



**Radio Telemetry
Wireline Extensometer System**

Hardware Installation Manual

CALL & NICHOLAS INSTRUMENTS, INC.
2475 N. Coyote Drive, Tucson, AZ 85745 USA
Tel. (520) 670-9774 ~ www.slideminder.com

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Crouse, Ronald L., P.E., and D. J. Lowe. 2003. *Radio Telemetry Wireline Extensometer System, Hardware Installation Manual*, Tucson, Arizona: Call & Nicholas, Inc.

SlideMinder[®] System Introduction

The ExtensBase program resides on the base station. It communicates with, and controls the sampling interval and data transmission interval of each extensometer. The extensometer records movement data on its internal data logger and transmits the data to the base station via radio telemetry. ExtensBase relays the movement data to the ExtensMon program. The ExtensMon compiles the data into a central database where it can be reviewed by the user when necessary.

ExtensMon compares the incremental movement rate to warning protocol established by the user. If the incremental movement rate exceeds a warning protocol threshold, ExtensMon sends a signal to activate remote warning devices (lights, sirens) and sends warning messages to the equipment control office, designated engineer, and other designated personnel.

Equipment operators, prior to beginning work in monitored areas, should be instructed to stop operations immediately when the warning devices are activated. In addition, the Equipment Control Office must notify equipment operators by radio to stop operations immediately in the area being monitored.

Upon receiving the warning message, the designated engineer accesses the central database to review movement data via ExtensMon, contacts the Equipment Control Office to discuss the situation and set interim operational procedures to be followed until the situation has been fully reviewed and a permanent operating plan has been approved.

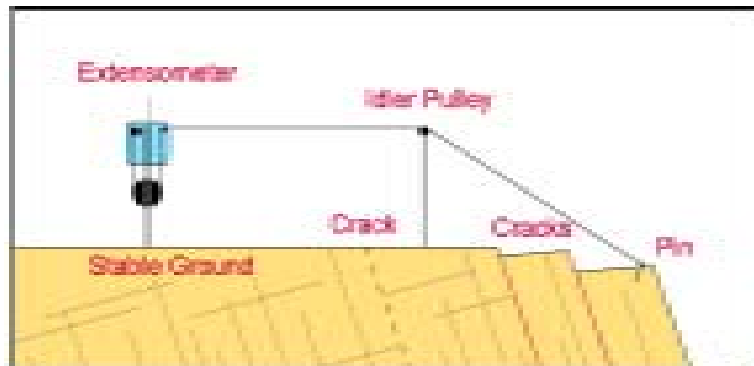
Note: The *SlideMinder*[®] System can be configured in several different ways. The preceding description assumes separate locations for the base station and central data base. It is possible, however, to install them both on the same computer.

SlideMinder® System

Quick Setup Instructions for the Extensometer Unit



If you are not familiar with the assembly and setup of the extensometer unit, please use the detailed assembly instructions located in the following section.



General Location of Extensometer & Idler Pulley

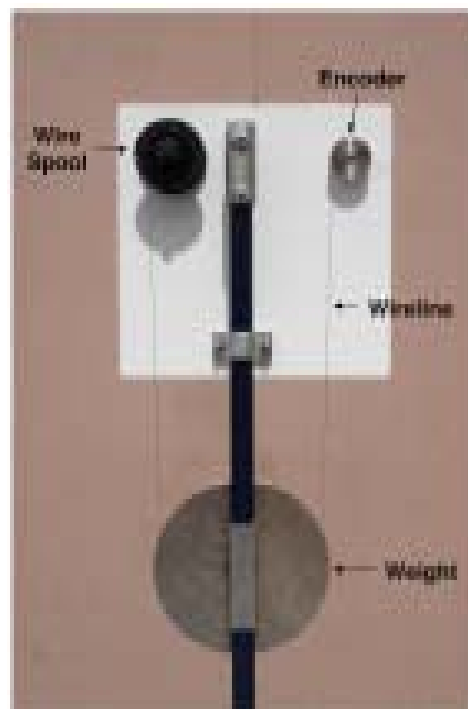
1. Determine the type of support structure to be used (drum or permanent).
2. Attach Kee Klamps to the extensometer box support pole, then attach pole to support structure.
3. Attach the solar panel support pole to the support structure using the U-bolts supplied. If using drum as support structure, mount solar panel pole opposite the extensometer pole.
4. Install the sliding weight on the extensometer pole, including spring coil and washers.
5. Tighten the Kee Klamps on the support pole.
6. If the drum design is used, fill with ballast now.



TO AVOID INJURY—DO NOT INSTALL THE SLIDEMINDER ENCLOSURE WITHOUT BALLAST INSIDE THE DRUM! IT WILL FALL OVER!

7. Mount the extensometer box on the pole, adjust the position and tighten clamps. The box should be on the outside, away from the drum, with the shaft encoder pointing towards the slope to be monitored.
8. If a grounding wire is to be used, connect to the lug on the outside of the extensometer box.
9. Open the extensometer box, insert the pre-wired 2-pin connector through the D-hole at the bottom and tighten.

10. Install the solar panel using the two short pipes and pipe T. Connect solar panel to the enclosure using the connector at the bottom.
11. Install radio antenna hand tight, then give a 1/4 turn with a wrench. Do not overtighten!
12. Lower the torque setting on the brake and extend the wireline to the area to be monitored.
13. Anchor wireline to rock mass to be monitored.
14. Set up idler pulley assembly. Line up pulley with wireline. Place wireline on pulley.
15. Wrap wire from spool *twice* around slide weight and *twice* around the encoder sheave.
16. Adjust brake setting to around 50 percent.
17. Connect Battery.
18. Turn on power at circuit board.



**Do not power up the radio if the antenna is not installed!
The radio can be permanently damaged.**

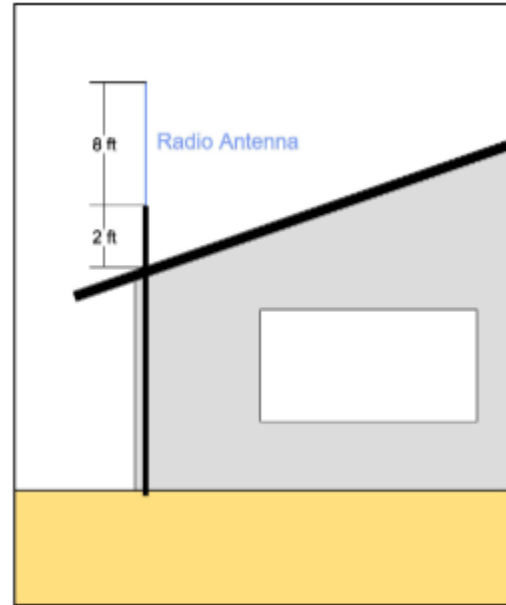


Inside the Extensometer Enclosure

- 1) Radio Modem
- 2) Data Logger
- 3) Encoder
- 4) Brake
- 5) Battery
- 6) Circuit Board
- 7) Voltage Regulator

SlideMinder[®] System Quick Setup Instructions for the Base Station

1. Set up base station PC, install ExtensBase.
2. Install antenna support structure.
3. Clamp antenna onto support structure. Antenna must be at least 2 ft above roof.
4. Set up *SlideMinder*[®] radio.
5. Connect antenna polyphaser to ground.
6. Plug antenna cord into *SlideMinder*[®] radio.
7. Plug *SlideMinder*[®] radio into PC serial port using 6-ft. cable.
8. **OPTIONAL.** Set up GPS antenna.
 - A. Place GPS antenna on a horizontal surface with an unobstructed view of the sky.
 - B. Plug antenna wire into GPS receiver.
 - C. Plug GPS receiver cord into PC serial port.
9. Plug *SlideMinder*[®] radio and GPS receiver into a power outlet.



General Location of Radio Antenna

Detailed instructions are located on page 17.

SlideMinder[®] System Hardware List for Extensometer Unit

Extensometer Box Components

1. **Radio** – VHF, 2 to 25 watt, 12.5 kHz packet radio with integrated D2015 series modem.
2. **Data Logger** – ADS Versatile Logic Module (VLM2000-SP)
3. **Encoder** – US Digital Shaft Encoder (HD25A)
4. **Brake** – Magnetic Technologies Hysteresis Brake with Adjustable Torque
5. **Battery** – 35 Amp Hour
6. **Circuit Board**
7. **Voltage Regulator**



Standard Components

Stainless Steel Wire
(two 600 ft spools)



Solar Panel
(60 watts)



Slide Weight (30 lbs)



Additional Components



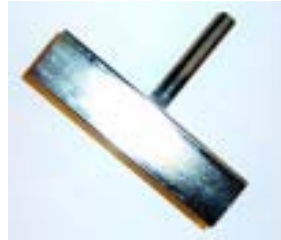
Idler Pulley Head

Hardware Included

Extensometer Mounting Brackets--Kee Klamps



Upper Barrel Mount
3"x 4" Backplate



Weight Mount

Additional Hardware Supplied

- 3 – 1/2" bore shaft collars
- 2 – 1/2" x 2" fender washers
- 2 – 1/2" x 1" hex bolts
- 2 – 5/16" x 1 1/2" hex bolts
- 2 – 1/2" lock washers
- 2 – 5/16" lock washers
- 2 – 1/2" hex nuts
- 2 – 5/16" hex nuts

Collar Clamps, Washers, and Weight Spring



Solar Panel U-bolts
with cross plates



Solar Panel Mounting Brackets

Hardware Required but NOT Included

- 1 – 55 gallon steel drum, with bottom perforated to allow drainage
- 1 – 1" ID x 52" galvanized water pipe for mounting the instrument enclosure
- 1 – 1" ID x 48" galvanized water pipe, threaded on one end,
- 2 – 1" ID x 14" galvanized water pipes, threaded on one end, and
- 1 – 1" ID galvanized pipe "T" for mounting the solar panel.
- 1 – 1" ID x 48" pipe for Idler Pulley (Optional)
 - Pin for attaching wireline
 - 10-gauge wire for grounding extensometer box
 - Grounding rod

Tools Supplied

Hex Key Wrenches and Wireline Ferrules

- 1 – 1/4" hex key
- 1 – 5/32" hex key
- 1 – 1/8" hex key
- 4 – Wireline ferrules



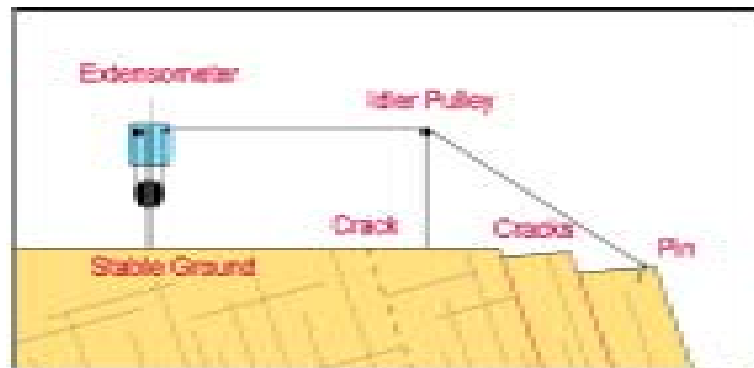
Tools Required but Not Included

- Electric Drill & Bits
- Hacksaw or Pipe Cutter
- Wrenches
- Pliers

SlideMinder[®] System Setup Details for Extensometer Unit

Typical Extensometer Placement

The extensometer should be placed far enough from the cracks being monitored that it is not in imminent danger of toppling over the edge, should a failure occur. The idler pulley allows correct tension to be applied to the wireline without contacting the slope being monitored.



General Location of Extensometer & Idler Pulley

Mounting Options

The only set requirement for mounting the extensometer is a means to mount it on a rigid vertical steel pole—a 1-inch inside diameter (ID) water pipe, preferably galvanized. Mounting assemblies for a drum support are provided. Drilling several holes in the bottom to allow for drainage is recommended. Use a drainable material for ballast after attaching the support poles. (See following instructions.)

Alternate mounting configurations may be used.

Drum Mount Design



Assemble the Extensometer and Support Structure

Assemble Support Structure

On the drum mount design, the 52-inch pipe for mounting the extensometer box is attached on the *outside* of the drum, and the 48-inch pipe for mounting the solar panel is directly opposite and attached on the *inside* of the drum.

1. Using the 1/4-inch hex key, attach the elbow and ring stand-off Kee Klamps to the 52-inch pipe, spaced approximately two feet apart to allow for vertical movement of the weight.
2. With the drum on its side, place the Kee Klamps on the drum so that the pipe will be vertical when the drum is set upright. The elbow bracket should be a few inches above the base of the drum, and the ring standoff should be positioned between the top of the drum and the uppermost rib. Mark the hole locations, remove Kee Klamps, drill holes: the lower elbow bracket requires two 1/2-inch holes, the upper ring stand-off requires two 5/16-inch holes.
3. Attach the pipe and Kee Klamp assembly.

- a. The lower bracket uses the 1/2 x 1-inch hex bolts, fender washers, and 1/2-inch lock washers and hex nuts.
- b. The upper bracket uses the 5/16 x 1 1/2-inch hex bolt, flat washers, the 3 x 4-inch steel backplate, and the 5/16-inch lock washers and hex nuts.



Pipe and Kee Klamp

4. Attach pipe for solar panel.
 - a. On the drum, opposite of the extensometer box pipe, mark and drill holes to mount the 48-inch pipe.
 - b. Using two of the 5/16-inch U-bolts, mount the pipe on the *inside*, with the threaded end up.
 - c. Tighten using the cross-plate, lock washers, and hex nuts. Use care when tightening the nuts to prevent galling the threads.
5. Stand drum up on end again.
6. Position the drum in the desired slope monitoring location.
7. Add Ballast to the inside of the drum to stabilize it and to prevent it from tipping over.

Assemble Slide Weight

Assemble the Weight to the Weight Carrier Assembly. The weight is used to tension the extensometer wireline.

1. Slide the weight onto the round shaft of the Weight Carrier Assembly with the side of the weight's SlinderMinder decal facing away from the square mounting tube.
2. Secure the weight onto the Carrier Assembly by installing the 1/2-inch collar onto the round shaft and tightening it into position so that it is flush to the end of the round shaft that supports the weight.



Weight and Spring Assembly

Install Weight on the Support Pole

The weight and impact spring should be installed onto the pole before the extensometer box is installed. Washers are installed above and below the spring. The weight must be able to move freely in a vertical direction—any potential obstructions must be removed from its path of motion.

1. Using the 1/4-inch hex key, loosen the 52-inch pipe and retract it from the elbow Kee Klamp.
2. Slide the weight assembly onto the pipe, followed by one of the 1 3/8-inch flat washers, the 3-inch compression spring, and the other flat washer.
3. Insert the pipe back into the bottom Kee Klamp and retighten the screws.

Ensure that the drum has been filled with Ballast.

Install Extensometer Box on Pole

Position the extensometer box on the pole so the encoder is toward the area to be monitored. Tighten the screws on both mounting brackets using the 1/4-inch hex key.

Install Grounding Wire

The grounding wire is intended to reduce damage to the unit in case of nearby lightning strike. A typical 10-gauge wire, not provided, can be attached to the grounding lug located on the outside of the extensometer box and connected to a standard grounding rod.

Install Radio Antenna

The connection for the radio antenna is located on the top of the extensometer box.

1. Thread the antenna onto the connection and hand tighten.
2. Give the antenna a 1/4 turn using a wrench. Do not overtighten!

Install Solar Panel

1. Thread the 1-inch ID pipe “T” on the 48-inch pipe.
2. Thread the two 14-inch pipes into the pipe “T”.
3. Attach the two angle brackets to the solar panel at the pre-drilled locations using two 1/4 x 1-inch bolts and two nylon stop nuts.
4. Attach the 5/16-inch U-bolts to the angle brackets, with the opening to the front of the solar panel.
5. Slide the U-bolts attached to the solar panel onto the base “T.” Tighten with the cross-plate, lock washers, and hex nuts.
6. Route the solar panel cable (2-pin connector) and the strobe cable (3-pin connector) through the two holes in the bottom of the enclosure. Secure each connector with the provided locking nut. Re-install the strobe cable dust cap if it will not be attached to a strobe.
7. Connect the power cord from the solar panel to the 2-pin connector located on the underside of the extensometer box. Route any excess cable so that it won't interfere with the operation of the extensometer.



8. Rotate and Tilt Solar Panel.
 - a. Rotate the panel to face due south in the northern hemisphere or due north in the southern hemisphere.
 - b. The optimal tilt orientation for the solar panel depends on the latitude of the site. Use the following table as a guideline for setting the tilt angle in degrees from vertical.

Tilt Angle Guideline*		Tilt Angles for Various Cities	
Latitude	Tilt Angle	City	Tilt Angle
0° - 10°	10°	Vancouver, Canada	65°
11° - 20°	Latitude +5°	Denver, USA	50°
21° - 45°	Latitude +10°	Bogotá, Colombia	10°
46° - 65°	Latitude +15°	Lima, Peru	17°
>65°	80°	Santiago, Chile	43°
		Jakarta, Indonesia	10°

*From "Design Aids for Small PV Power Systems" Solarex Corp.

Attach Wireline to Extensometer

Verify that one spool of wire is installed on the brake shaft that extends from the extensometer box. Ensure that the spool rotates *counterclockwise* as the wire is extended. (Extensometer box must be installed on vertical pole before attaching wire.)

1. Inside the enclosure, loosen the two red thumb screws on the brake. Rotate the brake until the torque setting is at about 10 percent.
2. Retighten the thumb screws.

Extend Wireline to Monitored Area

Extend the wireline to the rock mass to be monitored. It is usually best to do this with two people, so the wireline can be maneuvered around obstacles without snagging or kinking. For ease in extending the wireline, the torque setting on the brake should be near 10 percent (step 2 above).

1. Anchor Wireline to Rock Mass

Attach the wireline to a pin that has been hammered deeply into the rock mass, or other large immovable object. A loop can be made using the supplied ferrules to assist in attaching the wire to the pin. Once the end of the wire has been attached to the rock mass, carefully rewind any excess wire over the spool to remove most of the slack. This should be done before proceeding.

2. Set Up Idler Pulley/Place Wireline on Pulley.

The purpose of the idler pulley is to keep the wireline above the crest of the slope when the extensometer has been placed some distance away. The idler pulley should be viewed as expendable and placed close to the edge of the slope. The idler pulley support assembly is usually constructed of a steel tripod, not provided, with a pulley attached at the top. The pulley is designed to be clamped onto a 1-inch ID pipe. This idler support assembly can also be placed side a steel drum with rocks piled around it.

Place the wireline across the top of the pulley in the groove. **DO NOT** wrap the wireline around the idler pulley! It will be held in place by the tension in the wireline.

Install Wireline at the Extensometer Box

1. Wrap the wire *twice* around the encoder sheave, then *twice* around the slide weight.

The wire should be wrapped around the encoder pulley approximately 1 1/3 times. This will ensure that the encoder rotates properly with movement of the wireline.

2. Inspect the Wireline

Inspect the entire wireline from spool to the connection on the rock mass, to make sure it is free of obstruction, loops, kinks, and other potential problem sources.

Adjust Brake and Wireline Tension

The brake functions to maintain enough tension on the extensometer wireline to keep the weight elevated. Too little tension will cause the weight to fall, resulting in a loss of sensitivity to small amounts of movement.

The adjustment procedure is as follows:

1. Loosen the two red thumb adjustment screws.
2. Rotate the brake until the percentage of maximum possible torque is close to 50 percent at the reference line.
3. If more tension is required to keep the weight elevated, increase the brake percentage setting.
4. Tighten the thumb screws.

Connecting the Battery

Connect the battery after the entire installation is set up properly, the wireline is in place, and the brake has been adjusted to tension the wireline.

Battery Installation:

Install the battery using the retension strap provided. Connect the positive (red) terminal first, then the negative (black) terminal.

Switching the Power On



**Do not power up the radio if the antenna is not installed!
The radio can be permanently damaged. (See page 11.)**

The extensometer unit is now ready for operation. Open the door to the extensometer box, and locate the switch. Switch the Toggle from “OFF” to “ON.”

Indicator lights on both the VLM and the radio will come on, indicating that the system is working.



Adding More Wire to the Wireline

The wire is NOT CONNECTED to the spool! If there is sufficient ground movement to pull the wireline to its full extent, the wire will simply run off the spool. SlideMinder is designed this way to prevent damage to the extensometer. Add the second spool of wire, which was included with the extensometer, when the length of the extended wireline approaches its 600-foot limit.

Add the Wire

1. Turn off the Extensometer.
2. Extend enough wire from the spool to anchor the wireline temporarily.
3. Replace the nearly empty spool with the full one.
4. Make a secure mechanical connection of the wires from the two spools. this connection must be downstream from the encoder sheave.
5. Remove the excess wire from the old spool behind the connection.
6. Restart the extensometer.



Turn off the Extensometer before servicing.

Adding more wire to the extensometer can generate false readings because it is difficult to avoid turning the encoder. Therefore, it is important to turn off the extensometer to avoid recording movements during wireline installation.

Upon restart, the software will automatically reset the distance to the last recorded reading before the unit was turned off.

SlideMinder[®] System Hardware List for Base Station Unit

Base Station Components

- 1 – Base radio modem
- 1 – 6 ft. Serial cable
- 1 – 12VDC power supply for radio
- 1 – 2 ft. Coaxial cable
- 1 – Polyphaser lightning arrestor
- 1 – 75 ft. Coaxial cable
- 1 – 8 ft. Fiberglass antenna

Optional GPS Items

- 1 – GPS antenna with 25 ft. cable
- 1 – GPS receiver
- 1 – 6 ft. Serial cable
- 1 – 9VDC power supply for GPS receiver

Components Required but not Included

- Mounting kit for the 8 ft. antenna
- Computer for base station

Tools Required

- Small standard screwdriver

Minimum Computer Requirements

- 500 MHz CPU speed
- 256 RAM memory
- 1 gigabyte hard drive
- Windows 2000 or XP
- 2 serial COM ports with usage of GPS receiver
- Local area network (LAN) connection
- Telephone modem (optional)

SlideMinder[®] System Setup Details for Base Station Unit

General Location of Base Station Radio Antenna

The preferable location for the base station antenna is in line-of-sight to the extensometer and not more than two to three miles away. The base station should be easily accessible or include a local area network (LAN) so that the data can be easily obtained.

How the Software Works

There are two software programs required for the SlideMinder system. The first, ExtensBase, controls the radio communications and collects the data from the extensometers. It then sends the data to the second software program, ExtensMon, which compiles the data into a database. ExtensMon is the primary interface for setting thresholds and alarms.

The two programs can be run on the same computer, or with a local area network (LAN), on separate computers.

Minimum Computer Requirements

The base station software requires a 500 MHz computer with at least 256K memory and Windows 2000 or XP operating system. If the GPS receiver will be used to keep time, then two 9-pin serial ports will be needed (COM1 and COM2). Otherwise, there are several programs available that will update the CPU clock from the Internet.

Base Station Setup

1. Select Location for Base Station Computer

The cable for the base station antenna is 75 feet long. The GPS antenna cable is 25 feet long. If the GPS receiver will be used, the computer must be within 25 feet of the antenna.

2. Install Base Station Antenna

Fasten the 8-foot fiberglass antenna to a rigid support structure, such as Unistrut, or other antenna mounting kit. The bottom of the antenna should be approximately two feet above the roof line, if possible.

The GPS antenna, if used, can be mounted to any flat surface with an unobstructed view of the sky, such as directly on the roof.

In colder climates, it can be mounted on the same strut as the radio antenna to reduce likelihood that it will be covered by snow.

3. Select Location for Base Radio Modem

The radio modem can be placed directly on the desk with the computer, or mounted to a nearby wall. To mount the radio to the wall, insert the plastic key into the front of the radio and slide it out of the chassis. The chassis can then be disassembled and hung on the wall. Slide the radio back in and make the necessary cable connections.

4. Ground the Antenna Polyphaser

The antenna cable and the radio modem cable should be connected to the Polyphaser. In the event of a lightning strike on the antenna, the Polyphaser will prevent the electrical surge from reaching the radio modem and the computer.

- a. Connect the Polyphaser lightning arrestor to a grounding plate or circuit.
- b. Connect the Polyphaser to the radio modem using the 2-foot-long coaxial cable. Connect the cable at the rear of the radio.

5. Connect Radio Modem to Computer

Using a screwdriver, attach the 9-pin serial cable to the rear of the radio, then connect the cable to the computer at the COM1 serial port.

6. Install GPS Receiver

The GPS receiver can be placed on the same desk as the computer. Plug the GPS antenna cable into the receiver box. Connect the 6-foot serial cable first to the receiver box, then to the COM2 serial port on the computer. Then connect the GPS power supply.

7. Connect Radio Modem to Power Supply

Plug the power supply into the back of the radio modem and then into a wall outlet. LED lights on the front of the unit will indicate that the radio has power.



**Do not power up the radio if the antenna is not installed!
The radio can be permanently damaged.**