Document Number: 990-00274

Revision: 0.14

contact@lansitec.com

The product does NOT include a helmet.

1. General Introduction

This sensor is designed based on GNSS, Bluetooth Low Energy, and LoRa technology. With the advanced LoRa technology and built-in accelerometer, the sensor employs ultra-long standby time compared with the traditional GPRS-based solution. It supports indoor tracking with Bluetooth and outdoor tracking with GNSS technology. The position acquisition period, heartbeat period, and LoRa work mode are adjustable according to your use case.

2. Abbreviation

- **ABP**: Activation by Personalization
- **ADR**: Adaptive Data Rate
- **DR**: Data Rate
- **NS**: Network Server
- **PRI**: Position Report Interval
- **AS**: Application Server
- **CRC**: Cyclic Redundancy Checking
- **GNSS**: Global Navigation Satellite System
- **OTAA**: Over the Air Activation
- **RFU**: Reserved for Future Usage
- **RSSI**: Received Signal Strength Indicator
- **UTC**: Universal Time Coordinated

3. Key Features

- Wearing Detection
- Fall Detection
- Panic Button
- Search and Rescue Mode with Alarm
- Zone detection and alarm
- Bluetooth Positioning
- GNSS Positioning
- Simple Installation
- Asset Management
- Borameter

4. Product Specifications

Table 1: Product Specifications

LoRaWAN	
Protocol	Version 1.0.2B, Class A
Activation Mode	OTAA or ABP
LoRa Frequency	US915, AU915, EU868, AS923, RU864, KR920, IN865, KZ865, CN470
LoRa TX Power	0 to 20 dBm
LoRa Sensitivity	-137dBm @ SF12, BW 125kHz, 868MHz/915MHz
LoRa Communication Distance	>1km in an urban area
Encryption	AES128

Bluetooth	
Protocol	5.0, iBeacon
TX Power	-20 to +4dBm TX Power, configurable in 4dB steps
Sensitivity	-96dBm
GNSS	GPS/GLONASS/BeiDou/Galileo/QZSS
Band	1575 to 1610MHz
Accuracy	<2.5m (CEP50)
Cold Start Duration	30 ~ 120s

System	
Standby Current	25μA
FOTA Over Bluetooth	Support
Accelerometer	Support
NFC	Support

Battery Life	Please refer to the battery life calculator spreadsheet for details.
GNSS (report interval 10 minutes)	Approx. 8,000 times
Bluetooth positioning	Approx. 33,000 times

Physical Parameters	
Dimension	80 x 80 x 35mm
Housing Material	ABS + PC + Silicone
Switch	Silicone button
Operating Temperature	-10°C ~ +60°C

5. Function Description

5.1 LoRaWAN Mode

DevAddr, NwkSKey, and AppSKey are stored in the tracker and are needed to join a network. DevEUI or DevAddr is

labeled at the back of the device. Lansitec will help to configure these parameters before shipping if needed.

After powering on and joining the LoRa network, the tracker sends a registration message to the Application Server (AS). Configuration information of the tracker is included in this registration message for AS to validate.

5.2 Tracking Feature

The sensor supports both Bluetooth and GNSS positioning. Bluetooth positioning beacons (UUID: F2-A5-2D-43-E0-AB-48-9C-B6-4C-4A-83-00-14-67-20) must be deployed around the sensor to use Bluetooth tracking. The sensor always turns on Bluetooth receiving for 3 seconds (not configurable) at the end of each Bluetooth positioning interval. It sends nearby beacons' information (major, minor, and RSSI) to the server and only reports the 3 beacons with the highest RSSI value, no matter how many beacons are received. The RSSI reported is an average of all messages received. The beacons' positions are known, and the server calculates the distance to the beacons nearby for presence detection. Or it calculates the three beacons nearby and the coordinates according to the triangulation algorithm.

Please refer to the following documents for a detailed explanation:
930-001232 "LoRaWAN Tracker Positioning Service API Document" for detailed information on the triangulation.
990-00170 "B-Fixed® PERSONNEL& ASSET TRACKING SOLUTION" to design and develop your tracking system.

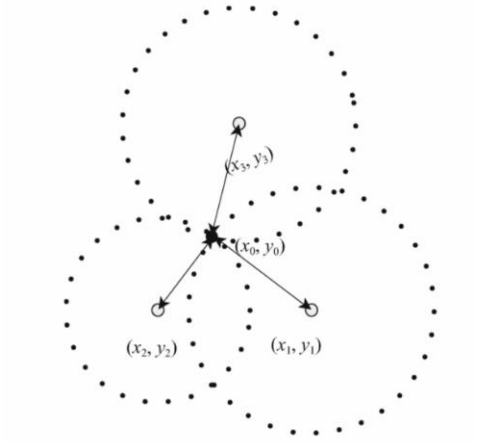


Figure 1. Triangulation method

The sensor switches between Bluetooth and GNSS position report intervals for outdoor tracking. Suppose it does not receive any beacon in a Bluetooth position report interval. In that case, it goes into the GNSS position report interval and turns on the GNSS module 3 minutes before the end of each GNSS position report interval (refer to *Figure 2. When no beacon is received in BLEPRI*), and then sends the coordinates to the server. If it fails to acquire satellites within 3 minutes, it will stop the GNSS module and retry in the next cycle. Meanwhile, suppose a beacon is received in a GNSS position report interval. In that case, the sensor will also stop the GNSS module and go into Bluetooth receiving in the Bluetooth position report interval (refer to *Figure 3. When beacons are received in GNSSPRI*).

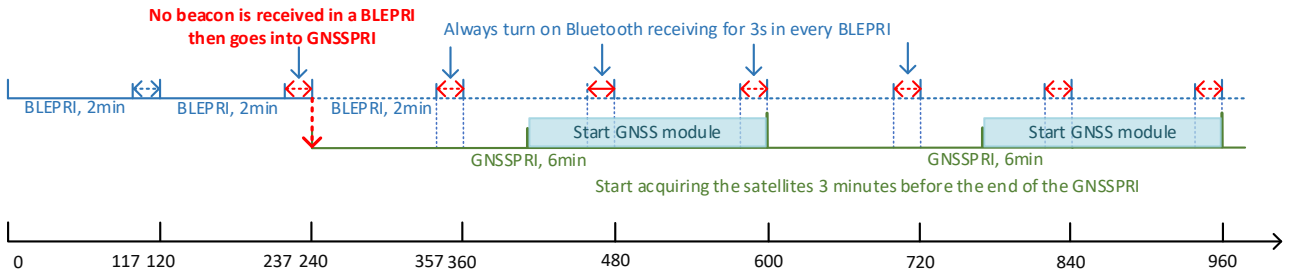


Figure 2. When no beacon is received in BLEPRI

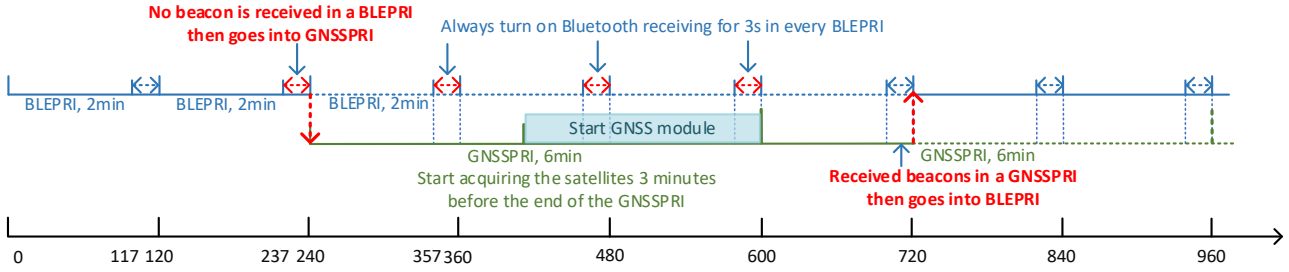


Figure 3. When beacons are received in GNSSPRI

5.3 Heartbeat Message

The heartbeat message includes the status information of the sensor. An AS can use it to monitor the sensor. Its report interval can be configured as an integral multiple of 30 seconds.

5.4 Position Report Mode

- **Periodic Reporting Mode**
  The sensor periodically starts the positioning process and reports the positioning results at fixed intervals as configured, no matter whether the sensor is moved or not.
  ***Note**: Due to the overtime of the GNSS positioning process, the actual positioning report interval received by the Application Server is longer than the configured position report period.*
- **Autonomous Report Mode**
  The sensor decides whether to start the positioning process and reports the result based on the motion state perceived by the accelerometer in the last positioning cycle.
- **On-Demand Report Mode**
  The sensor starts the positioning process and reports the positioning results only when it receives a downlink instruction deployed by the AS.

5.5 Positioning Process

1) When the positioning process starts, the sensor turns on Bluetooth receiving for 3 seconds.

   If beacons with advertising UUID "F2-A5-2D-43-E0-AB-48-9C-B6-4C-4A-83-00-14-67-20" are received, the sensor reports the Major, Minor, and RSSI of 3 beacons with the strongest RSSI. Then the positioning process terminates.

2) The sensor turns on the GNSS module if no beacon is received.

Generally, the sensor can obtain the coordinates in about 30 ~ 120 seconds in an open outdoor space. After successful GNSS positioning, it reports the longitude, latitude, and UTC, and then the positioning process terminates.

If the GNSS module cannot obtain the coordinates due to the weak satellite signal, the sensor terminates the positioning process in 3 minutes.

5.6 On/Off and LED Status

- Turn on: Press the button for four seconds; the red LED flashes with the green LED on four times.
- Turn off: Press the button for four seconds; the red LED flashes four times.
- Reboot: LED status is the same as turning on.
- When joining the LoRa network: The green LED is on until the end of the joining process.
- Short press the button:
  a) The green LED flashes one time: Joined the LoRaWAN network successfully.
  b) The red LED flashes one time: Disconnected from the LoRaWAN network.
  c) No LED flashes: The sensor is Power-off.
- When the charging cable is connected:
  a) Red LED flashes: The sensor is in charge.
  b) Red LED is solid: The sensor is fully charged.

5.7 Confirmed and Unconfirmed Uplink Message Configuration

All GNSS position and beacon uplink messages are unconfirmed to reduce the number of downlink messages.

Heartbeat messages can be configured as confirmed or unconfirmed. Refer to the CFMMSG Field in Section ***7.2 Tracker Configuration*** for details.

5.8 Tracker GNSS Antenna and Placement

The helmet sensor uses an 18x18mm ceramic antenna. Its position is shown in ***Figure 4***. It is recommended to face the antenna toward the sky to get the best signal quality.

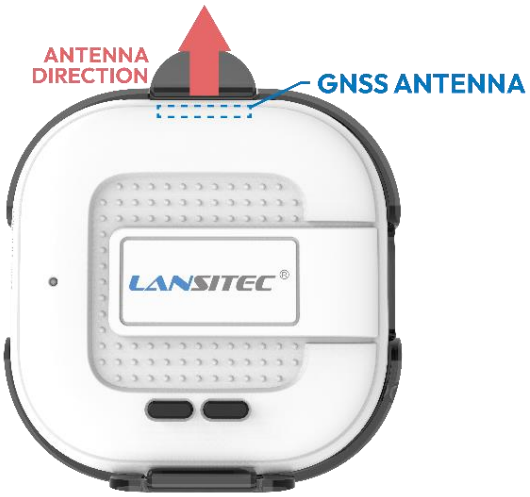


Figure 4. Helmet Tracker GNSS Antenna

5.9 LoRa Network Connectivity

The sensor determines LoRa network connectivity by counting the number of lost confirmed heartbeat messages.

CFMMSG Field is 2 and HBCOUNT Field is 5 in default as described in Section ***7.2 Tracker Configuration***. It means that if 5 confirmed and 5 unconfirmed heartbeat messages are lost and the sensor considers it to be disconnected from the network. It will not send the position report anymore. Instead, it will try to join the network 3 times every 5 minutes. If unsuccessful, it will try to join once at the beginning of each hour. The position report resumes once the network is reconnected.

5.10 Bluetooth Beacon Use Case

The sensor can receive four different types of beacons: position beacon, asset beacon, special area beacon, and search beacon. Each type of beacon uses a specific UUID:

Table 2: Bluetooth Beacon Type

Beacon Type	Use Case
Position Beacon	The default UUID is F2A52D43E0AB489CB64C4A8300146720. This type is used for Bluetooth positioning.
Asset Beacon	The default UUID is F2A52D43E0AB489CB64C4A8300146721. This type is used for asset monitoring and management. For example, attached a beacon to each asset in a room, then the sensor can receive all these beacons and report their major, minor, and RSSI to a LoRaWAN gateway.
Special Area Beacon	The default UUID is F2A52D43E0AB489CB64C4A8300146722. This type is used to detect some special areas, such as entering a restricted zone. The sensor will send an alarm when it is close to this type of beacon.
SearchBeacon	The default UUID is F2A52D43E0AB489CB64C4A8300146723. This type is used in search and rescue scenarios. When the sensor receives this beacon, it buzzes and reports the alarm information. Searchers can use beacons with this UUID for search and rescue. You can also configure an iBeacon app on your phone to this UUID and use your phone to search for the sensor or wearer.

The UUIDs of the four types of beacons are all configurable, refer to Section ***7.4 UUID Configuration*** for more details.

5.11 Wearing Detection

This sensor can detect whether a helmet is worn or not, and for how long. It automatically calibrates the unworn state when it is turned on. After that, if the sensor detects that the helmet is worn, it will report this status in the position information and the wearing time in the heartbeat message.

5.12 Alarm

The sensor has four different alarm states: SOS, Fall, Special Area, and Search. Each state has a different trigger and alarm:

- SOS: Pressing the button 3 times within 3s. It is used when the user needs help. The sensor will report an alarm of 0x8001 and the light will flash.
- Fall Detection: When the sensor detects it's falling, it will report an alarm of 0x8002 and the light will flash immediately. The height of the falling is adjustable. Refer to section ***7.2 Tracker Configuration***.
- Special Area: If the sensor receives the special area beacon, it buzzes and reports 0x8003.
- Search: If the sensor receives the search beacon, it will send an audible and visual alarm and report 0x8004.

Refer to Section ***6.6 Alarm*** for more details.

6. Uplink Message

Table 3: Uplink Message Table

Message Type	Name	Description
0x1	Registration	The sensor sends this message once it successfully joins the LoRa network or it is requested to send one as described in Section ***7.3 Command Request***.
0x2	Heartbeat	The sensor periodically sends this message to confirm the status of the LoRa network connection.
0x3	GNSS Position	According to the report policy, the sensor sends this message when GNSS coordinates are acquired.
0x5	UUID Report	Report the sensor configuration's UUIDs for each beacon Type.
0x7	Beacon	The sensor sends this message according to the report policy when specific beacons are received.
0x8	Alarm	The sensor sends a confirmed message to report the alarm.

6.1 Registration

Bytes	**1**	**1**	**1**	**1**	**2**	**2**	**1**	**2**	**1**	**1**	**1**
Item	Type	RFU	Power	CFG	BLEPRI	GNSSPRI	HB	VER	CFMMSG	HBCOUNT	Fall

Type Field (the most significant byte)

Bit	Name	Value	Description
7 ~ 4	Type	0x1	Message Type Bit7 is the most significant bit.
3	ADR	0: OFF 1: ON	LoRa ADR (Adaptive Data Rate) status The default is OFF. ***Note****: As the sensor is a mobile device, we suggest turning off ADR and setting proper DR according to the distance between the sensor and Gateway.*
2 ~ 0	RFU	0x0	Reserved for Future Usage.

RFU Field

Bit	Name	Value	Description
7 ~ 0	RFU	0x0	Reserved for Future Usage.

Power Field

Bit	Name	Value	Description
7 ~ 3	LoRa TX Power	0 ~ 31	Unit: dBm. The default value depends on the sensor work mode. It is always the largest TX Powers allowed. For example, the default value is 16 dBm in EU868. ***Note**: For each LoRa frequency band plan, please refer to **Table 4: LoRa TX Power Table** for the available TX Power value.*
2 ~ 0	RFU	0x0	Reserved for Future Usage.

Table 4: LoRa TX Power Table

	EU868	US915	EU433	AU915	CN470	AS923	KR920	IN865	STE920
TX Power (dBm)	16	20	12	20	20	16	14	20	20
	14	18	10	18	18	14	12	18	18
	12	16	8	16	16	12	10	16	16
	10	14	6	14	14	10	8	14	14
	8	12	4	12	12	8	6	12	12
	6	10	2	10	10	6	4	10	10
	4	8	-	8	8	4	2		
	2	6	-	6	6	2	0		
	-	4	-	4	-	-	-		
	-	2	-	2	-	-	-		
	-	0	-	0	-	-	-		

CFG Field

Bit	Name	Value	Description
7 ~ 4	DR	0 ~ 5	LoRa Data Rate (DR0 ~ DR5) If ADR is disabled, the sensor works in this data rate. The default is DR2 (0x2). ***Note**: For the available DR value in each LoRa frequency band plan, please refer to **Table 5: LoRa Data Rate and Payload Length Limitation Map (bytes)**.* ***Note**: The data Rate in US915 cannot be set to DR0. The payload length limitation of DR0 in US915 is 11 Bytes, which is short than the maximum message length defined by this sensor.*
3	GNSSEN	0: Disable 1: Enable	GNSS status If GNSSEN is disabled, only Bluetooth positioning is effective. When indoor positioning is needed only, turning off this option saves Power. GNSS is enabled by default (0x1).
2 ~ 1	Position Report Mode	0: Period mode 1: Autonomous mode 2: On-Demand mode	Position report mode The default is the autonomous mode (0x1).

0	BLEEN	0: Disable 1: Enable	BLE enable status If BLEEN is disabled, only GNSS positioning is effective. When outdoor positioning is needed only, turning off this option saves Power. The default is Enable (0x1). ***Note:*** *Either GNSSEN or BLEEN must be enabled.*

Table 5: LoRa Data Rate and Payload Length Limitation Map (bytes)

DR	EU868	US915	EU433	AU915	CN470	AS923	KR920	IN865	STE920
0	51	11	51	51	51	51	65	51	51
1	51	53	51	51	51	51	151	51	51
2	51	126	51	51	51	51	242	51	51
3	115	242	115	115	115	115	242	115	115
4	242	242	242	242	242	242	242	242	242
5	242	-	242	242	242	242	242	242	242
6	242	-	242	242	-	242	-	242	242

BLEPRI Field

Bit	Name	Value	Description
15 ~ 0	Bluetooth Position Report Interval	0 ~ 65535	The period of Bluetooth position report, unit 5s, big-endian. 0 means OFF. The default is 5 minutes (0x003C).

GNSSPRI Field

Bit	Name	Value	Description
15 ~ 0	GNSS Position Report Interval	0 ~ 65535	The period of GNSS position report, unit 5s, big-endian. 0 means OFF. The default is 30 minutes (0x0168).

HB Field

Bit	Name	Value	Description
7 ~ 0	HB	1 ~ 255	The period of heartbeat message, unit 30s, big-endian. Heartbeat can't be disabled. The default is 2 hours (0xF0).

VER Field

Bit	Name	Value	Description
15 ~ 0	Version	16-bit hex	Firmware version

CFMMSG Field

Bit	Name	Value	Description
7 ~ 0	CFMMSG	0 ~ 255	The interval of heartbeat messages must be acknowledged. The default is 2 (0x02). Example:

			For every two heartbeat messages, the first one must be acknowledged.
7 ~ 0	HBCOUNT	0 ~ 255	The number of heartbeat ACK that the tracker misses. When it reaches this number, the tracker considers itself disconnected from the network. The default value is 5. If 5 consecutive confirmed heartbeat messages are missed, the device is disconnected from LoRaWAN and will rejoin the network. Refer to Section ***5.9 LoRa Network Connectivity*** for details.

Fall Detection Threshold Field

Bit	Name	Value	Description
7 ~ 0	Fall Detection Threshold	0 ~ 10	The threshold of the fall detection, the unit is 0.5 meters, big-endian. When the value is 0x00, the fall detection feature is disabled. The default is 2 meters (0x04). 0x0A stands for the threshold is 5 meters.

6.2 Heartbeat

Bytes	**1**	**1**	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**4**
Item	Type	Battery Level	RSSI	SNR	BLENUM	GNSSNUM	CHGTIME	WEAR TIME	VIBSTATE	Temperature

Type Field (the most significant byte)

Bit	Name	Value	Description
7 ~ 4	Type	0x2	Message Type Bit7 is the most significant bit.
3 ~ 0	RFU	0x0	Reserved for Future Usage.

Battery Level Field

Bit	Name	Value	Description
7 ~ 0	Battery Level	0 ~ 100	Battery level in percentage.

RSSI Field

Bit	Name	Value	Description
7 ~ 0	RSSI	0 ~ 127	LoRa Received Signal Strength Indication, unit -1 dBm LoRa signal strength received from LoRa gateway.

SNR Field

Bit	Name	Value	Description
15 ~ 0	SNR	-3000 ~ 3000	LoRa Signal Noise Ratio, unit 0.01 dB Signal noise ratio received from the LoRa gateway.

BLENUM Field

Bit	Name	Value	Description
7 ~ 0	Bluetooth Receiving Number	0 ~ 255	The number of BLE receiving was turned on during the heartbeat period. Default 0x00

GNSSNUM Field

Bit	Name	Value	Description
7 ~ 0	GNSS Searching Number	0 ~ 255	The number of the GNSS module was turned on during the heartbeat period. Default 0x00

CHGTIME Field

Bit	Name	Value	Description
7 ~ 0	Charging Time	0x00	The battery charging duration between two heartbeat reports, unit:30s Default 0x00

WEARTIME Field

Bit	Name	Value	Description
7 ~ 0	Wearing Time	0x00	Helmet wearing duration between two heartbeat reports, unit:30s Default: 0x00

VIBSTATE Field

Bit	Name	Value	Description
7 ~ 4	VIBSTATE	0 ~ 9	The percentage of sensor movement time in the heartbeat period. 0 means no movement. 1 means the sensor movement time is 10% of the heartbeat period. … 9 means the sensor moves for the entire heartbeat period.
3 ~ 0	RFU	0x0	Reserved for Future Usage.

Temperature Field

Bit	Name	Value	Description
31 ~ 0	Temperature	Float	The ambient temperature inside the housing. Unit: ±0.1°C, default: 0x00000000

6.3 GNSS Position

Bytes	1	4	4	4	4
Item	Type	Atmospheric Pressure	Longitude	Latitude	Time

Type Field (the most significant byte)

Bit	Name	Value	Description
7 ~ 4	Type	0x3	Message Type Bit7 is the most significant bit.
3	State	0x0 ~ 0x1	**0x0**: GNSS location success. **0x1**: GNSS location failed.
2 ~ 1	RFU	0x0	Reserved for Future Usage.
0	Wearing state	0x0 ~ 0x1	**0x0**: Do not wear. **0x1**: Wear.

Atmospheric Pressure Field

Bit	Name	Value	Description
31 ~ 0	Atmospheric Pressure	Float	The value is the actual value * 10, Unit: 0.1Pa. For example: If the hex value is 0x00-0F-54-9B, then the decimal value is 1,004,699, True atmospheric pressure = 1004699/10 = 100,469.9Pa. Refer to the ***8 Appendix*** on how to calculate the relative altitude.

Longitude Field

Bit	Name	Value	Description
31 ~ 0	Longitude	Float	IEEE 754 format, the positive value represents east longitude, and the negative value represents west longitude.

Latitude Field

Bit	Name	Value	Description
31 ~ 0	Latitude	Float	IEEE 754 format, the positive value represents north latitude, and the negative value represents south longitude.

Time Field

Bit	Name	Value	Description
31 ~ 0	Time	Integer	UTC time, seconds since 1970-01-01 00:00:00

6.4 UUID Report

Bytes	**1**	**1**	**16**	**1**	**16**	**…**
Item	Type	Beacon Type ID	UUID	Beacon Type ID	UUID	…

Type Field (the most significant byte)

Bit	Name	Value	Description
7 ~ 4	Type	0x5	Message Type Bit7 is the most significant bit.
3 ~ 0	RFU	0x0	Reserved for Future Usage.

Beacon Type Field

Bit	Name	Value	Description
7~ 0	Beacon Type ID	0x0 ~ 0x3	The ID of the beacon type is used to distinguish the different types of beacons. **0x0**: Position beacon UUID **0x1**: Asset beacon UUID **0x2**: Special area beacon UUID **0x3**: Search beacon UUID.

UUID Field

Bit	Name	Value	Description
127 ~ 0	Beacon UUID	128-bit hex	The default UUID: Position beacon F2A52D43E0AB489CB64C4A8300146720, Asset beacon F2A52D43E0AB489CB64C4A8300146721, Special area beacon F2A52D43E0AB489CB64C4A8300146722, Search beacon F2A52D43E0AB489CB64C4A8300146723.

6.5 Beacon

Bytes	**1**	**4**	**1**	**1**	**2**	**2**	**1**	**2**	**2**	**..**
Item	Type	Atmospheric Pressure	POSNUM	RFU	Major	Minor	RSSI	Major	Minor	..

Type Field (the most significant byte)

Bit	Name	Value	Description
7 ~ 4	Type	0x7	Message Type Bit7 is the most significant bit.
3 ~ 1	RFU	0x0	Reserved for Future Usage.
0	Wearing Status	0x0 ~ 0x1	**0x0**: Not wearing. **0x1**: Wearing.

Atmospheric Pressure Field

Bit	Name	Value	Description
31 ~ 0	Atmospheric Pressure	Float	The value here is displayed ten times the actual value, unit: 0.1Pa. For example: If the hex value is 000F549B then its decimal value is 1004699, True atmospheric pressure = 1004699/10 = 100469.9Pa. Refer to the ***8 Appendix*** on how to calculate the relative altitude.

POSNUM Field

Bit	Name	Value	Description
7 ~ 0	Positioning	1 ~ 15	The number of Positioning beacons.

	Beacon Number		

RFU Field

Bit	Name	Value	Description
7 ~ 0	RFU	0x0	Reserved for Future Usage.

Major Field

Bit	Name	Value	Description
15 ~ 0	Major	16-bit hex	Major of the Bluetooth beacon.

Minor Field

Bit	Name	Value	Description
15 ~ 0	Minor	16-bit hex	Minor of the Bluetooth beacon.

RSSI Field

Bit	Name	Value	Description
7 ~ 0	RSSI	-128 ~ 0	Bluetooth Received Signal Strength Indication, unit dBm Signal strength received from beacon; application server utilizes this to calculate the indoor position. ***NOTE**: This field is represented by a negative 8-bit number.*

6.6 Alarm

Bytes	**1**	**1**
Item	Type	Alarm

Type Field

Bit	Name	Value	Description
7 ~ 4	Type	0x8	Message Type, AS uses it to identify different uplink messages.
3 ~ 0	RFU	0x0	Reserved for Future Usage.

Alarm Field

Bit	Name	Value	Description
7 ~ 0	Alarm	**0x01**: SOS **0x02**: Fall	**0x01:** When the button is pressed 3 times within 3s, the sensor sends a confirmed uplink message to report the alarm, and both green and red LEDs blink to show the alarm status and the position will be reported. A single click on the button stops the blink. If it can't receive an ACK, it will send the message every 10min until the battery runs out. **0x02:** When the sensor falls, it sends a confirmed uplink message to report the alarm immediately, and the red LED blinks to show the alarm status and reports the position once acquired. A single click on the button can stop the blink (if the button is not pressed, the red LED

			will turn off after 60 blinkings). If the sensor can't receive an ACK, it will send the message every 10min until the battery runs out.
		0x03: Special area	**0x03:** When the sensor receives the special area beacon information, it sends a confirmed uplink message to report the alarm, and the red LED blinks and the buzzer keeps beeping until this beacon can't be received to show the alarm status. A single click on the button stops the blink (if the button is not pressed, the red LED will turn off after 60 blinks). If the sensor can't receive an ACK, it will send the message every 10min until the battery runs down.
		0x04: Search	**0x04:** When the sensor receives the search beacon, it sends a confirmed uplink message to report the alarm, and the red LED blinks, and it keeps buzzing until the button is pressed to show the alarm status. A single click on the button can stop the blink (if the button is not pressed the red LED will turn off after 60 blinks). If the sensor can't receive an ACK, it will stop sending the message.

7. Downlink Message

Table 6: Downlink Message Table

Message Type	Name	Description
0x8	LoRa Configuration	The application server deploys this message to configure LoRa parameters.
0x9	Tracker Configuration	The application server deploys this message to configure sensor parameters.
0xA	Command Request	The application server deploys this message to request the sensor to execute instructions.
0xB	UUID Configuration	The application server deploys this message to configure UUID parameters.

7.1 LoRa Configuration

Bytes	**1**	**1**	**1**
Item	Type	DR	Mode

Type Field (the most significant byte)

Bit	Name	Value	Description
7 ~ 4	Type	0x8	Message Type Bit7 is the most significant bit.
3	ADR	0: OFF 1: ON	ADR (Adaptive Data Rate) status The default is OFF. ***Note**: As the sensor is a mobile sensor, we suggest turning*

			off ADR and setting proper DR according to the distance between the sensor and Gateway.
2 ~ 0	RFU	0x0	Reserved for Future Usage.

DR Field

Bit	Name	Value	Description
7 ~ 4	DR	0 ~ 15	LoRa Data Rate (DR0 ~ DR15) The sensor works in this data rate when ADR is disabled The default is DR2 (0x2). ***Note**: For each LoRa frequency band plan, the available DR value, please refer to **Table 5: LoRa Data Rate and Payload Length Limitation Map (bytes)**.* ***Note**: US915 DR0 is not supported. The payload length limitation of DR0 in US915 is 11 Bytes, which is short than the maximum message length defined by this sensor.*
3 ~ 0	RFU	0x0	Reserved for Future Usage.

Mode Field

Bit	Name	Value	Description
7 ~ 5	RFU	0x0	Reserved for Future Usage.
4 ~ 0	LoRa TX Power	0 ~ 31	Unit: dBm. The default value depends on the sensor work mode. It is always the largest one of the TX Powers allowed. For example, the default value is 16 dBm in EU868. ***Note**: For each LoRa frequency band plan, please refer to **Table 4: LoRa TX Power Table** for the available TX Power value.*

7.2 Tracker Configuration

Bytes	**1**	**1**	**1**	**2**	**2**	**1**	**1**	**1**	**1**
Item	Type	CFG	Special Area Beacon RSSI	BLEPRI	GNSSPRI	HB	CFMMSG	HBCOUNT	Fall

Type Field (the most significant byte)

Bit	Name	Value	Description
7 ~ 4	Type	0x9	Message Type. Bit7 is the most significant bit.
3	GNSSEN	0: Disable 1: Enable	GNSS enable status If GNSSEN is disabled, only Bluetooth positioning is effective. When indoor positioning is only needed, turning off this option saves Power. The default is Enable (0x1).
2 ~ 1	Position Report Mode	0: Period mode 1: Autonomous mode 2: On-Demand mode	Position report mode The default is the autonomous mode (0x1).

0	BLEEN	0: Disable 1: Enable	BLE enable status If BLEEN is disabled, only GNSS positioning is effective. When outdoor positioning is only needed, turning off this option saves Power. The default is Enable (0x1). ***Note:*** *Either GNSSEN or BLEEN must be enabled.*

CFG Field

Bit	Name	Value	Description
7 ~ 4	BLE CFG	1 ~ 15	The maximum number of beacons that can be received. Default: 0x3
3	Switch off Enable	0: Disable 1: Enable	Switch off enable status. If Switch Off Enable is disabled, the switch cannot be used to shut down the sensor. Default: 0x1.
2 ~ 0	RFU	0x0	Reserved for Future Usage.

Special Area Beacon RSSI Field

Bit	Name	Value	Description
7 ~ 0	Special Area Beacon RSSI	0 ~ 255	Bluetooth Received Signal Strength Indication, unit dBm Signal strength is received from a special beacon; Default: 50(0x32).

BLEPRI Field

Bit	Name	Value	Description
15 ~ 0	Bluetooth Position Report Interval	0 ~ 65535	The period of position report, unit 5s, big-endian 0 means OFF. The default is 5 minutes (0x003C).

GNSSPRI Field

Bit	Name	Value	Description
15 ~ 0	GNSS Position Report Interval	0 ~ 65535	The period of position report, unit 5s, big-endian 0 means OFF. The default is 30 minutes (0x0168).

HB Field

Bit	Name	Value	Description
7 ~ 0	HB	1 ~ 255	The period of heartbeat message, unit 30s, big-endian Heartbeat can't be disabled. The default is 2 hours (0xF0).

CFMMSG Field

Bit	Name	Value	Description
7 ~ 0	CFMMSG	0 ~ 255	The interval of heartbeat messages must be acknowledged. The default value is 2 (0x02). For every two heartbeat messages, the first one must be

			acknowledged.

HBCOUNT Field

Bit	Name	Value	Description
7 ~ 0	HBCOUNT	0 ~ 255	The number of heartbeat ACK that the tracker misses. When it reaches this number, the tracker considers itself disconnected from the network. The default value is 5. If 5 consecutive confirmed heartbeat messages are missed, the device is disconnected from LoRaWAN and will rejoin the network. Refer to Section ***5.9 LoRa Network Connectivity*** for details.

Fall Field

Bit	Name	Value	Description
7 ~ 0	Fall Detection	0 ~ 10	The threshold of the fall detection, the unit is 0.5 meters, big-endian. When the value is 0x00, the fall detection feature is disabled. The default value is 2 meters (0x04).

7.3 Command Request

Bytes	**1**	**1**
Item	Type	RFU

Type Field (the most significant byte)

Bit	Name	Value	Description
7 ~ 4	Type	0xA	Message Type Bit7 is the most significant bit.
3 ~ 0	Command		Requested command
		0x1: Position request	**0x1**: Request the sensor to send a position.
		0x2: Register request	**0x2**: Request the sensor to send a register message if AS wants to get the sensor's current parameters.
		0x3: Sensor reboot	**0x3**: Request the sensor to reboot.
		0x4: Wear calibration	**0x4**: Calibrate the initial state of the wear detection. Do not send this command while the helmet is worn.
		0x5: Start beeping	**0x5**: Request the sensor to start beeping and the red LED blinks to show the alarm status, and position will be reported. A single click on the button can stop the blinking and beeping (if the button is not pressed the red LED will turn off after 60 times blinking).
		0x6: UUID report	**0x6**: Report the UUID of the position beacon, asset beacon, danger area beacon, and search beacon.

RFU Field

Bit	Name	Value	Description
7 ~ 0	RFU	0x0	Reserved for Future Usage.

7.4 UUID Configuration

Bytes	**1**	**16**
Item	Type	UUID

Type Field (the most significant byte)

Bit	Name	Value	Description
7 ~ 4	Type	0xB	Message Type Bit7 is the most significant bit.
3 ~ 0	UUID Config	0 ~ 3	**0x0**: Position beacon UUID **0x1**: Asset beacon UUID **0x2**: Danger area beacon UUID **0x3**: Search beacon UUID

UUID Field

Bit	Name	Value	Description
127 ~ 0	Beacon UUID	128-bit hex	The default UUID: Position beacon: F2A52D43E0AB489CB64C4A8300146720, Asset beacon: F2A52D43E0AB489CB64C4A8300146721, Special area beacon: F2A52D43E0AB489CB64C4A8300146722, Search beacon: F2A52D43E0AB489CB64C4A8300146723.

8. Appendix

*Follow the steps below to measure the relative altitude:

1) Place a sensor downstairs to measure the reference atmospheric pressure P_r.
2) Use the formula $H = 44330[1 - \left(\frac{P}{P_0}\right)^{\frac{1}{5.255}}]$ to calculate the reference altitude value H_r, where P_0 is the standard atmospheric pressure (101.325kPa).
3) Place another sensor upstairs or elsewhere to measure the atmospheric pressure P_n.
4) Use the same formula to calculate the altitude value H_n based on P_n.
5) The relative altitude = H_r-H_n. The relative altitude error is less than 1m.

Note: *The atmospheric pressure should be measured at the same place and same time., The relative altitude error < 1m.*

9. Ordering Information

Description	PN
Sensor, Helmet use, BLE5.0, GNSS, 1000mAh	100-02388

10. Packaging

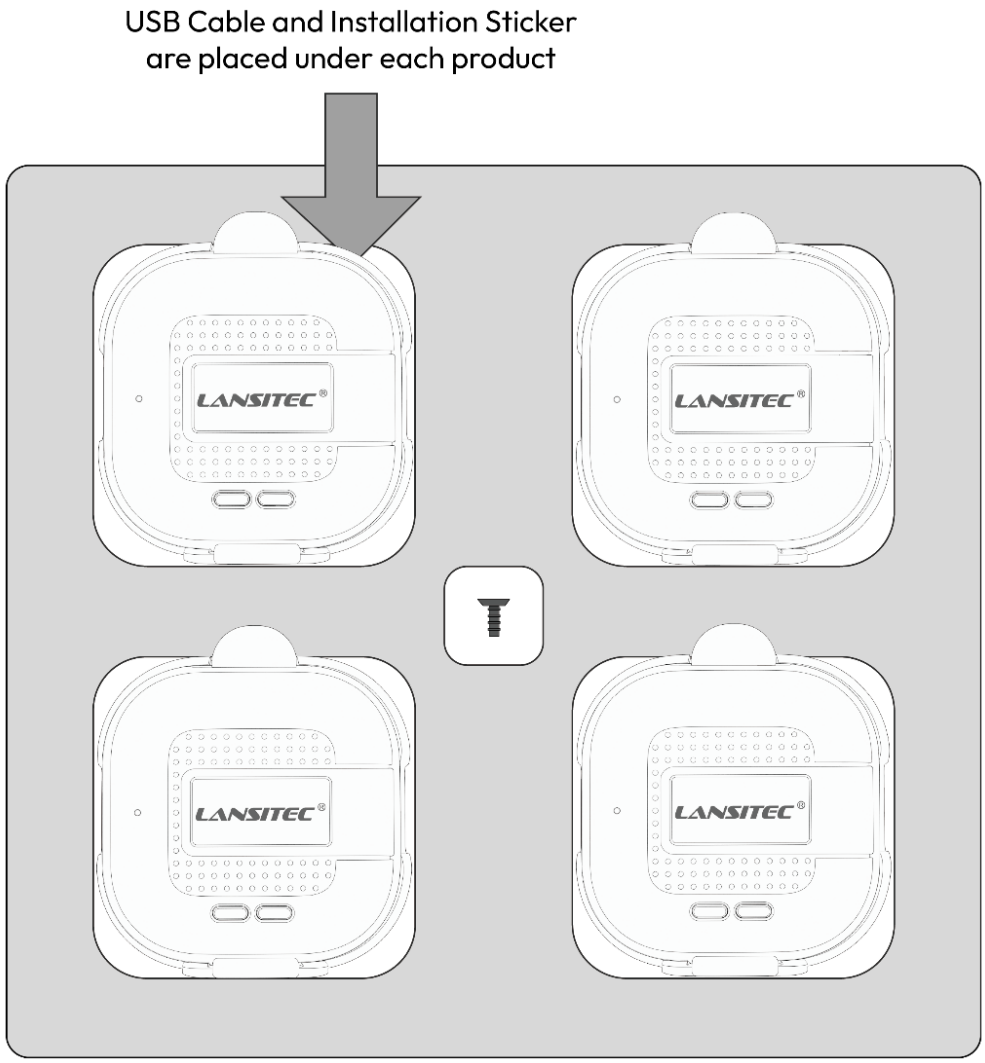
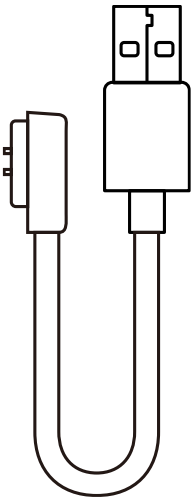


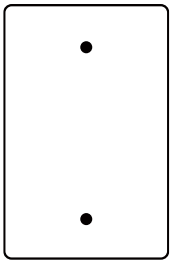
Figure 5. Packaging

Packing List:

(Helmet Sensor + Clip + Silicon Rubber Pad) x4



Micro USB Charging Cable (0.6m) x4



Installation Sticker x4

Screw x8

11. Installation

The silicon rubber pad is soft and can make the sensor match all helmets' outline. The clip holds the sensor so that the sensor can be removed for charging and return without any tools.

1) Drill two holes on the helmet.
2) Fasten the silicon rubber pad and the clip onto the helmet with two screws.
3) Push the sensor into the clip.

You can also install the sensor without the clip

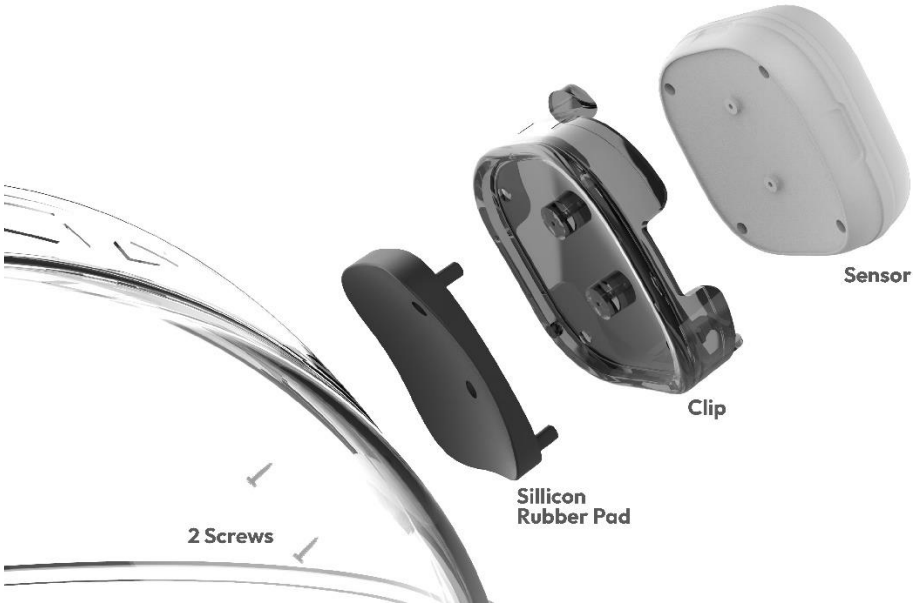


Figure 6. Installation Diagram with the Clip

Figure 7. Helmet Sensor with the Clip

Figure 8. Installation Diagram without the Clip

Figure 9. Helmet Sensor without the Clip

End of document