LW001-BGE User Guide

Version 1.0

MOKO TECHNOLOGY LTD.

Content

1 Product Introduction

1.1 Overview

LW001-BGE is LoRaWAN Tracker that can be used for indoor and outdoor positioning, for building construction, logistics tracking or other asset tracking.

Due to the smaller size, LW008-MTE can be used to track smaller size vehicles and assets than traditional trackers. For example, small precious assets tracking, shared balance bikes tracking, shared bicycles tracking, etc.

1.2 Key Feature

➢ Multiple installation options (screws, double-sided sticker, tape or magnetic)

➢ Long wireless transmission distance

➢ High durability and impact resistance

➢ Built-in accelerometer

➢ Multiple working mode

➢ IP67 rating

2 Product specification

2.1 Appearance

2.2 Dimensions

122.4mm

33.8mm   72.9mm

2.3 LED Indicators

There are 3 LED indicators to indicate the network status, fix status and power status

Status	Power LED	Network LED	Fix LED
Power on	Solid green 3s		
Power off	Flash green 3s		
Lower-power	Flash green 500ms every 10s		
Bluetooth broadcasting	Flash green slowly		
Charging	Flash green		
Full charged	Solid green		
LoRaWAN network connected		Solid white 3s	
LoRaWAN network connecting		Flash white 1s	
Linkcheck		Flash white 3s	
Fixing			Flash blue slowly
Fix success			Solid blue 2s
Fix fail			Flash blue quickly 2s

OTA upgrading	Flash green slowly	Flash white slowly	Flash blue slowly
OTA upgrade success	Solid green 3s	Solid white 3s	Solid blue 3s
OTA upgrade fail	Flash green quickly 3s	Flash white quickly 3s	Flash blue quickly 3s
Factory reset	Flash green slowly 5s	Flash white slowly 5s	Flash blue slowly 5s
Self-inspection fail	Solid green	Solid white	Solid blue

3 Packing List

LW001
Individual packaging

Screw
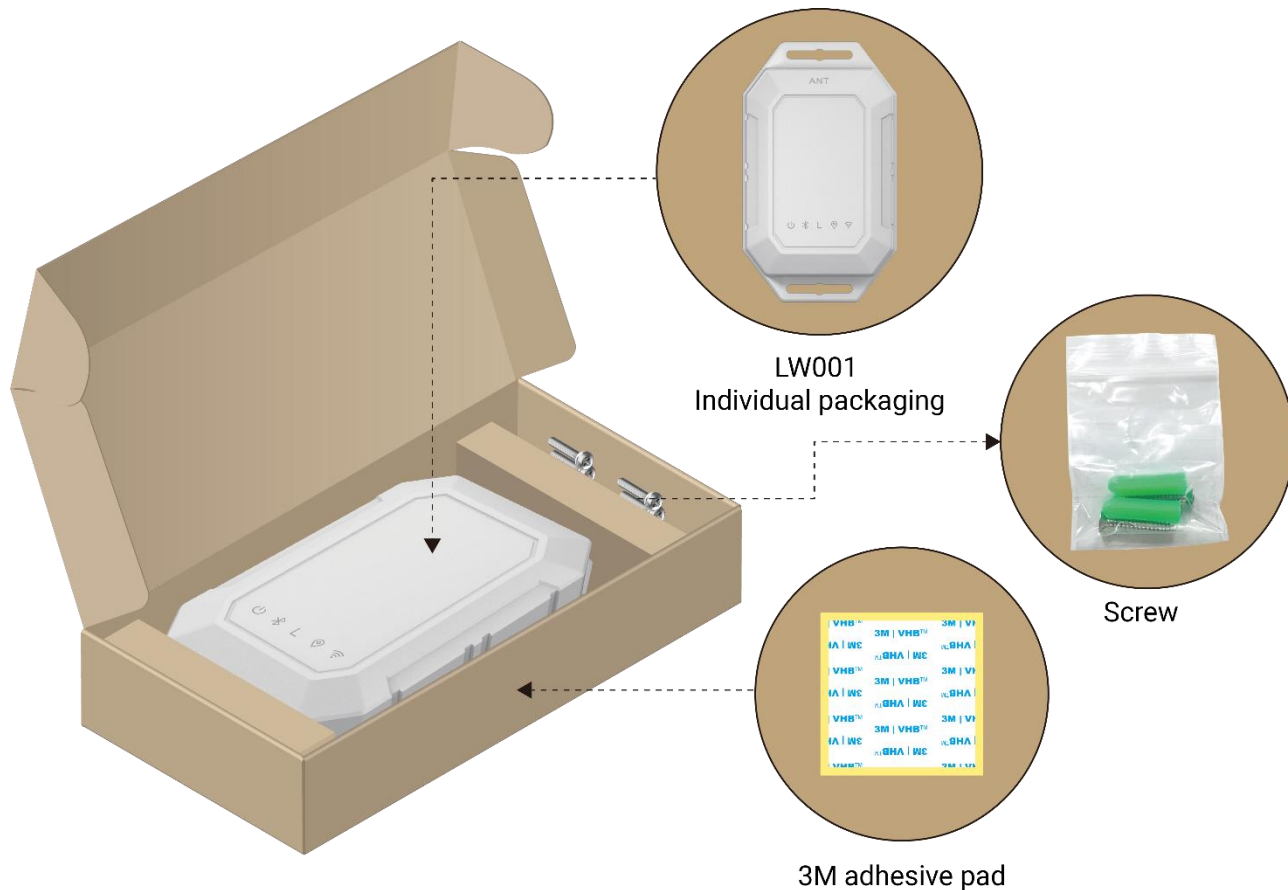
3M adhesive pad

Standard Packing List

No.	Description	Quantity
1	LW001-BGE individual packing	1
2	Screw	2
3	3M adhesive pad	1

Optional Accessories List

Sku	Description	Photo for reference
AP003	Magnetic switch	

AP018	Magnetic switch	
AP007MK0010010	Magnetic installation kit	
AE021	12000mAh battery	

4 Installation

Multiple installation options of LW001-BGE like hanging with screws, double-sided sticker, tape or DIN rail can be selected by user.

3M Sticker
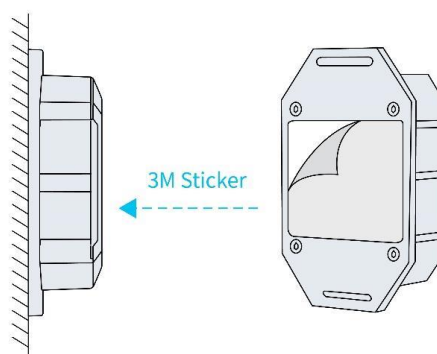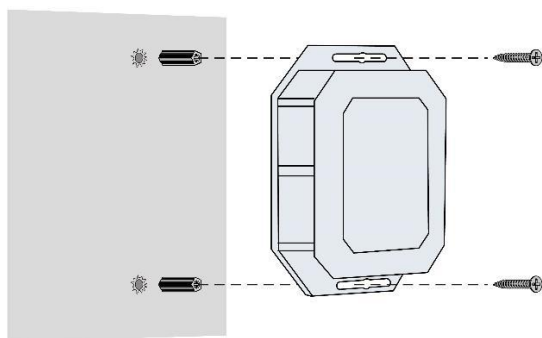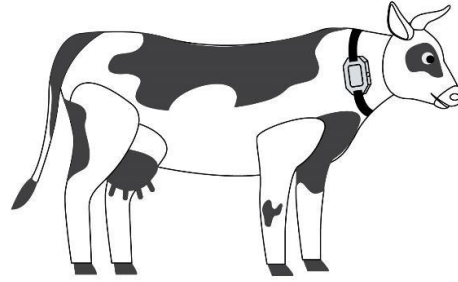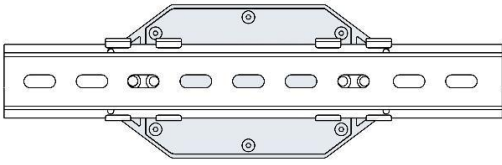
5 Access to the device

5.1 Power On/Off

Power On: 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)

Power Off: There are 3 ways to power off the device.
- ◇ 1. Power off the badge via MKLoRa APP.
- ◇ 2. Power off the badge via LoRaWAN downlink command.
- ◇ 3. 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)

5.2 Enable Bluetooth Connect Function

The device can make a Bluetooth broadcast and can be connected in the following two cases.

- ◇ Within the first N minutes after the device is turned back on.
- ◇ .LoRaWAN server sends LoRa command to turn on Bluetooth broadcast for N minutes.

Note: N is the broadcast timeout duration which can be set via MKLoRa APP, the unit is s, 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.

6 APP Configuration Guide

6.1 Connect to APP

Please download "MKLoRa" APP from app store directly. Please allow Bluetooth to be enabled during the installation process. This APP communicates with the device via Bluetooth, and it only supports above android 4.4 and IOS 9.0 system.
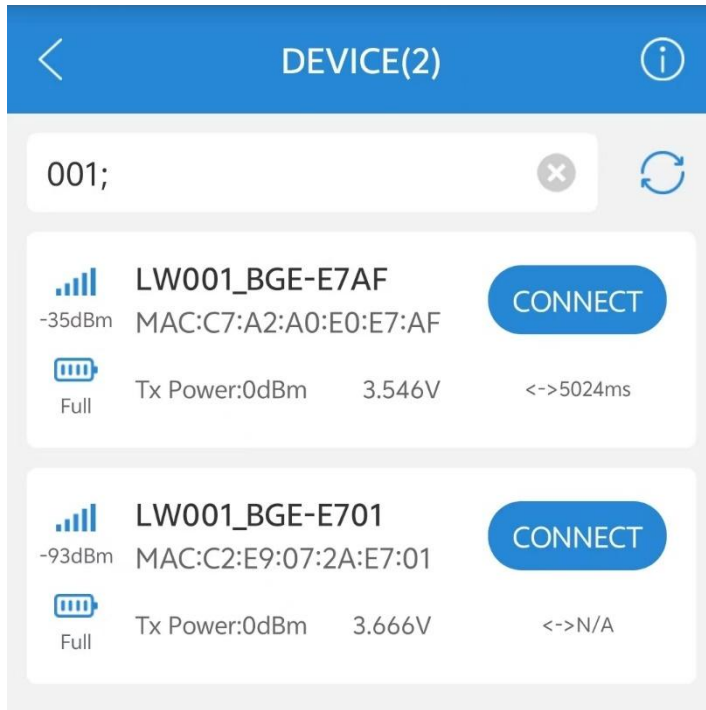
After the device is turned on, the device Bluetooth will start broadcasting. Open the MKLoRa APP and choose LW001, then you can search the LW001-BGE device by click the refresh icon. The default broadcast name of the device: LW001-BGE -XXXX.

Then click "Connect" button, the default login password is Moko4321.

The Edit Filter at the top can help user filter the keywords and RSSI. RSSI ranges from -127dBm to 0dBm;

6.2 Configure LW001-BGE Parameters

6.2.1 LORA Parameters
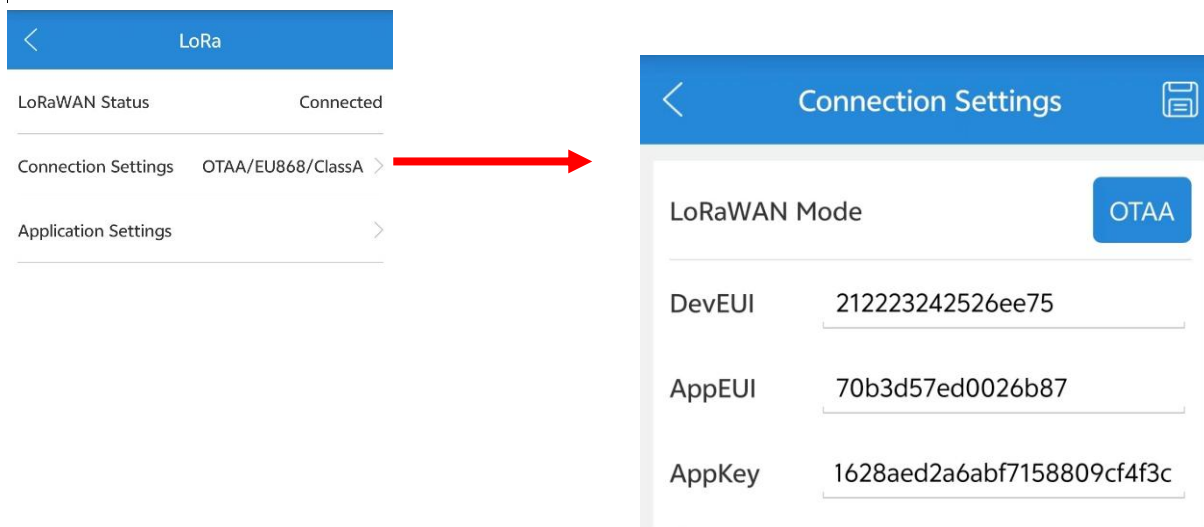
Configure/Read the LoRaWAN mode and the key parameters, such as DevEUI, AppEUI and AppKey.

6.2.2 Position Parameters

In this page, users can set parameters for position strategies.
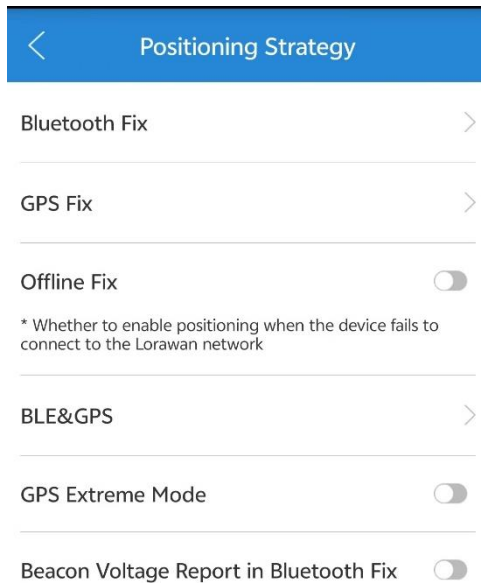
GPS Fix:
Set GPS fix timeout and PDOP value

Offline Fix:
Whether to enable positioning when the device is not connected to Lorawan network.

GPS Extreme Mode:
the reported GPS data will be shortened to achieve the maximum transmission distance. The default is off

Beacon Voltage Report in Bluetooth Fix:
BLE fix data will include the beacon voltage information
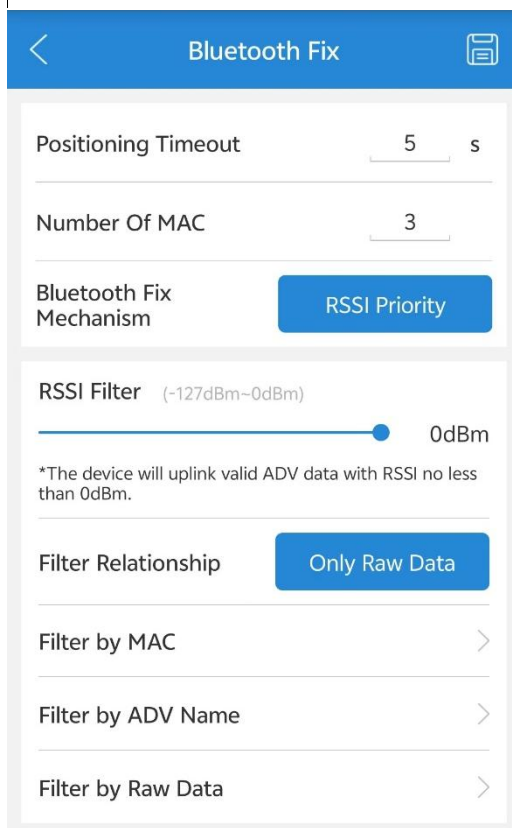
Positioning Timeout:
Bluetooth maximum scan time.
The value ranges from 1-10s, the default is 5s

Number of MAC:
Maximum Bluetooth MAC reported
The value ranges from 1-10, the default is 1
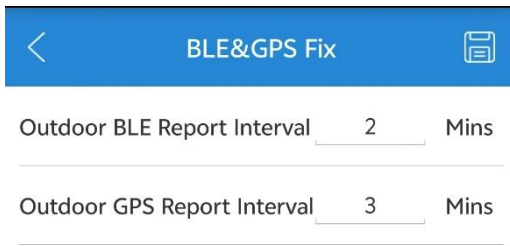
Bluetooth Fix Mechanism:
RSSI priority: run out of fix time, rank the beacon info by RSSI, and report the highest N beacon info (N= number of MAC)
Time priority: when the number of scanned beacon meets number of MAC, the scan ends immediately

RSSI Filter:
LW001-BGE will upload the beacon advertising data with RSSI no less than the setting value.
The value ranges from -127~0dBm, the default is -127dBm.

BLE&GPS Fix 〈 ⊟

Outdoor BLE Report Interval   2   Mins

Outdoor GPS Report Interval   3   Mins
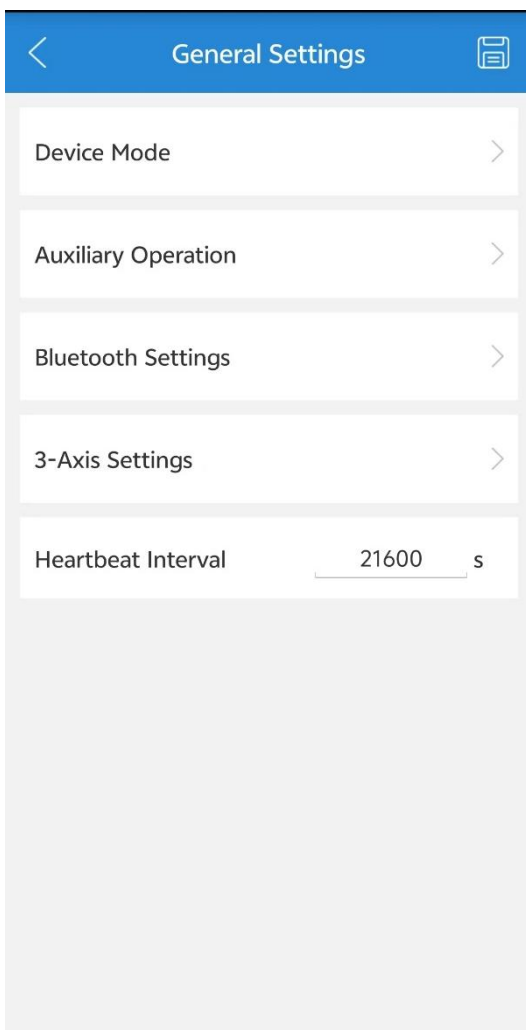
BLE&GPS Fix:

Step1: device start BLE fix with BLE fix timeout, if BLE fix success, report BLE fix payload

Step2: if BLE fix failed, device report BLE fix failure payload, and start GPS fix

Step3: the device will continue GPS fix with outdoor GPS report interval, and device scan the beacon data with outdoor BLE report interval at same time

Step4: if BLE fix success with outdoor BLE report interval, report BLE fix payload, and back to step1, stop GPS fix.

6.2.3 General Parameters

General Settings 〈 ⊟

Device Mode   〉

Auxiliary Operation   〉

Bluetooth Settings   〉

3-Axis Settings   〉

Heartbeat Interval   21600   s

Device Mode:
Various working mode can be chosen (standby mode, period mode, timing mode, motion mode and time segmented mode)

Auxiliary Operation:
Man down, Alarm and shock detection parameters can be set

Bluetooth setting:
Set Bluetooth broadcast adv name, interval and beacon mode

3-Axis Settings:
Set 3-Axis wakeup threshold, duration parameters

Heartbeat Interval:
The device will send heartbeat payload with the configured interval

LoRa   POSITION   GENERAL   DEVICE

Time Period Setting

*Swipe your finger from right to left on the screen to delete the time period.

Time-Segmented Mode:
User can set maximum 3 segment to report positioning data with configurable report interval.

Time period:
Start from 00:00 to 24:00, user can choose the prefer time period.

Report interval:
Device will report position data with the interval that set in the period.

Time-Segmented Mode		
Positioning Strategy		GPS

Time Period 1

00	00	to	01	00

Report Interval 1 — 600 s

Time Period 2

01	00	to	02	00

Report Interval 2 — 30 s

Time Period 3

0	0	to	0	0

Report Interval 3 — 600 s

6.2.4 Device Parameters
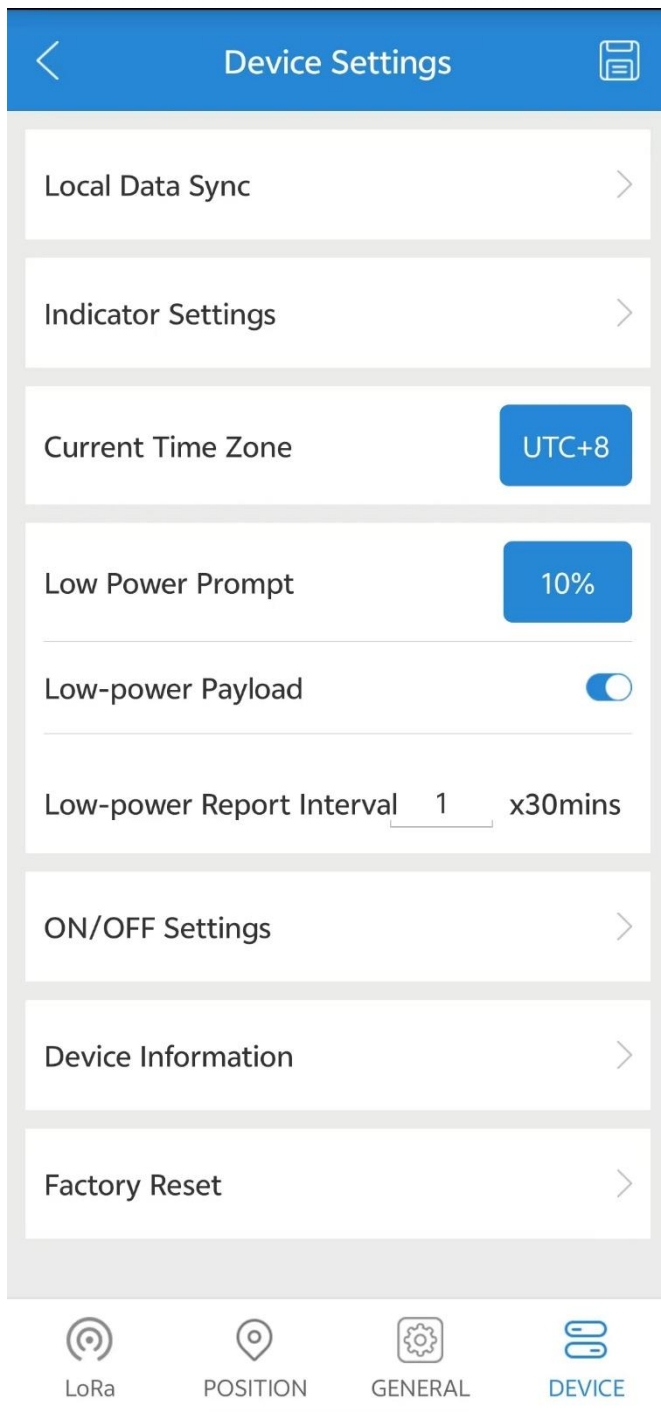
Low power parameters:
Set Low power threshold, and whether to report the low power payload, and the report interval of low-power payload.

Device Information:
Check the device basic information and do the firmware upgrade and debug.

Device Firmware Upgrade (DFU):
To update the firmware via the DFU should use the upgrade package that MOKO provides with ZIP format. If you use an android phone, place the ZIP file of firmware upgrade package into the phone folder, select the upgrade package file from the OTA page of the APP, and click to upgrade.
IOS phones need to share the upgrade package file with MKLoRa via computers and iTunes tools. and then select the upgrade package file from the OTA page of the APP, and click to upgrade.

Debugger Mode:
Click start button to start debugging, around 1 minute later, click stop button to stop debugging, then share the file to moko support engineers.

Note: *for more APP configuration details, pls refer to **MKLoRa APP guide***.

7 Communication Protocol

7.1 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	Information

7.1.1 Common Payload Header

	Common header		
Byte Index	Byte 0	Byte 1	Byte 2
Content	Device Status	Temperature	ACK and Device Voltage

Device Status:

Device Status	
Bit Index	Content
Bit 0~2	Operation mode: 000 -- Standby mode 001 -- Periodic mode 010 -- Timing mode 011 -- Motion mode 100 – Time-Segmented mode
Bit 3	Battery level: 0 -- Normal; 1 -- Low battery
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 and Device Voltage

ACK and Device Voltage	
Bit Index	Content
Bit 0~3	ACK, 0~15
Bit 4~7	Battery voltage, based on 2.2V, unit is 100mV. If value =10, current battery is 3.2V

7.1.2 Heartbeat Payload (Port 1)

Heartbeat Payload will be sent in Port (Fport) 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	Reserve, all bytes are 0

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

04 – reboot after factory reset

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

7.1.3 Location Payload (Port 2)

Location Fixed Payload will be sent in Port 2.

	Common header	Location Fixed Payload Data				Timestamp
Byte Index	Byte 0~2	Byte 3~4	Byte 5	Byte 6	Byte 7~XX	Last 4 Bytes
Content	Common payload header	reserved	Positioning success type	The length of location fixed data	Location fixed data	Timestamp of successful positioning

Positioning success type:

02 -- Bluetooth positioning success

03 -- GPS positioning success

The length of location fixed data: Convert to decimal.

Location fixed data:

If positioning success type is 02(Bluetooth positioning success) and disable report beacon voltage, 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	……..	……..

If positioning success type is 02(Bluetooth positioning success) and enable report beacon voltage, the location data is as below:

Bluetooth Location Fixed Data					
Byte 0~5	Byte 6	Byte 7~8	Byte 9~14	……..	……..
MAC address of Bluetooth device 1	RSSI of Bluetooth device 1	Beacon battery voltage	MAC address 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 03 -- 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.

7.1.4 Low-power Payload (Port 3)

Low-power payload will be sent in Port (Fport) 3.

Byte Index	Common header	Low-power data	Power consumption data
	Byte 0~2	Byte3	Bytes4~7
Content	Common payload header	Low-power threshold	Power consumption in current cycle

Low-power threshold: Convert to decimal, unit is %

Power consumption in current cycle: convert to decimal, unit is mAh

7.1.5 Location Failure Payload (Port 4)

Location Failure Payload will be sent in Port (Fport) 4.

	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:

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)

06 -- GPS positioning timeout (Pls increase GPS positioning timeout via MKLoRa app)

07 -- 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 – PDOP limit (Please increase the PDOP value via MKLoRa app)

0B -- Interrupted by Downlink for Position

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

0D -- Interrupted positioning at start of movement (the movement ends 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 Bluetooth positioning failure, and disable report beacon voltage. 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	……..	……

If it is Bluetooth positioning failure, and enable report beacon voltage. the location data is as below:

Bluetooth Location Failure Data					
Byte 0~5	Byte 6	Byte 7~8	Byte 9~14	……..	… …
MAC address of Bluetooth device 1	RSSI of Bluetooth device 1	Beacon battery voltage	MAC address 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 (Optional)	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.

7.1.6 Shut-Down Payload (Port 5)

Shutdown Payload will be sent in Port 5.

	Common header	Shutdown Payload Data
Byte Index	Byte 0~2	Byte 3~4
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

7.1.7 Shock Payload (Port 6)

Vibration Payload will be sent in Port 6.

	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.

7.1.8 Man Down Detection Payload (Port 7)

Man-Down detection Payload will be sent in Port 7.

	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.

7.1.9 Event Message Payload (Port 8)

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

7.1.10 Battery Consumption Payload (Port 9)

Battery consumption Payload will be sent in Port 9.

Byte Index	Type	Content	Description
Byte 0~2	Common header		
Byte 3~6	Working data	Device working time	Convert to decimal, unit is S

Byte 7~10	Bluetooth data	Bluetooth broadcast times	Convert to decimal, unit is times
Byte 11~14	Reserved	00	
Byte 15~18	3-axis sensor data	3-axis sensor wake up time	Convert to decimal, unit is S
Byte 19~22	Bluetooth fix data	Bluetooth fix time	Convert to decimal, unit is S
Byte 23~26	Reserved	00	
Byte 27~30	GPS fix data	GPS fix time	Convert to decimal, unit is S
Byte 31~34	LoRaWan uplink data	LoRaWan uplink times	Convert to decimal, unit is times
Byte 35~38	LoRaWan power consumption data	LoRaWan send and receive power consumption	Convert to decimal, unit is mAS
Byte 39~42	Tatal power consumption data	Total power consumption	Convert to decimal, unit is 0.001mAH

7.2 Downlink Command

LW001-BGE supports to configure the device via downlink commands. Application port is 10 by default

7.2.1 Payload Format

The content of the downlink command consists of four parts: HEAD, CMD, LEN and DATA

Byte Index	Type	Content	Description
Byte 0	HEAD	0x00, 0x01, or 0x02	Command type. 0x01: Read device parameters; 0x02: Configure device parameters; 0x00: control command
Byte 1~2	CMD	0x0000 ~ 0xFFFF	Message ID.

			Each parameter has a unique ID
Byte 3	LEN	0x00 ~ 0XF0	The length of Command Data 0x00 means the "DATA" part is empty.
Byte 4 – XX	DATA	Maximum 240 bytes	Command Data The Command Data is available only if the instruction type is 0x01. Other instruction types don't have this part.

7.2.2 Common Downlink Command

HEAD	CMD	LEN	Description
02	0000	0	Turn off the device
02	0001	0	Reboot the device
02	0002	0	Factory reset the device
01/02	0022	4	Heartbeat interval, parse rule: convert to decimal, the unit is S
01/02	0203	1	Switch of beacon mode
01/02	0320	1	Position strategy of period mode
01/02	0321	4	Report interval of period mode
01/02	0820	1	Bluetooth fix mechanism

Example:

1. Turn off the device

02 00 00 00		
HEAD	**CMD**	**LEN**
02	00 00	00

2. Reboot the device:

02 00 01 00		
HEAD	**CMD**	**LEN**
02	00 01	00

3. Factory reset the device:

02 00 02 00		
HEAD	**CMD**	**LEN**
02	00 02	00

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4. Set heartbeat interval as 100s:

02 00 22 04 00 00 00 64			
HEAD	**CMD**	**LEN**	**DATA**
02	00 22	04	00 00 00 64=>100

5. Enable beacon mode

02 02 03 01 01			
HEAD	**CMD**	**LEN**	**DATA**
02	02 03	01	01

6. Set position strategy of period mode as GPS

02 03 20 01 01			
HEAD	**CMD**	**LEN**	**DATA**
02	03 20	01	01=>GPS

7. Set report interval of period mode as 600s

02 03 21 04 00 00 02 58			
HEAD	**CMD**	**LEN**	**DATA**
02	03 21	04	00 00 02 58=>600

8. Set Bluetooth fix mechanism as time priority

02 08 20 01 00			
HEAD	**CMD**	**LEN**	**DATA**
02	08 20	01	00 =>time priority

*Note: For more downlink command, user can refer to **LW008-MTE Downlink Command v1.0***

8 Decoder

Users can download the decoder from github via the following link:

https://github.com/LoRaWAN-Product-Decoder/MOKOSMART-LoRaWAN-Product-Decoder/tree/main/LW008-MTE%3APTE%3ALW001-BGE%3ALW011-MT

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9 Revision History

Version	Description	Editor	Date
1.0	Initial version	Damon	2024-07-20

FCC Caution:

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception,which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

-- Reorient or relocate the receiving antenna.

-- Increase the separation between the equipment and receiver.

-- Connect the equipment into an outlet on a circuit different

   from that to which the receiver is connected.

-- Consult the dealer or an experienced radio/TV technician for help.

RF warning statement:

The device has been evaluated to meet general RF exposure requirement. The device can be used in portable exposure condition without restriction.

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