MOKO SMART

LW003-B

User Manual

Version 2.1

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Contents

1 About This Manual

The purpose of this manual is to outline how to apply LW003-B in suitable scenarios, as well as the main function of LW003-B.

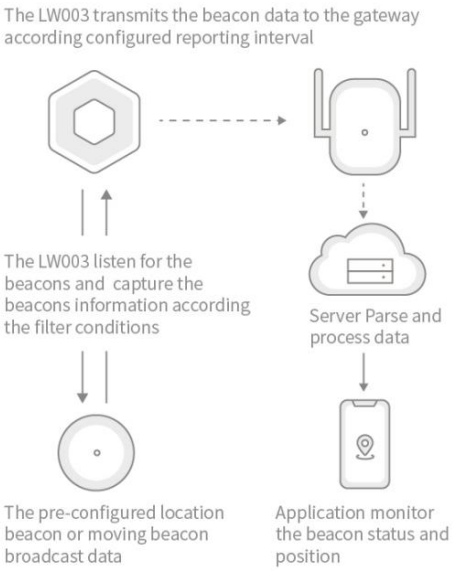
2 Product Introduction

2.1 Overview

LW003-B is a Bluetooth-LoRaWAN gateway integrating LoRa and Bluetooth wireless Communication. LW003-B can scan Bluetooth Beacon data and send data to LoRaWAN-Based gateway, and then upload to server, so as to realize personnel tracking, indoor positioning, asset monitoring and environmental monitoring.

2.2 Application

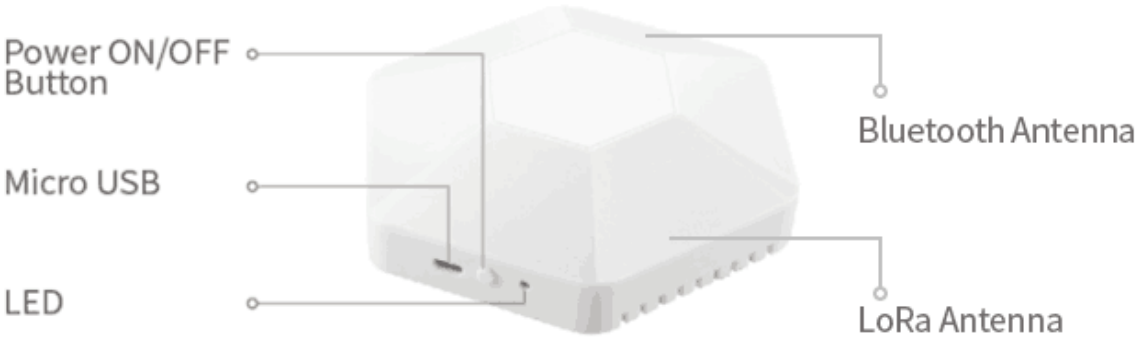
- Positioning & Location tracking
- Asset& Equipment tracking
- Personal tracking
- Environmental temperature and humidity monitoring



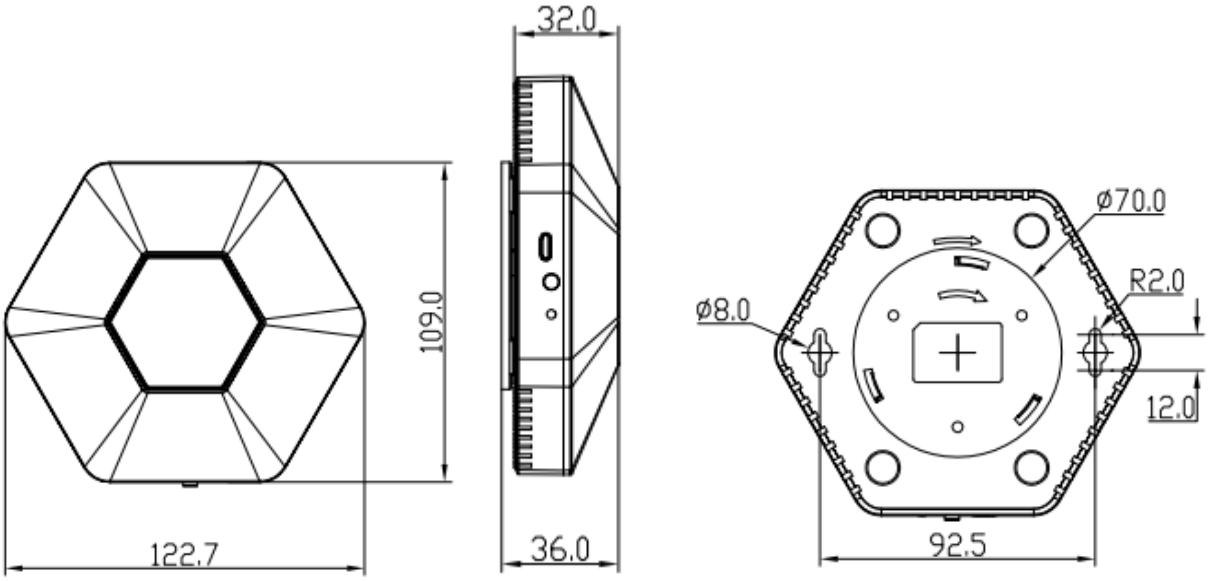
In the actual application, it should consider the ability of Bluetooth scan, and the time synchronization should be considered in the indoor position application otherwise the time stamp will not be accurate.

2.3 Product Specifications

2.3.1 Appearance



2.3.2 Mechanical Size



Unit：mm

2.3.3 LED Indicators and Button

Items	Indicator	Operation	Remark
Turn ON	Solid blue and keep 3S	Press and hold the power button for 5 seconds till the LED indicate blue and release. The LED will indicate blue for 3 seconds to show the LW003-B is turned on.	
Turn OFF	Red LED Blink 3S	Press and hold the power button for 5 seconds till the red indicator flashes quickly and release. The indicator will flash red for 3 seconds to show the LW003-B is turned off.	
Join LoRa Network	Solid green and keep 3S	If the device had never Joined any network, after turning on, the device automatically sends join request	It will send join request automatic after power on the device or save "LoRa Setting" parameter in APP
Bluetooth connection established successfully	Green LED Blink 1S	Connect to the device via APP successfully	
Bluetooth connection disconnected	Red LED Blink 1S	APP disconnect to the device	If the device is in alarm status, the indicator may be not visible
Firmware Upgrade	Green LED Blink during the upgrade	Firmware upgrade via OTA in DFU mode	
	Solid Blue and keep 3S after upgrade successfully		
	Solid Red and keep 3S after upgrade failed		
Charging	Blue LED blink	Plug in Micro USB charger	
Full Charged	Solid blue	Plug in Micro USB charger	
Low Battery Reminder	Red LED blink once every 30s	Battery level lower than 10%	
Over-limit Indication	Solid Red	Solid red when the device is in Over-limit status	

3 Device Feature and Function

3.1 Introduction to Device Application

3.1.1 Indoor Positioning

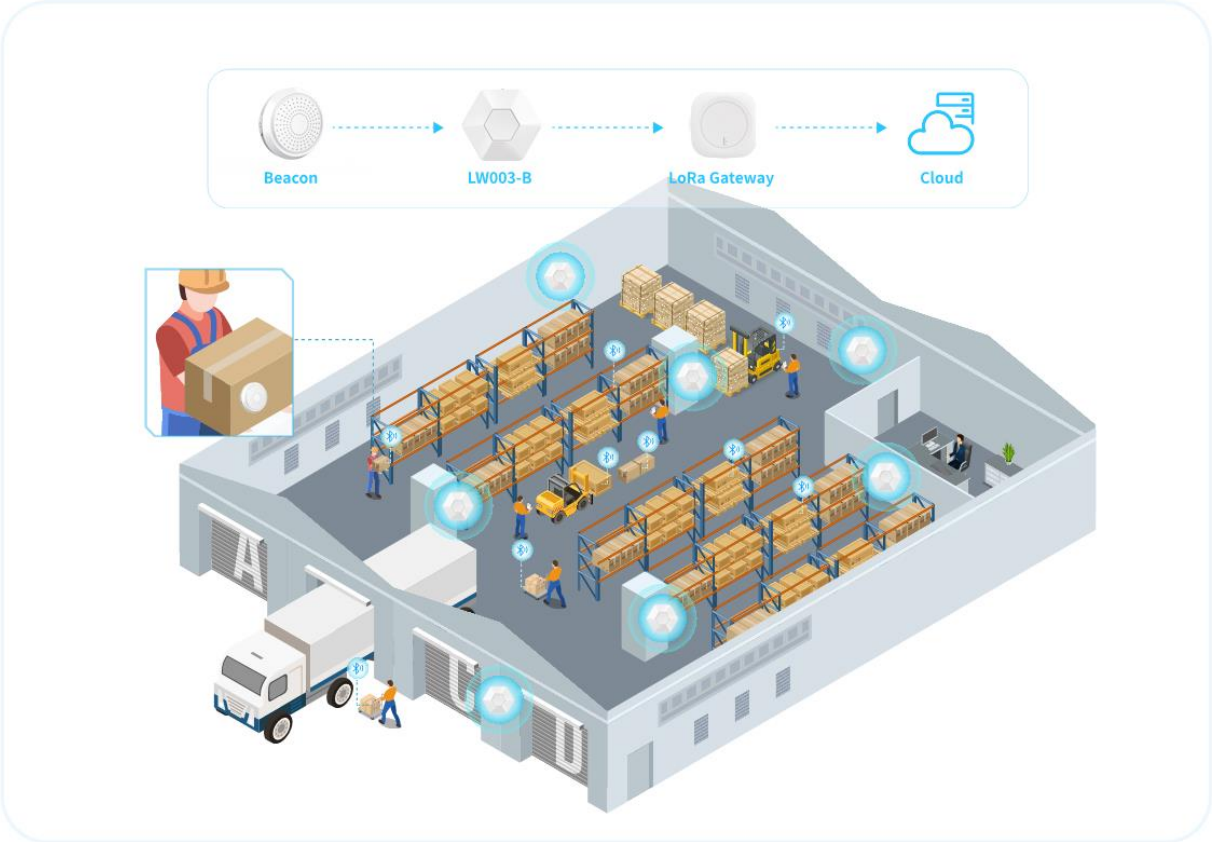
- Firstly, the LW003-B should be installed in the corresponding position according to the preset position to ensure that the scanning range of LW003-B can cover the space to be positioned.
- The beacon information required by customers can be filtered according to *Scanning Filtering Rules* (Pls refer to ***3.2.2.1 Scanning Filtering Rules***).
- Because the installation location of the LW003-B is known, the user can continuously analyze the *Beacon Payload* (Pls refer to ***4.2 Beacon Payload***) data on the server side to monitor the location and movement of the personnel.

3.1.2 Asset Monitoring

LW003-B also can be used in factory to monitor critical assets.

For example:

- user can attach Bluetooth beacons to important devices that need to be monitored and install LW003-B around the important devices in factory.
- LW003-B will continuously scan the Bluetooth beacon broadcast information and report to the server.
- In this case, the background server should be able to continuously receive the information from the Bluetooth beacon bound on the device transmitted from the corresponding LW003-B. If no information is received in a certain period of time or the data is not transmitted from the corresponding LW003-B, the server can trigger an alarm to indicate that the device has been moved.



3.1.3 Personnel Over-Limit Alarm

When too many people gather around the same place in a short duration, the indicator light of LW003-B will turn red to remind the crowd of too many people.

For example:

- In the office application scenario, all people wear the Bluetooth Beacon device of work card type in office and install a LW003-B on meeting room or Tea area. Set a limited number (7 people) of people in each area in advance via MKLoRa APP and ensure that the Bluetooth Beacon device worn by all people meets the filtering conditions of LW003-B.
- On meeting room or Tea area, if eight or more people gather here in a short duration (The duration can be set according to the actual situation after testing), LW003-B will send out an alarm warning of overstaffing.

Note: *The area of each area is different, and we can change the Over-Limit RSSI to adjust the coverage of the over-limit function*

3.1.4 Environment Monitoring

LW003-B has built-in temperature and humidity sensors and regularly reports data to the server. The user can analyze and statistics the temperature and humidity of the server, so as to realize the function of environmental monitoring, which is mainly suitable for office, factory, hospital, school and other occasions.

3.2 Bluetooth Capabilities

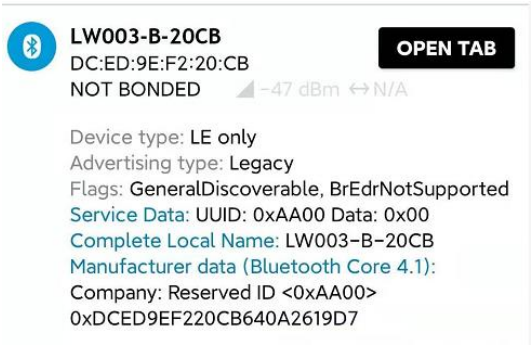
3.2.1 Bluetooth Advertise

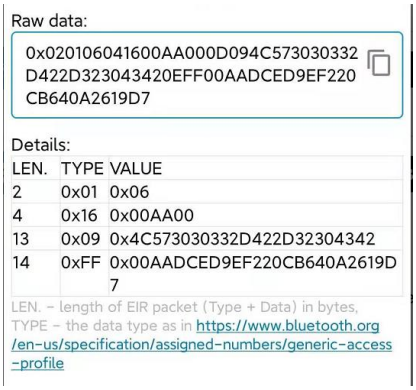
When user turn on the LW003-B, the LW003-B will constantly Bluetooth broadcast.

When the device is broadcasting, users can scan LW003-B and establish a connection via cell phones, iPad, etc.

Note: *About the MKLoRa app, pls refer to* ***LW003-B APP Guide***

The following is an example of the Advertise Packet:





- Service UUID: AA00
- MAC Address: DC ED 9E F2 20 CB
- Battery Level: 0x64 (100%)
- Environment Temperature: 0x 0A 26 (25.98℃)
- Environment Humidity: 0x 19 D7 (64.292%)

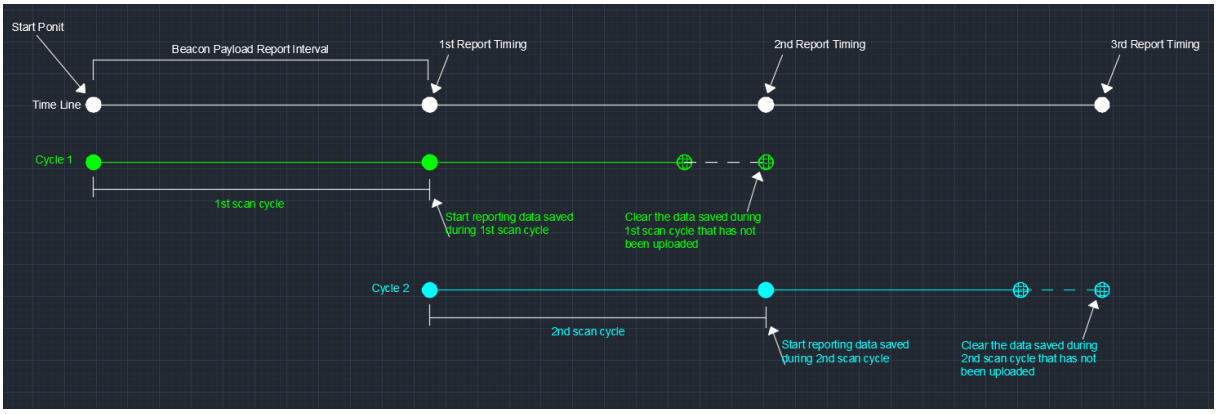
Note: For data conversion, refer to the corresponding parameter data conversion in ***Chapter 4 Uplink Payload***, especially for battery level, environment temperature, environment humidity.

3.2.2 Bluetooth Scan

➢ When scan switch status is on, the device will start to scan beacons nearby and cache the beacon information that meets the conditions. Then the device will report beacon data regularly, and the reporting interval can be set.

➢ Scan capacity of BLE is limited by uplink beacon data payload length. Based on our default format of the uplink beacon data payload, the max BLE scan capacity is 300 beacons. And it will filter out duplicate beacon and follow FIFO.

➢ The quantities of beacons upload to server is also limit by the report interval. If the upload interval time is not enough to upload all beacon payload it will be covered by new cycle beacon payload.



- The Bluetooth scan window can be set by user, if you want improve the scanning performance, you can make it higher, but accordingly broadcast performance will be reduced and will affect the battery life of the device.

3.2.2.1 Scanning Filtering Rules

In order to better scan and filter out the user's desired beacon device, we develop *Scanning Filtering Rules* on LW003. Only beacons that meet *Scanning Filtering Rules* will be cached and uploaded.

The following is the specific description of *Scanning Filtering Rules*:

① There are two sets of filter conditions, one is Filter Condition A, and other one 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 set of 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 can this filter condition 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.

Note: *For the RSSI Filter item, it can't be set to Reverse filter. Refer to* ***LW003-B APP Guide*** *for detailed Settings of filter items and an example.*

3.2.2.2 Filter Repeating Data

Because each beacon device may be scanned and saved more than one time in one scan cycle, we have opened up Filter Repeating Data. With this function, for the same data, we only reported it once in the same reporting cycle and the data reported was the most recent scanned.

There are four types of Filter Repeating Data:

No: Don't do anything.

MAC: Beacon data with the same MAC will only be reported once in the same cycle

MAC + Data Type: Beacon data with the same MAC and the same beacon data type will only be reported once in the same cycle. Common data types are IBEACONS, Eddystone and AltBeacon.

MAC + Raw Data: Beacon data with the same MAC address and raw data will only be reported once in the same cycle.

Some beacons have multiple slots and each slot can broadcast different types of data and different content. Through the Filter Repeating Data, users can better get the data they want.

3.3 LoRaWAN Capabilities

The data of LW003 will be transmitted via LORA and LW003 is based on the standard LoRaWAN protocol V1.0.3. LW003 is compatible with most gateways and servers (TTN, SENET, LORA IOT, etc.) in the market

Link Check MAC Commands: LW003 supports LinkCheck function. Users can use this function to realize regular network monitoring function and confirm the network status of the device.

Device Time MAC Commands: LW003 supports the DeviceTime feature, which enables Users can periodically synchronize the time of the device to avoid time offset. The *Time Sync Interval* of the MKLoRa APP is the Device Time MAC Command interval. (Please refer to ***Chapter 2.3.1 LORA Parameter of LW003-B APP Guide***)

Note: *Some LoRa Server platforms did not support LinkCheck and DevicTtime function, for example TTN server, if you want use device in these platforms, should set the corresponding Settings item to 0.*

3.4 Local Data Sync

LW003-B 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.

Note: *When the data is synchronized and exported successfully, pls remember to delete the device local data in case there is too much data in the next synchronization.*

3.5 Temperature and Humidity Monitoring

LW003-B has built-in temperature and humidity sensor SHT30, which can be used to monitor environmental temperature and humidity through continuous analysis of uplink data.

3.6 Default Power Status

In the application scenario of LW003-B, power supply may be suddenly cut off. Because the LW003-B's built-in battery has limited capacity, in this case, the device will quickly run out of power and shut down.
When power is restored later, if the device will not automatically be turn on, the user must manually turn on the LW003, this will result in increased human costs and there will be a risk of losing some uplink payload.

Based on the above situation, LW003-B adds the function to set the state of the device when the device is powered back on. There are three options: “Switch off”, “Switch on” and “Revert to last status”.

- If set to “switch on”, it means that the LW003-B will be on when the device is powered back on.
- If set to “switch off”, it means that the LW003-B will be off when the device is powered back on.
- If set to “Revert to last status”, it means that the LW003-B will be in the same state as it was before the power was cut off.

3.7 Battery Performance

The LW003-B can support both battery and DC power. The device is equipped with a 4200 mAh rechargeable battery.

With batteries, the typical service life of the device is around 20 days (Scan Window:50ms, Report Interval:3 minutes).

3.8 Time Synchronization

There are four methods to sync time through the MKLoRa APP, DeviceTime function, RTC or Downlink Command.

- MKLoRa APP: When the APP connect with the device success the phone system time will be sync to the device.
- Device Time MAC Commands: LW003 supports the DeviceTime feature, which enables users can periodically synchronize the time of the device to avoid time offset.
- RTC: The LW003 has a built-in RTC circuit. When LW003 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 LW003.
- Downlink Command: User can use the downlink command to sync time, it is better to send the RTC time to device when the device send heartbeat (device information packet) as the device only open the receive window in CLASS A when there is uplink transmission or CLASS C.

3.9 Configuration Tool

The device can use MKLoRa app developed by Moko for quick OTA upgrades and parameter settings. About the detail of MKLoRa, pls refer to ***LW003-B APP Guide***.

4 Uplink Payload

There are two different types uplink payloads: device information payload and beacon data payload.

4.1 Device Information Payload

When the device is successfully connected to the LoRaWAN network, the device will immediately send a Device Information Payload to server, and periodically report Device Information Payload thereafter.

Device information payloads will be sent in Port 1.

Byte Index	Type	Data Type	Value	Description
Byte 0	Battery Level	Uint	0x00-0x64	Convert to decimal, unit is %.

				Note: *The battery level will be always nearly 100% when the device is powered by USB.*
Bytes 1-2	Battery Voltage	Uint	0x0000-0xFFFF	The voltage value of battery, the byte order is Big-Endian. The actual voltage need divide 1000 after the hexadecimal data convert to decimal. Example: 3C 0Econvert to decimal is 3644, the actual voltage is 3.644V. If the device is powered by USB, the voltage will always above 3.4V
Byte 3	Firmware Version	Uint	0x00-0xFF	Firstly, convert to 8-bit binary number. Example:86 is 1000 0110 in binary number, 10 equals to 2, 00 equals to 0, 0110 equals to 6, so the firmware version is V 2.0.6
Byte 4	3-Axis sensitivity	Uint	0x00-0xFF	Converts directly to decimal numbers, the unit is mg.
Byte 5	Tamper state	Uint	0x00/0x01	0x00 means normal,0x01 means that the device was removed abnormally. ***Note:*** *This function is not enabled yet*
Byte 6-7	Temperature	Int	0x0000-0xFFFF	Converts directly to decimal numbers, then divide 100.The unit is degree centigrade.
Byte 8-9	Humidity	Uint	0x0000-0xFFFF	Converts directly to decimal numbers, then divide 100.The unit is %.
Byte 10	Region	Uint	0x00-0x09	0x00 means AS923;0x01 means AU915;0x02 means CN470;0x03 means CN779;0x04 means EU433;0x05 means EU868;0x06 means KR920;0x07 means IN865;0x08 means US915;0x09 means RU864.

Example: 4D 0F 42 86 64 00 0A 2B 11 7E 05

- 4D: battery level is 100%
- 0F 42: battery voltage is 3.906V
- 86: firmware version is V2.0.6
- 64: 3-Axis sensitivity is 100mg
- 00: Tamper state is normal.

- 0A 2B: Temperature is 26.03℃
- 11 7E: Humidity is 44.78%
- 05: Region is EU868

4.2 Beacon Payload

- Beacon data will be uploaded per 10s by default after the device start to scan beacon, and the report interval can be changed by MKLoRa APP or downlink command.
- Beacon Data Payloads will be sent in Port 2.
- The user can select what type of beacon data to report and the content of the beacon payload (Pls refer to ***LW003 APP Guide***).
- The user can select the maximum length of the reported beacon payload. There are two options, one is 115bytes and the other is 242bytes. It affects the number of beacons per beacon payload.

Byte Index	Type	Data Type	Value	Description
Byte 0	Payload Type	Uint	0x20-0xFF	The header of the beacon data payload message. In each beacon payload reporting cycle, the beacon data payload header will start on 20. 20: the first packet beacon data. 21: the second packet beacon data and so on.
Byte 1	Total Beacon Quantities of this payload	Uint	0x00-0xFF	The total beacon quantities in this payload. It depends on the length of beacon broadcast data.
Byte 2	The First Beacon Data Length	Uint	0X00-0XFF	Converts directly to decimal numbers.
Byte 3-9	The First Beacon Timestamp	Uint	0X00000000000000-OxFFFFFFFFFFFFFF	
Byte 10-15	The First Beacon MAC	Uint	0X00000000000000-0XFFFFFFFFFFFF	The byte order is Big-Endian. Example: B1 FA 1E 36 EF 03, the real MAC address is B1 FA 1E 36 EF 03.
Byte 16	The First Beacon RSSI	Int	0X00-0XFF	Converts directly to decimal numbers, then Minus 256. The unit is dBm.
Byte 17-XX	The First Beacon Raw Data	Uint		The beacon raw data length and data content depend the real beacon, please check the beacon

	The Second Beacon Data Length	Uint	0X01-0XFF	Converts directly to decimal numbers.
	The Second Beacon Timestamp	Uint	0X00000000000000- OxFFFFFFFFFFFFFF	
	The Second Beacon MAC	Uint	0X00000000000000- 0XFFFFFFFFFFFF	The byte order is Big-Endian
	The Second Beacon RSSI	Int	0X00-0XFF	Converts directly to decimal numbers, then Minus 256. The unit is dBm.
	The Second Beacon Raw Data	Unit		The beacon raw data length and data content depend the real beacon, please check the beacon.
	……..	……..	……..	……..

Example: 21 03 2D 07 E5 04 1C 09 06 0C 58 B7 2E 09 F2 A5 BD 1E FF 06 00 01 09 20 02 B7 D7 18 C2 1D B5 F4 49 A7 50 FB 52 E5 0E 89 40 54 BF 4F 58 15 19 73 49 07 E5 04 1C 09 06 0C E4 4B 4B A7 93 D0 BA 02 01 06 1A FF 4C 00 02 15 E2 C5 6D B5 DF FB 48 D2 B0 60 D0 F5 A7 10 96 E0 00 00 00 00 BF 12 16 01 AA 01 00 00 00 00 BF 00 0E 64 E4 4B 4B A7 93 D0 09 09 4C 57 30 30 34 2D 43 54 2D 07 E5 04 1C 09 06 0C 37 6A D3 16 30 D9 BC 1E FF 06 00 01 09 20 02 90 7B A4 89 DA 98 7A EC 14 24 F3 8D 60 13 A4 28 42 C2 E6 6E 6C 85 FC

- 21: beacon data payload.
- 03: Total Beacon Quantities of this payload is 3.
- 2D: The first Beacon Data Length is 45.
- 07 E5 04 1C 09 06 0C: Timestamp of 1st beacon, it has been scanned at 2021-4-28 9:6:12.
- 58 B7 2E 09 F2 A5: The 1st MAC Address is 58 B7 2E 09 F2 A5.
- BD: 1st beacon RSSI is -67 dBm.
- 1E FF 06 00 01 09 20 02 B7 D7 18 C2 1D B5 F4 49 A7 50 FB 52 E5 0E 89 40 54 BF 4F 58 15 19 73: The first beacon broadcast raw data.
- 49: The second Beacon Data Length is 73.
- 07 E5 04 1C 09 06 0C: Timestamp of 1st beacon, it has been scanned at 2021-4-28 9:6:12.
- E4 4B 4B A7 93 D0: The 2nd MAC Address is E4 4B 4B A7 93 D0.
- BA: 2nd beacon RSSI is -70 dBm.
- 02 01 06 1A FF 4C 00 02 15 E2 C5 6D B5 DF FB 48 D2 B0 60 D0 F5 A7 10 96 E0 00 00 00 00 BF 12 16 01 AA 01 00 00 00 00 BF 00 0E 64 E4 4B 4B A7 93 D0 09 09 4C 57 30 30 34 2D 43 54: The second beacon broadcast raw data.
- 2D: The third Beacon Data Length is 45.
- 07 E5 04 1C 09 06 0C: Timestamp of 1st beacon, it has been scanned at 2021-4-28 9:6:12.
- 37 6A D3 16 30 D9: The 3rd MAC Address is 37 6A D3 16 30 D9.

- BC: 3rd beacon RSSI is -68 dBm.
- 1E FF 06 00 01 09 20 02 90 7B A4 89 DA 98 7A EC 14 24 F3 8D 60 13 A4 28 42 C2 E6 6E 6C 85 FC: The third beacon broadcast raw data.

4.3 Uplink Payload Decoder

GITHUB Link: https://github.com/LoRaWAN-Product-Decoder/Decoder

```
/*
according dev config，show report data format choose, this flag must be the same as the device
bit 4 have timestamp
bit 3 have ble mac
bit 2 have ble rssi
bit 1 have ble adv data
bit 0 have ble response data
*/
var flag = 0x1F;

function substringBytes(bytes, start, len)
{
    var char = [];
    for(var i = 0; i < len; i++)
    {
        char.push("0x"+ bytes[start+i].toString(16) < 0X10 ? ("0"+bytes[start+i].toString(16)) :
bytes[start+i].toString(16) );
    }
    return char.join("");
}
function Decoder(bytes, port)
{
    var region =
["AS923","AU915","CN470","CN779","EU433","EU868","KR920","IN865","US915","RU864"];
    var dev_info = {};
    if(port == 1)
    {
        dev_info.batt_level = bytes[0] + "%";
        dev_info.batt_v = bytes[1]*256 + bytes[2] + "mV";
        ver_major = (bytes[3]>>6)&0x03;
        ver_mijor = (bytes[3]>>4)&0x03;
        ver_patch = bytes[3]&0x0f;
        dev_info.ver = "V" + ver_major+"."+ver_mijor+"."+ver_patch;
        dev_info.sensitivity = bytes[4] + "mg";
        dev_info.demolition_state = bytes[5];
        temperature = bytes[6]*256 + bytes[7];
        if(temperature >0x8000)
```

```
            dev_info.temperature = "-" + (0X10000-temperature )/100 + "°C";
        else
            dev_info.temperature = temperature /100 + "°C";
        dev_info.humility = (bytes[8]*256 + bytes[9])/100+"%";
        dev_info.region = region[bytes[10]];
    }
    else if(port == 2)
    {
        dev_info.head = bytes[0];
        dev_info.beacon_num = bytes[1];
        var parse_len = 2;
        var datas = [];
        for(var i = 0; i < dev_info.beacon_num; i++)
        {
            var data = {};
            var beacon_len = 0;
            var current_data_len = bytes[parse_len++];
            if(flag&0x10)
            {
                year = bytes[parse_len]*256 + bytes[parse_len+1];
                parse_len += 2;
                mon = bytes[parse_len++];
                days = bytes[parse_len++];
                hour = bytes[parse_len++];
                minute = bytes[parse_len++];
                sec = bytes[parse_len++];
                data.utc_time = year + "-" + mon + "-" + days + " " + hour + ":" + minute + ":" +
sec;
                beacon_len +=7;
            }
            if(flag&0x08)
            {
                data.mac = substringBytes(bytes, parse_len, 6);
                parse_len += 6;
                beacon_len +=6;
            }
            if(flag&0x04)
            {
                data.rssi = bytes[parse_len++]-256 +"dBm";
                beacon_len +=1;
            }
            if(flag&0x03)
            {
                data.adv_len = current_data_len-beacon_len ;
                data.adv_data = substringBytes(bytes, parse_len, data.adv_len);
```

```
                parse_len += data.adv_len;
            }
            datas.push(data);
        }
        dev_info.scan_data = datas;
    }
    else if(port == 4)
    {
        var parse_len = 0;
        dev_info.beacon_num = bytes[4];
        if(dev_info.beacon_num)
        {
            parse_len += 5;
            var datas = [];
            for(var i = 0; i < dev_info.beacon_num; i++)
            {
                var data = {};
                var beacon_len = 0;
                var current_data_len = bytes[parse_len++];

                year = bytes[parse_len]*256 + bytes[parse_len+1];
                parse_len += 2;
                mon = bytes[parse_len++];
                days = bytes[parse_len++];
                hour = bytes[parse_len++];
                minute = bytes[parse_len++];
                sec = bytes[parse_len++];
                data.utc_time = year + "-" + mon + "-" + days + " " + hour + ":" + minute + ":" +
sec;
                beacon_len +=7;

                data.mac = substringBytes(bytes, parse_len, 6);
                parse_len += 6;
                beacon_len +=6;

                data.rssi = bytes[parse_len++]-256 +"dBm";
                beacon_len +=1;

                data.adv_len = current_data_len-beacon_len ;
                data.adv_data = substringBytes(bytes, parse_len, data.adv_len);
                parse_len += data.adv_len;

                datas.push(data);
            }
            dev_info.store_data = datas;
```

```
            }
            else
            {
                dev_info.total_num = bytes[5]*256 + bytes[6];
            }
        }
        return dev_info;
}
```

5 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.

6 Revision

Version	Description	Editor	Data
1.0	Initial version	Iris	2020-07-08
1.1	Adjust document structure	Iris	2020-09-11
2.1	Suitable for firmware version V2.0.7 &HW Version V2.1	Allen	2021-04-16

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