VSN240

Sensys Networks VDS240 Wireless Vehicle Detection System

VSN240 Wireless Magnetometer Sensor Installation Guide

P/N 152-240-100-001, Rev H
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Document Properties

This document is reference material for the Sensys Networks VDS240 wireless vehicle detection system from Sensys Networks, Inc.

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Regulatory Statements

FCC Compliance Statement

This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference.

(2) This device must accept any interference received, including interference that may cause undesired operation.

Any changes or modifications to this product not authorized by Sensys Networks could void the EMC compliance and negate the authority to operate the product.

RF Exposure Statement

This device has been tested and meets the FCC RF exposure guidelines. It should be installed and operated with a minimum distance of 20 cm between the radiator of RF energy and the body of users, operators or others.

Improper use or tampering with the device is prohibited and may not ensure compliance with FCC exposure guidelines.

Warnings

No Safety Switching

Sensys Networks **does not** allow its equipment to be used for safety applications such as controlling a mechanical gate or switching a train to avoid a collision.

Lithium Thionyl Chloride Batteries

Sensys Networks uses Lithium Thionyl Chloride batteries in the following products:

- Sensors (VSN240-F, VSN240-T, VSN240-S)
- Repeaters (RP240-B, RP240-BH, RP240-B-LL, and RP240-BH-LL)

Lithium batteries are widely used in electronic products because they contain more energy per unit -weight than conventional batteries. However, the same properties that deliver high energy density also contribute to potential hazards if the batteries are damaged. Improper use or handling of the batteries may result in leakage or release of battery contents, explosion or fire.

Following are the recommendations of the battery manufacturer for proper use and handling of batteries in the Sensys Networks devices mentioned above:

- **DO NOT** charge or attempt to recharge the batteries (they are NOT rechargeable)
- **DO NOT** crush or puncture batteries
- **DO NOT** short-circuit the batteries
- **DO NOT** force over-discharge of the batteries
- **DO NOT** incinerate or expose batteries to excessive heating
- **DO NOT** expose battery contents to water
- **DO** dispose of batteries and devices containing batteries in accordance with local regulations

NOTE:

Sensys Networks wireless sensors contain no serviceable parts and should never be disassembled. Installation and removal of sensors from pavement should only be done by trained personnel and care should be taken to insure that the sensor casing is not punctured or crushed.

Additional safety information is available from the battery's manufacturer:

- Sensor battery cell: http://www.able-battery.com/msds/ABLE_MSDS_ER14505.pdf
- Repeater battery cell: http://www.able-battery.com/msds/ABLE_MSDS_ER34615.pdf

Document Control

Sensys Networks continually reviews and revises its technical publications Please address questions, suggestions or corrections to support@sensysnetworks.com.

Sensys Networks Technical Publications

Readers of this document are encouraged to contact Sensys Networks for the latest technical information, design guides, and best practices.

The following is a list of Sensys Networks technical publications.

General and Reference Information

- *Wireless Vehicle Detection System Reference Guide*

Freeway and Arterial Applications

- *Design Guidelines for Freeway and Arterial Applications*
- *Configuration Guidelines for Freeway and Arterial Applications*
- *Installation Guidelines for Freeway and Arterial Applications*

Intersection Applications

- *Design Guidelines for Intersection Applications*
- *Configuration Guidelines for Intersection Applications*
- *Installation Guidelines for Intersection Applications*

Installation & Maintenance Procedures

- *Wireless Sensor Installation Guide*
- *Access Point Installation Guide*
- *Repeater Installation Guide*
- *Contact Closure Card Installation Guide*
- *Access Point Controller Card (APCC) Installation Guide*

Application Notes

- *Using Sensys Networks With Motorcycles*
- *Executing Commands on an Access Point with HTTP*

Sensys Networks Management Server

- *SNAPS Professional Set Up and Operating Guide*

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Contents

Introduction

This guide provides information and procedures for installing Sensys Networks wireless sensors in conjunction with the Sensys Networks VDS240 wireless vehicle detection system. This document is intended to be used by Sensys Networks customers, consultants, partners, dealers, and those who are interested in the application of wireless communication technology to the challenges of traffic detection, management and control.

What's Inside

This guide is organized into the following chapters:

- *Chapter 1: Introduction*, defines the purpose and scope of the guide, and provides information regarding related documentation and Sensys Networks library of technical documentation.
- *Chapter 2: Overview*, describes the Sensys Networks sensor, the contents of a product shipment, and sensor storage recommendations.
- *Chapter 3: Installation Prerequisites*, provides information regarding the tools required for a sensor installation.
- *Chapter 4: Installation Procedures*, provides step-by-step instructions for the installation of sensors.
- *Chapter 5: Removal Procedures*, provides step-by-step instructions for the removal of sensors.

Overview

This chapter describes the Sensys Networks wireless sensor; provides information on the contents of a sensor package, and the label affixed to each sensor; discusses sensor storage recommendations.

Wireless Sensor

A Sensys Networks wireless sensor is a magnetometer capable of low-power radio communications. Sensors detect changes in the earth's magnetic field to determine the presence or absence of vehicles relative to the detection zone of the sensor. Detection “events” are transmitted via wireless radio communications to a Sensys Networks access point where they are processed, stored and forwarded to other systems.

Sensor Package Contents

Each sensor shipment includes the following items:

- Flush-mount sensors
- One sensor shell per sensor
- Information sheet
- *Wireless Sensor Installation Guide* (this document)

NOTE:

Verify that you have received all of above items. In the event that some items are missing, contact Sensys Networks or the party that supplied the sensors to you.

Factory Default Configuration

Sensors are shipped with a factory default configuration suitable for bench-testing the device and applicable to many field environments. The information sheet details the following sensor attributes and configuration elements:

- *Sensor ID* – a globally unique identifier for the sensor (expressed in HEX format)
- *RF channel* – a critical configuration property
- Firmware release version

NOTE:

Sensor ID and RF channel are essential for communicating with, and further configuring of, the Sensys Networks wireless sensor. Save the information sheets for the party who configures and uses the network after it is installed. Refer to the *Configuration* chapter of the *Sensys Networks VDS240 Wireless Vehicle Detection System Reference Guide* for more information about these properties.

Sensor Label Information

A manufacturer's label is affixed to the top surface of each sensor and contains essential identifying information for the device. The elements of the label are:

- *Part number*
- *Orientation arrow* – an arrow that points in the direction of normal traffic flow when the sensor is properly installed. VSN240-T sensors have a red arrow visible while VSN240-F sensors display a black arrow.
- *Orientation statement* – a text message ("This end up") visible to the installer when the sensor is properly placed in its hole prior to covering it with industrial-grade epoxy.
- *Barcode* – an encoded representation of the device's unique id.
- *Sensor ID* – a HEX string that identifies the sensor in data reports and the TrafficDot network management tool from Sensys Networks.
- *Sensor Type Designator* – Some sensors are designed to operate only in stop bar modes (known as "T" model sensors). These units carry an indication to that effect; sensors that do not have such a designation (known as "F" model sensors) can be used in both freeway/arterial and intersection applications.

Sensor Storage Recommendation

To prevent damage prior to installation, it is recommended that sensors are stored in ambient temperatures from 32°F (0°C) to 100°F (38°C). It is also recommended that sensors are stored no longer than two years.

Installation Prerequisites

This chapter provides information to consider before installing sensors. The best practice recommendations discussed in this chapter are **not** directives mandated by Sensys Networks.

Safety Considerations

During a typical sensor installation, the work area can present temporary or constantly changing traffic conditions. This can create a high degree of vulnerability for the installation crew on or near the roadway.

The following are a few key elements that you might want to considered to ensure worker safety:

- Perform installations during daylight hours.
- Reduce the time you are exposed to traffic.
- Place orange safety cones around the installation site.
- Use hazard lights and/or beacons.
- Use your vehicle as a buffer between yourself and traffic.
- Wear appropriate attire:
  - Bright, reflective clothing
  - Gloves
  - Eye protection
  - Ear protection (when using coring equipment)
  - Hard hat (during highway/freeway installations)

General Site Requirements

The site of a Sensys Networks VDS240 vehicle detection system must be dry, as sensors perform at the optimum peak when installed in dry payment. Sensors can be effectively installed into any pavement type that allows a hole to be cored.

Types of pavement include Superpave Hot Mix Asphalt (HMA); Stone Matrix Asphalt Portland Cement Concrete, including Jointed Plain Concrete Pavement, Jointed Reinforced Concrete Pavement, and Continuously Reinforced Concrete Pavement; open-graded HMA, including Open Graded Friction Course and asphalt-treated permeable materials (rubberized asphalt).

NOTE:

Do not install sensors in pavement that has cracks or crumbling pavement. If needed, relocate planned position away from any cracks.

Tools and Equipment for Sensor Installation

A typical sensor installation requires the following:

- *Wireless sensor(s)*
- *Coring bit* – 4" (10.2 cm) diamond-tip bit suitable for the type of pavement to be cored
- *Coring drill* – outfitted for wet coring operations, ideally mounted to a lift gate
- *Paint* – to mark the pavement at the coring location
- *Shop vacuum* – to clean out the cored hole
- *Heat gun* – hot air or propane torch to dry the hole (or roadway moisture) prior to epoxy application

NOTE:

Ensure that the core is checked after using a compressor as moisture may actually come from the compressor

- *Water* – used with the coring drill
- *Bushing tool* – to flatten out the hole
- *Tape measure* – to check hole depth
- *Epoxy* – to fill the hole after sensor installation (a minimum of one tube of FJS epoxy for each sensor)

NOTE:

A 2:1 ratio pack of Fabick Joint Seal (FJS), a two-component 100% sealant is recommended. This self-leveling joint sealant displays fast cure times (approximately five minutes), and excellent adhesion to concrete.

- *Epoxy applicator* (including mixing tubes) – to mix and apply epoxy

Coring and Drilling Considerations

Sensor holes can be created with either a core drill or hammer drill. When a hammer drill with carbide or other tip is used, be sure that the tip will last for the number of sensors planned for installation. Keep a spare tip in reserve if possible.

When a core drill is used with a bit requiring water cooling, ensure the following items are available:

- Water in sufficient quantities to cool the drill
- Hand chisel or other tool to clear the hole
- Hot air, propane torch or other tool to dry the hole prior to application of the epoxy

NOTE:

Apply epoxy only to a hole that is completely dry. Moisture in any amount may cause a chemical reaction with epoxy, which causes it to bubble.

Additionally, ensure that adequate plans have been made to capture the slurry resulting from drilling into the road. Dispose of it according to local environmental regulations.

Coring Bits

Coring bits must be suitable for creating a hole in the target surface. For soft road surface, a 4" *double cylinder coring bit* is recommended and for harder surfaces, a 4" *grinding coring bit* is recommended. Once a 2½" (6.5 cm) deep hole is drilled, chisel any remaining material so that the result is a flat bottomed hole.

Two types of 4-inch drill bits, each with 1¼" standard machine threaded sleeves, are recommended and shown in the following diagram.

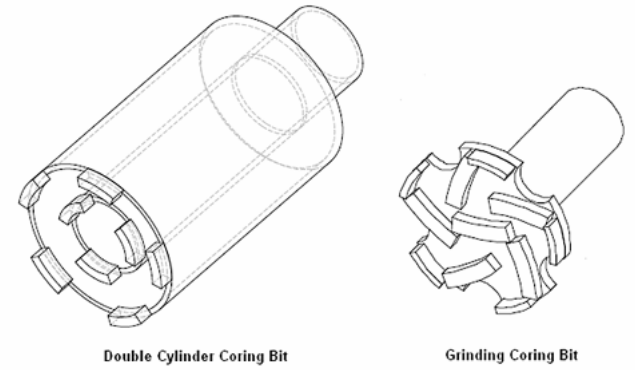

Figure 3.1. Coring bits

Installation Procedures

This chapter provides step-by-step sensor installation procedures.

Installation Crew Requirements

Wireless sensor installations require a crew consisting of a roadway drill operator, and an assistant who operates a device to remove loose debris and dust from the hole in the pavement that holds the sensor. A typical sensor installation requires at least one core or hammer drill truck. Additional trucks may be required to implement traffic control and lane closures.

Step-by-Step Procedures

Sensor installation consists of the following operations:

- Enclosing the sensor in a sensor shell
- Installing the sensor/shell assembly into the road

NOTE:

In most cases, sensors are already enclosed in sensor shells. In the case of a sensor reinstallation, the sensor must be enclosed in a new shell as shown in the following section.

Enclosing the Sensor in a Sensor Shell

1. Lay out the sensor and a sensor shell on a flat work surface. Open the empty shell by separating the top from the bottom.

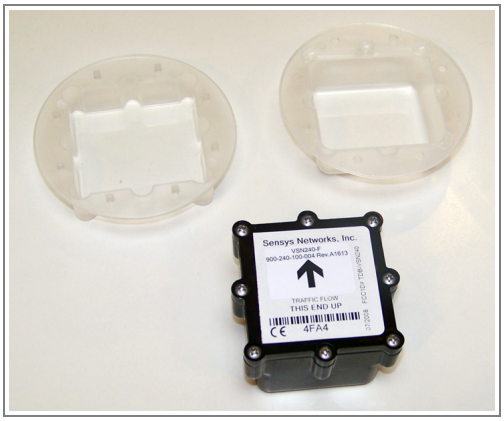

Figure 4.1. Sensor and shell

2. Place the sensor (label side up) into the bottom of the sensor shell. Grasp the top of the shell.

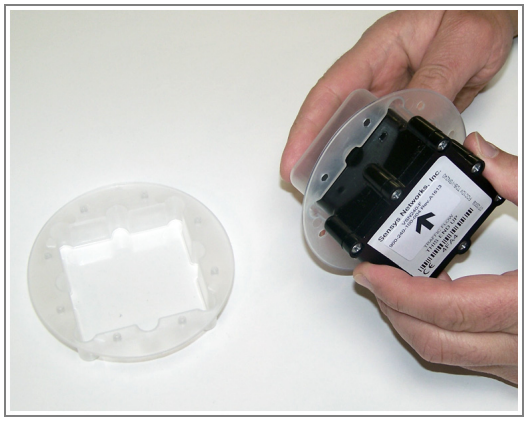

Figure 4.2. Placing sensor in shell

Figure 4.3. Placing sensor in shell

3. Place the top of the shell over the sensor matching the short alignment pins in the shell top to the holes in the shell bottom. The pins should fit easily into the holes.

NOTE:

Do **not** use excessive force to fit the pins into the holes.

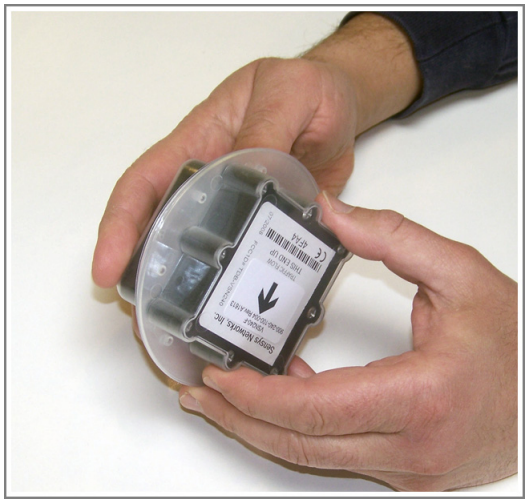

Figure 4.4. Fitting top of sensor shell to bottom of sensor shell

4. Gently pinch the edges of the shell together to seat the alignment pins. Use light pressure to press the edges together.

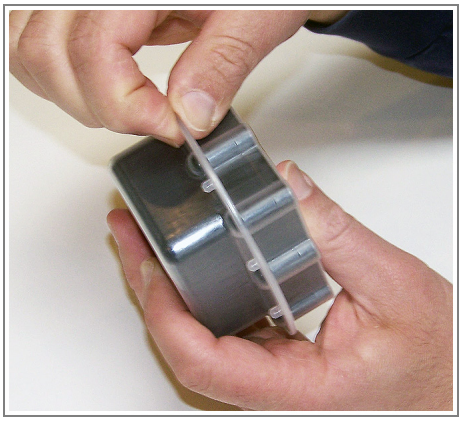

Figure 4.5. Pinching the shell edges together to seat the pins.

Figure 4.6. Pinching the shell edges together to seat the pins.

5. Repeat the prior step at all (8) areas around the edge of the sensor shell as shown below.

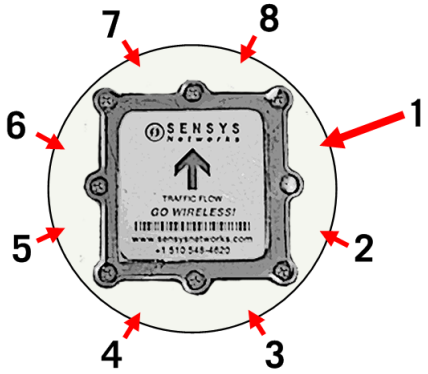

Figure 4.7. Areas to press the edges of the shell together

A completed sensor/shell assembly is shown below. Ensure that the sensor label is visible.

Figure 4.8. Finished sensor and shell assembly

Installing the Sensor/Shell Assembly into the Road

IMPORTANT!

SAFETY WARNING: **Always wear safety glasses, gloves, and observe other precautions when installing sensors. Do not puncture or crush sensor when drilling. Doing so may subject sensor batteries to adverse shock resulting in explosion and release of harmful gases.**

1. Find and mark the center of the desired sensor location.
2. Core a hole approximately 4” (10 cm) in diameter, and 2½” (6.5 cm) deep into the pavement. Check depth as your drill, remove debris periodically.

NOTE:

To reduce the chance of introducing contaminates, avoid coring and installing a sensor too deeply into the road.

3. Vacuum or brush the hole clear of dust and debris.

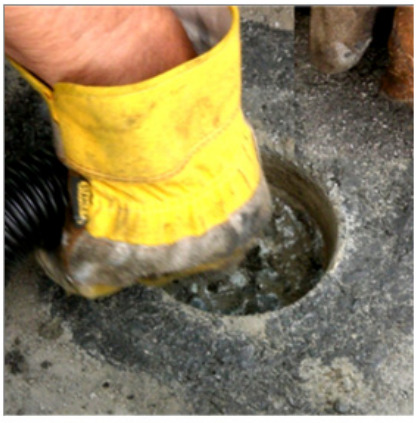

Figure 4.9. Clearing sensor hole

Ensure that the hole is dry as moisture may impede the curing of the epoxy. If moisture is observed, use the heat-gun or torch to dry the inside of the hole completely.

When using a heat-gun or torch ensure that you **do not overheat the binding element in the pavement**. If overheated, the asphalt may crumble and the epoxy will not adhere to the sides of the core correctly.

NOTE:

The hole **must** be cool before performing the next step. An overheated hole will not cure properly, trapping air in the epoxy and possibly damaging the sensor. It will also burn away the binder making the pavement brittle.

4. Trim the sensor shell legs to level as needed.

NOTE:

To aid in leveling the sensor in the hole, ensure that the sensor and shell reach the required height of 3/8" (1 cm) to 1/2" (1.3 cm).

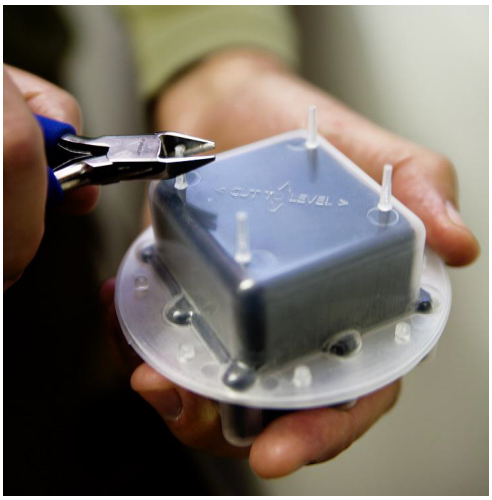

Figure 4.10. Trimming shell legs

5. Apply epoxy to the bottom of the hole at a depth of approximately 1”.

Figure 4.11. First epoxy application

6. Place sensor in hole. Verify the following:
   - Sensor is dry and clean
   - Sensor is level
   - Label is visible
   - Arrow on label points in the direction of traffic flow
   - Sensor location and sensor ID are recorded

NOTE:

When placing the sensor into the first application of epoxy, it must be pressed down firmly to push out any air pockets, and to ensure that it does not float up when the remaining epoxy is applied to completely cover the sensor.

Fill the hole with epoxy, completely covering the sensor and its shell.

Figure 4.12. Placing the sensor in road

Figure 4.13. Filling hole with epoxy until level with road surface

Figure 4.14. Filling hole with epoxy until level with road surface

Figure 4.15. Installed sensor

NOTE:

Protect the edge of the core by placing epoxy around the edge of the asphalt.

Removal Procedures

This chapter provides step-by-step instructions for removing previously installed sensors.

Removing Sensors From a Nominal Installation

Nominal installations refer to networks that use flush-mount sensors enclosed in molded plastic shells. The procedure involves prying off the top of the sensor shell.

Estimated Procedure Duration

The estimated per-sensor duration, exclusive of site set-up (lane closure, marking, etc.) and road surface repair, is 15 minutes.

Required Tools

- Hammer drill with chisel (without rotate mode)
- 3' (1 m) steel pry bar
- a means to permanently mark the sensor/epoxy unit removed from the road

Step-by-Step Procedures

IMPORTANT!

SAFETY WARNING: **Always wear safety glasses, gloves, and observe other precautions when removing sensors. Do not puncture or crush sensor when drilling, prying, or removing. Doing so may subject sensor batteries to adverse shock resulting in explosion and release of harmful gases.**

1. Locate and mark the sensor to be removed.

2. Make four (4) shallow chisel cuts around the sensor as shown in the figures below. Drill straight down. Do **not** exceed 1” (3 cm) in depth.

NOTE:

Drilling deeper than directed increases the chances of intruding into the sensor unit which may result in damage. Additionally, when prying the sensor/shell assembly from the hole, deep cuts may result in prying out the entire assembly instead of just the top half. Recovering the sensor may be more difficult as a result.

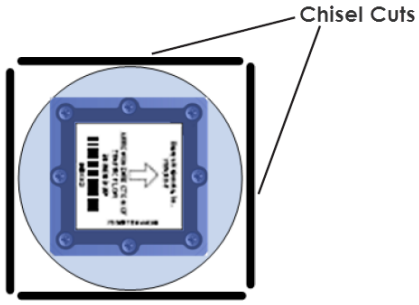

Figure 5.1. Orientation of chisel cuts to sensor

Figure 5.2. Chisel cuts

Figure 5.3. Chisel cuts

NOTE:

The drill bit should **not** spin.

3. Insert the pry bar into one of the cuts and pry upward with moderate force.

Figure 5.4. Prying upward to loosen shell top

Figure 5.5. Prying upward to loosen shell top

4. Alternate prying between the different chisel cuts.

Figure 5.6. Prying upward on opposing side

Figure 5.7. Prying upward on opposing side

5. After loosening the shell top, pry it away from the sensor and carefully remove the top. Do not use excessive force.

Figure 5.8. Removing sensor shell top

Figure 5.9. Removing sensor shell top

6. Grasp the sensor and pull it away from the base of the shell. Remove dust or debris from the sensor. Leave shell base in the road.

Figure 5.10. Removing sensor

Figure 5.11. Removing sensor

Removing Sensors From a Legacy Installation

Legacy installations refer to networks that use flush-mount sensors without molded plastic shells. The procedure involves coring into the pavement around the sensor and removing the sensor and the surrounding cured epoxy as a unit.

Estimated Procedure Duration

The estimated per-sensor duration, exclusive of site set-up (lane closure, marking, etc.) and road surface repair, is 15 minutes.

Required Tools

- Hammer drill with chisel (without rotate mode)
- 3' (1 m) steel pry bar
- a means to permanently mark the sensor/epoxy unit removed from the road

Consideration – Permanently Marking the Sensor with the Direction of Traffic

This procedure results in a sensor and its surrounding epoxy being separated as a unit from the road. The resulting sensor/epoxy "plug" can be re-used as-is, without the need to carve into the epoxy to free the sensor.

However, to reuse the sensor/epoxy plug, it is essential to permanently mark the sensor/epoxy unit with an arrow that indicates the direction of traffic in the lane where it was removed.

To operate effectively the sensor must be correctly oriented to the normal traffic flow. Failure to record this information before removal increases the likelihood that future use of the sensor will be impaired due to an invalid orientation of its magnetometer to vehicle movements.

Step-by-Step Procedures

IMPORTANT!

SAFETY WARNING: **Always wear safety glasses, gloves, and observe other precautions when removing sensors. Do not puncture or crush sensor when drilling, prying, or removing. Doing so may subject sensor batteries to adverse shock resulting in explosion and release of harmful gases.**

1. Locate and mark the sensor to be removed.
2. Core a 5" diameter hole into the road around the sensor to a depth of approximately 2½" (6.5 cm).
3. Permanently mark the direction of traffic onto the top of the sensor/epoxy plug.
4. Use the pry bar as needed to work the sensor/epoxy plug free from the bottom of the hole.
5. Pull the sensor/epoxy plug free from the hole.
6. Remove loose dirt or debris.

NOTE:

The sensor/epoxy unit can be stored in normal shop conditions and reused "as is." To reinstall the unit, core a 5" diameter hole and epoxy the sensor/epoxy unit into place.