

1. General Introduction

This tracker design is based on GNSS, Bluetooth Low Energy, and LoRa technology. With the advanced LoRa technology and built-in accelerometer, the tracker 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 needs.

2. Abbreviation

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

3. Product Specifications

Table 1: Product Specifications

LoRaWAN	
Protocol	Version 1.0.2B, Class A
Activation Mode	OTAA or ABP
LoRa Frequency	US915, AU915, EU868, EU433, AS923, RU864, KR920, IN865, KZ865, CN470
LoRa TX power	0 to 20dBm
LoRa Sensitivity	-137dBm @ SF12, BW 125 kHz, 868MHz/915MHz
LoRa Communication Distance	>1 km in an urban area
Encryption	AES128
Bluetooth	
Protocol	5.0, iBeacon
TX Power	-20 to +4 dBm TX power, configurable in 4dBm steps
Sensitivity	-96dBm
GNSS	
GNSS	GPS, BDS, GALILEO, GLONASS, QZSS, SBAS (WAAS/EGNOS/GAGAN/MSAS)
Accuracy	<2.5m (CEP50)
Cold Start Time Duration	30 ~ 120s
System	
Max. Current	20 μ A

FOTA Over Bluetooth	Support
NFC	Support

Battery Life	Please refer to the battery life calculator spreadsheet for details.
GNSS (report interval 10 minutes)	Approx. 30,000 times
Bluetooth positioning	Approx. 1 million times

Physical Parameters	Badge	Asset management tracker
Dimension	95.4x61.4x7.3mm	76 x 70 x 40 mm
Housing Material	ABS	ABS
Switch	Physical button	Physical button
Operating Temperature	-10 °C ~ +60 °C	-40 °C ~ +70 °C
Storage Temperature	-40 °C ~ +80 °C	-50 °C ~ +80 °C

4. Application Information

4.1 LoRaWAN Mode

The tracker supports both OTAA and ABP modes and works in Class A mode. DevEUI, AppEUI, and AppKey, or DevAddr, NwkSKey, and AppSKey are stored in the tracker. 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.

4.2 Tracking Features

The tracker supports both Bluetooth and GNSS positioning. Bluetooth positioning beacons must be deployed around the tracker to use Bluetooth tracking. The Bluetooth receiving duration is 3 seconds, and it cannot be configured. The tracker sends nearby beacons' information (major, minor, and RSSI) to the server. It 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 within 3 seconds. Since the beacons' positions are already known, the server calculates the distance to the three beacons nearby. Then the coordinates can be acquired according to the triangulation algorithm.

Please refer to:

930-01232 "LoRaWAN Tracker Positioning Service API Document" for detailed information on the triangulation

990-00170 "B-Fixed® PERSONNEL& ASSET TRACKING SOLUTION" to find out how to design and develop your tracking system.

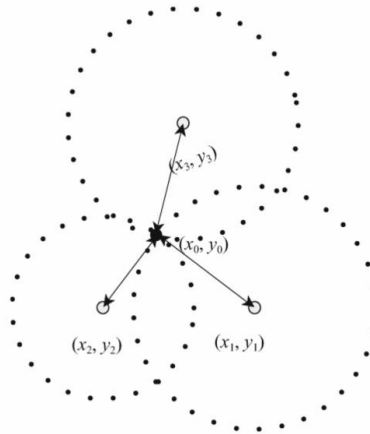


Figure 1. Triangulation Method

The tracker turns on Bluetooth receiving for 3 seconds before tracking (at the beginning of each interval). The tracker turns on the GNSS module if it can't receive any beacons. Vice versa, if the beacon signal is received, GNSS will not be turned on. GNSS timeout duration is 3 minutes. It stops acquiring satellites during a timeout and will in the next cycle.

According to LoRaWAN specification, an uplink duty cycle decides the downlink response time in the Class A mode. The tracker uses a heartbeat message to control the downlink response time and avoid relying on the position message for the downlink configuration. The heartbeat message report period can be configured as multiples of 30 seconds. The heartbeat message also contains the status information of the tracker. AS can use it to monitor the tracker.

4.3 Positioning Report Mode

1) Periodic reporting mode

The tracker periodically starts the positioning process and reports the positioning results at fixed intervals as configured.

Note: The satellite acquisition time could be longer than the positioning process, so the actual positioning report interval received by the Application Server may be longer than the configured position period.

2) Autonomous reporting mode

The tracker decides whether to start the positioning process and reports the positioning result based on the motion state perceived by the accelerometer in the last positioning cycle.

3) On-Demand reporting mode

The tracker starts the positioning process and reports the positioning results only when it receives a LoRa downlink instruction deployed by the AS.

4.4 Positioning Process

- 1) When the positioning process starts, first turn on the Bluetooth scanning 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 tracker reports the Major, Minor, and RSSI of 3 of the beacons which have the strongest RSSI. Then the positioning process terminates.

- 2) If no beacon is received, the tracker turns on the GNSS module.

Generally, the tracker can obtain the coordinates in about 25 ~ 60 seconds under the condition of a good GNSS satellite signal in the outdoor environment. After successful GNSS positioning, it reports the longitude, latitude, and UTC, and then the positioning process is terminated.

If the GNSS module cannot obtain the coordinates due to the weak satellite signal, the GNSS module turns off until 3 minutes after the accelerometer senses stillness. Then the positioning process terminates.

4.5 On/Off and LED Status

- 1) Turn on: Press the button for four seconds; the red LED flashes four times while the green LED is on.
- 2) Turn off: Press the button for four seconds; the red LED flashes four times.
- 3) Reboot: LED status is the same as turning on.
- 4) When joining the LoRa network, the green LED is on until the end of the joining process.
- 5) Short press the button:
 - a) The green LED flashes once: LoRa network successfully joined.
 - b) The red LED flashes once: LoRa network lost connection.
 - c) No LED flashes: The device is powered off.
- 6) When the Micro USB charging cable is connected:
 - a) Red LED flashes: The device is in charge.
 - b) Red LED is on: The device is fully charged.

4.6 Confirmed and Unconfirmed Uplink Message Configuration

To reduce the number of downlink messages, all GNSS position and beacon uplink messages are unconfirmed. The confirmed heartbeat message can be configured. Refer to the CFMMSG field in section **6.2 Tracker Configuration** for details. This feature only applies to firmware version 0x0501 or higher.

4.7 Tracker GNSS Antenna and Placement

The badge and outdoor asset tracker use an 18x18mm ceramic antenna. Their position is shown in **Figure 2. Badge Tracker GNSS Antenna**. Face the GNSS antenna toward the sky is recommended to get the best signal quality.



Figure 2. Badge Tracker GNSS Antenna

4.8 LoRa Network Connectivity

The device determines LoRa network connectivity by counting the number of confirmed uplink heartbeat messages that are lost.

The default settings are: CFMMSG field is 2, and HBCOUNT field is 5 as described in section **6.2 Tracker Configuration**. It means that 5 confirmed and 5 unconfirmed heartbeat messages are lost, and the device considers LoRa is disconnected. It will not send the position report anymore. Instead, it will try to join the network once every 5 minutes for 3 times. If unsuccessful, it will try to join once at the beginning of each hour. The position report resumes once the network is reconnected.

This feature only applies to firmware version 0x0501 or higher.

5. Uplink Message

Table 2: Uplink Message Table

Message Type	Name	Description
0x1	Registration	The tracker sends this message once when it joins the LoRa network successfully, or it receives a specific command request downlink message (6.3 Command Request).
0x2	Heartbeat	The tracker periodically sends this message to confirm the status of the LoRa network connection.
0x3	GNSS Position	The tracker sends this message according to the report policy when GNSS location information is acquired.
0x7	Beacon	The tracker sends this message according to the report policy when specific beacons are received.
0x8	Alarm	The tracker sends a confirmed message to report the alarm.

5.1 Registration

Bytes	1	1	1	1	2	2	1	2	1	1	1
Item	Type	SMODE	Power	Config	BLEPRI	GNSSPRI	Heartbeat	Version	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 enables status The default value is OFF. Note: As the tracker is a mobile device, we suggest turning off ADR and setting proper DR according to the distance between the tracker and Gateway.
2 ~ 0	MODE	0x0	The current working LoRa frequency band plan Deprecated, this field has been firmly set to 0x0 since firmware version 5.0.

SMODE Field

Bit	Name	Value	Description
7 ~ 0	SMODE	0x0	Supported LoRa frequency band plan Deprecated, this field has been firmly set to 0x0 since firmware version 0x0501.

Power Field

Bit	Name	Value	Description
7 ~ 3	Power	0 ~ 31	LoRa TX power (dBm) The default value depends on the tracker work mode. It is always the biggest one of the allowed TX powers. For example, the default value is 16 dBm if MODE is EU868. Note: For each LoRa frequency band plan, the available TX Power value, refer to Table 3: LoRa TX Power Table .
2 ~ 0	RFU	0x0	Reserved for future usage.

Table 3: LoRa TX Power Table

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

Config Field

Bit	Name	Value	Description
7 ~ 4	DR	0 ~ 15	LoRa Data Rate (DR0 ~ DR15) If ADR is disabled, the tracker works in this data rate. The default value is DR2 (0x2). Note: For each LoRa frequency band plan, the available DR value, refer to Table 4: LoRa Data Rate and Payload Length Limitation Map (bytes) . Note: Data Rate in US915 cannot be set to DR0. The payload length limitation of DR0 in US915 is 11 Bytes, which is shorter than the maximum message length defined by this device.
3	GNSSSEN	0: Disable 1: Enable	GNSS enable status If GNSSSEN is disabled, only Bluetooth positioning is effective. When Bluetooth positioning is needed only, turning off this option saves power. The default is enabled (0x1).
2 ~ 1	POSMODE	0: Period mode 1: Autonomous mode 2: On-Demand mode	Positioning report mode The default value 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 GNSSSEN or BLEEN must be enabled.

Table 4: LoRa Data Rate and Payload Length Limitation Map (bytes)

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

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 value 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).

Heartbeat Field

Bit	Name	Value	Description
7 ~ 0	Heartbeat Report Interval	1 ~ 255	The period of heartbeat message, unit 30s, big-endian Heartbeat can't be disabled. The default value is 1 hour (0x78).

Version 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 messages that need to be acknowledged. The default value is 2, meaning the server must acknowledge the first one for every two heartbeat messages.
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.

Fall Detection Field

Bit	Name	Value	Description
7 ~ 0	Fall detection	0 ~ 10	The threshold of the fall detection. 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).

Example: 10 00 A0 32 003C 0168 78 0525 02 05 04

- **10:** "1" is the message type of registration message, and "0" in binary expression is 0000, where bits 3 indicates the ADR status is off and bits 0-2 are reserved for future usage.
- **00:** This field is reserved for future usage.
- **A0:** The binary expression is 1010 0000, where bits 3-7 represent the Tx power as 10100 (20 in decimal), indicating a Tx Power of 20dBm. Bits 0-2 are reserved for future usage.
- **32:** The binary expression is 0011 0010, where bits 4-7 represent the DR value as 0011 (3 in decimal), indicating a DR value of 3. Bits 3 represents the GNSS status, and 0 means the GNSS function is disabled. Bit 1-2 represent

the position report interval configured as 01, which is the autonomous mode. In this mode, the tracker decides whether to start the positioning process and reports the positioning result based on the motion state perceived by the accelerometer in the last positioning cycle. Refer to chapter **4.3 Positioning Report Mode** for details. Bit 0 is reserved for future usage.

- **003C**: The position report interval is configured as 003C in hexadecimal, which equals 60 in decimal. Therefore, the position report interval is calculated as $60 \times 5s = 300s = 5 \text{ minutes}$.
- **0168**: The GNSS position report interval is configured as 0168 in hexadecimal, which equals 360 in decimal. Therefore, the position report interval is calculated as $360 \times 5s = 1800s = 30 \text{ minutes}$.
- **78**: The heartbeat report interval is configured as 78 in hexadecimal, which equals 120 in decimal. Therefore, the heartbeat report interval is calculated as $120 \times 30s = 3600s = 1 \text{ hour}$.
- **0525**: This field represents the firmware version of the tracker. Therefore, the firmware version of the tracker is V5.25.
- **02**: The interval of the heartbeat message must be acknowledged and configured as 02, which means for every two heartbeat messages, the first one must be acknowledged.
- **05**: The number of heartbeat ACK that the tracker missed is configured as 05, which means if 5 consecutive confirmed heartbeat messages are missed, the device is disconnected from LoRaWAN and will rejoin the network.
- **04**: The threshold of the fall detection is configured as 04. Therefore, the fall detection threshold is calculated as $4 \times 0.5m = 2 \text{ meters}$

5.2 Heartbeat

Bytes	1	1	1	2	1	1	2
Item	Type	Battery	RSSI	SNR	GNSSSTAT	CHGSTAT	RFU

Type Field (the most significant byte)

Bit	Name	Value	Description
7 ~ 4	Type	0x2	Message type Bit7 is the most significant bit.
3 ~ 0	SNREN	0: No SNR field 1: The SNR field is enabled	The field indicates whether the SNR field is enabled or not. The default value is SNR field enabled (0x1). The SNR field has been included since firmware version 0x0501.

Battery Field

Bit	Name	Value	Description
7 ~ 0	Battery	0 ~ 100	Battery 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 LoRa gateway. Note: If the SNRINC field is 0, the Application Server should ignore this field.

GNSSSTAT Field

Bit	Name	Value	Description
7 ~ 4	GNSSSTATE	0x00: Off 0x01: Boot GNSS 0x02: Locating 0x03: Located 0x09: No signal	Status of the GNSS module
3 ~ 0	VIBSTATE	0 ~ 9	Moving state of the tracker. 0 means no moving. 9 means it moves at a high accelerated speed.

CHGSTAT Field

Bit	Name	Value	Description
7 ~ 4	CHGSTATE	0x0: Power cable disconnected 0x5: Power cable connected (charging) 0x6: Power cable connected (charge complete)	Status of battery charging.
3 ~ 0	RFU	0x0	Reserved for future usage.

RFU Field

Bit	Name	Value	Description
15 ~ 0	RFU	0x0	Reserved for future usage.

Example: 20 64 3E 033E 00 60 00

- **20:** This represents the message type of heartbeat message.
- **64:** The battery percentage, represented as 64 in hexadecimal, equals 100 in decimal. Therefore, the tracker's battery percentage is 100%.
- **3E:** The LoRa RSSI, represented as 3E in hexadecimal equals 62 in decimal. Therefore, the LoRa RSSI value is -62dBm.
- **033E:** The signal noise ratio, represented as 033E in hexadecimal equals 830 in decimal. Therefore, the signal-noise ratio is calculated as $830 \times 0.01 = 8.3\text{dB}$.
- **00:** The GNSSSTAT field's binary expression is 0000 0000, where bits 4-7 represent the status of the GNSS module, indicating the GNSS module is off. Bits 0-3 are the moving state of the tracker, 0 means no moving.
- **60:** The field represents the battery charging status, "6" means the power cable is connected and charge complete, and bits 0-3 are reserved for future usage.
- **00:** This field is reserved for future usage.

5.3 GNSS Position

Bytes	1	4	4	4
Item	Type	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 ~ 0	Flag	0x0 ~ 0x1	0x0 : GNSS positioning succeeded. 0x1 : GNSS positioning failed.

Longitude Field

Bit	Name	Value	Description
31 ~ 0	Longitude	Float	Longitude 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	Latitude 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 1970/1/1 00:00:00

Example: 30 42ED8AC4 41FFCE2E 6572E8A8

- **30**: “3” represents the message type of GNSS position message. “0” represents the GNSS positioning is succeeded.
- **42ED8AC4**: Is the longitude value, which is 118.77094921719423.
- **41FFCE2E**: Is the latitude value, which is 31.975854870778903.
- **6572E8A8**: Is the timestamp, which is 2023-12-09T05:58:05.000Z.

5.4 Beacon

Bytes	1	5	2	2	1	2	2	..
Item	Type	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 ~ 0	LENGTH	1 ~ 3	Number of beacons received.

RFU Field

Bit	Name	Value	Description
39 ~ 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 is received from the beacon; the application server utilizes this to calculate the indoor position. NOTE: For compatibility with the legacy version, this field is represented by a negative 8-bit number.

Example: 73 0000000000 00010001 D9 00101127 C7 00990098 B8

- **70:** “7” represents the message type of beacon message. “3” represent the number of beacons that received and reported.
- **0000000000:** This field is reserved for future usage.
- **00010001:** The major/minor value of the first position beacon.
- **D9:** The RSSI value of the first position beacon. D9 in hexadecimal equals 217 in decimal, and the RSSI formula is $217 - 256 = -39\text{dBm}$, so the device RSSI value is -39dBm .
- **00101127:** The major/minor value of the second position beacon.
- **C7:** The RSSI value of the second position beacon. C7 in hexadecimal equals 199 in decimal, and the RSSI formula is $199 - 256 = -57\text{dBm}$, so the device RSSI value is -57dBm .
- **00990098:** The major/minor value of the third position beacon.
- **B8:** The RSSI value of the third position beacon. B8 in hexadecimal equals 184 in decimal, and the RSSI formula is $184 - 256 = -72\text{dBm}$, so the device RSSI value is -72dBm .

5.5 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	<p>0x01: SOS</p> <p>0x02: Fall Detection</p>	<p>0x01: When the button is pressed 3 times within 3s, the badge sends a confirmed uplink message to report the alarm. If it can't receive an ACK, it will send the message every 10 minutes until the battery runs down. Both green and red LEDs flash to show the alarm status, and the badge starts tracking. A single click on the button can stop the flash. Once the ACK is received, the badge will stop sending the alarm message.</p> <p>0x02: When the tracker falls, the badge sends a confirmed uplink message to report the alarm. Both green and red LEDs flash to show the alarm status, and the badge starts tracking. A single click on the button can stop the flash.</p>

Example: 80 01

- **80:** This represents the message type of alarm message.
- **01:** This field represents the alarm type, 01 means this alarm is a SOS alarm.

6. Downlink Message

Table 5: Downlink Message Table

Message Type	Name	Description
0x8	LoRa Configuration	The application server can deploy this message to configure LoRa parameters.
0x9	Tracker Configuration	The application server can deploy this message to configure tracker parameters.
0xA	Command Request	The application server can deploy this message to request the tracker to execute instructions.

6.1 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 value is OFF. Note: As the tracker is a mobile device, we suggest turning off ADR and setting proper DR according to the distance between the tracker 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 ~ DR5) If ADR is disabled, the tracker works in this data rate. The default value is DR2 (0x2). Note: For each LoRa frequency band plan, the available DR value, refer to Table 4: 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 shorter than the maximum message length defined by this device.
3 ~ 0	RFU	0x0	Reserved for future usage.

MODE Field

Bit	Name	Value	Description
7 ~ 5	RFU	0x0	Reserved for future usage.
4 ~ 0	TX Power	0 ~ 31	LoRa TX power (dBm) The default value depends on the tracker work mode. It is always the biggest one of the allowed TX powers. For example, the default value is 16 dBm if MODE is EU868. Note: For each LoRa frequency band plan, the available TX Power value, refer to Table 3: LoRa TX Power Table .

Example: 80 40 14

- **80:** In the LoRaWAN configuration message, 8 represents the message type. And 0 is 0000 in binary, where bit 3 is 0, which means the ADR function is turned off, and bits 0-2 are reserved for future usage.
- **40:** This represents the DR field, where bits 4-7 are 0100 in binary, which equals 4 in hexadecimal. This indicates that the DR value is 4, and bits 0-4 are reserved for future usage.
- **14:** 14 in hexadecimal equals 0001 0100 in binary. In this binary representation, bits 5-7 are reserved for future usage, and bits 0-4 represent the Tx power as 10100 (20 in decimal), indicating a Tx Power of 20dBm.

6.2 Tracker Configuration

Bytes	1	2	2	1	1	1	1
Item	Type	BLEPRI	GNSSPRI	Heartbeat	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	GNSSSEN	0: Disable 1: Enable	GNSS enable status If GNSSSEN is disabled, only Bluetooth positioning is effective. When indoor positioning is only needed, turning off this option is power-efficient. The default value is Enable (0x1).
2 ~ 1	POSMODE	0: Period mode 1: Autonomous mode 2: On-Demand mode	Positioning report mode The default value 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 GNSSSEN or BLEEN must be enabled.

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 value is 5 minutes (0x3C).

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).

Heartbeat Field

Bit	Name	Value	Description
7 ~ 0	Heartbeat Report	1 ~ 255	The period of heartbeat message, unit 30s, big-endian

	Interval		The heartbeat message can't be disabled. The default value is 1 hour (0x78).
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CFMMSG Field

Bit	Name	Value	Description
7 ~ 0	CFMMSG	0 ~ 255	The interval of messages that need to be acknowledged. The default value is 2, meaning the server must acknowledge the first one for every two heartbeat messages.

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 4.8 LoRa Network Connectivity for details.

This feature only applies to firmware version 0x0501 or higher.

Fall Detection Field

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

Example: 90 000C 0168 3C 02 05 04

- **90:** “9” represents the downlink tracker configuration message type. The binary expression of 0 is 0000. Bit 3 represents the GNSS status, and 0 means the GNSS function is disabled. Bits 1-2 represent the position report interval configured as 00, which is the period mode. In this mode, the tracker periodically starts the positioning process and reports the positioning results at fixed intervals as configured, no matter whether the sensor is moved or not. Refer to Chapter **4.3 Positioning Report Mode** for details. Bit 0 is reserved for future usage.
- **000C:** This represents the position report interval configuration. If you want to change the position report interval from 5 minutes to 1 minute, please use the formula: **1 minute = 12 x 5s**, and **12** in decimal equals **000C** in hexadecimal. Therefore, this position report interval should be configured as **000C**.
- **0168:** This represents the GNSS position report interval configuration. If you want to configure the GNSS position report interval for 30 minutes, please use the formula: **30 minutes = 1800s = 360 x 5s**, and **360** in decimal equals **0168** in hexadecimal. Therefore, the GNSS position report interval should be configured as **0168**.
- **3C:** This represents the heartbeat report interval configuration. If you want to change the heartbeat report interval from 1 hour to 30 minutes, please use the formula: **30 minutes = 60 x 30s**, and **60** in decimal equals **3C** in hexadecimal. Therefore, this heartbeat report interval should be configured as **3C**.
- **02:** The interval of the heartbeat message must be acknowledged and configured as 02, which means for every two heartbeat messages, the first one must be acknowledged.

- **05**: The number of heartbeat ACK that the tracker missed is configured as 05, which means if 5 consecutive confirmed heartbeat messages are missed, the device is disconnected from LoRaWAN and will rejoin the network.
- **04**: The threshold of the fall detection is configured as 04. Therefore, the fall detection threshold is calculated as $4 \times 0.5\text{m} = 2 \text{ meters}$

6.3 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	0x1 : Position request 0x2 : Register request 0x3 : Device reboot	Requested command 0x1 : Request the tracker to send the position. 0x2 : Request the tracker to send a register message if AS wants to get the tracker's current parameters. 0x3 : Request the tracker to reboot.

RFU Field

Bit	Name	Value	Description
7 ~ 0	RFU	0x0	Reserved for future usage.

Example : A2 00

- **A2**: In the downlink command request message, A represents the message type, and 2 is the command to request the tracker to send a register message.
- **00**: The value field is reserved for future usage.

7. Packaging

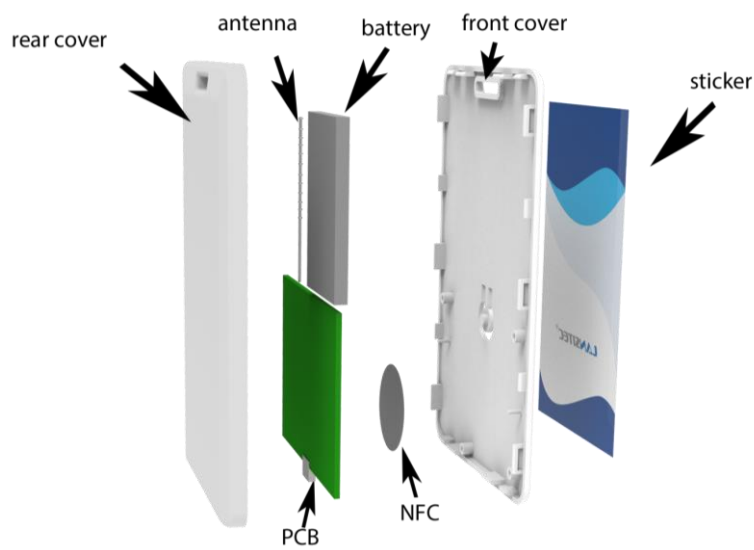
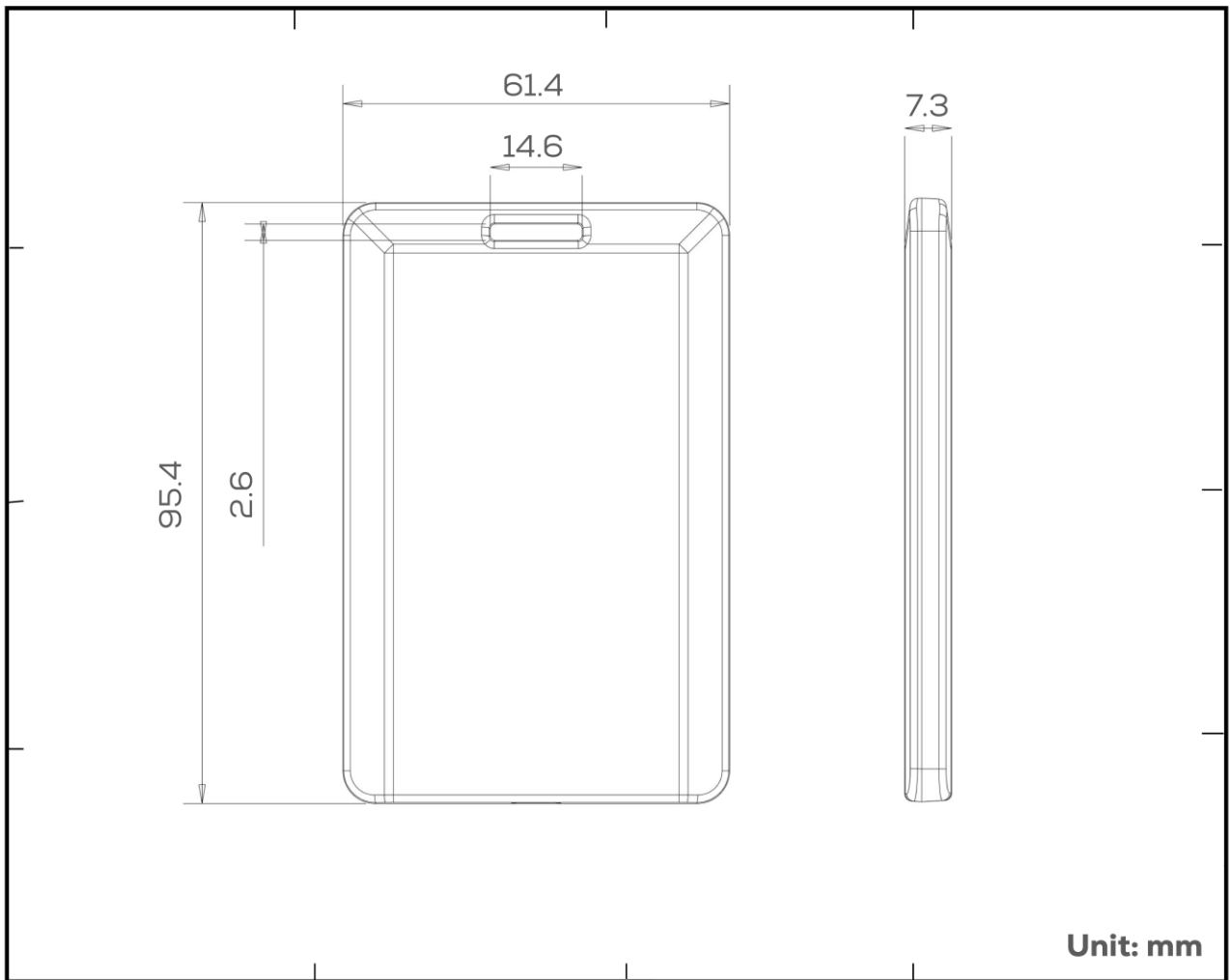


Figure 3. Overall Composition Diagram

Below is the packaging for the Badge Tracker:

When shipped as samples:

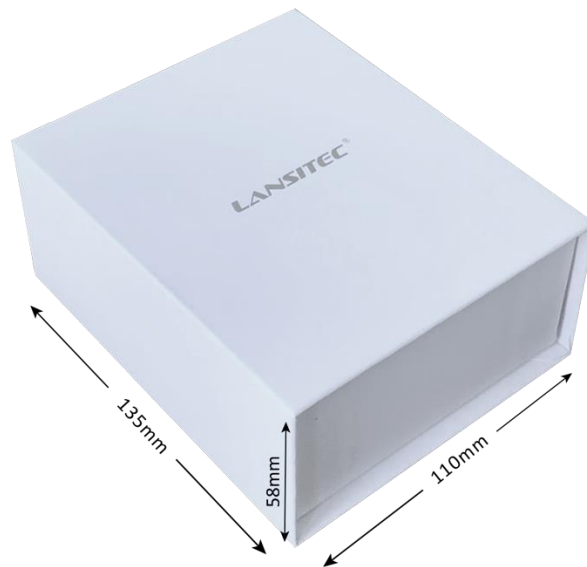
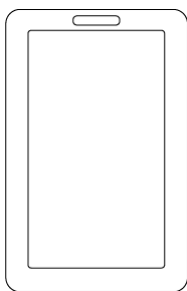
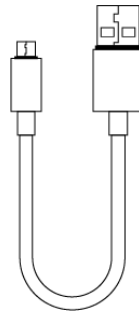


Figure 4. Packaging When Shipped as Samples

Packing list:



Badge Tracker x 1



Micro USB Charging Cable (1.0m) x 1



Lanyard x 1



PVC Sticker x 1

When shipped in batches:

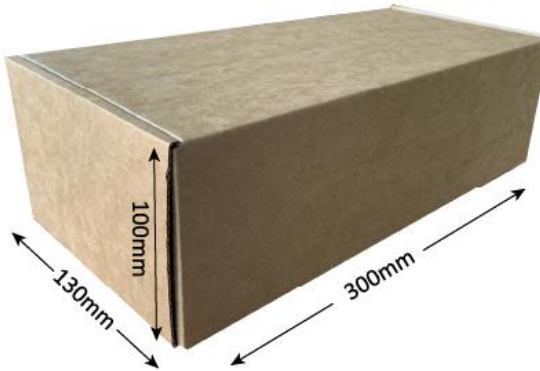
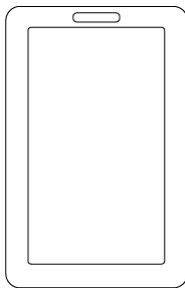


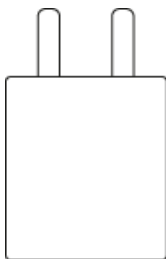
Figure 5. Packaging When Shipped in Batches

Packing list:

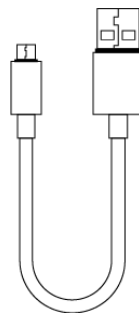


Badge Tracker x 12

Accessories for each tracker (shipped in another package):



USB charger



Micro USB Charging Cable (1.0m)



Lanyard



PVC Sticker



Badge with a lanyard



Badge with a clip

8. Ordering Information

Description	PN
Badge, AS923, Bluetooth 5.0, 95.4x61.4x7.3mm, 600mAh	100-02876
Badge, AS923, Bluetooth 5.0, GNSS, 95.4x61.4x7.3mm, 600mAh	100-02476
Badge, In865, Bluetooth 5.0, GNSS, 95.4x61.4x7.3mm, 600mAh	100-02566
Badge, In865, Bluetooth 5.0, 95.4x61.4x7.3mm, 600mAh	100-02567
Badge, EU868, Bluetooth 5.0, GNSS, 95.4x61.4x7.3mm, 600mAh	100-02490
Badge, EU868, Bluetooth 5.0, 95.4x61.4x7.3mm, 600mAh	100-02489
Badge, US915, Bluetooth 5.0, GNSS, 95.4x61.4x7.3mm, 600mAh	100-02478
Badge, US915, Bluetooth 5.0, 95.4x61.4x7.3mm, 600mAh	100-02461
Badge, RU864, Bluetooth 5.0, GNSS, 95.4x61.4x7.3mm, 600mAh	100-02491
Badge, RU864, Bluetooth 5.0, 95.4x61.4x7.3mm, 600mAh	100-02493
Badge, AU915, Bluetooth 5.0, GNSS, 95.4x61.4x7.3mm, 600mAh	100-02501
Badge, AU915, Bluetooth 5.0, 95.4x61.4x7.3mm, 600mAh	100-02502
Badge, KR920, Bluetooth 5.0, 95.4x61.4x7.3mm, 600mAh	100-02497
Badge, KR920, Bluetooth 5.0, GNSS, 95.4x61.4x7.3mm, 600mAh	100-02499
Badge, CN470, Bluetooth 5.0, 95.4x61.4x7.3mm, 600mAh	100-02371
Badge, CN470, Bluetooth 5.0, GNSS, 95.4x61.4x7.3mm, 600mAh	100-02372

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