PLACEPOD® VEHICLE DETECTION SENSOR USER MANUAL

PlacePod® Vehicle Detection Sensor

In-Ground and Surface-Mount

PlacePod is an in-ground or surface-mounted vehicle detection sensor that communicates with a LoRa gateway to provide real-time parking data. It provides accurate vehicle detection in parking spaces, up to 7 years of battery life, and is stable over temperature fluctuations, even in harsh environments.

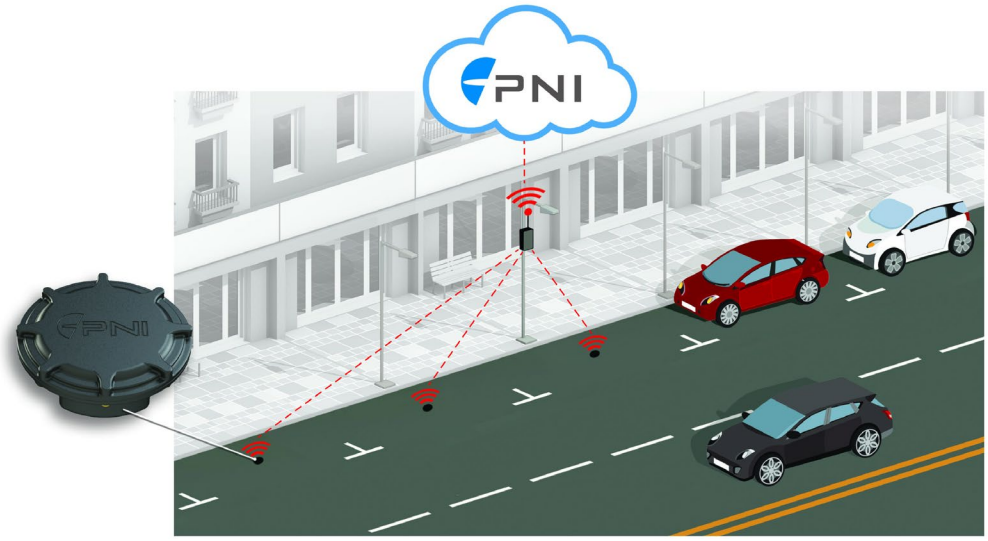

Figure 1-1: PNI Parking Solution Overview

Key Features & Benefits

- Includes the industry's most accurate magnetic sensing system for vehicle detection with the combination of PNI's high-performance magnetic sensor and vehicle detection algorithms that accurately detect the presence or absence of a car in a parking space.
- Includes a built-in LoRa radio that communicates to a gateway with complete LPWAN compatibility.
- Sensors and algorithms are finely tuned for ultra-low power consumption, providing continuous vehicle detection without missing a parking event.
- Capability for wireless configuration and software updates using Bluetooth Low Energy (BLE) via PNI's mobile iOS application.
- PNI's Parking Management Application provides a software service for managing and monitoring all parking resources and data. The application is also available for testing and proof of concept purposes.
- PlacePod specifications are located in Appendix II.

Applications

- Smart Parking Management, Enforcement, Reporting
- Parking Guidance
- Smart City
- Commercial Real Estate

TABLE OF CONTENTS

1 INTRODUCTION

This guide is designed to support the PlacePod device. For questions relating to other elements of a Parking Management system, please contact the provider.

The PlacePod User Manual is divided into three sections:

- **System Functional Elements**

  PNI's PlacePod sensor is one component of a parking management system. The System Functional Elements section describes the system components and preliminary decisions that must be made to enable a smooth implementation.

- **Setup and Installation**

  The Setup and Installation section provides a setup and installation overview for the PlacePod sensor and references to additional materials that will assist with this process.

- **Appendices: Additional Information**

  The Appendices provide additional information such as a glossary and detailed technical specifications.

2 SYSTEM FUNCTIONAL ELEMENTS

2.1 SYSTEM OVERVIEW

The diagram below shows the primary elements of the PlacePod system architecture. A brief description of these functional elements follows.

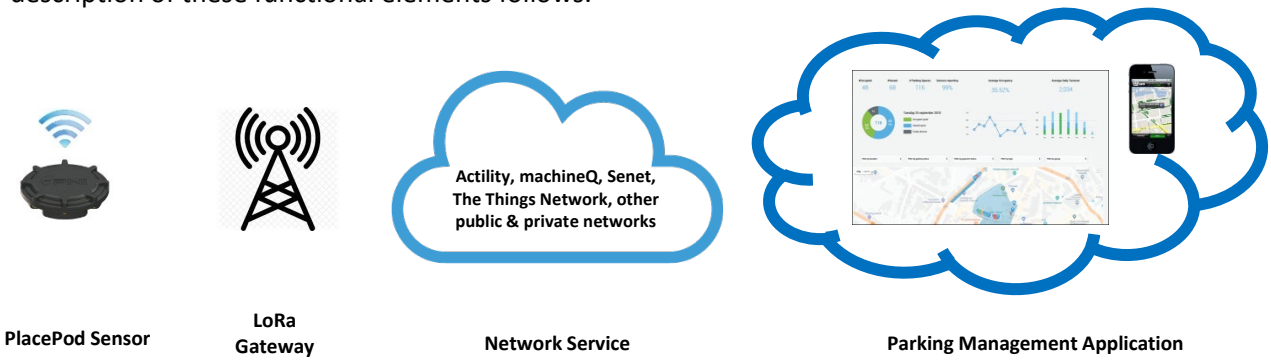

Figure 2-1: PNI Parking Solution - Functional Elements

- **PlacePod Sensor – The PlacePod sensor** is a LPWAN-compatible vehicle detection device. It is built with PNI's high-performance magnetic sensor and vehicle detection algorithms that accurately detect the presence or absence of a vehicle in a parking space. Each sensor has a unique ID for easy provisioning, tracking and management.

- **Gateways –** Each PlacePod device communicates to the gateways set up to receive their signals. The gateways collect the signals from the PlacePod devices and send the information on to the Network Service. The number of gateways required depends upon the size and environment of the parking areas covered by the parking system.

- **Network Service –** The Network Service collects the signals from the gateways and communicates this data to the Parking Application. The choice of provider for the Network Service is a key integration decision determined by the scope of the project.

- **Parking Application -** A Parking Application is a dashboard for visualizing and managing parking data, including installation and verification, diagnostics, monitoring, and reporting. The choice of a Parking Application will determine the customer's user experience and can be part of a stand-alone service or larger Smart City applications. Customers can use PNI's parking application, or a third-party application, to manage their parking data.

2.2 PLACEPOD PHYSICAL SENSOR

The physical sensor detects vehicle presence using the combination of PNI's high-performance magnetic sensor and vehicle detection algorithms to determine the presence or absence of a car in a parking space.

Two decision factors determine which PlacePod product is optimal for a particular installation:

1) **In-Ground or Surface Mount:**

Generally, the in-ground model should be the default since placing the PlacePod just below the parking surface provides the most durable installation. However, in certain circumstances, such as in parking garages or other applications where there is limited ability to excavate the parking surface, the surface-mount model is recommended.

In-ground **Surface-mount**

Figure 2-2: PlacePod vehicle detection sensor models

2) **LoRa Communications Bandwidth:**

The PlacePod communicates with the gateway over several LoRa bandwidths – 915 MHz, 868 MHz, or 923 MHz. The applicable bandwidth is determined by regional communications regulations. For example, in the United States 915 MHz is used, while in Europe 868 MHz is the default. Additional regional frequencies will be supported.

Product Ordering Information

LoRa RF Band	Part #
US 915 MHz	VS-NA915LR (in-ground); VSS-NA915LR (surface-mount)
EU 868 MHz	VS-EU868LR (in-ground); VSS-EU868LR (surface-mount)
AU 915 MHz	VS-AU915LR (in-ground); VSS-AU915LR (surface-mount)
AS 923 MHz	VS-AS923LR (in-ground); VSS-AS923LR (surface-mount)

2.3 GATEWAY

PlacePod supports gateways that use the LoRaWAN™ specification for wireless communication. Note that this manual describes the functional components in a linear manner – PlacePod to Gateway to Network Service to Parking Application. However, the network service is generally chosen before the

gateway since many network providers offer bundled services that allow for smoother implementation. Once a network service has been selected, talk to the network provider regarding the bundled services they may offer.

The two decisions related to gateway deployment are: 1) choosing the desired gateway features, and 2) determining the number of gateways required based on coverage area and number of PlacePods deployed on the network.

PNI strongly recommends that the customer conduct a pre-installation site survey in order to determine the number of gateways required for reliable network performance. The number of gateways needed depends on the signal strength (RSSI) and the noise level (SNR) of PlacePods in each parking space. Factors affecting the number of gateways required include location of gateways, density of gateways, nearby buildings and obstructions, antenna size, and choice of manufacturer. The same parking space may have RSSI variation of 10 to 15dB when a car is present or when the space is vacant. PNI recommends testing for a -90dBm RSSI without a car in the space as the baseline for gateway setup. For small parking projects, a minimum of two gateways are recommended as redundancy protection. Generally, more gateways translate to better coverage. Deploying too few gateways will affect the network reliability due to weak signal strength at the gateways and a lack of redundancy.

Gateways can be ordered from many LoRa gateway manufacturers, such as Multitech, Cisco, Tektelic, Kerlink, The Things Network, and others.

2.4 NETWORK SERVICE

The Network Service uses remote servers to collect PlacePod sensor data relayed from the gateways. This data is stored on the network service provider's servers and accessed by the customer through the Parking Application. PlacePod works with either public or private LoRa networks (such as Actility, PNI, machineQ, The Things Network, and Senet). PlacePod is also successfully integrated into other LoRa networks in the United States, Canada, Australia and South America.

PNI partners with service companies that provide integrated gateway and network cloud solutions. Utilizing the bundled services from these companies allows for the smoothest implementation.

Some customers prefer to create and run their own custom parking management solutions. A systems integrator can help implement a customized solution using less common components.

2.5 PARKING MANAGEMENT APPLICATION

The web interface in the Parking Management Application is used to manage interaction with the vehicle detection sensors and gateways. The web interface can provide an overview of sensor data and reports, such as:

- Real-time spaces available
- Average daily occupancy
- Sensor events per space
- Turnover heat map

PNI offers a parking management application that can be used to manage and monitor parking resources. PNI's parking management application is also ideal for testing and proof of concept and in basic system implementations. Please contact your system integrator or the third-party parking application vendor directly for information regarding these options.

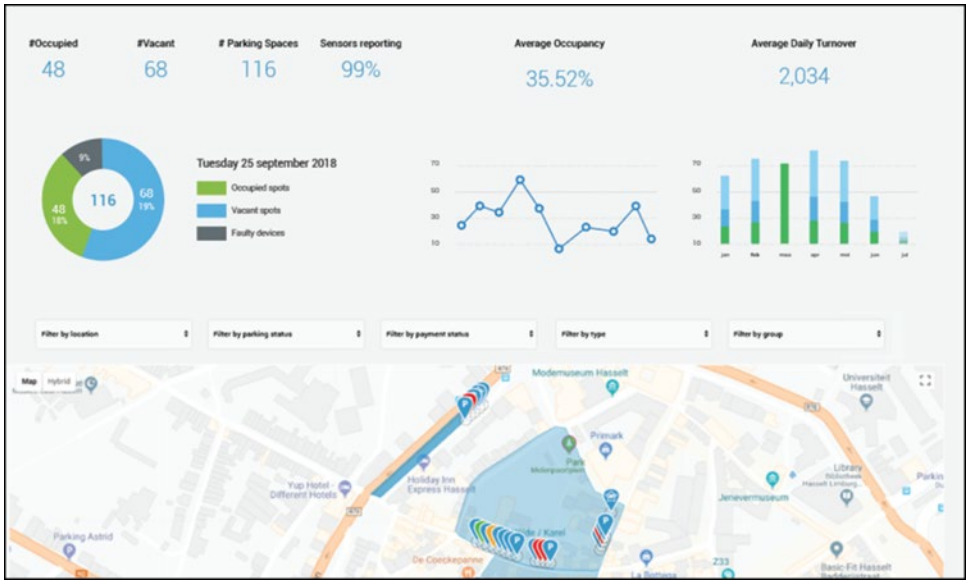

Figure 2-5: Dashboard screenshot from PNI's Parking Management Application

3 PLACEPOD PARKING SOLUTION SETUP AND INSTALLATION

3.1 SETUP AND INSTALLATION OVERVIEW

This section will outline the steps needed to ensure the PlacePod is successfully installed and functional.

This assumes that the customer has already chosen a LoRa network service provider and installed gateways.

3.2 SET-UP OVERVIEW

Following are the recommended steps to set up the PlacePod vehicle detection solution with a LoRa network service:

Pre-Installation Steps:

1. Choose a LoRa network service provider
2. Acquire gateways and install in pre-determined location decided from pre-installation LoRa RF site survey. A pre-installation survey can be an important step in determining the number of gateways required for reliable network coverage. A PlacePod sensor can be used as a survey tool in a site survey as follows:
    a. Determine all locations PlacePods are expected to be installed.

b. Determine possible gateway locations taking into consideration the following:
    i. Distance from gateway to each PlacePod
    ii. Line of sight from gateway to each PlacePod
    iii. Power connection for gateway
    iv. Internet connection for gateway
c. Install a test gateway in one of the possible gateway locations.
d. Bring a PlacePod to each of the possible PlacePod installation locations and place it on the ground in the center of the parking space.
e. Turn on PlacePod and watch on Network Logger* the RSSI levels as the PlacePod sends messages.
   * Network Logger will vary based on network service provider. Contact your network service provider for information.
f. If signal is not within expected range (PNI recommends -90dBm), then gateway location must be improved. This may be accomplished by bringing the gateway closer to the PlacePod or repositioning the gateway so that it has direct line of sight to the PlacePod.

Note: For help installing gateways, please contact your gateway manufacturer.

3. Ensure PlacePods have been provisioned onto the LoRa network.

PlacePod Installation Steps:

1. Activate the PlacePod
2. Installation Site Survey
3. Install the PlacePod
4. Calibrate the PlacePod for the vacant parking space

3.3 ACTIVATE PLACEPOD

PNI's PlacePod vehicle detection sensor ships in a special mode where the RF radio is inactive in order to conserve power. Using the PlacePod Vehicle Detection Sensor Utility iOS application will activate the PlacePod so that it will join and communicate with the RF network. As such, it is important that the RF network the PlacePod will connect to be available at the time of activation.

This iOS application enables communication with PNI's PlacePod Vehicle Detection Sensor using Blue-tooth Low Energy (BLE).

The application is compatible with iOS platforms 9.0+ and has been tested on the following devices:

- iPhone 6 Plus (A1522) iOS 12.0
- iPad mini (Wi-Fi Only/1st Gen) (A1432) iOS 9.3.5
- iPhone 6s (A1688) iOS 12.0

There are two main groups of core functionality in this application. These include:

- BLE application for direct communication with a PlacePod
- Label scanning application

Figure 3-3: Utility Application Main Screen

To download the PlacePod Vehicle Detection Sensor Utility, visit the iOS App Store at:

https://itunes.apple.com/us/app/placepod-sensor-utility/id1383901393?mt=8&app=itunes&ign-mpt=uo%3D4

Detailed instructions for using the PlacePod Vehicle Detection Sensor Utility iOS application are included in the PlacePod Vehicle Detection Sensor Utility User Manual. To download the user manual, visit:

https://www.pnicorp.com/download/placepod-utility-application-ios-user-manual/

3.4 INSTALLATION SITE SURVEY

Once the PlacePod has been activated it is important to ensure that the sensors are able to communicate with the LoRa network by performing an installation survey. The installation survey is performed in a similar manner to the pre-installation survey described in Section 3.2.2. However, in this case the actual PlacePods and gateways being deployed are tested during installation (but before final installation so adjustments can be made if required). If the pre-installation site survey was performed, the installation site survey should confirm the signal strengths from the PlacePods to the gateways are sufficient for the system to function properly. If a pre-installation site survey was not completed, then gateways may need to be moved to a better location and/or added. PNI recommends testing for a -90dBm RSSI without a car in the space as the baseline for gateway setup.

3.5 INSTALL THE PLACEPOD

PlacePod can be installed in-ground or surface-mounted, depending upon the model which was purchased. Please refer to the Installation Guide for details on each type of installation. Each PlacePod has a unique ID which can be found on the bottom of the sensor. PNI recommends that you record each sensor ID and match it to the Parking Space ID before installing it into the parking space. Customers generally want to associate a sensor with a physical location. PNI's Parking Application allows this information to be input as part of the provisioning process. Third-party Parking Applications will also generally allow this, although in some systems this information is configured directly into the Network Service.

Download the PlacePod Installation Guide at:

https://www.pnicorp.com/download/placepod-installation-guide/

3.6 CALIBRATE THE PLACEPOD

The PlacePod must be calibrated before it is able to properly detect vehicle parking events. Once the PlacePod is installed in the parking space, ensure that the space is free of any non-permanent ferrous objects such as toolboxes, installation tools, and other equipment. Also, ensure that there are no vehicles in any adjacent parking spaces.

Consult the PlacePod Vehicle Detection Sensor Utility iOS Application User Manual for detailed instructions about calibrating PlacePod.

4 APPENDICES

4.1 APPENDIX I: GLOSSARY

Bluetooth Low Energy (BLE): A wireless technology designed to connect an individual person's devices.

Ferrous: A material containing Iron. Materials containing iron in the vicinity of a PlacePod can interfere with the calibration of the device.

Gateway: LPWAN equipment that receives wireless signals from remote devices (such as parking sensors) using LoRa bandwidth, and then relays these signals to a network service using a different communications protocol.

LoRaWAN™: A protocol, defined by the LoRa Alliance, specifying how devices (such as parking sensors) communicate with LPWAN gateways.

LoRa: A low-power consumption, long-range technology for wireless data communication, utilizing unlicensed sub-1GHz bandwidths. The bandwidth utilized varies by region (915 MHz in North America, 868 MHz in Europe). PlacePod communicates with gateways using LoRa bandwidths.

LPWAN: A Low Power Wide Area Network, utilizing wireless communications to allow battery powered devices (such as parking sensors) to communicate.

Network: Two or more devices that communicate with each other. The internet is a very large network including every device connected to the internet, but a router connecting a computer and a printer is also a network.

Provisioning: The process of identifying a device and incorporating it into a network so that it can be utilized together with the software managing the network.

RSSI: Received Signal Strength Indicator (RSSI) is a measure of the power level at a receiving device from a sending device. This power is often measured in dBm, and the higher the power, the stronger the signal.

SNR: Signal to Noise Ratio (SNR) is the ratio of the power of a particular signal to the background noise associated with that signal.

4.2 APPENDIX II: PLACEPOD SPECIFICATIONS

Table 4-1: Performance Specifications*

Parameter	Values
Communication	• LoRa 915 MHz or 868 MHz Module • LoRaWAN compliant • Uses Sub-GHz ISM bands in North America, Europe, South America, Asia, and other regions
LoRaWAN Device Type	Class A
Outputs	2 states: • Occupied • Vacant
Battery Life/Type	• Up to seven years depending on configuration and distance from gateway • Lithium-Thionyl Chloride
Dimensions In-Ground	4.3 in (10.92 cm) diameter -minimum hole 4.5 in (11.43 cm) 1.18 in (3.00 cm) height -minimum hole 2.5 in (6.35cm)
Dimensions Surface-Mount	9.0 in (22.86 cm) diameter 1.25 in (3.15 cm) height
Installation Position	Center of the parking space
Operating Temperature	-30°C to +70°C / -22°F to +158°F
Storage Temperature	-40°C to +85°C / -40°F to +185°F
Activation Type	OTAA
Certifications	FCC (915 MHz), CE (868 MHz)

Footnote:

* Specifications are subject to change.

Table 4-2 PlacePod Vehicle Detection Sensor Default Settings

Parameter	Default
Frequency Sub Band (US915, AU915)	2
Spreading Factor	10
Frame Port	3
Adaptive Data Rate Support	Yes (Configurable via BLE, Off by default)
Keep-Alive Interval	1 Hour
Over-The-Air Activation Keys	Programmable
Payload Format	CayenneLPP [1]
Confirmed Messages	None
BLE Advertise	Once every second while deactivated and once every 10 seconds once activated

For Customer Support, please contact PNI Sensor at: https://www.pnicorp.com/support/

PNI Sensor
2331 Circadian Way
Santa Rosa, CA 95407, USA
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DO NOT OPEN THE PLACEPOD SENSOR. THE PLACEPOD SENSOR IS SHIPPED READY TO ACTIVATE AND INSTALL. THE SENSOR SHOULD NOT BE OPENED FOR ANY REASON. OPENING THE SENSOR VOIDS THE PRODUCT WARRANTY.

Warranty and Limitation of Liability – PlacePod Vehicle Detection Sensor ("Product"). PNI Sensor ("PNI") manufactures its Products from parts and components that are new or equivalent to new in performance. PNI warrants that each Product to be delivered hereunder, if properly used, will, for one year (365) days following the date of shipment be free from defects in material and workmanship and will operate in accordance with PNI's published specifications and documentation for the Product in effect at time of order. Any Product that is non-functional and unresponsive to firmware and software updates will be considered failed hardware units and will be replaced at no charge. This warranty includes one year (365 days) of debugging maintenance for customers that use the PNI Parking Management Software to manage PNI's Product.

This warranty does not cover wear and tear due to normal use, or damage to the Product as the result of improper installation, misuse, neglect of care, alteration, vandalism, theft, accident, or unauthorized repair.

THE ABOVE WARRANTY IS IN LIEU OF ANY OTHER WARRANTY, WHETHER EXPRESS, IMPLIED, OR STATUTORY, INCLUDING BUT NOT LIMITED TO, ANY WARRANTY OF MERCHANTABILITY, FITNESS FOR ANY PARTICULAR PURPOSE, OR ANY WARRANTY OTHERWISE ARISING OUT OF ANY PROPOSAL, SPECIFICATION, OR SAMPLE. PNI NEITHER ASSUMES NOR AUTHORIZES ANY PERSON TO ASSUME FOR IT ANY OTHER LIABILITY.

If any Product furnished hereunder fails to conform to the above warranty, Customer's sole and exclusive remedy and PNI's sole and exclusive liability will be, at PNI's option, to repair, replace, or credit Customer's account with an amount equal to the price paid for any such Product which fails during the applicable warranty period provided that (i) Customer promptly notifies PNI in writing that such Product is defective and furnishes an explanation of the deficiency; (ii) such Product is returned to PNI's service facility at Customer's risk and expense; and (iii) PNI is satisfied that claimed deficiencies exist and were not caused by improper installation, misuse, neglect of care, alteration, vandalism, theft, accident, or unauthorized repair. If a Product is defective, transportation charges for the return of the Product to Customer within the United States and Canada will be paid by PNI. For all other locations, the warranty excludes all costs of shipping, customs clearance, and other related charges. PNI will have a reasonable time to make repairs or to replace the Product or to credit Customer's account. PNI warrants any such repaired or replacement Product to be free from defects in material and workmanship on the same terms as the Product originally purchased.

Except for the breach of warranty remedies set forth herein PNI shall have no liability for any indirect or speculative damages (including, but not limited to, consequential, incidental, punitive and special damages) relating to the use of or inability to use this Product, whether arising out of contract, negligence, tort, or under any warranty theory, or for infringement of any other party's intellectual property rights, irrespective of whether PNI had advance notice of the possibility of any such damages, including, but not limited to, loss of use, revenue or profit. In no event shall PNI's total liability for all claims regarding a Product exceed the price paid for the Product. PNI neither assumes nor authorizes any person to assume for it any other liabilities.