CS-iTVP-07 **Wireless Dual-mode Parking occupation status Sensor**

User documentation

(CS-iTVP-07-SS)

(REV A)

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1. Overview

1.1 Product Introduction

The CS-iTVP-07 series dual-mode wireless parking sensors is an intelligent parking monitoring product that integrates the triaxial magneto-resistive sensor and millimeter wave radar sensor, wireless NBIOT and LORAWAN transmission mode, and Low-power management technology.

The efficient dual-mode joint detection algorithm is integrated to monitor the disturbance change of magnetic field on the parking space, and the status is further confirmed by the millimeter-wave radar sensor. The comprehensive algorithm analysis determines whether the parking space is occupied or vacant.

It supports LORAWAN, NB-IOT and other transmission methods to send data to the gateway or operator base station, then the gateway or base station will be able to transmit the data to the remote server

This product uses large-capacity battery power, low-power management design, under ground installation and shell split design. It features high detection rate, stable work, no cable, easy installation, simple maintenance, long service life, etc., applicable to indoor parking lots, municipal roadside parking lots, open parking lots, illegal occupation detection, non-parking area detection etc.

1.2 Working Principle

The static strength of the Earth's magnetic field is in the range of 0.5 to 0.6 Gauss. And the strength is constant over a wide area (about a few kilometers). When a ferromagnetic object such as a car is exposed to a magnetic field, it will cause the magnetic field to change, and the magnetoresistive parking sensor can capture the strength changes of the geomagnetic field and judge the existence of vehicles. However, in actual cases, some factors may influence the magnetic field data and then lead to low detection accuracy. For example, the field disturbance caused by some vehicles (vans, electrical vehicles, single or double seats vehicles with compact size etc.) is so subtle that it is often neglected by the parking sensor algorithm. Furthermore, construction sites, subway and high speed rail around the parking lots also affect the magnetic field. Using dual-mode technology, CS-iTVP-07 series can solve the low detecting problem caused by surrounding magnetic fields as well as the subtle field change and thereby improve the detecting accuracy.

1.3 Product classification

According to different transmission modes, the products can be divided into two categories: NBIOT and LORAWAN transmission.

1.4 Main Functions

- Timely reporting of parking status change.
- Regular status reporting.
- Low battery alarm.
- Local data cache when data transmission fails at bad network connection, and data re-sending when the network is normal.
- Automatic and manual calibration of magnetic fields.
- Synchronized RTC time for web-based auto-calibration and remote calibration
- Remote code upgrade.

1.5 Main features

- Platform communication interfaces supported: Telecom's IOT platform and AEP platform, China Mobile’s ONENET platform, Huawei cloud platform and customer's private platform.
- High detection accuracy and adjustable sensitivity levels.
- Magnetic field and radar calibrations are fast and efficient, with no need to open the cap and no other equipment.
- Parameter devices support local and remote command modifications.

- Low power management design with long battery life.
- Compatible with 3GPP Rel-13, LORAWAN V1.0.2 etc., communication standards.
- The shell is designed to withstand compression and load, suitable for installation on all surfaces and roads.
- Shell split design, only inner tube replacement or repairing is necessary. Maintenance and replacement is convenient and quick.

1.6 Product architecture

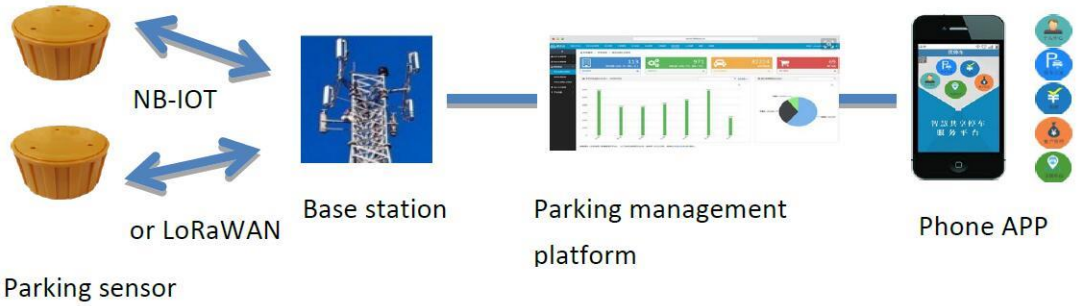

Figure 1 Product architecture

1.7 Product picture

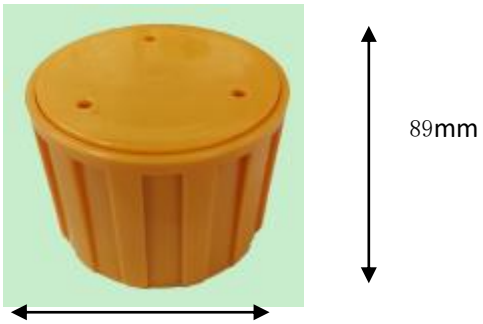

Figure 2 Product dimension drawing

2. Main technical parameters

Table 1 Main technical parameters

Name	**Technical parameters**	**Note**
Working band	433MHz/470MHz/868MHz/915MHz/923MHZ	LoRaWAN
	B1/B3/B5/B8/B20	NB-IoT
	24GHZ	Radar
Type of equipment	Class A	LoRaWAN
Antenna interface	Built-in FPC antenna	
Configure serial port settings	9600,n,8,1	Open the product cover and use the configuration serial port to configure the product
Operating Voltage	3.6V	
Battery Life	>5 years（Under typical working conditions）[1]	

Maximum operating current	＜300mA	
Average reaction time for detection	＜30S	Terminal to platform (based on local operator base station signal quality [2])
Detection height	0.2~1.2m	Radar antenna parameters
Horizontal Beam Width (-3DB)	80°	
Vertical Beam width (- 3DB)	34°	
Reported information	Status, Battery, Signal Strength, PCI, Report Periodicity	
Integrated Detection accuracy	≥97% [3]	
Protection level	IP68	
Shell material	PC+ABS Material, flame-retardant and sunlight-resistant (up to 5 tons)	
Shell size	Φ114mm×89mm	
Operating Temperature	(-20～+70)℃	NB-IOT（consumer grade SIM card）
	(-40～+85)℃	LORAWAN/ NB-IOT（industrial grade SIM card）
Storage temperature	(-40～+85)℃	
Product weight	About 600g	

Note [1]: Typical working condition means the regular reporting interval is 24 hours, there are 10 changes in the status of parking spaces per day, and network communication is good.

Note [2]: Parking space ground signal RSRP > -95 and there's car parking; When the parking space is vacant, it's best to have RSRP > -85, SNR > 70. With car parking on top, signals will weaken .

Note [3]: The accuracy test method is described in detail in Note 19

3. Instructions

3.1 Product usage steps

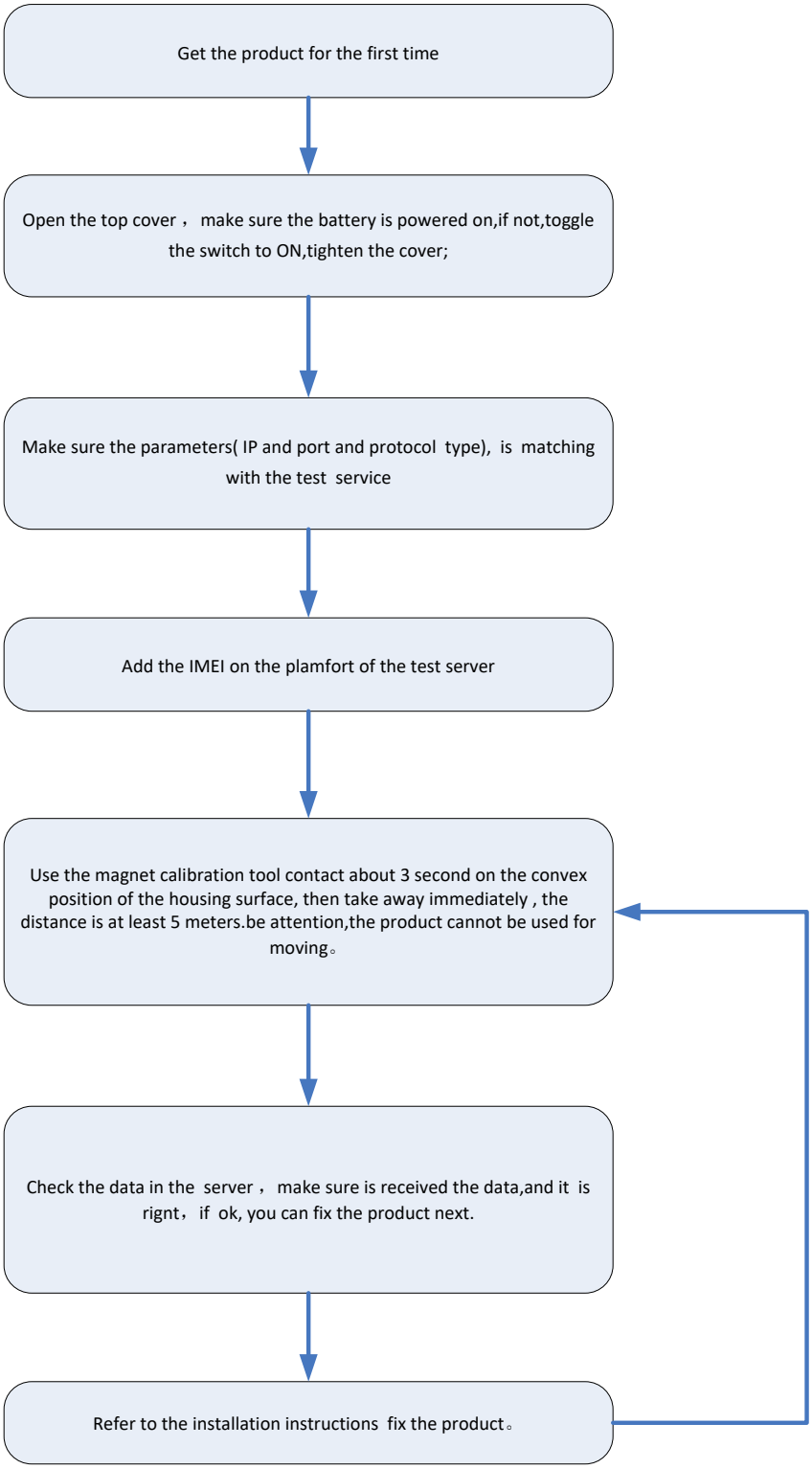

Figure 3 NBIOT mode using guide

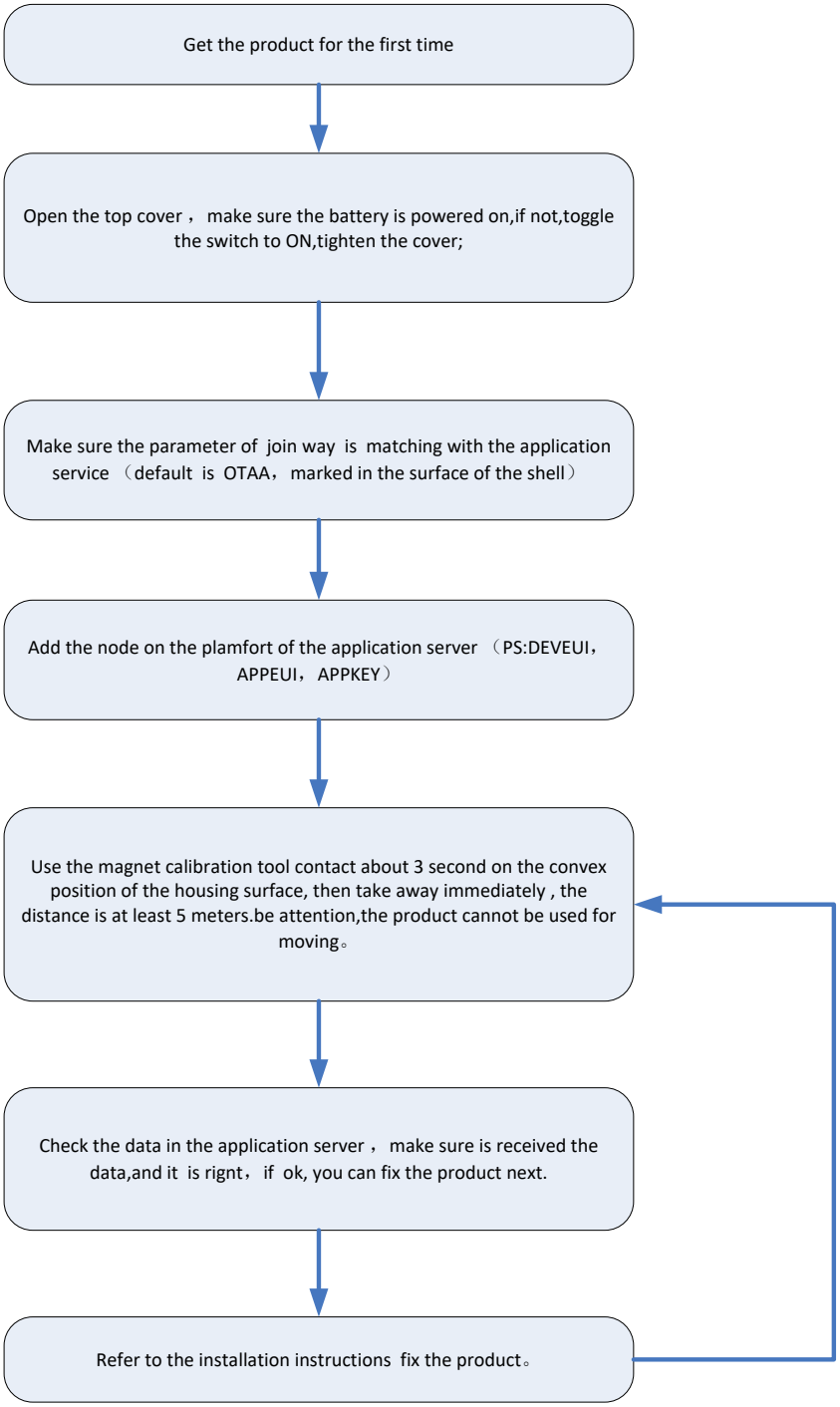

Figure 4 LORAWAN mode using guide

3.2 SIM Card Installation Instructions (only for NB-IoT transmission mode)

NB Card Installation Procedure

Unscrew the cover with the matching tool ⟶ insert the NB card ⟶ turn the toggle switch to ON ⟶ screw the cover to the main body ⟶ installation complete.

Unscrew the top cover The cover is separated from the main body Insert the NB card Turn the switch to ON

Figure 5 NB Card Installation Procedure

Special Notes

1） Open the SIM card holder along the OPEN direction, install the NB card, and then lock the SIM card holder along the LOCK direction.

2） Connect the battery connector to ensure that the red and black wires are not reversed.

3） Install and remove the cover of the sensor with the matching tool and tighten the threads.

3.3 Battery Replacement Method

1）The dual-mode parking sensors are powered by the built-in disposable lithium battery, which has been equipped with a battery before leaving the factory. When the battery level is low after a certain time of use (low voltage alarm information will be sent), the same type and model of battery should be replaced (model: ER34615, 38AH battery pack).

2） Remove the inner tube from the outer sleeve (with the matching mounting tool).

3）Open the top cover, disconnect the battery connector, disconnect the antenna connector, remove the screws connecting the battery bracket assembly to the inner case, remove the battery bracket components, replace the battery with the same size battery, install the screws connecting the battery bracket assembly to the inner case, connecting the battery connector and the antenna connector.

4）Close the top cover and tighten the inner tube.

4） Rotate and screw the inner tube into the outer sleeve (using the matching mounting tool).

5） Battery replacement complete.

3.4 Network Access Instructions

LORWAN Parking Sensor Network Access Instructions

LORAWAN output mode supports OTAA and ABP network access mode. Users can use factory default tetwork access parameters or choose to configure network access parameters themselves.

If users choose to configure the network access configuration by themselves, they can ask the supplier for the relevant instruction documents.

The DEVEUI of the product is printed on the product shell and can be used directly when connected to the network.

NBIOT Parking Sensor Network Access Instructions

The product's IMEI number is printed on the product shell and can be used directly to access the operator's platform. The product supports UDP, COAP and TCP communication protocols. The product is compatible with China Telecom's Internet of Things open platform, and codec plug-ins can be provided for platform docking if required.

3.5 Communication Protocols

Refer to "CS-iTVP-07-XY Wireless Dual Mode Parking Sensor Communication Protocol".

4 Installation instructions

The installation steps for cement and asphalt surface are as follows.

For special installation surfaces, please communicate with the supplier before construction and installation.

See the document "Installation and Debugging Instructions for Under-ground Dual-mode Parking Sensors" for details.

The installation steps are as follows.

- As shown in Figure 7, drill a round hole of Φ 130-140mm in the middle of the parking space, and the depth of the hole should exceed the product height by 2-5cm.
- Pour an appropriate amount of fine sand into the round hole so that the bottom of the hole is smooth to prevent stones or sharp objects in the hole from damaging the bottom of the parking sensor.
- Put the parking sensor in the round hole, with the top at the ground level or 1 to 2 mm above the ground. Make sure that the product is oriented in the direction indicated by the arrows on the surface of the housing and in the longer-side direction (length 5.5 m) of the parking space.
- Fill the holes with epoxy asphalt.
- The product installation is complete after the epoxy asphalt has solidified as in Figure 7.

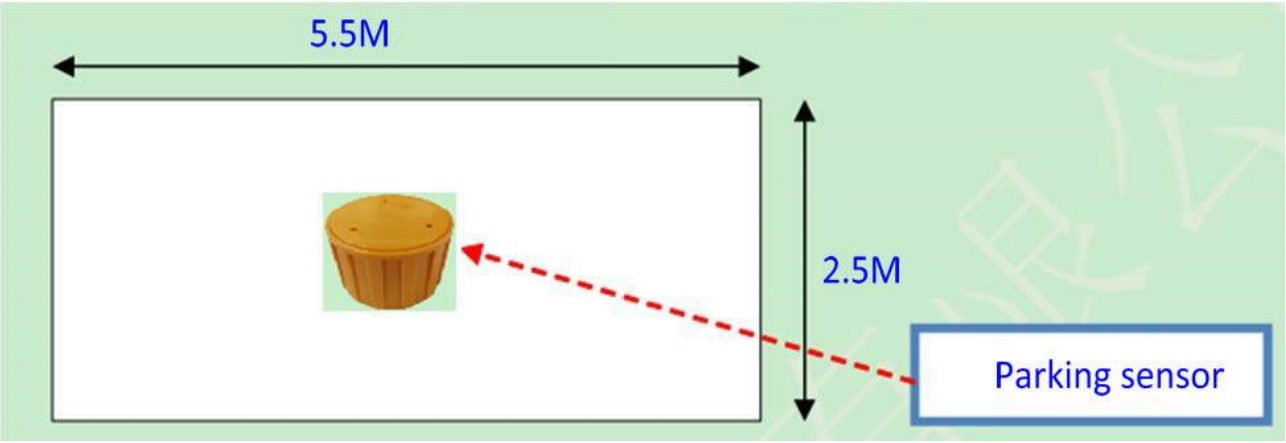

Figure 6 Schematic Diagram of Product Installation Location

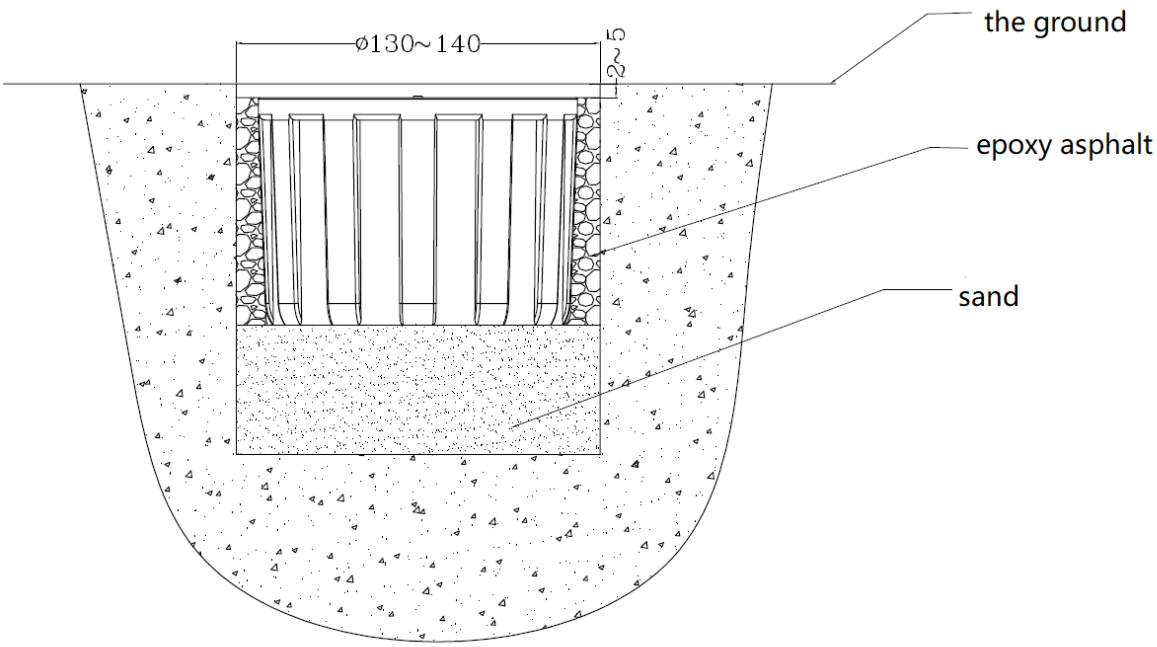

Figure 7: Installation of the product

Product calibration activation

After installation of the product, make sure that no car parks in the parking space before finishing activation. Use the

matching magnet to contact the bump on the housing as shown in figure 8 for 3 seconds and then remove it (at least 5 meters away from the parking sensor). The calibration activation is complete, and the product starts to enter the working state.

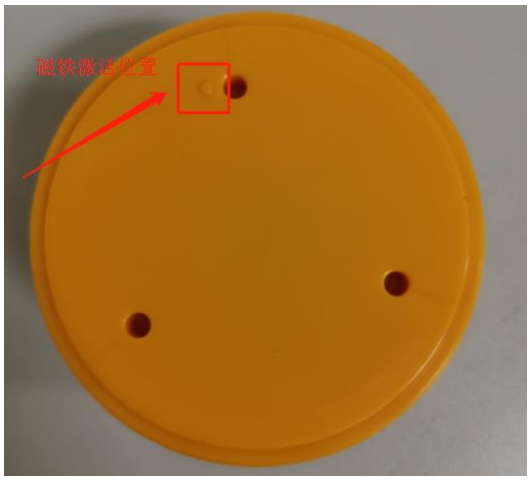

Figure 8. Marking at the magnet calibration position

Users can check the data on the cloud platform, referring to the document "CS-iTVP-07-XY Wireless Dual Mode Parking Sensor Communication Protocol" for data decoding.

5. Type selection guidance

Part no.			
CS-iTVP-07	Communication mode		
	LW	LoRaWAN	
	NB	NB-IoT	
		Frequency band	
		B1	NB-IOT communication mode
		B3	NB-IOT communication mode
		B5	NB-IOT communication mode
		B8	NB-IOT communication mode
		B20	NB-IOT communication mode
		G	B1/B3/ B5/ B8/B20（NB-IOT communication mode）
		EU433	433MHz（LORAWAN communication mode）
		CN470	470MHz（LORAWAN communication mode） not CLAA
		EU868	868MHz（LORAWAN communication mode）
		US915	915MHz（LORAWAN communication mode）
		AS923	923MHZ（LORAWAN communication mode）
			Package type

			P	Bubble bag
			B	Paper box
			↓	
CS-iTVP-07	NB	B8	P	

For example.

CS-iTVP-07_NB_B8_P means NBIOT output mode, B8 frequency band, ordinary plastic bubble wrap.

CS-iTVP-07_LW_868_B means LORAWAN output mode, EU868 frequency band, packed in paper box.

Our company can provide industrial grade SIM card and consumer grade SIM card. Please specify SIM card type in orders if SIM card is required before product delivery.

6.Installation and Configuration Accessories

- USB to UART-TTL cable. It's only necessary when configuration is needed. One cable will be supplied for each order.
- Battery: Model ER34615 x 2pcs. The product comes with a battery at delivery. If you need extra batteries, please specify when purchasing.
- One installation handle is supplied for one order by default. For extra installation handles, please specify when purchasing.
- Customers can select accessories according to the accessories selection table shown in Table 2.

Note: If there is any disagreement about the selection table, please contact the supplier.

Table 2 Accessories selection table

Accessory Type	Description	Remarks
PL2303TA	USB to UART-TTL cable. It's only necessary when configuration is needed.	
ER34615@ 38AH 2pcs battery pack	Products equipped with a battery before leaving the factory. If you need additional batteries, please specify when purchasing.	
CS-iTVP-07-A01	Installation handle for under-ground type parking sensors . It's for product installation and maintenance. One handle comes with one batch by default. If extra handle is needed, please specify when purchasing.	
CS-iTVP-07-A02	Calibration magnet tool. One piece is included with the one order by default. If extra tool is needed, please specify when purchasing.	

7. Note

- It's recommended to use the installation accessories provided by the factory, which are non-magnetic and can tighten the parking sensors firmly to the ground to prevent moving.
- When calibrating the background magnetic field, make sure there's no strong metallic obstacles on and within 5 m range of the parking sensor, such as vehicles, magnets, coils, iron pillars, etc. Otherwise, it may

cause abnormal detection.

- The parking sensor must be installed firm enough to ensure that it will not move when wheels run over it.
- When calibrating a product via remote command, it is important to ensure that the parking space is free of cars or it will be calibrated incorrectly.
- Always recalibrate if the parking sensor changes position during testing.
- Install the parking sensors in strict accordance with the installation instructions. Please contact the supplier for a proper solution if the ground environment of the installation site is special (for example, the underground is filled of loose soil, not suitable for parking sensor installation or the tiles are not firm and not easy to drill holes).
- The parking sensors are suitable for detecting normal cars, vans, off-road vehicles, and the recommended parking space is at least 2.5*5.5 meters. Please clarify when purchasing if it is for special parking spaces or vehicles.
- Battery life is estimated under typical conditions. It will affect the normal working and battery life of the parking sensor when it is installed in a poor NBIOT network environment(RSRP < -100,SINR < 3) or when the performance of LORAWAN gateway is poor (the short communication distances couldn't cover all end nodes).
- The parking sensor should not be installed in environments with large magnetic fields or strong magnetic field variations, such as places near high-voltage cables, subways, high-speed trains, train tracks, etc..
- Parking sensor detection accuracy data was acquired in the following test: take 10 parking spaces as an example. Use 10 randomly selected normal vehicles with less than 7 seats (Either cars or SUVs are ok, as long as the vehicles contain a certain amount of iron). Ensure each vehicle drives in and out of each parking space for 5 cycles with each "in" or "out" state lasts for about 2 minutes. So it totals 10 times status change by one vehicle per parking space. 10 parking spaces get 100 times by one vehicle. And 10 parking spaces by 10 cars will get a total of 1000 times status changes. If the management platform actually receives n times of status changes, then the detection accuracy N=(n/1000)*100%, Note: factors like strong magnetic interference around the parking sensor, rain or snow water on top of the parking sensor, or poor network signal will affect the accuracy of the detection.
- The high power consumption and malfunction problem resulting from the malfunction of customer self-supplied SIM card is not a product quality problem. (SIM card malfunctions like opening parameters error, SIM card out of credit or SIM card shutdown)
- When a command is sent from the application platform to the parking sensor, the sensor will not respond immediately because it is in a dormant state. It can only receive the command when it wakes up to send the uplink information.

8. Failure analysis and troubleshooting

Table 3 Failure analysis and troubleshooting

No.	Fault phenomenon	Cause Analysis	Remediation method
1	At initial calibration, the application platform does not receive a boot message from the sensor.	network access failure	Check if the magnetic field calibration method is correct. Check if the device is properly registered in the platform . For NB-IOT communication mode, check if the device information is deleted from the Telecom OC or AEP platform, used for testing.
2	The status of the vehicle in the parking space has changed multiple times, but the status on the platform has remained the same.	The initial calibration of magnetic field radar fails The battery is dead. Network anomaly Parking sensor is covered with water or snow	Recalibration required Battery replacement Check if parking sensors are offline. Water mist has an effect on radar detection, which will automatically restore after being cleaned or dried by air.
3	No uplink information from the sensor for a long time	The battery is dead. Or the parking sensor is damaged.	Battery replacement Staff on-site check Check if the local base station is abnormal or if the NB card is not charged.
4	Timing reporting is normal but parking status changes are not consistent with the platform	False detection due to improper parking	Check if the car parks properly in a normal parking space. Check if there other things covering the parking sensor.
5	Data format is different from normal message data	The protocol type is not properly set.	Check whether the sensor protocol type is consistent with the platform server parameters

9. Declarations

The Company reserves the right to modify the specifications and contents of this document without prior notice. Due to product updates, some details in this document may not be in accordance with the product, please refer to the actual product. The right to interpret this document belongs to our company.