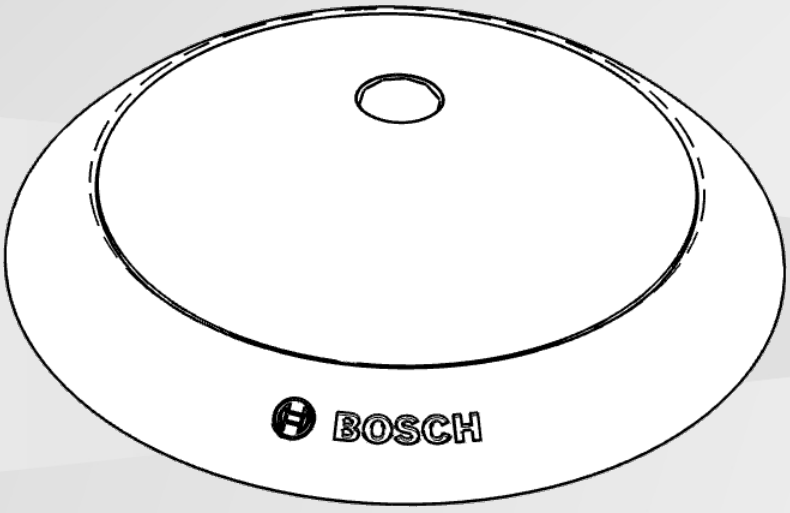
Parking Lot Sensor

Communication Interface - Technical Description

v0.23.3



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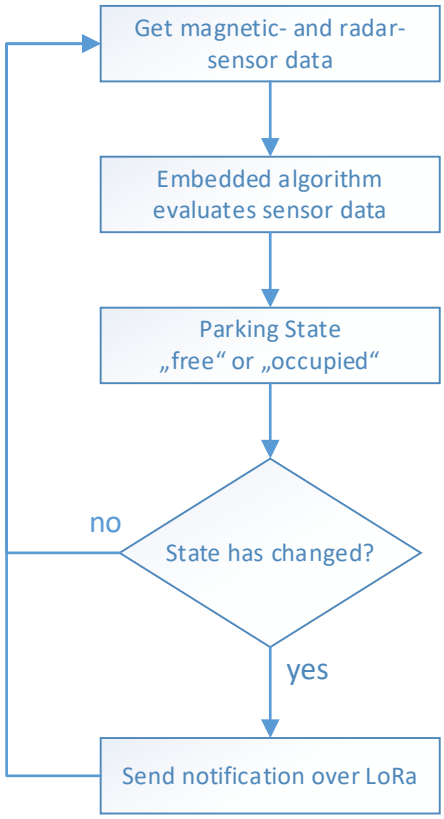
1 Principle of operation

The parking sensor device contains two independent sensing elements, a magnetometer for recognizing changes in the magnetic field of the environment and a RADAR sensor for measuring the reflectivity above the sensor device.



The sensors data are processed by the devices embedded algorithm. The algorithm output is the parking state “free” or “occupied”. The device checks, if the parking status has been changed since the last processing run and in case the parking state change will be communicated via the LoRa interface. This means, that the parking sensor will only report, if the parking state has changed.

2 LoRaWAN Interface

The parking sensor device is equipped with a LoRa radio operated in Class A. The implemented functionality complies with the LoRaWAN Specification 1.0.2.

The frequencies supported and receive window parameters are according to the LoRaWAN v1.0.2 EU868 Regional Parameters rev. b. Both RX1 offset and RX2 can be reconfigured by the Join Accept message (CFList) or related MAC commands.

The battery level is not reported in the DevStatusAns MAC command.

2.1 Join Procedure

The Join procedure follows the Over-the-Air Activation described in the LoRaWAN Specification 1.0.2. ABP is not supported.

After the powering up the parking sensor device, the sensor will try to join a LoRaWAN Network by sending the join request message. In case the join request is not answered, the sensor will retry after a certain time frame. This time frame will be increased from retry to retry (also known as exponential reboot). After the fifth retry the sensor will reboot and restart the join procedure after a dedicated time delay.

If the Join request message is not answered with a Join accept message, the sensor will retry, following the next sequence:

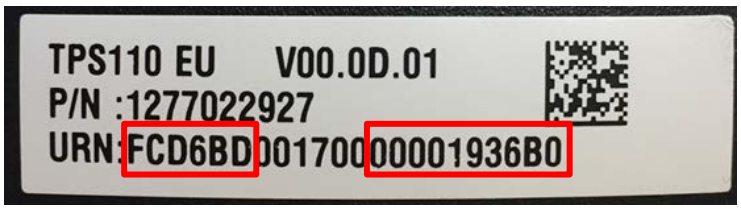
Attempt	DataRate
1	Configured DR or default (DR2)
2	Configured DR or default (DR2)
3	DR2
4	DR1
5	DR0

In case the Join accept message is received at the attempt 3, 4 or 5, the sensor restores the configured DataRate to the default value (DR2). This behavior assumes that the configured DataRate does not allow communication with the Gateway.

If the sensor does not receive a Join accept message after the 5th attempt, the sensor will initiate an exponential reboot, repeating the 5 attempts and behavior as described above.

2.2 Device EUI

The device EUI of the sensor is pre-provisioned during production and can be derived from the URN printed on the sensor core. The URN can be found either on the bottom of the parking sensor core or on the label on top of the parking sensor core. Beside of the URN, also a barcode allowing a simplified installation process can be found. The device EUI can be derived from the URN as in this example:



DevEUI: 0xFC 0xD6 0xBD 0x00 0x00 0x19 0x36 0xB0

Exchanging the DevEUI of the sensor is not possible.

2.3 Application EUI

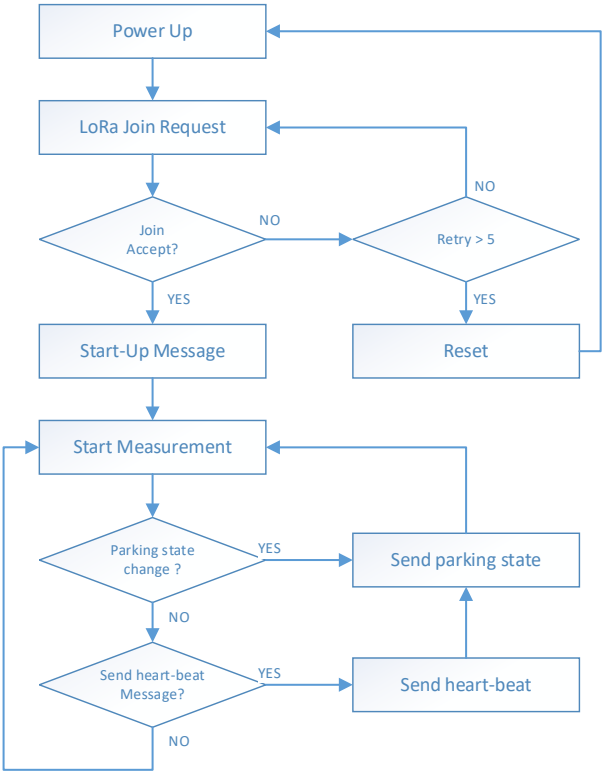
The AppEUI is pre-provisioned during production and will be delivered with the sensor batch. Exchanging the AppEUI of the sensor is not possible.

2.4 Application Key

The AppKey is pre-provisioned during production and will be delivered with the sensor batch. Exchanging the AppKey of the sensor is not possible.

3 Application protocol description

After a successful join (join accept message received) the sensor will send an start-up message, then begin with the normal operation and send park status messages whenever a change is detected. All application messages (start-up message, heart-beat message, and parking state message) are sent as confirmable by default. In case the confirmation is not received, the sensor will retry 7 more times, adapting the DataRate as recommended in the LoRaWAN v1.0.2 spec, chapter 18.4. Any confirmable message which does not receive a confirmation after the 7th re-transmission will initiate an exponential reboot. This behavior assumes that the connection with the network has been lost.



The parking state message can be configured as not confirmable. This reduces the use of duty cycle to acknowledge all messages, but may also reduce the percentage of successfully received messages by the Gateway.

The DataRate used in the uplink messages by the sensor is DR2 by default, but can be configured from DR0 to DR5.

The application protocol may be subject of change. The functionality may be extended in the next versions.

3.1 Uplink messages

3.1.1 Parking status message

Parking status message uses the **port 1** and is **confirmable by default**. It can be configured to not confirmable.

Byte [0]	
Bit [7 ... 1] **Reserved**	**Bit [0]** **Parking status**
Reserved	0: Free parking space 1: Occupied parking space

3.1.2 Heartbeat message

Heartbeat message uses the **port 2** and is **always confirmable**. The heartbeat message contains the same information as the parking status message and it is sent every 24 hours.

Byte [0]	
Bit [7 ... 1] **Reserved**	**Bit [0]** **Parking status**
Reserved	0: Free parking space 1: Occupied parking space

3.1.3 Start-up message

Start-up message uses the **port 3** and is **always confirmable**. It is sent after every start-up / reboot / (re-) join event.

Byte [16] **Parking status**		**Byte [15]** **Reset cause**	**Byte [14 : 12]** **FW version**	**Byte [11 : 0]** **Debug**
Bit [7 ... 1]	**Bit [0]**	0x01 - Watchdog reset 0x02 - Power On Reset 0x03 - System Request Reset 0x04 - Other Resets	Firmware Version (Currently 0.23.3)	Debug information
Reserved	0: Free parking space 1: Occupied parking space			

Note that if a confirmable message is not acknowledged (8 attempts) or the Join request is not accepted (5 attempts), the system schedules a reset, showing in the Start-up message the value 0x03 (System Request Reset) as Reset cause. This is generally a good indication that the Gateways are not able to maintain stable communication with the sensor.

3.2 Downlink messages

The sensor supports confirmable and not confirmable downlink messages.

3.2.1 Confirmable configuration

Confirmable configuration uses the **port 51** and it applies only to the parking status message. The default value is Confirmable (0x00). The configuration selected is persistent.

Byte [0] **Confirmable configuration**
0x00: Confirmable (up to 8 retries) 0x01: Not confirmable (0 repetitions)

3.2.2 DataRate configuration

DataRate configuration uses the **port 52** and it applies to all uplink messages. The default value is DR2 (0x02). The configuration selected is persistent, unless overwritten in the join procedure.

Byte [0] **DataRate configuration**
0x00: DR0 (SF12) 0x01: DR1 (SF11) 0x02: DR2 (SF10) 0x03: DR3 (SF9) 0x04: DR4 (SF8) 0x05: DR5 (SF7)

4 First commissioning

The parking sensor device is equipped with a self-learning algorithm. Thus it is not necessary to calibrate the sensor. Although the parking sensor device needs to learn how a parking event looks like. Therefore the detection performance after the installation and power-up is expected to be poor and reaches the optimal level after approximately 10 parking events. From this point on, the parking sensor devices learns with any new parking event. In case of a false detection or missing a parking state, the sensor will recover automatically after some parking events again.

5 Changelog

v0.23.3 24 Oct 2018

Features

- LoRaWAN v1.0.2 compliant
- Configurable DataRate and confirmed/unconfirmed park status messages
- Parking status message with new simplified format
- Hearbeat with new format
- Startup with new format
- Uplink messages queue
- Improved LoRa join retry handling and exponential reboots

Known issues and limitations

- None

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v0.17.1 01 May 2018 – Prototype PoC

Features

- Payload based on Type-Length-Value format

Known issues and limitations

- Not completely LoRaWAN v1.0.2 compliant
- Lack of uplink messages queue may silently drop messages when there is not enough duty cycle
- This is a Prototype release, which is only intended for experimental use cases

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