iSmarch

J3 LoRaWAN Smartwatch Integration Document

Table of Content

1. Product Configuration

1.1 J3 Watch Framework：

- Main Control Unit: NRF52840 with Bluetooth 5.2 + GPS module + LoRaWAN module
- GPS: An independent module
- LoRaWAN Module: Includes NRF52832 + Semtech

1.2 LoRaWAN Frequency Bands Currently Supported

- EU868
- AS923-1/-2/3
- US915
- AU915
- RU864
- IN865
- KR920
- Frequency Band Switching: The frequency band can be changed by accessing the Region Setting page in the smartwatch.

2. Basic Functions

2.1 Calibrating the Local Time of the Device

The following methods are available:

1) **APP**: Use the IXFIT app to connect to the smartwatch and synchronize the time (IXFIT can be downloaded directly from the App Store or Google Play; it is a non-commercial app).

2) **Bluetooth Base Station**: Use a Bluetooth base station to synchronize the time on the smartwatch.

- **Device Bluetooth Service UUID**: 0000fff0-0000-1000-8000-00805f9b34fb
- **Characteristic for Writing Data**: 0000fff1-0000-1000-8000-00805f9b34fb
- As shown in the diagram:

Write the time calibration protocol into the characteristic field marked with the red box to calibrate the time.

Time Calibration Protocol:

Message Format: 0x01, YY1, YY2, MM, DD, HH, mm, SS
0x01: Protocol header

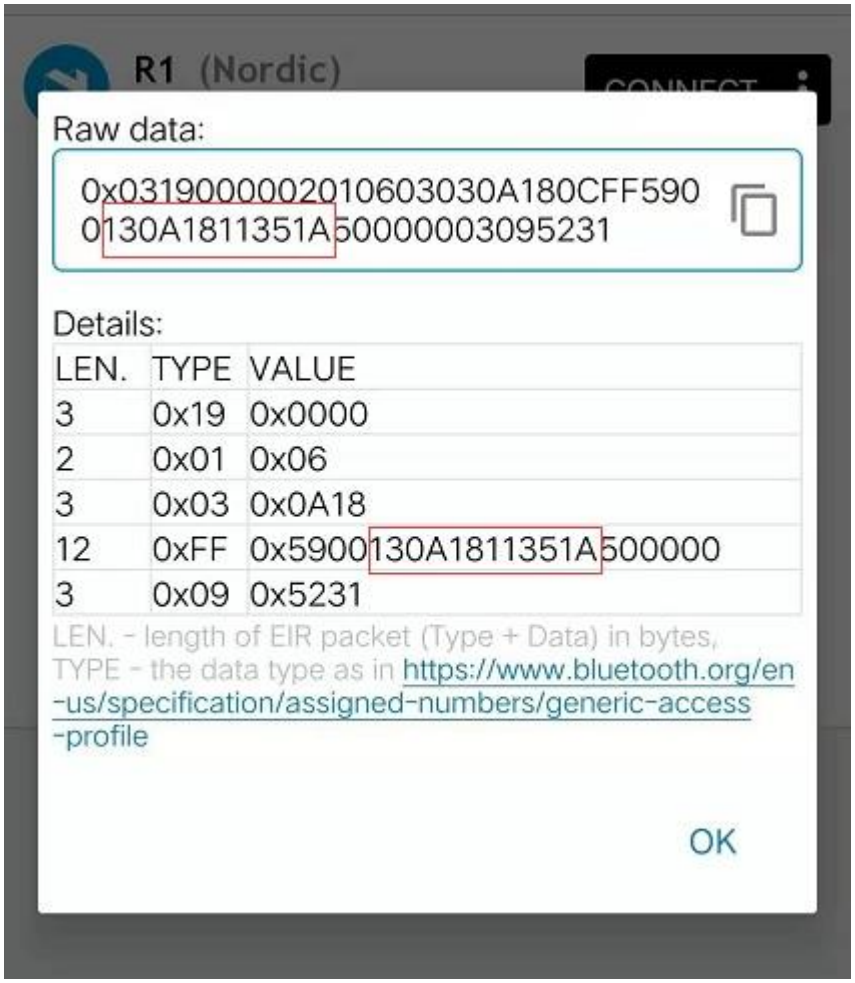
Year = YY1 * 100 + YY2
Month = MM
Day = DD
Hour = HH
Minute = mm
Second = SS

Example:
Message: 0x0114180C1A0E0325
0x01: Protocol header
1418: 20 * 100 + 24 = 2024 (Year)
0C: 12 (Month)
1A: 26 (Day)
0E: 14 (Hour)
03: 03 (Minute)
25: 37 (Second)

3) Bluetooth Base Station Broadcast and Time Synchronization by Smartwatch Scanning:

The smartwatch scans the Bluetooth base station for time synchronization (refer to the Bluetooth Time Synchronization Protocol).

The gateway broadcasts once every 240ms, and the content of each broadcast PDU is shown in the diagram.



The most critical part of the protocol is from the 16th byte onward, where the time is represented as follows:

- 0x13 (Year)
- 0x0A (Month)
- 0x18 (Day)
- 0x11 (Hour)
- 0x35 (Minute)
- 0x1A (Second)

For example, the time shown in the diagram is October 24, 2019, 17:53:26.

- Another key point is that the gateway's device name must be "R1".
- As shown in the diagram, 0x5231 corresponds to "R1."

Note: This method only works when the smartwatch is in beacon scanning mode.

4) **LoRaWAN Gateway Downlink Time Synchronization**
(Refer to the downlink protocol for specific details.)

2.2 Bluetooth Section

(1) Default Broadcast Interval: 300ms.
(2) Broadcast Time Unmodifiable: The current firmware does not allow modification of the broadcast interval.
(3) Bluetooth Always On: By default, Bluetooth remains enabled and does not turn off.
(4) Beacon Scanning:
   ① When scanning beacons is enabled, the scan interval is 500ms, and the scan duration is 100ms.
   ② By default, beacon scanning is disabled.
   ③ The scanning window cannot be adjusted but can be customized upon request.
(5) Receiving Bluetooth Broadcast Data: Data can be received via a Bluetooth base station.
(6) Using SDK/Bluetooth Protocol: The device can be connected via an app to retrieve data, referencing the APP SDK documentation.
(7) Beacon Positioning and Enabling Beacon Scanning on the Watch:
   ① The iBeacon UUID must be configured as:
   0xAB, 0x81, 0x90, 0xD5, 0xD1, 0x1E, 0x49, 0x41, 0xAC, 0xC4, 0x42, 0xF3, 0x05, 0xFF, 0x20, 0x20.
   ② The beacon ID is set as the Minor of the iBeacon.
   ③ Beacons must be pre-configured with the above UUID using a beacon configuration tool for the smartwatch to detect them.
(8) Configuring Beacon Parameters: Use a beacon configuration tool to set beacon parameters.
   Troubleshooting Beacon Scanning Issues:
   ① Distance: Different smartwatches may have varying Bluetooth ranges.
   ② Beacon Broadcast Frequency: If the beacon's default broadcast interval (500ms) prevents detection, try setting it to 200ms or 100ms.
   ③ Firmware Scanning Duty Cycle: The watch firmware’s scanning duty cycle is currently unmodifiable but can be

customized upon request.

(9) Signal Strength Sorting: The smartwatch sorts up to three detected beacons in descending order of signal strength.

(10) Enabling Beacon Scanning via LoRaWAN Downlink: Refer to the downlink protocol for specifics.

(11) Power-Saving Mode: If the smartwatch remains stationary for 1 minute, the firmware stops scanning beacons to save power. Scanning resumes when movement is detected (XYZ acceleration).

(12) Use Cases: Beacon scanning is used for precise positioning, zone determination, and applications in factories, hospitals, and similar environments.

2.3 Additional Notes on Time Calibration

The device will scan the gateway and calibrate the time according to the defined protocol:

Initial Upgrade or Power Loss:

- If the device undergoes its first upgrade (equivalent to a power loss), the time calibration mechanism will be triggered.
- Once the device enters the Bluetooth base station's signal range, it automatically captures the broadcast time from the base station and synchronizes its internal clock.

Power Loss:

- If the device loses power, the time resets to January 1, 2021, and the same process as described in point 1 will be followed.

Previously Calibrated Time:

- If the device has already been calibrated (whether the calibration was accurate or not), it will not automatically re-calibrate as long as it remains powered.
- If the time is incorrect, it must be corrected via the APP or by sending a command through LoRaWAN.

Increased Power Consumption During Scanning:

- The device's power consumption increases during the scanning process.

Balance Between Functionality and Power Consumption:

- The above mechanisms are designed to balance the functionality and power efficiency of the device.

Calibration Flag in Bluetooth Broadcast:

- Before calibration, the Bluetooth broadcast's time calibration flag is set to 0.
- After successful calibration, the flag changes to **1**.

2.4 SOS

a) Activating SOS:

- Press and hold the red button for 5 seconds. The device will vibrate and enter the SOS page.

b) Bluetooth Broadcast Characteristics:

- The SOS flag in the Bluetooth broadcast is set to 1 and remains active for 60 seconds before resetting to 0.

c) LoRaWAN Transmission Characteristics:

- SOS data is transmitted continuously every 20 seconds after entering the SOS page, and the transmission stops when the SOS state is exited.

2.5 Bluetooth Broadcast Protocol

Broadcast Interval

- The broadcast interval is **300ms**.
- There are **2 types of broadcasts**, alternating every second.

First Broadcast Format

Field	Size	Description
Broadcast Type	2 bytes	020106: 02: 2 bytes of data. 01: AD type flag. 06: Supports LE General Discoverable Mode; does not support BR/EDR.
Custom Header	4 bytes	0x17 0xff 0x00 0x01: Indicates the first broadcast type. 17ff0001: 17: 23 bytes of data. ff0001: Occupies 3 bytes, with the remaining 20 bytes for body data. ff: AD type for user-defined data. 0001: Broadcast type 1 (this device has two broadcast types).
Blood Oxygen (SpO2)	1 byte	• Value range: 0-99. • Measured under calm conditions; otherwise, results may be inaccurate. • Note: Use cautiously if activity level is below 10; accuracy is unreliable above 50.
Stress Level	1 byte	• Range: 0-255 • Stress value above 30 indicates focus. Accurate only under stationary conditions. • Note: Use cautiously if activity level exceeds 10; accuracy is unreliable above 50.
RRI (HRV)	2 bytes	High byte first. Example: 0x033f = 831ms.
Activity Level	1 byte	Value range: 0-255. Larger values indicate less stress or activity. A higher value indicates higher activity. This also affects the accuracy of SpO2 and stress values.
Blood Pressure (SBP)	1 byte	Systolic Blood Pressure value.
Blood Pressure	1 byte	Diastolic Blood Pressure value.

Field	Size	Description
(DBP)		
Calories	2 bytes	Low byte first. Example: 0300 = 0x0003 = 3 calories.
Skin Temperature	2 bytes	● Measured directly by the sensor, unit: 0.01°C. ● Low byte first. Example: d00a = 0x0ad0 = 27.68°C.
Steps Today	2 bytes	Low byte first. Example: 4300 = 0x0043 = 67 steps.
Body Temperature	2 bytes	● Range: 36°C to 40°C. ● Low byte first. ● If temperature exceeds 40°C, displays Hi (ASCII: 0x48 0x69). ● If temperature is below 36°C, displays Lo (ASCII: 0x4C 0x6F). ● Example: f80d = 0x0df8 = 35.76°C.
Heart Rate	1 byte	Example: 0x40 = 64 BPM.
SOS Status	1 byte	Press and hold the physical button for 3 seconds. SOS = 1 (active for 60 seconds), normal = 0.
Battery Level	1 byte	Value range: 5, 10, 20, ..., 100%.
Fall detection	1 byte	Flag = 1 for detected fall (active for 60 seconds), normal = 0.
Device Name	4 bytes	The device name is S1, and occupies 4 bytes.
Total Size	**31 bytes**	Broadcast packet size.

Broadcast Example

Hexadecimal Representation:

02010617ff000163010903A90566481100D10B6501130E40001402
03094131

Field Breakdown:

Field	Value	Description
Broadcast Type	020106	Indicates LE General Discoverable

Field	Value	Description
		Mode, no BR/EDR support.
Custom Header	17ff0001	First broadcast type.
Blood Oxygen (SpO2)	63	0x63 = 99%.
Stress Level	09	0x09 = 9. Relaxed state (values below 30 indicate relaxation).
RRI (HRV)	03A9	0x03A9 = 937ms.
Activity Level	05	0x05 = 5.
Blood Pressure (SBP)	66	0x66 = 102.
Blood Pressure (DBP)	48	0x48 = 72.
Calories	1100	0x0011 = 17 calories.
Skin Temperature	D10B	0x0BD1 = 30.25°C.
Steps Today	6501	0x0165 = 357 steps.
Body Temperature	130E	0x0E13 = 36.03°C.
Heart Rate	40	0x40 = 64 BPM.
SOS Status	00	0: No SOS event.
Battery Level	14	0x14 = 20%.
Fall Detection		Flag = 1 for detected fall (active for 60 seconds), normal = 0.
Device Name	03094131	• 03 = 3 bytes of data. • 09 indicates the AD type is a complete device name. • 4131 = "S1".

Second Broadcast Format

Field	Size	Description
Broadcast Type	2 bytes	0x02 0x01 0x06: Indicates LE General Discoverable Mode, no BR/EDR support.
Custom Header	4 bytes	0x17 0xff 0x00 0x02: Indicates the second broadcast type.
Beacon ID 1	2 bytes	High byte first.

Field	Size	Description
RSSI of Beacon ID 1	1 byte	Positive integer after removing the negative sign (e.g., -45 becomes 45).
Beacon ID 2	2 bytes	High byte first.
RSSI of Beacon ID 2	1 byte	Positive integer after removing the negative sign (e.g., -60 becomes 60).
Beacon ID 3	2 bytes	High byte first.
RSSI of Beacon ID 3	1 byte	Positive integer after removing the negative sign (e.g., -63 becomes 63).
Movement Detection	1 byte	1: Movement detected, 0: No movement detected.
Deep Sleep Time	2 bytes	Minutes, low byte first.
Light Sleep Time	2 bytes	Minutes, low byte first.
Fatigue Level	1 byte	Value range: 0-100, where 100 is maximum fatigue. Updates daily at 7 AM and resets at midnight.
Wearing Status	1 byte	1 = Worn, 0 = Not worn.
Time Calibration Flag	1 byte	1 = Time calibrated, 0 = Not calibrated.
RTC Hour	1 byte	Real-time clock (hour).
RTC Minute	1 byte	Real-time clock (minute).
RTC Second	1 byte	Real-time clock (second).
Device Name	4 bytes	Example: S1. Configured based on the project.
Total Bytes	**31 bytes**	Total broadcast packet size.

Example Broadcast Data:

Raw Data:
02010617ff000200422D00553C00253F01B70065014201010815000
3095331

Field	Value	Explanation
Broadcast Type	020106	2-byte data, 0x01 indicates AD type is flag, 0x06 = LE support only, no BR/EDR.
Custom Header +	17ff0002	AD type is user-defined data,

Field	Value	Explanation
Company ID		broadcast type 2.
Beacon ID 1	0042	0x0042 = 66 (high byte first).
RSSI of Beacon 1	2D	0x2D = 45, RSSI = -45.
Beacon ID 2	0055	0x0055 = 85 (high byte first).
RSSI of Beacon 2	3C	0x3C = 60, RSSI = -60.
Beacon ID 3	0025	0x0025 = 37 (high byte first).
RSSI of Beacon 3	3F	0x3F = 63, RSSI = -63.
Movement Detection	01	1 = Movement detected.
Deep Sleep Time	B700	0x00B7 = 183 minutes (low byte first).
Light Sleep Time	6501	0x0165 = 357 minutes (low byte first).
Fatigue Level	42	0x42 = 66 (higher value = more fatigued).
Wearing Status	01	1 = Device worn.
Time Calibration Flag	01	1 = Time calibrated.
RTC Hour	08	0x08 = 8 AM.
RTC Minute	15	0x15 = 21 minutes.
RTC Second	00	0x00 = 0 seconds.
Device Name	03095331	03 = 3 bytes, 09 indicates AD type for complete device name, 5331 = S1.

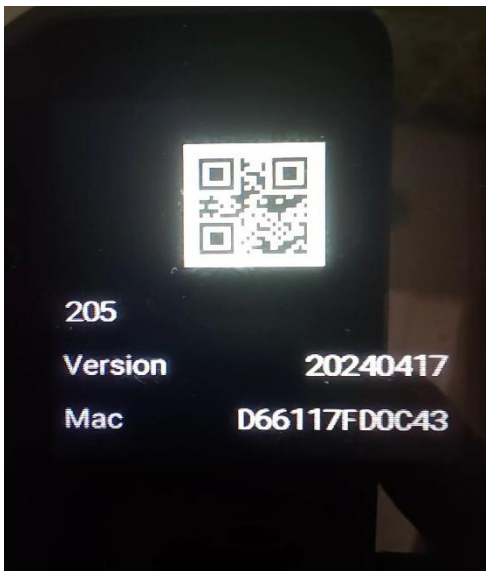
3. LoRaWAN Network Joining

Basic Information

- OTAA Join Mode
- Class A
- DevEUI: Add 00 at the front of the Bluetooth MAC address (refer

to the image below).

- Smartwatch Bluetooth MAC: 6 bytes.
- LoRa DevEUI: 0000 + Bluetooth MAC address.



Example:

- Bluetooth MAC: D6B72EF30D79
- LoRa DevEUI: 0000D6B72EF30D79
- AppKey: 112233445566778899aa112233445566
- Application EUI: Same as DevEUI

Steps for LoRaWAN Network Joining

Check and Set Frequency

- Navigate to the QR code page in the menu.
- Press and hold both buttons for 3 seconds to enter the Region Setting page.
- Verify if the frequency is correctly set. If not, use the up/down buttons to change the frequency.

- Once the correct frequency is selected, short press the touch button. If the smartwatch vibrates, the frequency is set successfully (refer to the image below).

Restart the Smartwatch

- Press and hold both buttons simultaneously to restart the smartwatch.
- After restarting, the device will automatically attempt to join the network for 10 minutes.

Retry Network Join

- If the device fails to join the network within the first 10 minutes, it will retry during the first 10 minutes of the next hour.
- To avoid waiting, you can restart the device, and it will immediately attempt to join the network again.

How to Set Frequency Bands

- Navigate to the QR code page in the menu.
- Press and hold both buttons to enter the Region Setting page.

Steps to Set the Region:

- Use the side buttons to scroll up or down and select the desired region.
- Short press the touch button to confirm the region.
- After confirmation, press and hold both buttons simultaneously to restart the device. The settings will take effect after the device restarts.

4. LoRaWAN Uplink Protocol

The LoRaWAN uplink protocol consists of three types of packets:

1. **Body Data Packet:** 48 bytes
2. **GPS Data Packet:** 22 bytes
3. **SOS Data Packet:** 9 bytes

Body Data Packet (48 bytes)

The 48 bytes of body data are divided into the following sections:

Byte 1 to 20

Field	Size	Description
Blood Oxygen	1 byte	**Range:** 0-99, blood oxygen saturation. Accurate only when tested in a calm state; otherwise, results may be inaccurate (refer to the technical documentation).If the activity level is below 10, use cautiously; if it exceeds 50, accuracy is

Field	Size	Description
		unreliable.
Respiration	1 byte	Breathing rate per minute.
Stress	1 byte	0-255. Stress values above 30 indicate focus. Accurate only under stationary conditions. Note: Use cautiously if activity level exceeds 10; accuracy is unreliable above 50.
RRI (HRV)	2 bytes	High byte first. Range: milliseconds. Example: 0x033f = 831 ms.
Activity Level	1 byte	Higher values indicate greater activity. Used to evaluate the accuracy of stress and SpO2 readings.
SBP (Systolic BP)	1 byte	Systolic blood pressure.
DBP (Diastolic BP)	1 byte	Diastolic blood pressure.
Calories	2 bytes	2 bytes Bytes stored in little-endian (low byte first) Calories: 0x0300 = 3 calories.
Surface Temp	2 bytes	Little-endian (low byte first) Skin Temperature: 0x0ad0 = 27.68°C (unit: 0.01°C).
Daily Steps	2 bytes	Little-endian (low byte first) For example: Steps Count: 0x0043 = 67 steps
Body Temp	2 bytes	Special Notes for Body Temperature: ● If body temperature exceeds 40°C, the watch displays Hi (ASCII: 0x48, 0x69). ● If body temperature falls below 36°C, the watch displays Lo (ASCII: 0x4C, 0x6F). Example: 0x0df8 = 35.76°C.
Heart Rate	1 byte	Beats per minute (BPM). Example: 0x40 = 64 BPM.
SOS Status	1 byte	Press and hold the physical button for 3 seconds. SOS = 1 (active for 60 seconds); otherwise, SOS = 0.
Battery Level	1 byte	Valid values: 5, 10, 20, 30, ..., 100 (%).

Field	Size	Description
Fall Flag	1 byte	Flag = 1 when a fall is detected (active for 60 seconds); otherwise, it is 0.

Bytes 21 to 40

Field	Size	Description
Beacon ID1	2 bytes	High byte first.
Beacon ID1 RSSI	1 byte	Positive integer (absolute value of RSSI without the negative sign).
Beacon ID2	2 bytes	High byte first.
Beacon ID2 RSSI	1 byte	Positive integer (absolute value of RSSI without the negative sign).
Beacon ID3	2 bytes	High byte first.
Beacon ID3 RSSI	1 byte	Positive integer (absolute value of RSSI without the negative sign).
Movement Detection	1 byte	1 for movement detected, 0 for no movement. Movement detection lasts 3 seconds, then resets to 0.
Deep Sleep Time	2 bytes	Low byte first. Time in minutes.
Light Sleep Time	2 bytes	Sleep tracking: 1. Sleep time is recorded between **10:00 PM and 6:00 AM**. 2. Data updates at **7:00 AM the next day**. Data is cleared at **midnight**, including displayed and broadcast data.
Fatigue Level	1 byte	0-100, higher values indicate greater fatigue (100 is the most fatigued) Fatigue level updates at **7:00 AM daily** and remains unchanged throughout the day. It resets to 0 at **midnight**
Wearing	1	1 for wearing the device, 0 for not wearing.

Field	Size	Description
Status	byte	

Time Calibration and RTC Information

Field	Size	Description
Time Calibration	1 byte	0 = Not calibrated, 1 = Calibrated.
Hour	1 byte	Current RTC hour.
Minute	1 byte	Current RTC minute.
Second	1 byte	Current RTC second.

Bytes 41 to 48

Field	Size	Description
Device MAC	6 bytes	Bluetooth MAC address of the device.
Terminator	1 byte	\r (carriage return).
Terminator	1 byte	\n (line feed).

Example Breakdown of the Data Packet:

Data Packet:
63100903A90566481100D10B6501130E4000140000422D00553C0
0253F01B70065014201010815 00C5B4FBB43BF40D0A

Breakdown and Description:

Field	Data	Description
Blood Oxygen	0x63	99% (SpO2)
Respiratory Rate	0x10	16 breaths/minute
Emotional Stress	0x09	9 (Relaxation if below 30).
RRI (HRV)	0x03A9	937ms (High byte first).
Activity Level	0x05	5 (Higher values indicate more intense activity).
SBP (Blood Pressure)	0x66	102 mmHg

Field	Data	Description
DBP (Blood Pressure)	0x48	72 mmHg
Calories	0x1100	17 calories (Low byte first).
Surface Temperature	0x0BD1	30.25°C (Low byte first).
Step Count	0x6501	357 steps (Low byte first).
Body Temperature	0x0E13	36.03°C (Low byte first).
Heart Rate	0x40	64 bpm.
SOS	0x00	0 = No SOS event (Non-zero indicates an SOS event).
Battery Level	0x14	20%.
Fall Detection	0x00	0 = No fall (1 indicates a fall detected for 1 minute).
Beacon 1 ID	0x0042	66 (High byte first).
Beacon 1 RSSI	0x2D	-45 RSSI (Absolute value).
Beacon 2 ID	0x0055	85 (High byte first).
Beacon 2 RSSI	0x3C	-60 RSSI (Absolute value).
Beacon 3 ID	0x0025	37 (High byte first).
Beacon 3 RSSI	0x3F	-63 RSSI (Absolute value).
Movement Detection	0x01	1 = Movement detected (0 indicates no movement).
Deep Sleep Time	0x00B7	183 minutes (Low byte first).
Light Sleep Time	0x0165	357 minutes (Low byte first).
Fatigue Level	0x42	66 (Maximum: 100, higher value indicates more fatigue).
Wearing Status	0x01	1 = Device is being worn (0 indicates not worn).
Time Calibration	0x01	1 = Time calibrated (0 indicates not calibrated).
RTC Hour	0x08	8:00 (Hour in device RTC).
RTC Minute	0x15	21 minutes (Minute in device RTC).

Field	Data	Description
RTC Second	0x00	0 seconds (Second in device RTC).
Device MAC Address	0xC5B4FBB43BF4	Device's BLE MAC Address.
LoRaWAN DevEUI	0x0000C5B4FBB43BF4	LoRaWAN DevEUI (Add two leading bytes 0x00).
Terminator	0x0D0A	Carriage return (\r) and line feed (\n) - End of the packet.

GPS Data Packet (22 Bytes)

The GPS data packet consists of 22 bytes:

Parameter	Size	Details
GPS Longitude	8 bytes	WGS84 coordinate system, format dddmm.mmmm, stored as a **little-endian double**.
GPS Longitude Direction	1 byte	'E' = 0x45 for East longitude, 'W' = 0x57 for West longitude.
GPS Latitude	8 bytes	WGS84 coordinate system, format dddmm.mmmm, stored as a **little-endian double**.
GPS Latitude Direction	1 byte	'N' = 0x4E for North latitude, 'S' = 0x53 for South latitude.
Default	1 byte	Reserved field.
Default	1 byte	Reserved field.
Terminator 1	1 byte	\r.
Terminator 2	1	\n.

Example:

7EC68503ED2AC64045707CED997578A1404E00010D0A

7EC68503ED2AC640 (GPS Longitude):

- Little-endian double: 0x40C62AED0385C67E.
- Converted to decimal: 11349.85167.
- Format: dddmm.mmmm (WGS84 coordinate system).

45 (Longitude Direction):

- 0x45 = 'E', representing East Longitude.

707CED997578A140 (GPS Latitude):

- Little-endian double: 0x40A1787599ED7C70.
- Converted to decimal: 2236.22969.
- Format: dddmm.mmmm (WGS84 coordinate system).

4E (Latitude Direction):

- 0x4E = 'N', representing North Latitude.

0000 (Default): Reserved.

0D0A (Terminator): End of data (\r\n).

SOS Data Packet (9 Bytes)

The SOS data packet consists of 9 bytes:

Parameter	Size	Details
SOS Status	1 byte	Non-zero for SOS active, 0 for no SOS.
Device MAC	6 bytes	BLE MAC address of the device.
Terminator 1	1 byte	\r.
Terminator 2	1 byte	\n.

Example:

03ae34afa323e20d0a

- 03 (SOS Status): Non-zero indicates SOS is active.
- ae34afa323e2 (Device BLE MAC Address):
  - Add two high bytes 0x00: 0x0000C5B4FBB43BF4 (LoRaWAN EUI).

0D0A (Terminator): End of data (\r\n).

Packet Transmission Intervals

Default intervals:

- Body Data: Sent every 1 minute.
- GPS Data: Sent every 5 minutes.
- SOS Data: Sent every 20 seconds when SOS is active and stops when SOS is deactivated.

Handling multiple packets:

- If multiple packets are queued, the second packet waits until the first packet is sent.
- Approximately 10 seconds delay between consecutive packets.

Example Transmission Schedule (Default):

1. At 7:05 AM:
2. 07:05:00: Send Body Data (48 bytes). GPS power is turned on.
3. 07:05:50: Send GPS Data (22 bytes). GPS power is turned off.
4. 07:06:00: Send Body Data (48 bytes).
5. 07:07:00: Send Body Data (48 bytes).
6. 07:08:00: Send Body Data (48 bytes).
7. 07:09:00: Send Body Data (48 bytes).
8. 07:10:00: Send Body Data (48 bytes). GPS power is turned on.
9. 07:10:50: Send GPS Data (22 bytes). GPS power is turned off.

4. Continuous GPS Transmission (1-minute interval)
If GPS is configured to send data every minute, both GPS and Body Data are sent at 1-minute intervals.

Example Transmission Schedule (Continuous GPS):

At 7:05 AM:

1) 07:05:00: Send Body Data (48 bytes). GPS power is turned on.
2) 07:05:50: Send GPS Data (22 bytes). GPS power is turned off.
3) 07:06:00: Send Body Data (48 bytes). GPS power is turned on.
4) 07:06:50: Send GPS Data (22 bytes). GPS power is turned off.
5) 07:07:00: Send Body Data (48 bytes). GPS power is turned on.
6) 07:07:50: Send GPS Data (22 bytes). GPS power is turned off.

Note: Due to mechanisms like preamble and re-transmissions, packet timings may not precisely align with the clock (e.g., 7:05:00). This is normal behavior.

How to Convert an 8-Byte Double Value into a Decimal

Here is an example explaining how to convert an 8-byte double value into a decimal latitude in the dddmm.mmmmm format.


```
void double_test(void)
{
    uint8 u8_n[8] = {0};
    uint8 u8_e[8] = {0};
    double n = 2236.22969;
    double e = 11349.85167;
    memcpy(u8_n,(uint8*)&n,8);
    memcpy(u8_e,(uint8*)&e,8);
    NRF_LOG_HEXDUMP_INFO(u8_n, 8);//70 7C ED 99 75 78 A1 40
    NRF_LOG_HEXDUMP_INFO(u8_e, 8);//7E C6 85 03 ED 2A C6 40

}
```

Example

The latitude obtained is **22°36.22969'N**, which fits the dddmm.mmmmm format.

The hexadecimal data uploaded via LoRaWAN is:
70 7C ED 99 75 78 A1 40.

Since the system uses **little-endian**, the data should be interpreted as:
0x40A1787599ED7C70.

Breaking Down the Double Format

In the double type, the data is represented as:

- Sign Bit (S): 1 bit.
- Exponent (E): 11 bits.
- Mantissa (M): 52 bits.

For 0x40A1787599ED7C70, converting to binary:
0100000010100001011110000111010110011001111011010111110001110000.

1. **Sign Bit:**
    - The first bit is 0, so the number is positive.
2. **Exponent (E):**

- Bits 2-12: 10000001010 = 1034 (decimal).
- Subtract 1023 (the bias for double types):
  1034 - 1023 = 11.

3. Mantissa (M):

- Bits 13-64:
  0001011110000111010110011001111011010111110001110000.
- In scientific notation, this is represented as:
  1.0001011110000111010110011001111011010111110001110

00 (binary).

4. Calculate the Decimal Value:

- The exponent value is 11, so the binary point is moved 11 places to the right:
100010111100.00111010110011001111011010111110001110000.

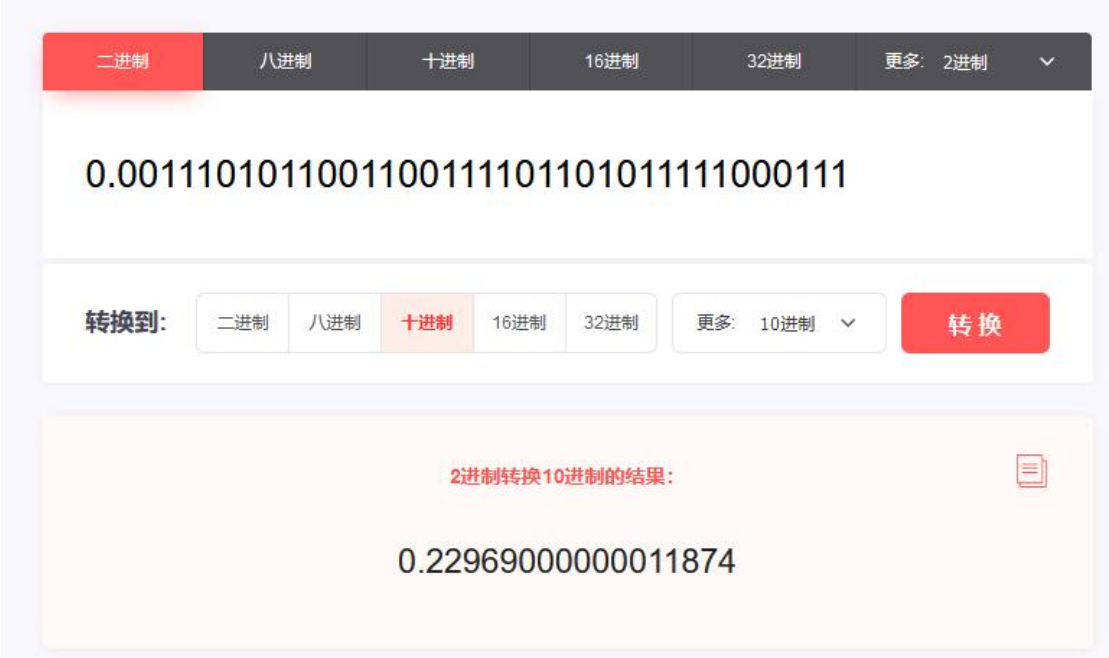
- **Integer Part:** 100010111100 = 2236.

- **Fractional Part:** To calculate the fractional part:
Each binary digit is expanded based on its power of 2. For example:

（ 101.101 ） 2=1*22+0*21+1*20+1*2-1+0*2-2+1*2-3=

（5.625）10

Following this method, the fractional part calculates to:
0.22969000000000011874.



Final Result

Combining the integer and fractional parts:
2236.22969 matches the original data.

Thus, the latitude is:
22°36.22969'N = 22.60382817°N (decimal degrees).

Similarly, using the same method, the longitude is calculated as:
113.8308612°E.

Coordinate Format Conversion

- The coordinate 113.8308612°E, 22.60382817°N is in the WGS84 format.
- WGS84 is compatible with Google Maps (international).

To use these coordinates in Chinese mapping systems, you need to convert them:

1. GCJ-02 for Google Maps China, AMap (Gaode), and Tencent Maps.
2. BD-09 for Baidu Maps.

Tools for Coordinate Conversion
You can use online tools to convert coordinates between formats:
Coordinate Conversion Tool

Simplified Approach
Instead of manually converting, the double value can be directly assigned to a double type variable in a programming language (e.g., Python, C++, etc.), which will automatically parse the decimal value. This method depends on the programmer's familiarity with their platform and its data-handling capabilities.

5. LoRaWAN Downlink Protocol

(1) Synchronizing the Watch's Local Time

The time synchronization protocol is as follows:

Format:
TIME:yyyy-mm-dd-hh-mm-ss\r\n

Example:

Time: 2023-05-18 18:23:23
Hexadecimal Representation:
0x54494D453A 323032332D30352D31382D31382D32332D3233 0D0A

- Start String: TIME:
- Time Body: yyyy-mm-dd-hh-mm-ss (Year, Month, Day, Hour, Minute, Second)
- End String: \r\n

(2) Setting Uplink Data Reporting Frequency

Set the uplink protocol to \u0055\u0050\u004c\u0049\u004e\u004b\u003a

Protocol Format:
UPLINK:a,b\r\n

Example:
Set body data upload frequency to 7 (1 minute) and GPS data upload frequency to 1 (5 minutes):

UPLINK:7,1

Hexadecimal Representation:

0x55504C494E4B3A 372C31 0D0A

- Start String: UPLINK:
- Data Body (a,b):
- a (1-7): Body data upload intervals in minutes (5, 10, 15, 30, 60, 120, 1).
- b (1-7): GPS data upload intervals in minutes (5, 10, 15, 30, 60, 120, 1).
- End String: \r\n

(3) Setting Alarm Information

Protocol Format:
ALERT:a,b\r\n

Example:
Set alarm mode to sound alert (1) and alarm tone to 1:
ALERT:1,1

Hexadecimal Representation:
0x414C4552543A 312C31 0D0A

Start String: ALERT:

Data Body (a,b):

- a (1-2):
  1: Sound alarm.
  2: Vibrate for 200ms.

- b (0-6):
  0: Stop the alert.
  1-6: Choose one of six alarm tones. (If a=2, b is ignored.)

End String: \r\n

(4) Pushing Text Messages to the Watch

Protocol Format:

MSG:<message>\r\n

Message Encoding: UTF-8.

Example:
Send the message "Hello" to the watch:

Hexadecimal Representation:

0x4D53473A 48656C6C6F 0D0A

- **Start String:** MSG:
- **Message Content:** UTF-8 encoded "Hello".
- **End String:** \r\n

Note:

- The total byte count (from 0x4D53473A to \n) must not exceed **220 bytes**

(5) Setting Personal Information

Setting personal information is a special type of message, identified by a **checksum**. The data structure is consistent with a general message.

Data Format

0x4D53473A <Personal Information Content + Checksum> 0D0A

- **Start String:** MSG: (0x4D53473A)
- **Content:** UTF-8 encoded personal information + checksum.
- **End String:** \r\n (0D0A).

Personal Information Structure

Field	Size	Details
Total Length	2 bytes	Total length excluding its own 2 bytes and the CRC checksum (low byte first).

Information Type	1 byte	Used for compatibility across multiple user information types (default: 0x00).
First Field Length	2 bytes	Length of the first field (low byte first).
First Field Content	Variable	UTF-8 encoded. Example: "xxx School" or "xxx Hospital".
Second Field Length	2 bytes	Length of the second field (low byte first).
Second Field Content	Variable	UTF-8 encoded. Example: "Class" or "Department Name".
Third Field Length	2 bytes	Length of the third field (low byte first).
Third Field Content	Variable	UTF-8 encoded. Example: "Student Name" or "Patient Name".
Fourth Field Length	2 bytes	Length of the fourth field (low byte first).
Fourth Field Content	Variable	UTF-8 encoded. Example: "Student ID" or "Patient ID".
CRC Checksum	2 bytes	CRC16 checksum for validation.

Notes

1. Each field supports **mixed Chinese and English text**.
2. Each field is limited to **20 characters**, regardless of language.
3. These fields can be customized to match project requirements.

Example Use Case in LoRa Project:

- **Field 1:** Name (e.g., "John Doe")
- **Field 2:** ID (e.g., "12345")
- **Field 3:** Unit (e.g., "XYZ School")
- **Field 4:** Card Number (e.g., "67890")

Examples

Setting Field 1 to "William":

0x4D53473A100000070057696C6C69616D000000000000DE080D0A

- 4D53473A: Prefix (MSG:).
- 1000: Total length (16 bytes = 0x0010, little-endian).
- 00: Information category.
- 0700: Field 1 length = 7 bytes.
- 57696C6C69616D: Field 1 content = "William" (UTF-8 encoded).
- 000000000000: Padding (remaining unused fields).
- DE08: CRC checksum.
- 0D0A: Terminator (\r\n).

Setting Field 1 to "1":

0x4D53473A0A0000100310000000000051490D0A

- Total length = 10 bytes (0x000A, little-endian).
- Field 1 = 1 (length = 1 byte).

Setting Field 2 to "1":

0x4D53473A0A0000000010031000000000111E0D0A

- Total length = 10 bytes.
- Field 2 = 1 (length = 1 byte).

Setting All Four Fields:

0x4D53473A220000070049536D617263680700E983A8E997A8320
70057696C6C69616D040037383930E3A70D0A

- 2200: Total length = 34 bytes (0x0022, little-endian).
- Field 1: "ISmarch" (7 bytes, 49 53 6D 61 72 63 68).
- Field 2: "部门 2" (7 bytes, UTF-8 encoded as E9 83 A8 E9 97 A8 32).
- Field 3: "William" (7 bytes, 57 69 6C 6C 69 61 6D).
- Field 4: "7890" (4 bytes, 37 38 39 30).
- E3A7: CRC checksum.
- 0D0A: Terminator (\r\n).

Display Limitations

If the screen cannot display the entire content of a field, only the part that fits is shown.

Example:

If **Field 1** is set to "We Are Earthlings" but the screen can only display 5 characters in a row, the display will show: "We Are Eart."

**********CRC16 Checksum **********

```
static const uint8_t aucCRCHi[] = {
  0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0,
0x80, 0x41,
  0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1,
0x81, 0x40,
  0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0,
0x80, 0x41,
  0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
0x80, 0x41,
  0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0,
0x80, 0x41,
  0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1,
0x81, 0x40,
  0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1,
0x81, 0x40,
  0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1,
0x81, 0x40,
  0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0,
0x80, 0x41,
  0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1,
0x81, 0x40,
  0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0,
0x80, 0x41,
  0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
0x80, 0x41,
  0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0,
0x80, 0x41,
  0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
0x80, 0x41,
```

```
    0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0,
0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1,
0x81, 0x40,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0,
0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0,
0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40
};

static const uint8_t aucCRCLo[] = {
    0x00, 0xC0, 0xC1, 0x01, 0xC3, 0x03, 0x02, 0xC2, 0xC6, 0x06,
0x07, 0xC7,
     0x05, 0xC5, 0xC4, 0x04, 0xCC, 0x0C, 0x0D, 0xCD, 0x0F,
0xCF, 0xCE, 0x0E,
    0x0A, 0xCA, 0xCB, 0x0B, 0xC9, 0x09, 0x08, 0xC8, 0xD8,
0x18, 0x19, 0xD9,
    0x1B, 0xDB, 0xDA, 0x1A, 0x1E, 0xDE, 0xDF, 0x1F, 0xDD,
0x1D, 0x1C, 0xDC,
    0x14, 0xD4, 0xD5, 0x15, 0xD7, 0x17, 0x16, 0xD6, 0xD2,
0x12, 0x13, 0xD3,
    0x11, 0xD1, 0xD0, 0x10, 0xF0, 0x30, 0x31, 0xF1, 0x33, 0xF3,
0xF2, 0x32,
    0x36, 0xF6, 0xF7, 0x37, 0xF5, 0x35, 0x34, 0xF4, 0x3C, 0xFC,
0xFD, 0x3D,
    0xFF, 0x3F, 0x3E, 0xFE, 0xFA, 0x3A, 0x3B, 0xFB, 0x39, 0xF9,
0xF8, 0x38,
    0x28, 0xE8, 0xE9, 0x29, 0xEB, 0x2B, 0x2A, 0xEA, 0xEE, 0x2E,
0x2F, 0xEF,
    0x2D, 0xED, 0xEC, 0x2C, 0xE4, 0x24, 0x25, 0xE5, 0x27, 0xE7,
0xE6, 0x26,
    0x22, 0xE2, 0xE3, 0x23, 0xE1, 0x21, 0x20, 0xE0, 0xA0, 0x60,
```

```
0x61, 0xA1,
   0x63, 0xA3, 0xA2, 0x62, 0x66, 0xA6, 0xA7, 0x67, 0xA5, 0x65,
0x64, 0xA4,
   0x6C, 0xAC, 0xAD, 0x6D, 0xAF, 0x6F, 0x6E, 0xAE, 0xAA,
0x6A, 0x6B, 0xAB,
   0x69, 0xA9, 0xA8, 0x68, 0x78, 0xB8, 0xB9, 0x79, 0xBB, 0x7B,
0x7A, 0xBA,
   0xBE, 0x7E, 0x7F, 0xBF, 0x7D, 0xBD, 0xBC, 0x7C, 0xB4, 0x74,
0x75, 0xB5,
   0x77, 0xB7, 0xB6, 0x76, 0x72, 0xB2, 0xB3, 0x73, 0xB1, 0x71,
0x70, 0xB0,
   0x50, 0x90, 0x91, 0x51, 0x93, 0x53, 0x52, 0x92, 0x96, 0x56,
0x57, 0x97,
   0x55, 0x95, 0x94, 0x54, 0x9C, 0x5C, 0x5D, 0x9D, 0x5F, 0x9F,
0x9E, 0x5E,
   0x5A, 0x9A, 0x9B, 0x5B, 0x99, 0x59, 0x58, 0x98, 0x88, 0x48,
0x49, 0x89,
   0x4B, 0x8B, 0x8A, 0x4A, 0x4E, 0x8E, 0x8F, 0x4F, 0x8D, 0x4D,
0x4C, 0x8C,
   0x44, 0x84, 0x85, 0x45, 0x87, 0x47, 0x46, 0x86, 0x82, 0x42,
0x43, 0x83,
   0x41, 0x81, 0x80, 0x40
};
```

CRC16 Function:

```
uint16_t usMBCRC16( uint8_t * pucFrame, uint16_t usLen )
  {
    uint8_t ucCRCHi = 0xFF;
    uint8_t ucCRCLo = 0xFF;
    uint16_t iIndex;
    while( usLen-- )
    {
        iIndex = ucCRCLo ^ *( pucFrame++ );
        ucCRCLo = ( uint8_t )( ucCRCHi ^ aucCRCHi[iIndex] );
        ucCRCHi = aucCRCLo[iIndex];
    }
    return ( uint16_t )( ucCRCHi << 8 | ucCRCLo );
```

```
}
```

(6) Setting Bluetooth Beacon Scanning On/Off

The protocol for enabling or disabling Bluetooth scanning is as follows:

Format:

SCAN:a\r\n

Example:
Enable Bluetooth scanning:

SCAN:1

Hexadecimal Representation: 0x5343414E3A 31 0D0A

- Start String: SCAN: (0x5343414E3A)
- Parameter (a):
  - 0: Disable Bluetooth scanning.
  - 1: Enable Bluetooth scanning.
- End String: \r\n (0D0A).

(7) Set GPS automatic time synchronization

SYNC:a,b

Example: SYNC:1,-120

0x53594E433A 312C2D313230 0D0A

Start character: SCAN: 1,-120 End character

- a range: 0-1, where 0 means disable automatic time synchronization, and 1 means enable automatic time synchronization.

- b range: -720 to 720, representing the time difference(minutes) between the respective time zone and Greenwich Mean Time (GMT).

More examples:

SYNC:1,210

0x53594E433A 312C323130 0D0A

SYNC:1,60

0x53594E433A 312C3630 0D0A

(8) Setting Screen On/Off

The protocol for enabling or disabling screen display is as follows:

Format:

SCREEN:a\r\n

Example:
Enable Screen display:

SCREEN:1

Hexadecimal Representation: 0x53435245454e3A 31 0D0A

- Start String: SCREEN: (0x53435245454e3A)
- Parameter (a):
  - 0: Disable Screen display.
  - 1: Enable Screen display.
- End String: \r\n (0D0A).

6. Technical Reference Documentation

Floating-Point Conversion Resources:

Floating Point (float, double) Memory Storage:
CSDN Article on Floating-Point Storage

Converting Binary Numbers with Decimals to Decimal Format:
Steps to Convert Binary to Decimal

Binary-to-Decimal Conversion Tool:
Binary to Decimal Calculator