LW001-BG PRO
Product Specification

CONTENT

# 1 Product Introduction

LW001-BG PRO is a wireless smart, ultra-low power consumption, indoor&outdoor LoRaWAN Tracker. It integrates GPS positioning, Bluetooth positioning and WiFi positioning, supports a variety of working modes, suitable for most tracking applications.

It supports ABP and OTAA two different LoRaWAN network access mode, and easy to configure and update firmware via MKLoRa APP. Ideal to optimize logistic process, asset management, warehouse and inventory scenarios, outdoor tracking, theft protection, livestock tracking and much more.

① Fixing holes

② Magnetic switch

③ LED indicator
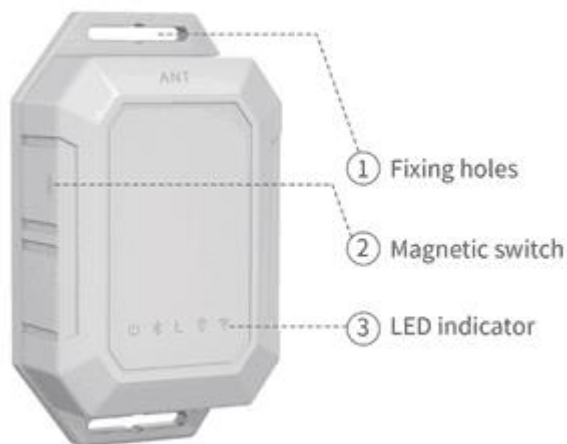
2 Application Scenarios

Scenario 1: Heavy Equipment Tracking

LW001-BG PRO can be used for real-time tracking of heavy equipment (vehicles, machines, and other outdoor facilities), or can be used to monitor heavy equipment based on its movement status.

Scenario 2: Container Tracking

The LW001-BG PRO can be used to track the location of containers in real time by fixing it on the container, which is suitable for container tracking and management in terminal and port scenarios.

Scenario 3: Livestock Tracking

The LW001-BG supports strap mounting, which allows the LW001-BG PRO to be mounted on the neck of livestock via a strap. By acquiring the livestock location information, it enables intelligent grazing management.
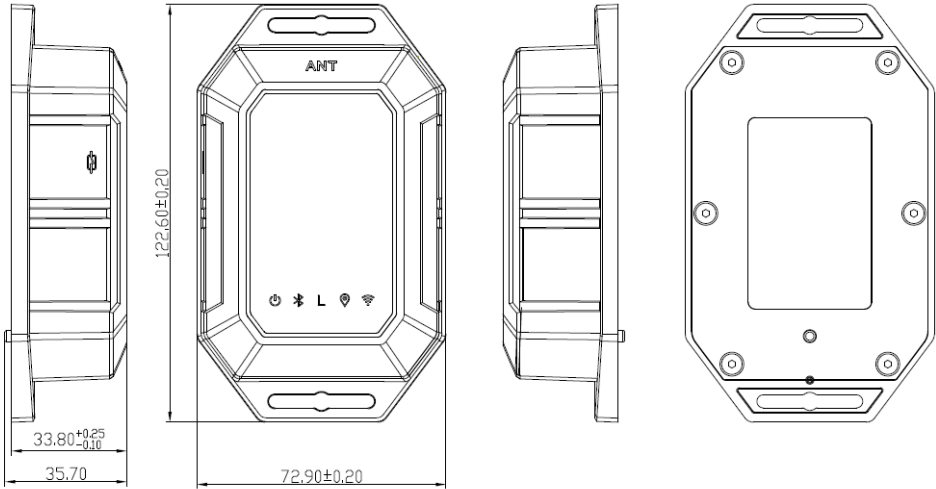
Scenario 4: Industrial Asset Tracking

The LW001-BG PRO is ideal for tracking, monitoring and anti-theft protection of critical industrial assets due to its motion-triggered location and anti-tamper alarm features.。

3 Product Specifications

3.1 Appearance and Mechanical Size

3.2 LED Indicators

Indicators	Items	Indicator	Operation
Power Indicators	Turn ON	Solid Green and keep 3S	Default operation: Approach and quickly move away from the Hall sensor area with a magnet 3 times (Each approach needs to be held for about 0.5s at least)
	Turn OFF	Green LED blink 3S	Default operation: Approach and quickly move away from the Hall sensor area with a magnet 3 times (Each approach needs to be held for about 0.5s at least)
	Low battery	Green LED blink once every 10s	The device is in Low battery.
LoRa Indicators	Join LoRa Network	Solid white and keep 3S	If the device had never Joined any network, after turning on, the device will automatically send join request
Bluetooth Indicators	Bluetooth connection established successfully	Solid Blue	Connect to the device via APP successfully
	In Bluetooth positioning	Blue LED slow blink	The device is in Bluetooth fix
	Bluetooth positioning successfully	Solid blue and keep 2S	
	Bluetooth positioning failure	Blue LED blink 2S	
	Firmware Upgrade	Blue LED slow blink during the upgrade/Solid Blue and keep 2S after upgrade successfully / Blue LED blink 2S after upgrade failed	Firmware upgrade via OTA in DFU mode
GPS Indicators	In GPS positioning	Blue LED slow blink	
	GPS positioning successfully	Solid blue and keep 2S	
	GPS positioning failure	Blue LED blink 2S	
WIFI Indicators	In WIFI positioning	Blue LED slow blink	
	WIFI positioning successfully	Solid blue and keep 2S	

	WIFI positioning failure	Blue LED blink 2S	
All Indicators	Tamper alarm indication	All LED slow blink	Tamper alarm is triggered
All Indicators	Self-test failure	All indicator lights remain on	Self-test failure after the device is powered on

3.3 General Specifications

Categories	Parameter	Value
LoRa Wireless Specification	LoRa Protocol	LoRaWAN V1.0.3
	Lora Frequency	EU868/AU915/US915/AS923/IN865/KR920/EU433/CN470/CN779/RU864
	Tx Power	Max 20dBm
	Sensitivity	-137dBm@SF12 300bps
	LoRa Communication Distance	Up to 7 km (in urban open space)
BLE Wireless Specification	Bluetooth® (BLE)	5.0
	TX Power	Max 8 dBm
	BLE Communication Distance	Up to 50m in free space
Physical Parameter	Dimension	122mm×72mm×33mm (±2mm)
	Shell Material	ASA+PC
Power Consumption	Power Supply	Around 10000mAH available (12000mAH no-chargeable battery)
	Operating Current	< 180mA
	Sleep Current	< 15uA
Application Parameter	Operating Temperature	-20 ~ + 60℃
	Operating Humidity	5%-95%（No condensation）
	IP Rating	IP67
	Certification	CE/UKCA/FCC approved

4 User Guidance

4.1 How to install

Multiple installation options of LW001-BG PRO like hanging with screws, double-sided sticker, tape or DIN rail can be selected by user. After deployment, LW001-BG PRO can be easily powered on by a magnet via integrated omni polar Hall-effect sensor and it can avoid

7

accidental control by an external button.

3M Sticker
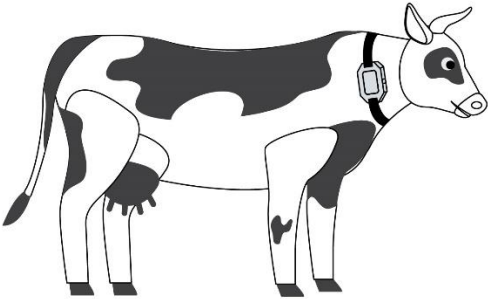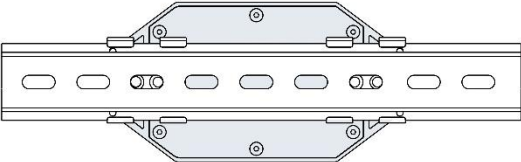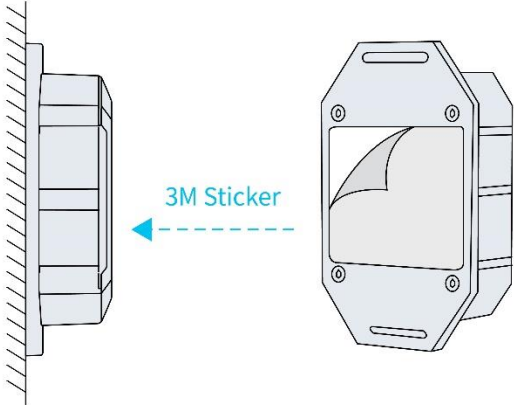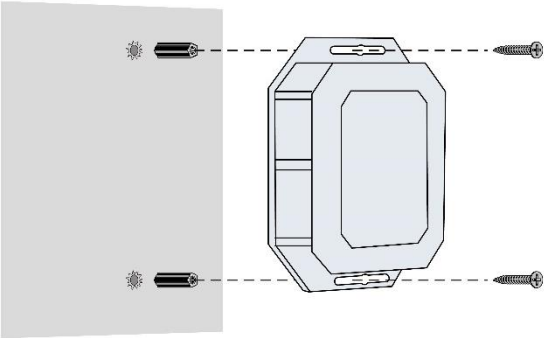
4.2 How to disassemble LW001-BG PRO

Disassemble flow:
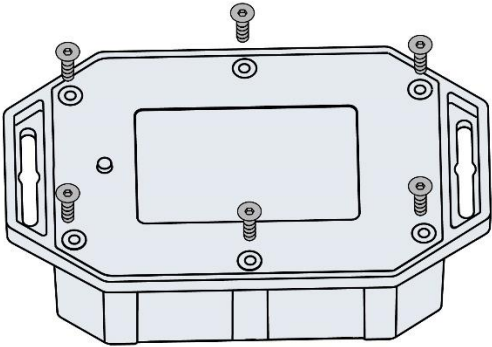
Step1：Remove the screws on the bottom of the device

Step2：Remove the back cover
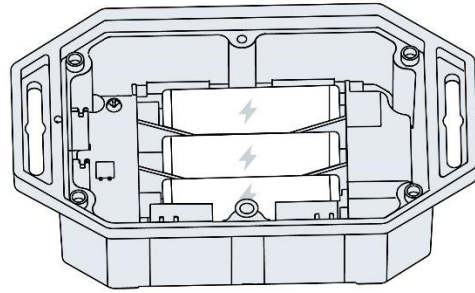
4.3 How to power on/off LW001-BG PRO

There is one way to power on LW001-BG PRO.

Magnetic switch: User can choose one of the following two methods as the magnetic induction switching action, the default is the first one.

Approach and quickly move away from the Hall sensor area with a magnet 3 times (Each approach needs to be held for about 0.5s at least)

Or
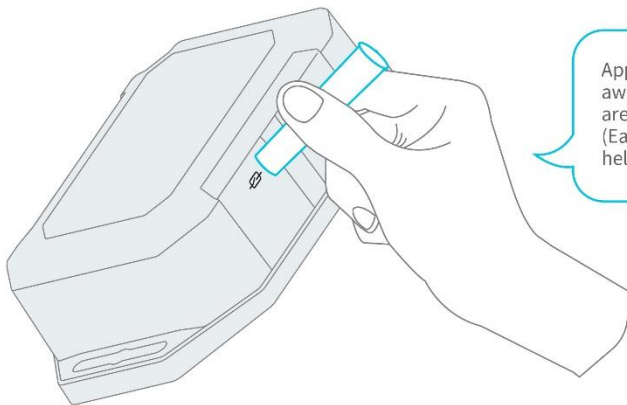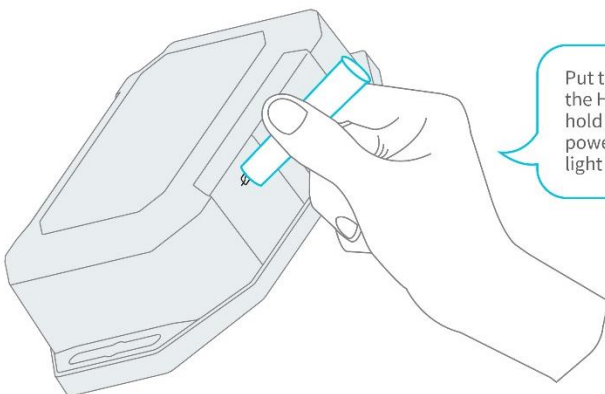
Put the magnet against to the Hall sensor area and hold for 3s at least, until the power indicator starts to light up.

There are three ways to power off LW001-BG PRO

1. Magnetic switch: User can choose one of the following two methods as the magnetic induction switching action, the default is the first one.

Approach and quickly move away from the Hall sensor area with a magnet 3 times (Each approach needs to be held for about 0.5s at least)

Or
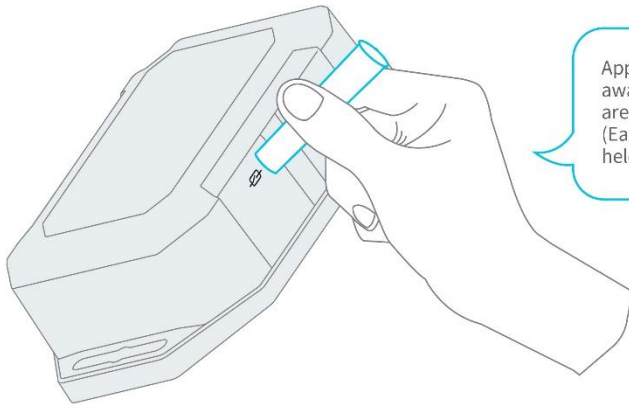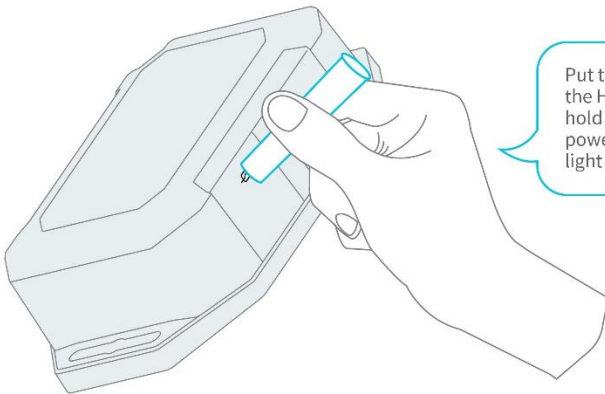
Put the magnet against to the Hall sensor area and hold for 3s at least, until the power indicator starts to light up.

2. Turn off the device via MKLoRa APP

3. Turn off the device via LoRa Downlink Command

4.4 How to make device working quickly

Step1: Check the device information
User can get device information according to the label on the boxes, as following picture:

Model:LW001-BG PRO
Region:US915
MAC:E5BE1DED20E5
DEVEUI:E5BE1DFFFFED20E5

Step2: Confirm the LoRaWAN network (Such as TTN, Senet, LoRIOT, Chirpstack) server to be used.

Step3: Register LoRaWAN gateway on LoRaWAN network server. If the gateway model is MKGW2-LW which is from moko, pls refer to *MOKO LoRaWAN Gateway MKGW2-LW Configuration Guide*.

Step4: Register the device on LoRaWAN network server (OTAA mode).

The region/subject and DEVEUI can be get on Step1.

The default AppEUI is 70 B3 D5 3A F0 20 08 09, the default AppKey is 2B 7E 15 16 28 AE D2 A6 AB F7 15 88 09 CF 4F 3C.

Note: When you use the US915 or AU915 band, the default FSB of the device is FSB2 (CH:8~15).

Step5: Join in LoRaWAN network server.

Please reboot the device, then device will send join request to LoRaWAN server automatically, then you can check the uplink payload on LoRaWAN server.

Step6: Uplink payload parse.

Option 1: You can refer to *chapter 6 Uplink Payload*, here is the description of the payload parsing rules and samples parsing.

Option 2: MOKOSMART can provide payload decoder code based on some common LoRaWAN network servers.

4.5 How to connect to APP and configure parameters

Please download "MKLoRa" APP from app store directly. For more configuration details, please refer to *LW001-BG PRO APP Guide*.

5 General Function

5.1 Multiple Working Mode

5.1.1 Overview

LW001-BG PRO supports four different working modes: *Standby Mode*, *Timing Mode*, *Periodic Mode* and *Motion Mode*. The device will be in *Periodic Mode* by default when it is first switched on.

LW001-BG PRO can only be in one mode at the same time, and the user can use the mobile app or LoRa downlink command to switch the working mode.

No matter what mode the device is, *Heartbeat Payload* will be sent according to *Heartbeat Interval* (The *Heartbeat interval* can be set by user). If other uplink payload is sent during the

11

Heartbeat Interval, the *Heartbeat Interval* will be recalculated with the uplink time point of that payload.

Along to the main working mode, LW001-BG PRO can perform extra operations known as *Auxiliary Operations*.

5.1.2 Standby Mode

In *Standby Mode*, the device will only report *Heartbeat Payload* according to *Heartbeat Interval* and will not send the *Location Payload* which includes LW001-BG PRO's positions.

If location information is needed in *Standby Mode*, user can use *Downlink for Position* (one of *Auxiliary Operations*) to get the *location payload*.

In additional, the user can also enable other auxiliary operations to achieve the corresponding functions. (*Refer to 5.2 Auxiliary Operations*)

5.1.3 Timing Mode

In *Timing Mode*, LW001-BG PRO will report *Location Payload* at the time point configured in advance. Each LW001-BG PRO can set up to 10 reporting time points.

We divided the day into 96 time points, each 15 minutes apart, with the first time point being 00:00. Each LW001-BG PRO can set up to 10 reporting time points.

User can select different *Positioning Strategies* for *Timing Mode* to obtain location information according to different application scenarios.

User also can use *Downlink for Position* (one of *Auxiliary Operations*) to get the extra *location payload*.

In additional, the user can also enable other auxiliary operations to achieve the corresponding functions. (*Refer to 5.2 Auxiliary Operations*)

5.1.4 Periodic Mode

In *Periodic Mode*, LW001-BG PRO will report its positions periodically. The report interval can be set by user.

User can select different *Positioning Strategies* for *Periodic Mode* to obtain location information according to different application scenarios.

User also can use *Downlink for Position* (one of *Auxiliary Operations*) to get the extra *location payload*.

In additional, the user can also enable other auxiliary operations to achieve the corresponding functions. (*Refer to 5.2 Auxiliary Operations*)

5.1.5 Motion Mode

When the LW001-BG PRO is in motion mode, it can monitor the whole process of the LW001-BG PRO from stationary to motion and from motion to stationary through the built-in 3-axis accelerometer sensor.

The whole motion process can be divided into four parts: *Start of movement*, *In movement*, *End of movement*, *Stationary*.

5.1.5.1 Start of movement

LW001-BG detects whether the device is moving by 3-axis accelerometer sensor, and if the preset moving judgment condition (*Motion Threshold* & *Motion Duration*) is reached, the device is considered to start moving and start positioning.

When the positioning process is finished, LW001-BG PRO will send *Location Payload*. User can choose to send this payload repeatedly. The number of repetitions can be set by user.

User can select different *Positioning Strategies* for *start of movement* to obtain location information according to different application scenarios.

Note: User can choose whether to report Location Payload or not at start of movement.

5.1.5.2 In movement

After *start of movement*, LW001-BG PRO will be *in movement* state.

LW001-BG PRO will send *Location Payload* periodically during the movement.

User can select different *Positioning Strategies* for *in movement* to obtain location information according to different application scenarios.

Note: User can choose whether to report Location Payload or not in movement.

5.1.5.3 End of movement

The LW001-BG detects whether the device is still moving by 3-axis accelerometer sensor. If the device never reaches the movement trigger condition within N seconds, the device is considered to have stopped moving and started positioning immediately. When the positioning process is finished, LW001-BG PRO will send 1st *Location Payload*.

LW001-BG PRO can report multiple different *Location Payloads*, the number of *Location Payloads* and the interval between *Location Payloads* can be set by user.

User can select different *Positioning Strategies* for *End of movement* to obtain location information according to different application scenarios.

Note: User can choose whether to report Location Payload or not at End of movement.

5.1.5.4 Stationary

After the last *Location Payload* of *End of movement* was sent, the device will come into *Stationary* state.

When the device is in *Stationary state*. The device will only report *Heartbeat Payload* according to *Heartbeat Interval* and will not send the *Location Payload.*

5.1.5.5 Event Message

Event messages are notifications sent by LW001-BG PRO to inform the server about a specific event when the device is in *Motion Mode*.

There are three types of event message notifications that can be activated:

Event message at *start of movement*: Event message will be sent when the preset moving trigger condition (*Motion Threshold* & *Motion Duration*) is reached.

Event message *During the movement*: When the device is *in movement*, Event messages will be sent whenever the device starts positioning.

Event message at *End of movement*: Event message will be sent when the device come into *End of movement* state.

Note: *All the above three events can be set individually to send or not to send event messages.*

5.2 Auxiliary Operations

5.2.1 Overview

Whatever the working mode, the LW001-BG PRO supports *Auxiliary Operations*, which can be:
➢ Downlink for Position
➢ Shock Detection
➢ ManDown Detection
➢ Active State Count
➢ Tamper Alarm

Notes: All Auxiliary Operations can be accrued.

5.2.2 Downlink for Position

When the *Downlink for Position* is used, LW001-BG PRO's position can be requested via LoRa downlink command. (*Refer to Document "LW001-BG PRO Downlink Command Document"*)

User can select different *Positioning Strategies* for *Downlink for Position* to obtain location information according to different application scenarios.

5.2.3 Shock Detection

When the LW001-BG PRO is used for asset tracking, the built-in three-axis sensor detects whether the asset has been hit or treated violently. If the set shock judgment condition (*Shock Threshold*) was met, *Shock Detection Payload* will be reported to the server and inform the user.

5.2.4 ManDown Detection

When the LW001-BG PRO is used to track large machinery and equipment or livestock, the LW001-BG PRO's built-in three-axis sensor can detect whether the equipment or livestock being tracked is stationary for a long time.

If the preset ManDown detection condition is reached, LW001-BG PRO will report the *ManDown Detection Payload* to remind the user to arrange the equipment usage or check the grazing status of the livestock in time.

5.2.5 Active State Count

The product's activity can be detected by the product's built-in three-axis sensor.

Whenever the state of the LW001-BG PRO changes stationary to motion, the activity count will be increased by one. One or more moves within *Activity State Timeout* will be judged as one activity, and *Activity State Timeout* can be set according to different application scenarios.

Each *Heartbeat Payload* will contain the number of activities since the last *Heartbeat Payload* was reported and the time the current heartbeat packet was sent.

5.2.6 Tamper Alarm

The LW001-BG PRO has tamper alarm function.

When LW001-BG PRO is abnormally removed from the installation location, the tamper button will pop up, LW001-BG PRO will flash the alarm alert and send the *Tamper Alarm Payload* to the

server to remind the user. Users can use *Downlink for Position* function to request for location information to secure the tracked assets.

Tamper Switch
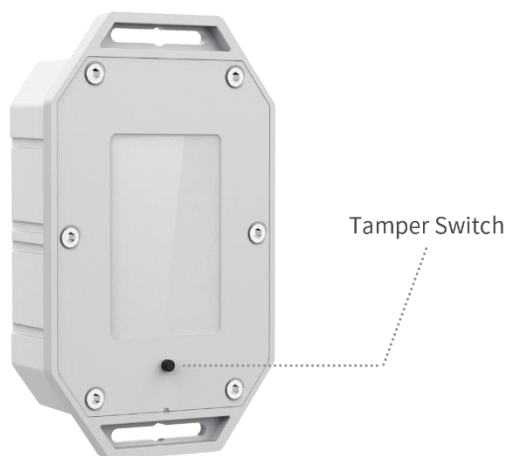
5.3 Positioning Strategies

The device can set the corresponding positioning strategy in periodic mode, timing mode, and motion mode.
In addition, *Downlink for Position* can also set a separate positioning strategy, which can be different from the positioning strategy in the working mode.

LW001-BG PRO has the following main positioning strategies:

➢ Only WIFI: Only WIFI scans are used for position determination.

➢ Only Bluetooth: Only Bluetooth scans are used for position determination.

➢ Only GPS: Only GPS is used for position determination.

➢ WIFI+GPS: WIFI then GPS if WIFI fails in one geolocation cycle.

➢ Bluetooth+GPS: Bluetooth then GPS if Bluetooth fails in one geolocation cycle.

➢ WIFI+Bluetooth: WIFI then Bluetooth if WIFI fails in one geolocation cycle.

➢ WIFI+Bluetooth +GPS: Use WIFI, Bluetooth, GPS for positioning in turn (switch to the next type of positioning after one type of positioning fails).

5.3.1 WIFI Fix

LW001-BG PRO obtains the surrounding hotspot information through WIFI scanning function and reports the MAC address of device and the corresponding RSSI to the server through LoRa, and the application server goes to calculate the location, the accuracy of positioning depends on the actual deployment of the customer and the calculation of the location algorithm.

The success of WIFI positioning depends on the WIFI location scan time and the number of BSSIDs. the time of WIFI scan and the number of BSSIDs thresholds can be set by the user.
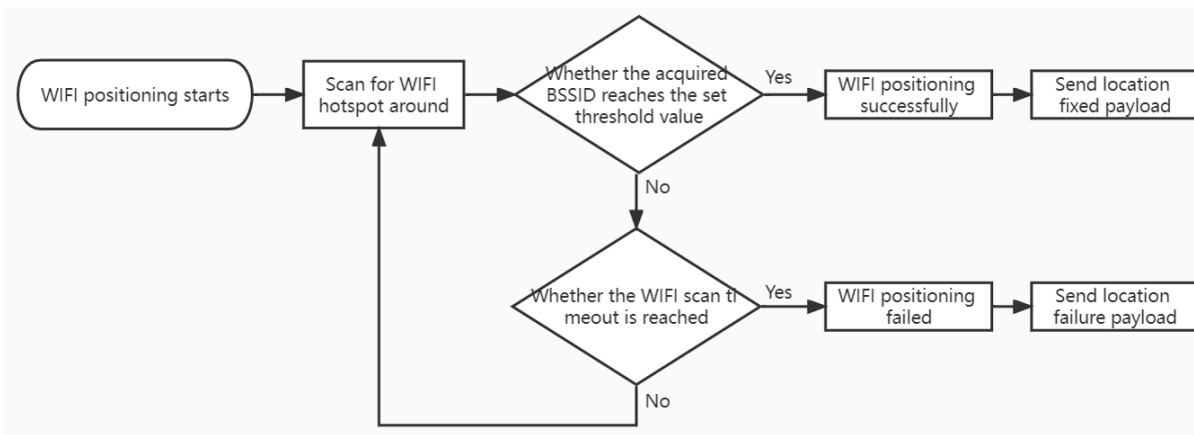
5.3.2 Bluetooth Fix

LW001-BG PRO obtains the broadcast information of surrounding Bluetooth devices through Bluetooth scanning function, and reports the information (MAC address and RSSI) of Bluetooth devices that meet the conditions of Bluetooth filtering to the server through LoRa, and the application server goes to calculate the location, the accuracy of positioning depends on the actual deployment of the customer and the calculation of the location algorithm.

The following BLE Beacon types are supported for scanning：

➢ iBeacon (Apple)

➢ Eddystone (Google)

➢ Unknown (For example, a manufacturer-defined format)

The success of Bluetooth positioning depends on the Bluetooth location scan time and Bluetooth device count threshold. The Bluetooth scan time and Bluetooth device count thresholds can be set by the user.
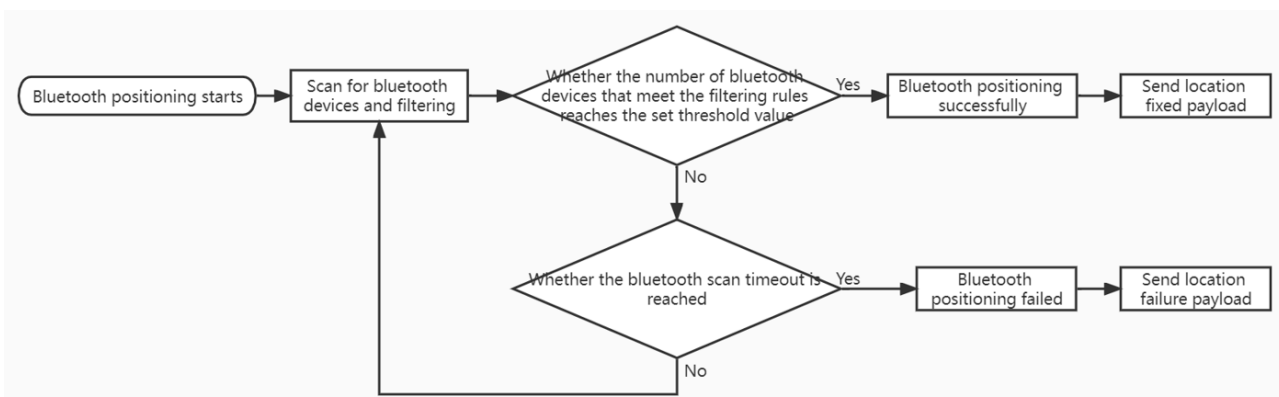
5.3.2.1 Filtering Rules

Because there are many Bluetooth devices in our lives, setting reasonable filtering rules can help remove interference from other Bluetooth devices to the Bluetooth positioning system.

The following is the specific description of Filtering Rules:

①There are two sets of filter conditions, one is Filter Condition A, and another is Filter Condition B. Each filter condition has a separate switch setting, which can be arbitrarily switched on or off.

② When both of Filter Condition A and Filter Condition B are switched on, the relationship between two sets of filter conditions can be set as AND or OR.

AND: Beacon information is stored and reported only when the data meets both Filter Condition A and Filter Condition B.

OR: Beacon information is stored and reported when the beacon data meets either filter condition A or filter condition B.

If only one condition is opening, the data that meets this filter condition will be saved and uploaded.

③ There are seven filter items in each filter conditions, which are RSSI Filter, MAC Address Filter, UUID Filter, ADV Name Filter, Major Filter, Minor Filter and Raw Data Filter. Only if these seven filter items are met at the same time, this filter condition can be considered to be met.

Each filter item can be set to **OFF**, **Positive filter** and **Reverse filter**.

   OFF: Regardless of this filter item.

   Positive filter: If the device being scanned matches the content of this filter item, it is considered to meet the filter item.

   Reverse filter: If the device being scanned does not match the contents of this filter item, it is considered to meet the filter item.

5.3.3 GPS Fix

LW001-BG PRO can obtain the corresponding positioning satellite information to Calculate the location of the product.

The product adopts high precision GPS positioning module and supports cold start, warm start and hot start mechanism.

When the device successfully obtains the location information, it will enter the sleep mode, and the location information will be reported at the reporting time point, and the reporting content will include the successful positioning time point, so that the location trajectory analysis can be performed.

Note: There are many advanced gps fix parameters can be set, which can be viewed in the LW001-BG PRO APP guide. If you are not familiar with these parameters, it is recommended to just use the default values.

5.3.4 Offline Fix

The user can choose to still locate the device even if it is not successfully connected to the LoRaWAN network, and save the location information in the device. Customer can later read the local data via Bluetooth or LoRa downlink to restore the historical location information of that time period.

Offline fix function can be switched on/off by MKLoRa app or LoRaWAN downlink command.

5.4 Bluetooth Broadcast Capabilities

LW001-BG PRO has two Bluetooth broadcast modes: Beacon mode and Configuration mode，which can be switched by users via MKLoRa app or LoRaWAN downlink command.

5.4.1 Beacon Mode

The LW001-BG PRO will keep broadcasting Bluetooth information in Beacon mode, and users can use the LW001-BG PRO as a beacon device to achieve Bluetooth positioning and other application development.

When the device is in Beacon mode, the user can choose to let the device in connectable state or non-connectable state, considering that it prevents strangers from being able to establish a Bluetooth connection with the LW001-BG PRO at will.

Connectable state: The device is always available to be connected by the hostb via bluetooth.

Non-connectable state: Bluetooth broadcasting will always be going on, but only within 3 minutes after the product is turned on, the user can use the host device to establish a Bluetooth connection with the LW001-BG PRO.

Note: When the device is in beacon mode, considering the performance of both broadcasting and scanning can't be taken into account, the Bluetooth positioning function will not work properly, and if Bluetooth positioning is performed at this time, it will be directly judged as failure.

5.4.2 Configuration Mode

If Bluetooth broadcast is in configuration mode, the device will broadcast Bluetooth information and can be connected in the following two cases.

1. Within the first N minutes after the device is turned on.

2. LoRaWAN server sends LoRa command to turn on Bluetooth broadcast for N minutes.

Note: N is the configuration mode broadcast timeout time, can be configured by the user. If the device is successfully connected and then disconnected, the broadcast timeout will be refreshed, and the user can choose to establish Bluetooth connection with the device again within this time.

5.4.3 Bluetooth Broadcast Contents

The broadcast contents of LW001-BG PRO are divided into advertise packet and response packet. The following is an example of the broadcast content:

5.4.3.1 Advertise Packet

Advertise packet is in standard iBeacon frame format.

LEN	TYPE	VALUE
2	0x01	0x06
26	0xFF	0x4C 00 02 15 E2 C5 6D B5 DF FB 48 D2 B0 60 D0 F5 A7 10 96 E0 00 00 00 00 BF

- UUID: E2C56DB5-DFFB-48D2-B060-D0F5A71096E0
- Major:0 (0x00 00)
- Minor:0 (0x00 00)
- RSSI@1m: -65dBm (0xBF)

5.4.3.2 Response Packet

LEN	TYPE	VALUE
14	0x16	0x02 AA 00 00 20 0E 46 F4 40 78 13 FA 22
14	0x09	0x4C 57 30 30 31 2D 42 47 2D 46 41 32 32

- Service: LW001-BG (0x AA 02)
- Bluetooth TX Power: 0 dBm (0x00)
- Device Status: 0x20 (0x20 = 0010 0000)
    - Bit5(1 means that the device moved since the last payload; 0 means that the device didn't move since the last payload)

- ➢ Bit4(1 means that the device is in idle status; 0 means that the device isn't in idle status)
- ➢ Bit3(1 means that the device was abnormally disassembled; 0 means that the device wasn't abnormally disassembled)
- ➢ Bit2(1 means low power; 0 means normal)
- ➢ Bit1(1 means that the device is in motion mode;0 means that the device is in timing mode)
- ➢ Bit0(1 means that the device is in periodic mode;0 means that the device is in standby mode)
- Battery Voltage: 3.654V (0x0E 46)
- Device ADV Name：LW001-BG-FA22 (0x4C 57 30 30 34 2D 43 54)

5.5 LoRaWAN Capabilities

The data of LW001-BG PRO will be transmitted via LoRa and LW001-BG PRO is based on the standard LoRaWAN protocol V1.0.3.

LW001-BG PRO is compatible with mainstream gateways and mainstream servers (TTN, SENET, LORA IOT, etc.) in the market.

5.5.1 Timed Reconnect

To ensure a smooth network after a long time, users can set up periodic reconnection to the LoRaWAN network. When the reconnect time point is reached, the device will send join-request.

If you mind that the device will rejoin the network regularly, you can set *Reconnect Interval* to 0 via the MKLoRa app. (Please refer to *LW001-BG PRO APP Guide*)

5.5.2 LoRa Uplink Transmission Strategy

Considering the load balance of the gateway, the battery power consumption and the reliability of the messages, the LW001-BG PRO is equipped with a LoRa uplink mechanism for users to choose, so that users can select a suitable sending strategy according to different application scenarios.

User can set different uplink strategy via MKLoRa.

5.5.3 DeviceTime MAC Command

LW001-BG PRO supports the DeviceTime feature, which enables users to periodically time their devices to avoid time offset.

The *Time Sync Interval* of the MKLoRa APP is the Device Time MAC Command interval. If you are concerned that this feature may overburden the downlink function, you can set *Time Sync Interval* to 0 for disable DeviceTime function. (Please refer to *LW001-BG PRO APP Guide*)

5.6 3-Axis Accelerometer Capabilities

With the built-in three-axis sensor, the device can achieve *ManDown Detection*, *Shock Detection*, *Active State Count* and motion detection in *Motion Mode*.

LW001-BG PRO has two different trigger conditions that apply to different functions:

Moving judgment condition (*Motion Threshold* & *Motion Duration*): If LW001-BG PRO exceeds the *Motion Threshold* and continues for a period of time (*Motion Duration)*, LW001-BG PRO will be considered to have reached the moving judgment condition.
Moving judgment condition is suitable for *ManDown Detection*, *Active State Count* and motion detection in *Motion Mode*.

Vibration judgment condition (*Vibration Threshold*): If LW001-BG PRO exceeds the *Vibration Threshold*, LW001-BG PRO will be considered to have reached the vibration judgment condition. Vibration judgment condition is suitable for *Shock Detection*.

5.7 Local Data Sync

LW001-BG PRO Built-in 4M FLASH memory chip, can support 20,000 pieces of data local storage at most. All data uploaded by the device is stored in the device.

Users can read data of the past 1 day, 7 days, 1 month, 3 months, 6 months, 1 year or custom days via Bluetooth or downlink command.

When the LoRaWAN network has problems or data loss is severe, users can quickly get the historical reporting data from the device.

5.8 Battery Performance

The LW001-BG PRO is equipped with non-rechargeable battery.

According to the operating voltage requirement of each component, the total actual available capacity of battery is about 10000mAH. Based on this, the endurance of the device is about 4.5 years under typical scenarios (WIFI scan for 5 seconds, Bluetooth scan for 5 seconds and GPS positioning for 3 minutes every day).

Users can ask the device send *Battery Consumption Payload* via LoRaWAN downlink command and calculate the approximate power consumption.

5.8.1 Low battery Alert

When LW001-BG PRO's battery level is low, its power indicator will flash every 10s and it will report *Low Power Payload* to the server as a prompt.

Note: Low battery threshold can be set to 5% and 10%. User can also choose not to blink the LEDs and not to report the shutdown payload when battery is low.

22

5.8.2 Shutdown message reminder

LW001-BG PRO supports sending the *shutdown payload* as a notification when the device is turned off. Users can also choose to turn off this feature.

Note: If the battery is suddenly disconnected or pulled out, the device cannot send the shutdown payload.

5.9 Time Synchronization

There are four methods to sync time of LW001-BG PRO.

1. LW001-BG PRO supports the DeviceTimeReq MAC Command, which enables users to periodically time their devices to avoid time offset.

2.When the APP connect with the device success the phone system time will be sync to the device via Bluetooth.

3. Time synchronization via GPS satellite

4. RTC: LW001-BG PRO has a built-in RTC circuit. When LW001-BG PRO is completely shut down, the RTC will continue to keep the time updated in ten days, then if the device is powered on in these ten days, the RTC will immediately synchronize the time to LW001-BG PRO.

5.10 Default Power Status

When the battery of LW001-BG PRO runs out, user needs to replace the battery in order to keep using the devcie. Based on this, the user can choose whether to automatically turn on the power after replacing the battery and keep the previous working mode.

There are two options: "OFF" and "Revert to last mode".
➢ OFF: Configure LW001-BG PRO to turn off, after the battery is replaced.
➢ Revert to last mode: Configure LW001-BG PRO to return to last working mode it was in, after the battery is replaced.

5.11 Bluetooth Configuration Tool

The device can use MKLoRa app developed by Moko for quick OTA upgrades and parameter configuration.

About the detail of MKLoRa, pls refer to *LW001-BG PRO APP Guide*.

6 Uplink Payload

Each payload is composed by:
➢ A common header (Except GPS Limit Payload)
➢ The specific data parts

	Common header			Data
Byte Index	Byte 0	Byte 1	Byte 2	Variable
Content	Device Status	Temperature	ACK & Battery voltage	Information

6.1 Common payload header

	Common header		
Byte Index	Byte 0	Byte 1	Byte 2
Content	Device Status	Temperature	ACK & Battery voltage

Device Status:

Device Status	
Bit Index	Content
Bit 0~1	Operation mode: 00 -- Standby mode 01 -- Periodic mode 10 -- Timing mode 11 -- Motion mode
Bit 2	Battery level: 0 -- Normal; 1 -- Low battery
Bit 3	Tamper alarm: 0 -- Not triggered; 1 -- Triggered
Bit 4	Man-Down status: 0 -- Not in idle; 1 -- In idle
Bit 5	Whether the tracker is in motion state since the last payload is sent
Bit 6	Positioning Type: (Only available for *Location Payload*) 0 -- Normal; 1 -- Downlink for position

Temperature: Temperature measured in the device, it is the temperature of MCU, expressed in degree Celsius.

Encoder rule: If the value > 128, convert to decimal and then minus 256, the unit is ℃;
If the value <=128, just convert to decimal, the unit is ℃.

Example 1: The original data of payload is 1C, the temperature is 28℃.
Example 2: The original data of payload is E6, the temperature is -26℃.

ACK& Battery voltage:

ACK& Battery voltage	
Bit Index	Content
Bit 0~3	ACK: Downlink frame count, Counting will start again from 0 when it exceeds 15.
Bit 4~7	Battery voltage:

	Encoder rule: 2.2V + 100mV*value; if the value is 1000(In binary), the voltage is 3.0V(2.2V+100mV*8); If the value is 1010(In binary), the voltage is 3.2V(2.2V+100mV*10)

6.2 Heartbeat Payload

Heartbeat Payload will be sent in Port 1.

	Common header	Heartbeat Payload Data		
Byte Index	Byte 0~2	Byte 3	Byte 4	Byte 5~8
Content	Common payload header	Reason for last device reboot	FW version	Number of Active State Counts since the last heartbeat payload.

Reason for last device reboot:

00 -- Restart after power failure

01 -- Bluetooth command request

02 -- LoRaWAN command request

03 -- Power on after normal power off

FW version: Firmware version of the device.

FW version	
Bit Index	Content
Bit 6~7	Major version number: 01 means V 1.X.X
Bit 4~5	Sub-version number: 02 means V X.2.X
Bit 0~3	Patch:0101 means V X.X.5

Example 1: If the data of FW version is 0x43, it means that the FW version is V1.0.3

Number of Active State Counts since the last heartbeat payload: Big-Endian format. Convert to decimal directly.

6.3 Location Payload

Depending on whether the positioning process is successful or not, there are two types location payloads: Location Fixed Payload and Location Failure Payload.

6.3.1 Location Fixed Payload

Location Fixed Payload will be sent in Port 2.

	Common header	Location Fixed Payload Data				
Byte Index	Byte 0~2	Byte 3	Byte 4~10	Byte 11	Byte 12	Byte 13~XX
Content	Common payload header	Positioning success	Timestamp	Time zone	The length of	Location fixed data

		type			location fixed data	

Positioning success type:

00 -- WIFI positioning success

01 -- Bluetooth positioning success

02 -- GPS positioning success

Timestamp: This is the time when the positioning process succeeded, and it is possible that the location was successfully located before the reported point in time.

Encoder rule: Big-Endian format. Convert to decimal. Byte 4~5 represents the year; Byte 6 represents the month; Byte 7 represents the date; Byte 8 represents the hour; Byte 9 represents minute; Byte 10 represents second;

Time zone: The currently set UTC time zone.

Encoder rule: It is a singed number, convert to decimal, if the value > 128, then minus 256.

Example 1: The original data of payload is 0C, the time zone is UTC+12.

Example 2: The original data of payload is F6, the time zone is UTC-10.

The length of location fixed data: Convert to decimal.

Location fixed data:

If positioning success type is 00(WIFI positioning success), the location data is as below:

WIFI Location Fixed Data					
Byte 0~5	Byte 6	Byte 7~12	Byte 13	…………….	…………….
MAC address of WIFI device 1	RSSI of WIFI device 1	MAC address of WIFI device 2	RSSI of WIFI device2	…………….	…………….

The number of reported WIFI devices can be set by the customer.

RSSI encoded rule: Convert to decimal and then minus 256, the unit is dBm.

If positioning success type is 01(Bluetooth positioning success), the location data is as below:

Bluetooth Location Fixed Data					
Byte 0~5	Byte 6	Byte 7~12	Byte 13	……..	……..
MAC address of Bluetooth device 1	RSSI of Bluetooth device 1	MAC address of Bluetooth device 2	RSSI of Bluetooth device 2	……..	……..

The number of reported Bluetooth devices can be set by the customer.

RSSI encoded rule: Convert to decimal and then minus 256, the unit is dBm.

If positioning success type is 02(GPS positioning success), the location data is as below:

GPS Location Fixed Data		
Byte 0~3	Byte 4~7	Byte 8
Latitude	Longitude	PDOP

Latitude and Longitude encoder rule: Big-Endian format. It is a singed number.

If the value > 0x80 00 00 00, minus 0x01 00 00 00 00 and convert to decimal, then divide by 10 00 00 00, the unit is degree (°);

If the value<=0x80 00 00 00, convert to decimal and then divide by 10 00 00 00, the unit is degree (°);

PDOP encoder rule: Convert to decimal and divide by 10.

6.3.2 Location Failure Payload

Location Failure Payload will be sent in Port 3.

	Common header	Location Failure Payload Data		
Byte Index	Byte 0~2	Byte 3	Byte 4	Byte 5~XX
Content	Common payload header	Reasons for positioning failure	The length of location failure data	Location failure data

Reasons for positioning failure:

00 -- WIFI positioning time is not enough (The location payload reporting interval is set too short, **please** increase the report interval of the current working mode via MKLoRa app)

01 -- WIFI positioning strategies timeout (**Please** increase the WIFI positioning timeout via MKLoRa app)

02 -- WIFI module is not detected, the WIFI module itself works abnormally

03 -- Bluetooth positioning time is not enough (The location payload reporting interval is set too short, **please** increase the report interval of the current working mode via MKLoRa app)

04 -- Bluetooth positioning strategies timeout (**Please** increase the Bluetooth positioning timeout via MKLoRa app)

05 -- Bluetooth broadcasting in progress (If the device is in beacon mode, please disable beacon mode via MKLoRa app; If the device is in configuration mode, please reduce the Bluetooth broadcast timeout or avoid Bluetooth positioning when Bluetooth broadcasting in process via MKLoRa app)

06 -- GPS position time budget over (Pls increase the GPS budget via MKLoRa app)

07 -- GPS coarse positioning timeout (Pls increase coarse positioning timeout or increase coarse accuracy target via MKLoRa app)

08 -- GPS fine positioning timeout (Pls increase fine positioning timeout or increase fine accuracy target via MKLoRa app)

09 -- GPS positioning time is not enough (The location payload reporting interval is set too short, **please** increase the report interval of the current working mode via MKLoRa app)

0A -- GPS aiding positioning timeout (Please increase gps aiding positioning timeout or disable gps aiding function)

0B -- GPS cold start positioning timeout (The gps signal current environment isn't very good, please leave the device in a more open area)

0C -- Interrupted by *Downlink for Position*

0D -- Interrupted positioning at *start of movement* (the movement ends too quickly, resulting in not enough time to complete the positioning)

0E -- Interrupted positioning at *end of movement* (the movement restarted too quickly, resulting in not enough time to complete the positioning)

The length of location failure data: Convert to decimal.

Location failure data:

If it is WIFI positioning failure, the location data is as below:

WIFI Location Failure Data					
Byte 0~5	Byte 6	Byte 7~12	Byte 13	....	..............…
MAC address of WIFI device 1	RSSI of WIFI device 1	MAC address of WIFI device 2	RSSI of WIFI device2	....	....

The information of the scanned WIFI devices will be reported.

RSSI encoded rule: Convert to decimal and then minus 256, the unit is dBm.

If it is Bluetooth positioning failure, the location data is as below:

Bluetooth Location Failure Data					
Byte 0~5	Byte 6	Byte 7~12	Byte 13	....	......
MAC address of Bluetooth device 1	RSSI of Bluetooth device 1	MAC address of Bluetooth device 2	RSSI of Bluetooth device 2	....	......

The information of the scanned Bluetooth devices which meet filter conditions will be reported.

RSSI encoded rule: Convert to decimal and then minus 256, the unit is dBm.

If it is GPS positioning failure, the location data is as below:

GPS Location Failure Data				
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4
PDOP of GPS positioning failure	C/N 0	C/N 1	C/N 2	C/N 3

PDOP of GPS positioning failure encoder rule: Convert to decimal and divide by 10. 0xFF means that the PDOP is unknown.

C/N 0: Carrier over noise (dBm) for the strongest signal satellite seen.
C/N 1: Carrier over noise (dBm) for the 2nd strongest signal satellite seen.
C/N 2: Carrier over noise (dBm) for the 3rd strongest signal satellite seen.
C/N 3: Carrier over noise (dBm) for the 4th strongest signal satellite seen.
C/N encoder: Convert to decimal, the unit is dBm.

6.4 Shutdown Payload

Shutdown Payload will be sent in Port 4.

	Common header	Shutdown Payload Data
Byte Index	Byte 0~2	Byte 1
Content	Common payload header	Shutdown Type

Shutdown type:

0x00 -- Bluetooth command to turn off the device
0x01 -- LoRaWAN command to turn off the device
0x02 -- Magnetic to turn off the device

6.5 Shock Payload

Vibration Payload will be sent in Port 5.

	Common header	Shock Payload Data
Byte Index	Byte 0~2	Byte 3~4
Content	Common payload header	Number of shocks since the last shock payload in case of continuous shock

Number of shocks: Big-Endian format. Convert to decimal directly, the unit is times.

6.6 Man Down detection Payload

Man-Down detection Payload will be sent in Port 6.

	Common header	Man-Down Detection Payload Data
Byte Index	Byte 0~2	Byte 3~4
Content	Common payload header	Total idle time

Total idle time: Big-Endian format. Convert to decimal, the unit is hour.

6.7 Tamper Alarm Payload

Tamper alarm Payload will be sent in Port 7.

	Common header	Tamper Alarm Data	
Byte Index	Byte 0~2	Byte 3~9	Byte 10
Content	Common payload header	Timestamp	Time zone

Timestamp: Big-Endian format. Convert to decimal. Byte 3~4 represents the year; Byte 5 represents the month; Byte 6 represents the date; Byte 7 represents the hour; Byte 8 represents minute; Byte 9 represents second;

Time zone: The currently set UTC time zone.
Encoder rule: It is a singed number, convert to decimal, if the value > 128, then minus 256.
Example 1: The original data of payload is 0C, the time zone is UTC+12.
Example 2: The original data of payload is F6, the time zone is UTC-10.

6.8 Event Message payload

Event message Payload will be sent in Port 8.

	Common header	Event Message Payload Data
Byte Index	Byte 0~2	Byte 3
Content	Common payload header	Event type

Event type:
0x00 -- Start of movement
0x01 -- In movement
0x02 -- End of movement
0x03 -- Uplink Payload triggered by downlink message

6.9 Battery Consumption Payload

Battery consumption Payload will be sent in Port 9.

	Common header	Data				
Byte Index	Byte 0~2	Byte 3~6	Byte 7~10	Byte 11~14	Byte 15~18	Byte 19~22
Content	Common payload header	GPS working time	WIFI working time	Bluetooth scan working time	Bluetooth broadcast time	LoRa working time

Time Encoder rule: Convert to decimal, the unit is seconds.

6.10 GPS Limit Payload

GPS Limit Payload will be sent in Port 12.

	GPS Limit Payload				
Byte Index	Byte 0	Byte1	Byte 2~5	Byte 6~9	Byte 10
Content	Device Status	ACK & Battery voltage	Latitude	Longitude	PDOP

Device Status:

Device Status	
Bit Index	Content
Bit 0~1	Operation mode: 00 -- Standby mode 01 -- Periodic mode 10 -- Timing mode 11 -- Motion mode
Bit 2	Battery level: 0 -- Normal; 1 -- Low battery
Bit 3	Tamper alarm: 0 -- Not triggered; 1 -- Triggered
Bit 4	Man-Down status: 0 -- Not in idle; 1 -- In idle
Bit 5	Whether the tracker is in motion state since the last payload is sent
Bit 6	Positioning Type: (Only available for *Location Payload*) 0 -- Normal; 1 -- Downlink for position

ACK& Battery voltage:

ACK& Battery voltage	
Bit Index	Content
Bit 0~3	ACK: Downlink frame count, Counting will start again from 0 when it exceeds 15.
Bit 4~7	Battery voltage: Encoder rule: 2.2V + 100mV*value; if the value is 1000(In binary), the voltage is 3.0V(2.2V+100mV*8); If the value is 1010(In binary), the voltage is 3.2V(2.2V+100mV*10)

Latitude and Longitude encoder rule: Big-Endian format. It is a singed number.
If the value > 0x80 00 00 00, minus 0x01 00 00 00 00 and convert to decimal, then divide by 10 00 00 00, the unit is degree (°);
If the value<=0x80 00 00 00, convert to decimal and then divide by 10 00 00 00, the unit is degree (°);

PDOP encoder rule: Convert to decimal and divide by 10.

7 Maintenance instruction

- Do not use or store the device in dusty or dirty areas.
- Do not use or store the device in extremely hot temperatures. High temperatures may damage the device or battery.
- Do not use or store the device in extremely cold temperatures .when the device warms to its normal temperature, moisture can form inside the device and damage the device or battery.
- Do not drop ,knock, or shake the device. Rough handing would break it.
- Do not use strong chemicals or washing to clean the device.
- Do not paint the device ,paint would cause improper operation
- Do not disassemble the device casually or use the tools for maintenance without permission

Handle your device, battery and accessories with care. The suggestions above help you keep your device operational.

8 Revision History

Version	Description	Editor	Date
1.0	Initial version	Allen	2021-08-18
V1.1	Minor revisions, mainly concerning Chapter 3.3, Chapter 4, Chapter 5.2, Chapter 6.	Allen	2022-06-27