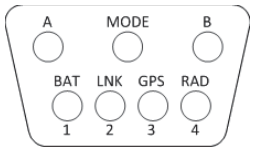
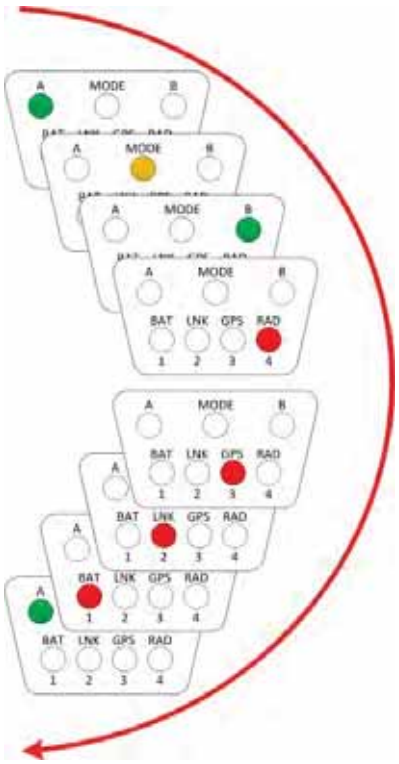
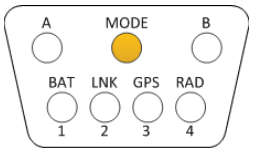
LED Indicators	Summary	Description
	Off	No lights

Table D–8 LIU LED Indications, Power-On Sequence (cont.)

LED Indicators	Summary	Description
	Hard Reset LIU	The LEDs light up in clockwise rotation starting and ending with the A battery LED in the following cases: • When the batteries are attached • Anytime the unit resets itself • In between updating firmware applications
	The unit is verifying the integrity of the firmware.	MODE Solid for approximately 5 seconds

D.5 LIU Normal Operation

The following tables describe the possible Normal Mode LIU Status Indications:

- *"LIU LED Status Indications, Normal Mode" on page 177*
- *"LIU LED Error Indications, Normal Mode" on page 179*

Table D–9 LIU LED Status Indications, Normal Mode

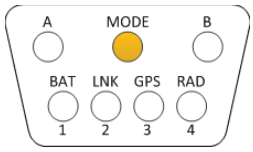
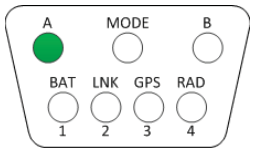
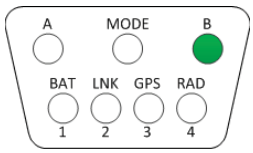
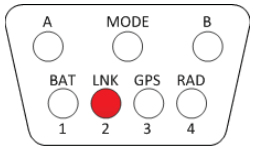
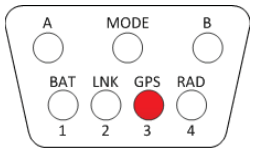
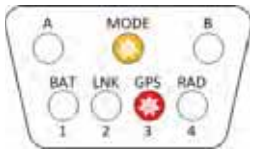
LED Indicators	Summary	Description
	On, Disciplined to GPS Checking firmware	MODE solid The MODE LED indicates that the integrity of the downloaded firmware is being verified.
	Battery A in use	A solid Indicates Battery A in use powering LIU. Battery Voltage is above depleted threshold.
	Battery B in use	B solid Indicates Battery B in use powering LIU. Battery Voltage is above depleted threshold.
	LIU connected to Central	LNK solid
	GPS lock	GPS solid
	GPS disciplined	Flashing: • GPS flashes in the 1 s rhythm of the PPS • MODE flashes in the 1 s rhythm of the PPS

Table D–9 LIU LED Status Indications, Normal Mode (cont.)

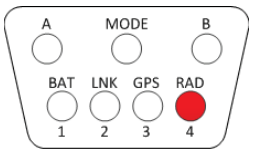
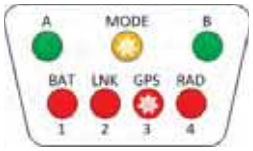
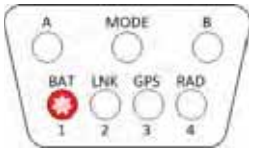
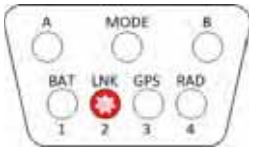
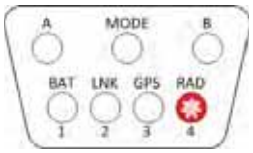
LED Indicators	Summary	Description
	Formed	RAD solid
	Normal	Solid: • A/B • BAT • LNK (connected) • RAD (formed) Flashing: • MODE • GPS • LNK (disconnected)
	Main (ARM) processor is upgrading its own firmware	BAT flashing
	Main (ARM) processor is upgrading the Power Control (XMEGA) processor firmware	LNK flashing
	Main (ARM) processor is upgrading the Radio processor firmware	RAD flashing

Table D–10 LIU LED Error Indications, Normal Mode

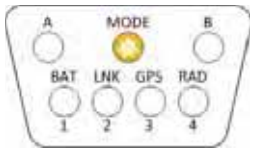
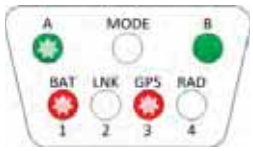
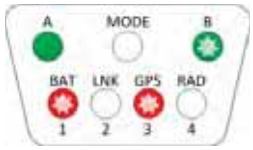
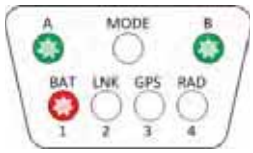
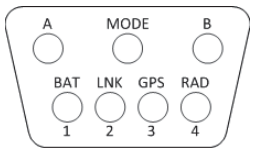
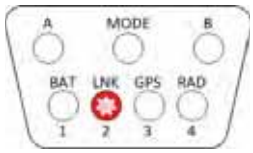
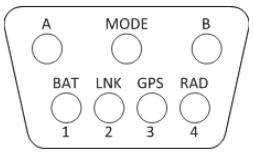
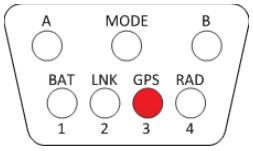
LED Indicators	Summary	Description
	On, no GPS discipline	MODE flashing every 1 second
	Single battery failure Battery B in use Battery A below threshold or disconnected	A: • Off, or • 4 long flashes, then off (On 4.5s, off 2s) or • GPS PPS flash B Solid BAT: • 4 long flashes, then off (On 4.5s, off 2s)
	Single battery failure Battery A in use Battery B below threshold or disconnected	A Solid B: • Off, or • 4 long flashes, then off (On 4.5s, off 2s) or • GPS PPS flash BAT: • 4 long flashes, then off (On 4.5s, off 2s)
	Both batteries below threshold –OR– One below threshold and one disconnected	A & B: • Off, or • 4 long flashes, then off (On 4.5s, off 2s) or • GPS PPS flashes BAT: • 4 long flashes, then off (On 4.5s, off 2s)
	No IP Address acquired	LNK off
	LIU has IP Address, but no communications with Central	LNK flashing

Table D–10 LIU LED Error Indications, Normal Mode (cont.)

LED Indicators	Summary	Description
	No GPS lock	GPS off No GPS or less than 3 satellites
	GPS lock, not disciplined	GPS on GPS lock, but not disciplined

D.6 Firmware Upgrade

The following table describes the possible WRU and LIU LED indications during firmware upgrade:

Table D–11 WRU and LIU LED Status Indications, Firmware Upgrade

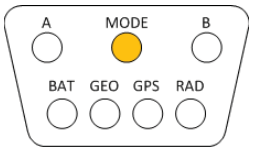
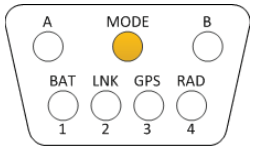
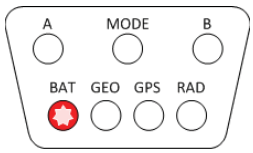
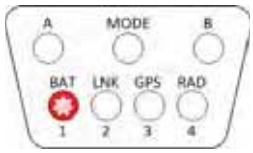
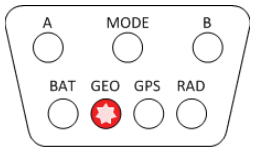
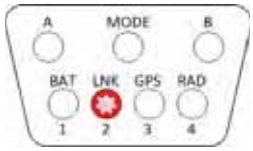
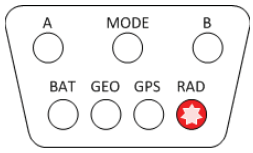
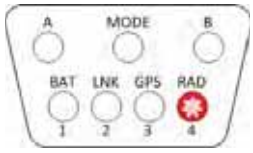
LED Indicators	Summary	Description
 	Firmware upgrade	MODE Solid for approximately 5 seconds During firmware upgrade, the MODE LED indicates that each processor's new firmware is being verified.

Table D–11 WRU and LIU LED Status Indications, Firmware Upgrade (cont.)

LED Indicators	Summary	Description
 	Firmware upgrade	BAT Flashing The main processor is saving the new firmware for all processors to non-volatile memory.
 	The power control processor's firmware is being upgraded	GEO/LNK Flashing for approximately 15 seconds
 	The Radio processor's firmware is being upgraded	RAD Flashing for approximately 1-2 seconds

E

Weighted Base

This section describes the mast that uses weights to maintain stability.

E.1 Specifications

Tripod Weight = 50 lbs (22.73 kg)

Minimum mast height = 53” (includes 6” for mounting)

Base size = 48” (1.2m) x 48” (1.2m)

Supports up to 12 – 16” x 8” blocks

Pre-galvanized steel frame

Accepts up to 2.5” mast (not included)

Figure E–1 Weighted Mast

E.2 Hardware Supplied

The following hardware is supplied with the tripod mast:

- 4 - Bolt, Carriage 1/4 - 20 x 3/4"
- 12 - Bolt, Carriage 1/4 - 20 x 5/8"
- 4 - Bolt, 1/4 - 20 x 3/4" Hex Head
- 4- Bolt, 1/4 - 20 x 1/2" Hex Head
- 24-Nut, 1/4 - 20
- 24 - Lock washer, 1/4 Int. tooth

E.3 Assembly Instructions

This section provides instructions and illustrations for assembly of the tripod.

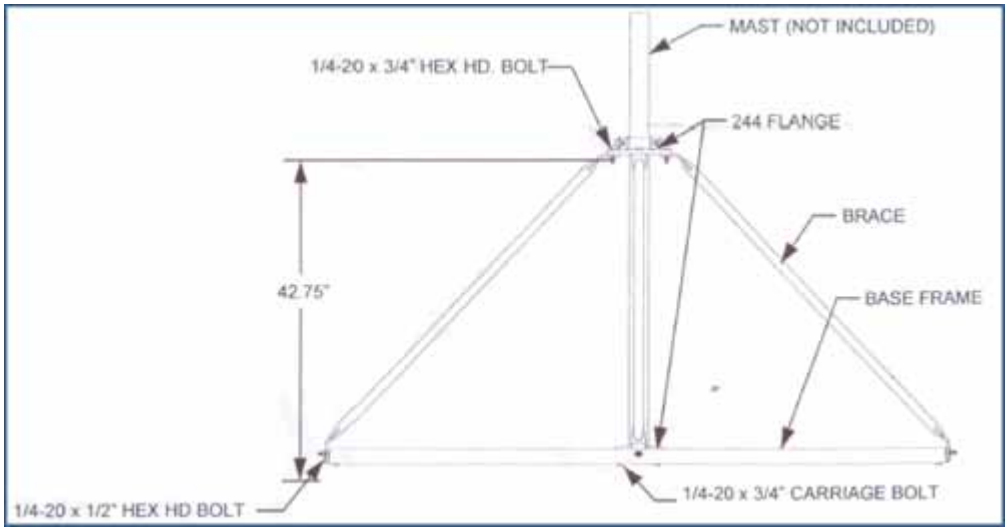


Figure E–2 Tripod Assembly, Front View

To assemble the tripod:

1. Assemble one 244 Flange to the Center Support Plate using four 1/4-20 x 3/4" carriage Bolts, Lock washers and Hex Nuts. Make sure to assemble the Bolts with the Heads on the underside of the frame. Hex Nut should be on the top side of the frame.
2. Assemble Base Frame and Center Support Plate using twelve 1/4-20 x 5/8" carriage Bolts, Lock washers and Hex Nuts. Make sure to assemble the Bolts with the Heads on the underside of the frame. Hex Nut should be on the top side of the frame.
3. Assemble the four (4) Braces to the upper support flange using four 1/4-20x3/4 Hex Head Bolts, Lock washers and Nuts.
4. Assemble the other end of the braces to the base frame using the four (4) 1/4-20 x 1/2" Hex Head Bolts, Lock washers, and Nuts.
5. Insert Bolts into upper and lower flange.
6. Slide the mast (not included) into position and tighten securely and weigh.

Wade Antenna Ltd., Ontario, Canada

F

Using a Compass

This chapter describes how to use a sighting compass. A sighting compass has the same features as a baseplate compass, but adds a vertical mirror that allows you to view the compass dial and the landmark at the same time.

Figure F–1 Sighting Compass (70-0067)

For a in-depth descriptions of using a compass with a map and setting the declination on a compass see the following links:

- http://www.compassdude.com/default.shtml
- http://www.compassdude.com/compass-declination.shtml
- http://www.rei.com/learn/expert-advice/navigation-basics.html
- http://www.thecompassstore.com/howtouseyour.html

A compass needle points to the magnetic north pole which is not the same as true or geographic north. The difference between magnetic and true north is called magnetic declination. The declination value depends on your actual location on the Earth. Over time, as the Earth's magnetic field shifts, the declination values also shift.

Maps are drawn with true north at the top edge. When using a compass to navigate or locate objects, you must adjust the readings to account for the angular difference between true north (★) and magnetic north (MN). The declination value is marked on topographical maps as shown in the following figure:

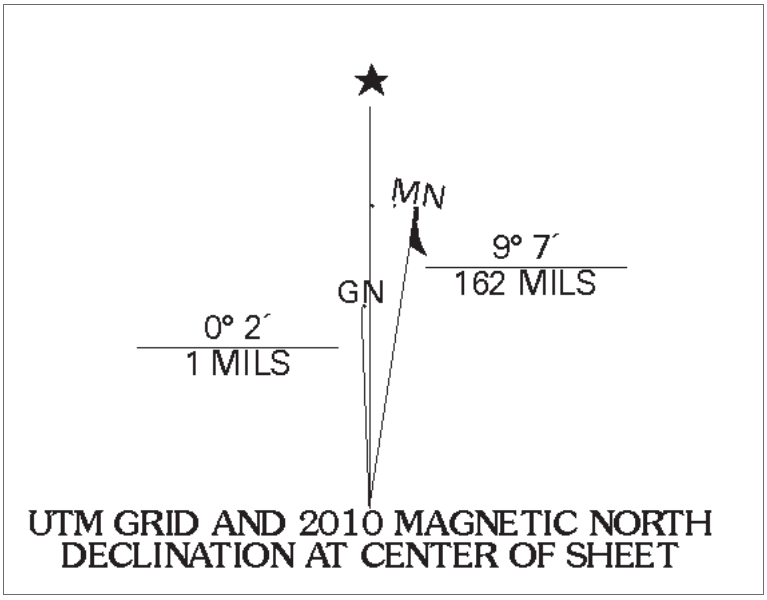


Figure F–2 Declination Indication on Map

However, because of the dynamic nature of the Earth's magnetic field, old maps are inaccurate. To obtain the most recent declination values, enter your map location at the following link:

http://www.ngdc.noaa.gov/geomag-web/#declination

NOTE

Placing magnetic objects near a compass can cause an incorrect reading (deviation). Examples include:

- *Objects that contain steel and iron such as pocket knives, belt buckles, vehicles, railroad tracks, and ore deposits in the Earth*
- *Objects that use magnets such as stereo speakers*
- *Electrical current in cables and overhead lines*

To locate an object using a map and a compass:

1. Place the long edge of the compass baseplate on the map, connecting the desired start and end points. For example, the start point could be where you are standing [A], and the end point [B] is where you want to locate the backhaul mast. The Direction of Travel arrow should point towards the end point (mast location).
2. While holding the compass on the map, turn the Degree Dial until the Meridian / Orienting Lines are parallel with the Meridian lines on the map. This is the same as turning the Degree Dial until the Orienting Arrow points to north on the map.

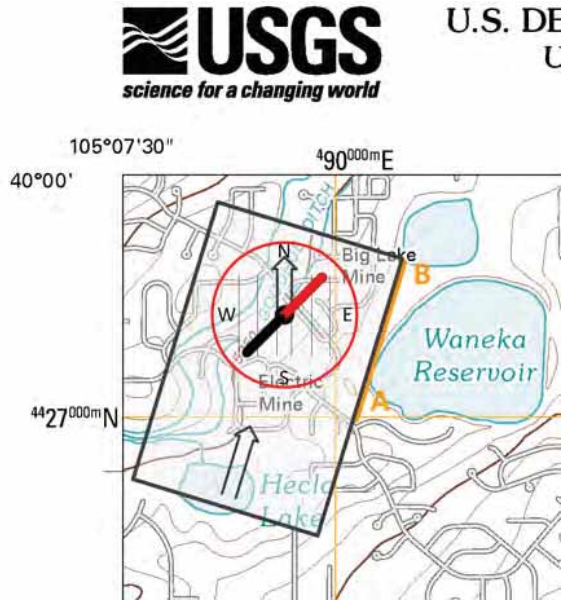


Figure F–3 Compass and Map

3 Adjust for declination.

- If you have an adjustable compass – Move the Orienting Arrow to the right or left by the declination number. When you align the magnetic needle with the Orienting Arrow, the declination is accounted for.
- If you do not have an adjustable compass – Mark the declination on your compass with a piece of tape. Align the magnetic needle with the tape mark.
- Adjust the Orienting Arrow to the left or right. For example:
  - For a declination of 0, no adjustment is necessary.
  - For a declination of 9 (9 degrees East), move the Orienting Arrow (or place a tape mark) to the right 9 degrees.
  - For a declination of -9 (9 degrees West), move the Orienting Arrow (or place a tape mark) to the left 9 degrees.

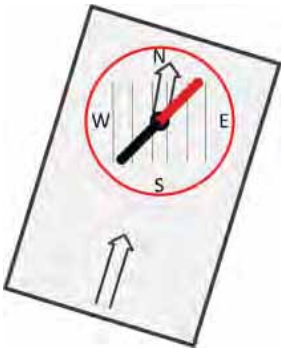


Figure F–4 Compass Adjusted for Declination

4 Pick up the compass and adjust the cover so the angle of the cover to the base is between 45 and 70 degrees.

5 Hold the base of the compass in the palm of your hand. Keep the compass level. Turn your entire body and the compass until the red end of the Magnetic Needle is aligned with the red end (north end) of Orienting Arrow.

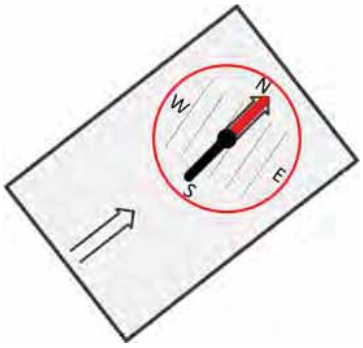


Figure F–5 Compass Adjusted for Declination

6 While holding the compass at eye level, keep the compass level and align your destination with the sight notch on the top of the case.

7 Ensure that the sighting line in the mirror passes through the center of the compass wheel.

G

Rope Knot

This chapter shows how to tie a taut-line hitch knot. This loop knot can be adjusted to loosen or tighten a line, yet holds under a load. This knot is commonly used to secure tent lines and loads on vehicles. It is the recommended knot for securing the RT System 2 guy rope mast.

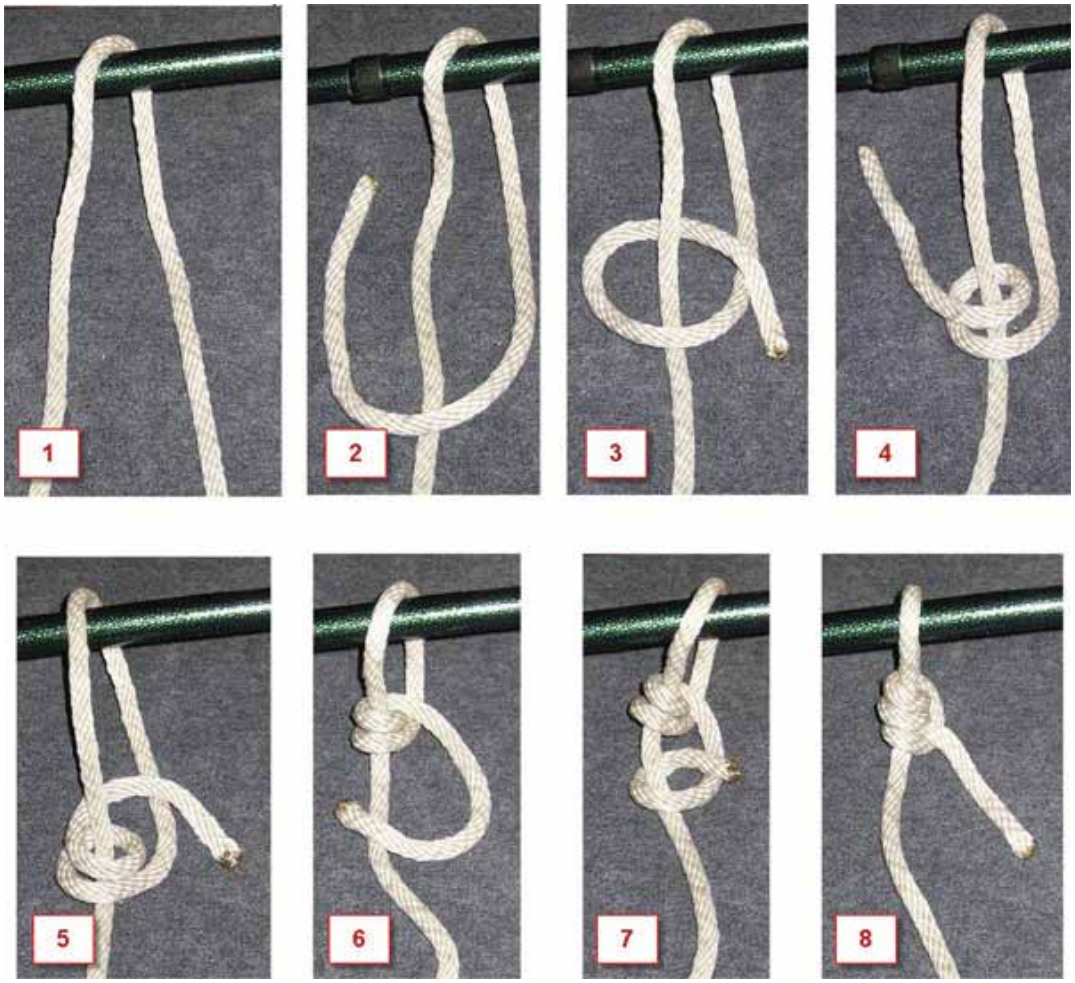


Figure G–1 Tying the Taut-line Hitch Knot

The following link provides a short video example:

http://www.sailingcourse.com/videos/taut_line_hitch.htm

H

Country Codes

This chapter provides a quick-reference to the ISO 3166 country codes.

Table H–1 ISO 3166 Country Codes

Name	Code
Afghanistan	004
Åland Islands	248
Albania	008
Algeria	012
American Samoa	016
Andorra	020
Angola	024
Anguilla	660
Antarctica	010
Antigua and Barbuda	028
Argentina	032
Armenia	051
Aruba	533
Australia	036
Austria	040
Azerbaijan	031
Bahamas (the)	044
Bahrain	048
Bangladesh	050
Barbados	052
Belarus	112
Belgium	056
Belize	084
Benin	204
Bermuda	060
Bhutan	064

Table H–1 ISO 3166 Country Codes

Name	Code
Bolivia, Plurinational State of	068
Bonaire, Sint Eustatius and Saba	535
Bosnia and Herzegovina	070
Botswana	072
Bouvet Island	074
Brazil	076
British Indian Ocean Territory (the)	086
Brunei Darussalam	096
Bulgaria	100
Burkina Faso	854
Burundi	108
Cambodia	116
Cameroon	120
Canada	124
Cape Verde	132
Cayman Islands (the)	136
Central African Republic (the)	140
Chad	148
Chile	152
China	156
Christmas Island	162
Cocos (Keeling) Islands (the)	166
Colombia	170
Comoros	174
Congo	178

Table H–1 ISO 3166 Country Codes

Name	Code
Congo (the Democratic Republic of the)	180
Cook Islands (the)	184
Costa Rica	188
Côte d'Ivoire	384
Croatia	191
Cuba	192
Curaçao	531
Cyprus	196
Czech Republic (the)	203
Denmark	208
Djibouti	262
Dominica	212
Dominican Republic (the)	214
Ecuador	218
Egypt	818
El Salvador	222
Equatorial Guinea	226
Eritrea	232
Estonia	233
Ethiopia	231
Falkland Islands (the) [Malvinas]	238
Faroe Islands (the)	234
Fiji	242
Finland	246
France	250
French Guiana	254
French Polynesia	258
French Southern Territories (the)	260
Gabon	266
Gambia (The)	270

Table H–1 ISO 3166 Country Codes

Name	Code
Georgia	268
Germany	276
Ghana	288
Gibraltar	292
Greece	300
Greenland	304
Grenada	308
Guadeloupe	312
Guam	316
Guatemala	320
Guernsey	831
Guinea	324
Guinea-Bissau	624
Guyana	328
Haiti	332
Heard Island and McDonald Islands	334
Holy See (the) [Vatican City State]	336
Honduras	340
Hong Kong	344
Hungary	348
Iceland	352
India	356
Indonesia	360
Iran (the Islamic Republic of)	364
Iraq	368
Ireland	372
Isle of Man	833
Israel	376
Italy	380
Jamaica	388

Table H–1 ISO 3166 Country Codes

Name	Code
Japan	392
Jersey	832
Jordan	400
Kazakhstan	398
Kenya	404
Kiribati	296
Korea (the Democratic People's Republic of)	408
Korea (the Republic of)	410
Kuwait	414
Kyrgyzstan	417
Lao People's Democratic Republic (the)	418
Latvia	428
Lebanon	422
Lesotho	426
Liberia	430
Libya	434
Liechtenstein	438
Lithuania	440
Luxembourg	442
Macao	446
Macedonia (the former Yugoslav Republic of)	807
Madagascar	450
Malawi	454
Malaysia	458
Maldives	462
Mali	466
Malta	470
Marshall Islands (the)	584
Martinique	474
Mauritania	478

Table H–1 ISO 3166 Country Codes

Name	Code
Mauritius	480
Mayotte	175
Mexico	484
Micronesia (the Federated States of)	583
Moldova (the Republic of)	498
Monaco	492
Mongolia	496
Montenegro	499
Montserrat	500
Morocco	504
Mozambique	508
Myanmar	104
Namibia	516
Nauru	520
Nepal	524
Netherlands (the)	528
New Caledonia	540
New Zealand	554
Nicaragua	558
Niger (the)	562
Nigeria	566
Niue	570
Norfolk Island	574
Northern Mariana Islands (the)	580
Norway	578
Oman	512
Pakistan	586
Palau	585
Palestine, State of	275
Panama	591

Table H–1 ISO 3166 Country Codes

Name	Code
Papua New Guinea	598
Paraguay	600
Peru	604
Philippines (the)	608
Pitcairn	612
Poland	616
Portugal	620
Puerto Rico	630
Qatar	634
Réunion	638
Romania	642
Russian Federation (the)	643
Rwanda	646
Saint Barthélemy	652
Saint Helena, Ascension and Tristan da Cunha	654
Saint Kitts and Nevis	659
Saint Lucia	662
Saint Martin (French part)	663
Saint Pierre and Miquelon	666
Saint Vincent and the Grenadines	670
Samoa	882
San Marino	674
Sao Tome and Principe	678
Saudi Arabia	682
Senegal	686
Serbia	688
Seychelles	690
Sierra Leone	694
Singapore	702

Table H–1 ISO 3166 Country Codes

Name	Code
Sint Maarten (Dutch part)	534
Slovakia	703
Slovenia	705
Solomon Islands (the)	090
Somalia	706
South Africa	710
South Georgia and the South Sandwich Islands	239
South Sudan	728
Spain	724
Sri Lanka	144
Sudan (the)	729
Suriname	740
Svalbard and Jan Mayen	744
Swaziland	748
Sweden	752
Switzerland	756
Syrian Arab Republic (the)	760
Taiwan (Province of China)	158
Tajikistan	762
Tanzania, United Republic of	834
Thailand	764
Timor-Leste	626
Togo	768
Tokelau	772
Tonga	776
Trinidad and Tobago	780
Tunisia	788
Turkey	792
Turkmenistan	795

Table H–1 ISO 3166 Country Codes

Name	Code
Turks and Caicos Islands (the)	796
Tuvalu	798
Uganda	800
Ukraine	804
United Arab Emirates (the)	784
United Kingdom (the)	826
United States (the)	840
United States Minor Outlying Islands (the)	581
Uruguay	858
Uzbekistan	860
Vanuatu	548
Venezuela, Bolivarian Republic of	862
Viet Nam	704
Virgin Islands (British)	092
Virgin Islands (U.S.)	850
Wallis and Futuna	876
Western Sahara*	732
Yemen	887
Zambia	894
Zimbabwe	716

I

Français

Ce chapitre fournit des informations sur le suivant :

I.1 Batteries

Ce chapitre fournit des informations sur les batteries utilisées dans le système

RT System 2 de Wireless Seismic, Inc.

I.1.1 Batteries au lithium-ion

Cette section fournit des informations sur les caractéristiques, l'utilisation et la manipulation des batteries au lithium-ion. Reportez-vous aux sections suivantes pour en savoir plus:

I.1.1.1 Spécifications

Le RT System 2 utilise une ou deux batteries au lithium-ion intelligentes et personnalisées, dotées d'un circuit de charge autonome qui protège les batteries contre les surcharges, décharges, courts-circuits ou changements extrêmes de température.

Le tableau suivant indique les spécifications des batteries:

Tableau I–1 Spécifications des batteries au lithium-ion

Élément	Description	Valeur
Tension	Nominale	3,7 V c.c.
	Arrêt	2,8 V c.c.
	Charge complète (90 %)	4,1 V c.c.
	Tension de charge excessive	4,28 V c.c.
	Tension de décharge excessive	2,80 V c.c.
Courant	Courant de charge maximum	2 A
	Consommation, mode actif	4,2 mA maximum
	Consommation, mode veille	66 µA maximum
Charge complète (90 %) mAh	Environ 12 000 mAh à la tension nominale	

Tableau I–1 Spécifications des batteries au lithium-ion (cont.)

Élément	Description	Valeur
Charge complète (90 %) mWh	Environ 44 400 mWh à la tension nominale	
Capacité		48,8 wattheures
Connecteur	5 broches	
DEL	Une DEL qui indique l'état de charge lors de la connexion à la station de charge, de la manière suivante :	• Vert : chargé • Rouge : en train de charger • Orange : phase transitionnelle entre l'état de chargement et l'état chargé, ou dépassement des limites de la température de charge
Étiquette	Une étiquette indiquant le numéro de série sous forme de code à barres	
Température	Fonctionnement	De -40°C à +85°C
	Chargement	De -5°C à +45°C
	Entreposage à température ambiente	• De -20°C à +45°C durant une période maximum d'un mois • De -20°C à +35°C durant 6 mois maximum ; passé ce délai, les blocs-batteries doivent être rechargés à plus de 50 % de leur capacité

I.1.1.2 Directives en matière de manipulation et de sécurité

Respecter les directives suivantes en matière de manipulation et de sécurité :

- Si un bloc-batterie présente une fuite de liquides, ne pas toucher les liquides. Jeter le bloc-batterie en cas de fuite. En cas de contact oculaire avec du liquide, ne pas se frotter les yeux. Rincer immédiatement les yeux avec de l'eau pendant au moins 15 minutes, en soulevant les paupières supérieures et inférieures jusqu'à ce qu'il n'y ait plus de trace de liquide. Consulter un médecin.
- Ne pas démonter, écraser ou percer une batterie
- Ne pas court-circuiter les contacts externes d'une batterie
- Ne pas jeter une batterie dans le feu ou l'eau
- Ne pas exposer une batterie à des températures supérieures à 60 °C (140 °F)
- Maintenir la batterie à l'écart des enfants
- Éviter d'exposer la batterie à des vibrations ou chocs excessifs
- Ne pas utiliser une batterie endommagée
- Les blocs-batteries au lithium-ion DOIVENT être entièrement déchargés avant leur élimination

- Bien qu'il puisse exister des restrictions locales ou nationales, les batteries au lithium-ion sont considérées comme des « déchets universels non dangereux » par le gouvernement fédéral. Il existe des restrictions qui s'appliquent à ceux qui gèrent de grandes quantités de déchets universels ; celles-ci définissent l'étiquetage, le confinement, etc. Dans la mesure du possible, les batteries doivent être déchargées avant de les jeter. Les conducteurs/contacts de batterie doivent être fixés de manière à éviter un court-circuit accidentel. Chaque bloc-batterie doit être placé dans un sac en plastique.
- Le recyclage est encouragé lorsqu'il est réalisable. Les batteries contiennent des matériaux recyclables et sont acceptées par plusieurs entreprises de recyclage de batteries. Reportez-vous à l'un des éléments suivants pour obtenir plus d'informations sur le recyclage et l'élimination :
  - http://www.swe.com
  - http://www.rbrc.org
  - http://www.call2recycle.org
  - 1-800-8-BATTERY
  - 1-877-2-RECYCLE

I.1.1.3 Transport

Aux États-Unis, les expéditions de grandes quantités de batterie au lithium-ion (plus de 24 piles ou 12 batteries par colis) sont réglementées comme des matières dangereuses (classe 9) par le gouvernement fédéral et sont soumises aux règlements décrits ci-après :

- Code of Federal Regulations, Title 49 Transportation.
  http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?sid=92868a82add6feba6afa796572133179&c=ecfr&tpl=/ecfrbrowse/Title49/49tab_02.tpl
- International Air Transport Association (IATA)
  http://www.iata.org/whatwedo/cargo/dangerous_goods/pages/lithium_batteries.aspx

Les batteries ne peuvent être expédiées par voie terrestre que si toutes les conditions suivantes sont satisfaites :

- La boîte utilisée satisfait le test de chute de 1,2 m (boîte classée « UN ») de boîte d'emballage
- Les bornes de bloc-batterie sont protégées pour éviter un court-circuit
- Le poids brut ne dépasse pas 30 kg (66 livres)
- L'emballage extérieur porte l'étiquette requise en vigueur. La figure suivante en montre un exemple.

Exemple I–1 Example Battery Shipping Label

Les batteries ne peuvent être expédiées par voie aérienne que si toutes les conditions suivantes sont satisfaites :

- La boîte utilisée satisfait le test de chute de 1,2 m (boîte classée « UN ») de boîte d'emballage
- Les bornes de bloc-batterie sont protégées pour éviter un court-circuit
- Le poids brut de chaque colis ne dépasse pas 10 kg (22 livres)
- L'emballage extérieur porte l'étiquette requise en vigueur. La figure précédente en montre un exemple (*"Example Battery Shipping Label" on page 197*).

REMARQUE

Les informations contenues dans le présent document ont pour but de fournir une connaissance générale des règlements s'appliquant aux batteries. Elles ne sont pas exhaustives, et les conditions mentionnées dans ce document peuvent avoir changées. Rien dans le présent chapitre ou dans le Guide de déploiement ne constitue un avis juridique ou est destiné à répondre aux problèmes juridiques, de conformité, ou réglementaires spécifiques qui peuvent survenir dans des circonstances particulières. Le présent chapitre et le Guide de déploiement ne sont pas destinés à remplacer les règlements officiels en vigueur concernant l'emballage et l'expédition de matières dangereuses ou un conseil juridique indépendant sur c es questions. Vous êtes seul responsable du respect de toutes les lois, règlements et autres exigences. Veuillez vous reporter à une copie officielle de la version en vigueur de ces documents pour obtenir les dernières informations.

I.1.1.4 Entreposage

Un entreposage et un entretien adéquats des batteries au lithium-ion est indispensable pour optimiser leur durée de vie utile et éviter une défaillance catastrophique. Respecter les précautions suivantes en matière d'entreposage :

- Retirer les batteries de l'unité distante sans fil avant l'entreposage
- Température d'entreposage recommandée des batteries au lithium-ion :
  - De -20°C à +45°C durant une période maximum d'un mois
  - De -20°C à +35°C durant 6 mois maximum ; passé ce délai, les blocs-batteries doivent être rechargés à plus de 50 % de leur capacité
  - L'entreposage à basses températures ralentit la décharge naturelle et la perte de capacité au fil du temps. Entreposer les batteries à 25°C ou moins si possible
- Niveaux de charge d'entreposage recommandés :
  - Charger (ou décharger) les batteries à un niveau de charge de 30 % à 50 % avant de les entreposer. Des niveaux de charge inférieurs ou supérieurs peuvent réduire la durée de vie des batteries.
  - Ne jamais entreposer des batteries entièrement déchargées, sauf en cas d'élimination.
  - Un chargement périodique est nécessaire pour maintenir une charge de 30 % à 50 % en cas d'entreposage de longue durée
- Entreposer les batteries dans un endroit bien aéré
- Ne pas laisser les batteries inutilisées pendant de longues durées, qu'elles soient dans le produit ou placées en entreposage. Si une batterie n'a pas été utilisée pendant 6 mois, vérifier l'état de charge et charger ou éliminer la batterie, le cas échéant.
- Vérifier régulièrement l'état de charge de la batterie
- Envisager le remplacement de la batterie par une nouvelle en cas de constat d'une des conditions suivantes :
  - L'autonomie de la batterie descend en dessous d'environ 80 % de son autonomie initiale
  - Le temps de charge de la batterie augmente sensiblement

I.1.2 Chargement des batteries au lithium-ion

Cette section décrit les précautions de chargement et présente le chargeur de batterie.

I.1.2.1 Précautions de chargement

Respecter les précautions de chargement suivantes :

- Avant de la charger, inspecter la batterie pour détecter les signes éventuels de dommages sur le boîtier ou les connecteurs susceptibles de créer un court-circuit.
- La batterie peut être chargée dans la plage de température de 0°C à +45°C. En cas de chargement de la batterie en dehors de cette plage, la batterie peut devenir très chaude ou se rompre.
- Être absolument sûr de l'utilisation d'une source de 5 V lors du chargement de la batterie.
- Prendre soin de charger les batteries sur une surface ininflammable.
- Ne pas charger les batteries à proximité d'objets ou de liquides inflammables.
- Conserver un extincteur à poudre chimique de classe C à proximité.
- Ne pas continuer de recharger la batterie si elle ne se recharge pas dans le temps de chargement spécifié.
- NE JAMAIS laisser une batterie au lithium-ion sans surveillance lorsqu'elle est en train de charger.

I.1.2.2 Chargeur de batterie

Le chargeur de batterie au lithium-ion est conçu pour fonctionner à partir d'une ligne de service simple 120 V c.a., 10 A.

Le bloc d'alimentation servant à charger le bloc-batterie fournit une tension régulée de 5 V c.c.

Exemple I–2 Chargeur de batterie

Exemple I–3 Étiquette avec numéro de série et voyant DEL

PRUDENCE

Le risque d'explosion si la batterie est remplacée par un type incorrect. Débarrassez-vous utilisé batteries selon les instructions.

I.2 l'information juridique

I.2.1 Conformité avec les règles et règlements de la FCC

La Federal Communications Commission (FCC) règlemente l'utilisation d'antennes dans l'article suivant : Code of Federal Regulations – Title 47, Part 15 – Radio Frequency Devices, Subpart C – Intentional Radiators, Section 15.203 Antenna Requirement.

REMARQUE

Cet équipement a été testé et jugé conforme aux limites fixées pour un appareil numérique de classe A, conformément à la partie 15 des règles de la FCC. Ces limites sont conçues pour fournir une protection raisonnable contre les interférences nuisibles lorsque l'équipement est utilisé dans un environnement commercial. Cet équipement génère, utilise et peut émettre l'énergie des fréquences radio et, s'il n'est pas installé et utilisé conformément au mode d'emploi, peut causer des interférences nuisibles avec les communications radio. Le fonctionnement de cet équipement dans une zone résidentielle est susceptible de provoquer des interférences nuisibles, auquel cas l'utilisateur devra corriger les interférences à ses propres frais.

REMARQUE

En vertu des règlementations d'Industrie Canada, cet émetteur radio peut être utilisé uniquement à l'aide d'une antenne de type et de gain maximum (ou inférieur) approuvés pour l'émetteur par Industrie Canada. Pour réduire les interférences radio éventuelles avec d'autres utilisateurs, le type et le gain de l'antenne doivent être choisis de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas la valeur nécessaire pour établir une communication réussie.

Lorsqu'il est utilisé comme prévu, le RT System 2 respecte les conditions de l'article 15.203 de la FCC et d'Industrie Canada CNR-Gen 7.1.2 de la manière suivante :

- Les antennes du RT System 2 doivent être installées et manipulées par des professionnels spécifiquement désignés pour cela.
- Les changements ou modifications non expressément approuvés par Wireless Seismic, Inc. peuvent annuler l'autorisation de l'utilisateur d'utiliser l'équipement.
- Le système RT 2 doit être utilisé uniquement avec les antennes fournies (*Tableau I–2*) attachées à l'unité distante sans fil ou WRU (tous les modèles) ou à l'unité d'interface de ligne ou LIU (tous les modèles) avec un connecteur (fileté ou HPQN) mâle de type N.

REMARQUE

Cet émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés ci-dessous. Le gain maximum permis et l'impédance d'antenne requise pour chaque antenne sont indiqués. Les types d'antenne non inclus dans cette liste, ayant un gain supérieur au gain maximum indiqué pour le type en question, sont strictement interdits pour ce dispositif.

Tableau I–2 Spécifications des antennes

Modèle	Fréquence (MHz)	Gain Maximal	Bande passante verticale	Poids	Dimensions (longueur x dia mètre)
WSI 65-0204/65-0264 (antenna standard)	2400	5,5 dBi (50 ohms)	25°	0.4 lbs 0.2 kg	32 x 0,6 po 810.5 x 15 mm
WSI 65-0091 (extenseur standard)	2400	0 dBi	s.o.	0.6 lbs 0.3 kg	30 x 0,7 po 762 x 18,5 mm

PRUDENCE

Afin de se conformer aux normes de la matière d'exposition aux radiofréquences (RF), les unités RT System 2 doivent être installées de manière à garder en permanence une distance minimale de 20 cm entre la ou les antennes et le corps de toute personne en mode de fonctionnement normal.

L'autorisation d'équipement de FCC a été accordée comme suit :

- Le 5Mbps unité d'interface de ligne a reçu l'autorisation d'équipement.
- Le 5Mbps unité lointaine sans fil a reçu l'autorisation d'équipement.

I.2.2 Industrie Canada Conformité

L'unité distante sans fil (WRU) fournie avec ce guide a obtenu l'approbation d'Industrie Canada (IC) ainsi que la certification en vertu de l'édition 8 de la norme RSS-210 et de l'édition 4 de la norme RSS-102.

Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

L'unté d'interface de ligne (LIU) fournie avec ce guide a obtenu l'approbation d'Industrie Canada (IC) ainsi que la certification en vertu de l'édition 8 de la norme RSS-210 et de l'édition 4 de la norme RSS-102.

Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

Cet appareil est conforme avec l'industrie Canada licence exemptes des normes. Son fonctionnement est soumis aux deux conditions suivantes :

- Ce dispositif ne peut causer des interférences, et
- Ce dispositif doit accepter toute interférence, y compris les interférences qui peuvent causer un mauvais fonctionnement du dispositif.

I.2.3 Acquiescement de CE

L'unité distante sans fil (WRU) et l'unité d'interface de ligne (LIU) fournies avec ce guide sont conformes aux directives applicables de l'UE pour la marque de Conformité européenne (CE). La marque suivante est apposée sur chaque unité.

Exemple I–4 Marque de CE

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