

**60G Millimeter Wave Radar Module  
R60ABD2  
Sleep monitoring radar module  
User manual (Ver.2.3)**

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**Notes:**

Click on the link or scan the QR code to make sure you're using the latest document:

[http://en.micradar.cn/go\\_file.php?id=202](http://en.micradar.cn/go_file.php?id=202)

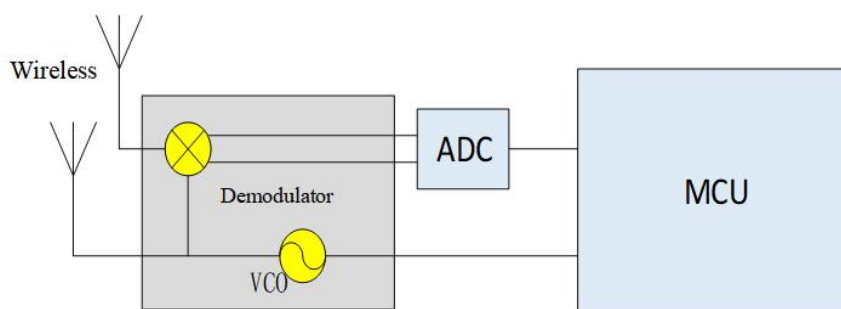
## 1. Overview

This document mainly describes how to use the module of R60ABD2 to develop a product and explain the problems should be paid attention to during the process. The manual can help to reduce the design cost and increase the stability of the product, which can improve the efficiency of development.

From the hardware circuit reference design, the layout requirements of the radar antenna and the housing, how to distinguish the interference and the multi-function standard UART protocol output.

This module is a self-developed air sensing device, which is composed of a radio frequency antenna, radar chip and high-speed main frequency MCU. It relies on a stable, flexible and superior algorithm architecture to solve users' various detecting requirements. It can be used with a host computer software or a host to flexibly output detection status and data. It contains several groups of GPIOs, which can satisfy user-customized development requirements.

## 2. Working principle



**Figure 1**

radar transmits a 60 G-band millimeter wave signal, and the measured target reflects the electromagnetic wave signal, and demodulates the transmitted signal, and then processes it through amplification, filtering, and ADC to obtain echo demodulated signal data. In the MCU unit, the amplitude, frequency, and phase of the echo signal are calculated, and the target parameters ( sleep quality, breathing, turning over, body movement , etc.) are measured and the scene evaluation is finally realized.

## 3. Hardware Design Considerations

The radar's rated power supply voltage needs to meet 4.9 - 6V, and under normal working conditions, the rated current requires an input of more than 200mA. Power supply design, power supply ripple should be  $\leq 100\text{mv}$ .

### 3.1 The power supply can refer to the following circuit design

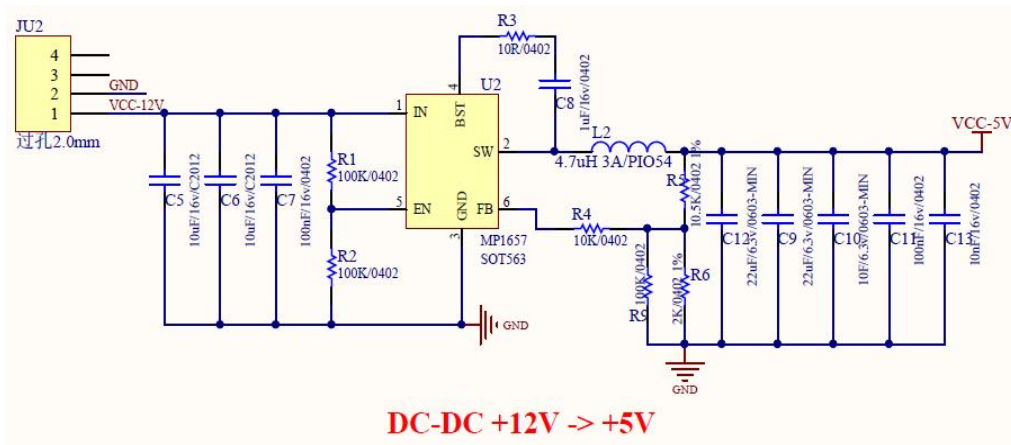


figure 2

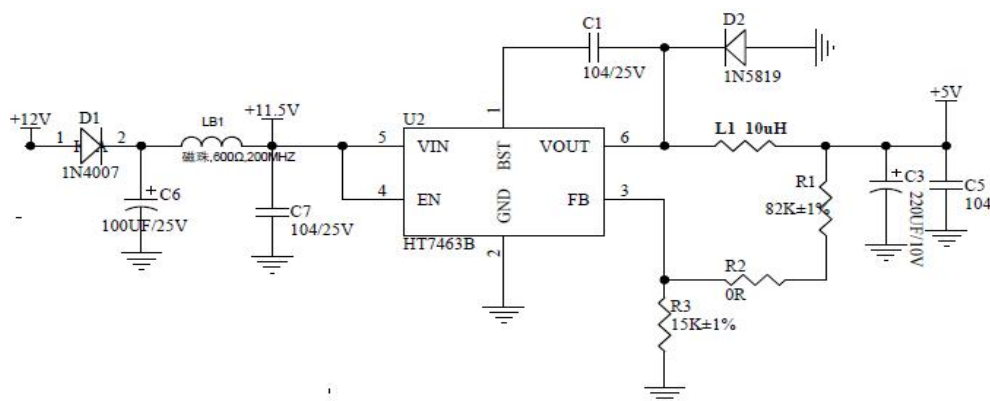


figure 3

### 3.2 Use wiring diagrams

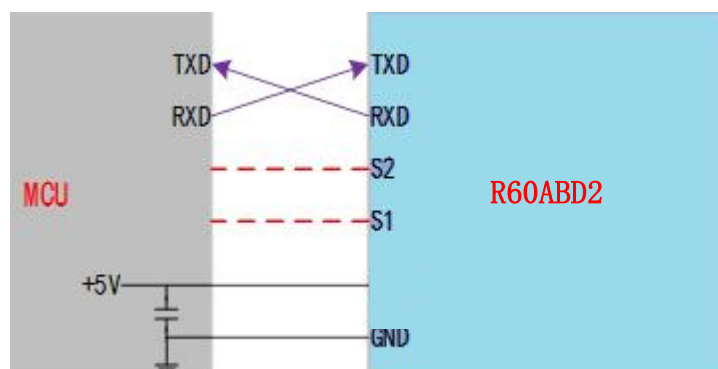


Figure 4 Schematic diagram of the connection between the radar module and the peripherals

## 4. Layout Requirements for Antenna and Housing

PCBA: Need to keep the height of the radar patch  $\geq 1\text{mm}$  than other devices

Shell structure: It is necessary to maintain a distance of 2 - 5mm between the radar antenna surface and the shell surface

Shell detection surface: non-metallic shell, need to be straight to avoid curved surface, affecting the performance of the entire scanning area

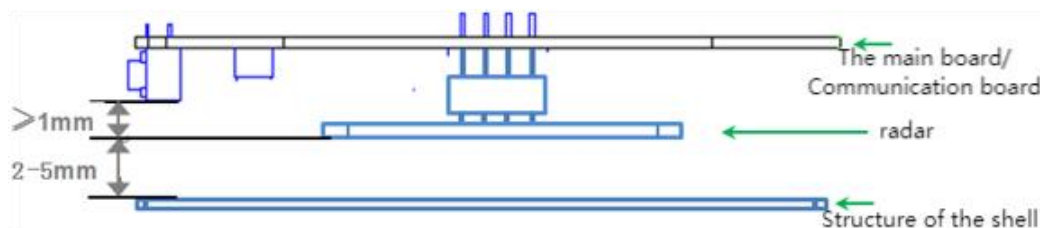


Figure 5

## 5. Static Protection

Radar products have static-sensitive circuits inside, which are prone to electrostatic hazards. Therefore, it is necessary to fully protect against static electricity during transportation, storage, work and handling. Do not touch and grab the radar module antenna surface and connector pins. Only touch its corners.

Wear anti-static gloves as much as possible when handling the radar sensor.

## 6. Detailed function

### 6.1. Function point description

| function points                                | State change time/function explanation                                                    |
|------------------------------------------------|-------------------------------------------------------------------------------------------|
| DP1: Someone/Nobody                            | No one to someone, report within 0.5s<br>From someone to no one, 40 s output no one state |
| DP2: Someone is stationary / Someone is active | Static and dynamic switching, reporting within 0.5 seconds                                |
| DP3: Heartbeat rate                            | Output data once every 3 seconds, the unit is times/minute                                |
| DP4: Body Motion Amplitude Parameter           | Output data once every 5 seconds [Reference: Description of Body                          |

|                                     |                                                                                                                                                          |
|-------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0 – 100                             | Motion Amplitude Parameter Output]                                                                                                                       |
| DP5: Getting in/Out of bed          | From getting out of bed to getting in bed, someone exists to report within 1 minute<br>From bed entry to bed exit, the exit state is output in about 40s |
| DP6: Sleep state (awake/light/deep) | When in bed, judge and report the sleep state once every 10 minutes                                                                                      |
| DP7: Sleep Quality Score            | At the end of the sleep process, report the score of this segment of sleep, with a score ranging from 0 to 100 points.                                   |
| DP8: Respiratory/Heart Rate Rate    | Output data once every 3 seconds, the unit is times/minute                                                                                               |

## 7. Protocol description

This agreement applies to 60G Communication between the millimeter wave breathing and sleep detection radar and the host computer.

This protocol briefly introduces the radar workflow, briefly introduces the structure of the interface protocol, and gives the control commands and data required for the related radar work. The serial port communication is defined as follows:

- Interface level: TTL
- Baud rate: 115200 bps
- Stop bit: 1
- Data bits: 8
- Parity: None

## 8. Communication command and parameter definition

### 8.1. Frame structure definition and description

#### A. frame structure definition

| frame header | control word | Command | length  |         | data  | check  | end of frame |
|--------------|--------------|---------|---------|---------|-------|--------|--------------|
| 0X53 0X59    | Control      | Command | Lenth_H | Lenth_H | Data  | Sum    | 0X54 0X43    |
| 2 Bytes      | 1 Byte       | 1 Byte  | 1 Byte  | 1 Byte  | nByte | 1 Byte | 2 Bytes      |

#### B. frame structure description

- Frame header: 2Byte, fixed at 0X53, 0X59;
- Control word : 1 Byte
- (0x0 1 - heartbeat packet identification, 0x0 2 - product information, 0x0 3 - OTA upgrade, 0x05 - working status, 0x07 - radar detection range information, 0x8 0 - human presence, 0x81 - breathing detection, 0x84 - sleep monitoring, 0x85 - heart rate monitoring)
- Command word : 1Byte ( identify the current data content )
- Length identification : 2Byte, equal to the specific byte length of the data
- Data: nByte, defined according to the actual function
- Check code: 1 Byte,
- (Check code calculation: frame header + control word + command word + length identifier + data) After summing, take the lower eight bits)
- Frame end : 2 Byte, fixed at 0X54, 0X43;

## 8.2. Address allocation and data information description

| Product Category | Function Description    | Transmission direction | frame header | control word | Command word | length identification | data                      | check field | end of frame | Remark |
|------------------|-------------------------|------------------------|--------------|--------------|--------------|-----------------------|---------------------------|-------------|--------------|--------|
| System functions | Heartbeat packet report | report                 | 5359         | 01           | 01           | 0001                  | OF                        | sum         | 5443         |        |
|                  | Heartbeat packet query  | Issued                 | 5359         | 01           | 80           | 0001                  | OF                        | sum         | 5443         |        |
|                  |                         | Reply                  | 5359         | 01           | 80           | 0001                  | OF                        | sum         | 5443         |        |
|                  | Module reset            | Issued                 | 5359         | 01           | 02           | 0001                  | OF                        | sum         | 5443         |        |
|                  |                         | report                 | 5359         | 01           | 02           | 0001                  | OF                        | sum         | 5443         |        |
|                  | Product model report    | report                 | 5359         | 02           | 01           | len                   | len B product information | sum         | 5443         |        |
|                  | Product ID report       | report                 | 5359         | 02           | 02           | len                   | len B product id          | sum         | 5443         |        |

|                            |                                                   |        |      |    |    |      |                                     |     |      |  |
|----------------------------|---------------------------------------------------|--------|------|----|----|------|-------------------------------------|-----|------|--|
|                            | Hardware<br>model<br>report                       | report | 5359 | 02 | 03 | len  | len B<br>hardware<br>model          | sum | 5443 |  |
|                            | Firmware<br>version<br>report                     | report | 5359 | 02 | 04 | len  | len B<br>firmware<br>version        | sum | 5443 |  |
| Information query          |                                                   |        |      |    |    |      |                                     |     |      |  |
| product<br>informatio<br>n | Product<br>model<br>query                         | Issued | 5359 | 02 | A1 | 0001 | OF                                  | sum | 5443 |  |
|                            |                                                   | Reply  | 5359 | 02 | A1 | len  | len B<br>Product<br>Informati<br>on | sum | 5443 |  |
|                            | product id<br>query                               | Issued | 5359 | 02 | A2 | 0001 | OF                                  | sum | 5443 |  |
|                            |                                                   | Reply  | 5359 | 02 | A2 | len  | len B<br>product id                 | sum | 5443 |  |
|                            | Hardware<br>model<br>query                        | Issued | 5359 | 02 | A3 | 0001 | OF                                  | sum | 5443 |  |
|                            |                                                   | Reply  | 5359 | 02 | A3 | len  | len B<br>hardware<br>model          | sum | 5443 |  |
|                            | Firmware<br>version<br>query                      | Issued | 5359 | 02 | A4 | 0001 | OF                                  | sum | 5443 |  |
|                            |                                                   | Reply  | 5359 | 02 | A4 | len  | len B<br>firmware<br>version        | sum | 5443 |  |
| working<br>status          | Initializati<br>on<br>complete<br>informatio<br>n | report | 5359 | 05 | 01 | 0001 | OF                                  | sum | 5443 |  |
|                            | Whether                                           | Issued | 5359 | 05 | 81 | 0001 | OF                                  | sum | 5443 |  |

|                                                |                                                     |        |      |     |    |      |                                           |     |      |                                                     |
|------------------------------------------------|-----------------------------------------------------|--------|------|-----|----|------|-------------------------------------------|-----|------|-----------------------------------------------------|
|                                                | the<br>initializati<br>on<br>completes<br>the query | Reply  | 5359 | 05  | 81 | 0001 | 01: Complete<br>d<br>02: Not<br>completed | sum | 5443 |                                                     |
| Radar<br>detection<br>range<br>informatio<br>n | Location<br>out-of-bou<br>nds status<br>report      | report | 5359 | 07  | 07 | 0001 | 00: Out of<br>range<br>01: In<br>range    | sum | 5443 | Reporting method: when the<br>status changes        |
|                                                | Location<br>out-of-bou<br>nds status<br>query       | Issued | 5359 | 07  | 87 | 0001 | OF                                        | sum | 5443 |                                                     |
|                                                |                                                     | Reply  | 5359 | 07  | 87 | 0001 | 00: Out of<br>range<br>01: In<br>range    | sum | 5443 |                                                     |
| human body report                              |                                                     |        |      |     |    |      |                                           |     |      |                                                     |
|                                                | Switch the<br>human<br>presence<br>function         | Issued | 5359 | 8 0 | 00 | 0001 | 01: On<br>00: Off                         | sum | 5443 |                                                     |
|                                                |                                                     | Reply  | 5359 | 8 0 | 00 | 0001 | 01: On<br>00: Off                         | sum | 5443 |                                                     |
| human<br>body<br>function                      | Actively<br>report<br>existence<br>informatio<br>n  | report | 5359 | 80  | 01 | 0001 | 00: no one<br>01: no one                  | sum | 5443 | Reporting method: report<br>when the status changes |
|                                                | Active<br>reporting<br>of sports<br>informatio<br>n | report | 5359 | 80  | 02 | 0001 | 00: None<br>01: Still<br>02: Active       | sum | 5443 | Reporting method: report<br>when the status changes |

|                   |                                                  |        |      |     |    |       |                                        |     |      |                                                                                                                                                                                 |
|-------------------|--------------------------------------------------|--------|------|-----|----|-------|----------------------------------------|-----|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                   | Active reporting of physical activity parameters | report | 5359 | 80  | 03 | 0001  | 1B Body Movement Parameters            | sum | 5443 | Reporting method: report once every 1s<br>Value range: 0-100                                                                                                                    |
|                   | Active reporting of human distance               | report | 5359 | 80  | 04 | 0002  | 2B Human distance                      | sum | 5443 | Reporting method: Report once every 2 s<br>Value range: 0-65535<br>Unit: cm                                                                                                     |
|                   | Active reporting of body position                | report | 5359 | 80  | 05 | 000 6 | 6B (2B:x, 2B:y, 2B:Z) Body Orientation | sum | 5443 | Reporting method: report once every 2s<br>Unit: cm<br>position information has positive and negative, the first 0 of 16-bit data means positive, and the first 1 means positive |
| Information query |                                                  |        |      |     |    |       |                                        |     |      |                                                                                                                                                                                 |
|                   | Query the human presence switch                  | Issued | 5359 | 8 0 | 80 | 0001  | OF                                     | sum | 5443 |                                                                                                                                                                                 |
|                   |                                                  | Reply  | 5359 | 85  | 80 | 0001  | 01: On<br>00: Off                      | sum | 5443 |                                                                                                                                                                                 |
|                   | Existence information query                      | Issued | 5359 | 80  | 81 | 0001  | OF                                     | sum | 5443 |                                                                                                                                                                                 |
|                   |                                                  | Reply  | 5359 | 80  | 81 | 0001  | 00: no one<br>01: no one               | sum | 5443 |                                                                                                                                                                                 |
|                   | Sports information query                         | Issued | 5359 | 80  | 82 | 0001  | OF                                     | sum | 5443 |                                                                                                                                                                                 |
|                   |                                                  | Reply  | 5359 | 80  | 82 | 0001  | 00: None<br>01: Still<br>02: Active    | sum | 5443 |                                                                                                                                                                                 |
|                   | Body Motion                                      | Issued | 5359 | 80  | 83 | 0001  | OF                                     | sum | 5443 |                                                                                                                                                                                 |

|                                                     |                                                      |        |      |    |    |      |                                        |     |      |                                                                                                                                            |
|-----------------------------------------------------|------------------------------------------------------|--------|------|----|----|------|----------------------------------------|-----|------|--------------------------------------------------------------------------------------------------------------------------------------------|
| Human existence information query                   | Parameter Query                                      | Reply  | 5359 | 80 | 83 | 0001 | 1B Body Movements Parameter s          | sum | 5443 | Value range: 0-100                                                                                                                         |
|                                                     | Human body distance query                            | Issued | 5359 | 80 | 84 | 0001 | OF                                     | sum | 5443 |                                                                                                                                            |
|                                                     |                                                      | Reply  | 5359 | 80 | 84 | 0002 | 2B Human distance                      | sum | 5443 | Value range: 0-65535<br>Unit: cm                                                                                                           |
|                                                     | Human body orientation query                         | Issued | 5359 | 80 | 85 | 0001 | OF                                     | sum | 5443 |                                                                                                                                            |
|                                                     |                                                      | Reply  | 5359 | 80 | 85 | 0006 | 6B (2B:x, 2B:y, 2B:Z) Body Orientation | sum | 5443 | Unit: cm<br>position information has positive and negative, the first 0 of 16-bit data means positive, and the first 1 means positive      |
| Heart rate monitoring active reporting and settings |                                                      |        |      |    |    |      |                                        |     |      |                                                                                                                                            |
| Heart rate monitoring function                      | Switch the heart rate monitoring function on and off | Issued | 5359 | 85 | 00 | 0001 | 01: On<br>00: Off                      | sum | 5443 |                                                                                                                                            |
|                                                     |                                                      | Reply  | 5359 | 85 | 00 | 0001 | 01: On<br>00: Off                      | sum | 5443 |                                                                                                                                            |
|                                                     | Heart rate value                                     | report | 5359 | 85 | 02 | 0001 | 1B Heart rate value                    | sum | 5443 | Reporting method: Report once every 3 s<br>Value range: 0 - 100                                                                            |
|                                                     | Heart rate waveform                                  | report | 5359 | 85 | 05 | 0005 | 5B Heart Rate Waveform                 | sum | 5443 | Reporting method: Report once every 1 s<br>Value range: 0-255<br>5 bytes represent 5 values in real-time 1s, which is the real value + 128 |
|                                                     | Information query                                    |        |      |    |    |      |                                        |     |      |                                                                                                                                            |

|                                                        |                                                 |        |      |    |    |      |                        |     |      |                                                                                                                                                                                                                                                                                               |
|--------------------------------------------------------|-------------------------------------------------|--------|------|----|----|------|------------------------|-----|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                        | Querying the heart rate monitor switch          | Issued | 5359 | 85 | 80 | 0001 | OF                     | sum | 5443 |                                                                                                                                                                                                                                                                                               |
|                                                        |                                                 | Reply  | 5359 | 85 | 80 | 0001 | 01: On<br>00: Off      | sum | 5443 |                                                                                                                                                                                                                                                                                               |
|                                                        | Heart rate value query                          | Issued | 5359 | 85 | 82 | 0001 | OF                     | sum | 5443 |                                                                                                                                                                                                                                                                                               |
|                                                        |                                                 | Reply  | 5359 | 85 | 82 | 0001 | 1B Heart rate value    | sum | 5443 | Value range: 0-100                                                                                                                                                                                                                                                                            |
|                                                        | Heart rate waveform query                       | Issued | 5359 | 85 | 85 | 0001 | OF                     | sum | 5443 |                                                                                                                                                                                                                                                                                               |
|                                                        |                                                 | Reply  | 5359 | 85 | 85 | 0005 | 3B Heart Rate Waveform | sum | 5443 | Reporting method: report once every 1 second<br><br>Value range: 0-255<br><br>5 bytes represent 5 values within 1 second in real time, the waveform is sine wave data, and the central axis is 128, which means that when the heart rate intensity is equal to 0, it will be displayed as 128 |
| Active reporting and setting of respiratory monitoring |                                                 |        |      |    |    |      |                        |     |      |                                                                                                                                                                                                                                                                                               |
|                                                        | Switch breathing monitoring function on and off | Issued | 5359 | 81 | 00 | 0001 | 01: On<br>00: Off      | sum | 5443 |                                                                                                                                                                                                                                                                                               |
|                                                        |                                                 | Reply  | 5359 | 81 | 00 | 0001 | 01: On<br>00: Off      | sum | 5443 |                                                                                                                                                                                                                                                                                               |

|                           |                                            |        |      |    |    |      |                                                                           |     |      |                                                                                                                                                                                                                                                                                       |
|---------------------------|--------------------------------------------|--------|------|----|----|------|---------------------------------------------------------------------------|-----|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Breath detection function | breathing information                      | report | 5359 | 81 | 01 | 0001 | 01: Normal<br>02: Breathing too high<br>03: Breathing too low<br>04: None | sum | 5443 | Reporting method: report when the status changes                                                                                                                                                                                                                                      |
|                           | Breath value                               | report | 5359 | 81 | 02 | 0001 | 1B Respiratory value                                                      | sum | 5443 | Reporting method: Report once every 3 s<br>Value range: 0- 25                                                                                                                                                                                                                         |
|                           | Respiratory waveform                       | report | 5359 | 81 | 05 | 0005 | 5B Respiratory waveform                                                   | sum | 5443 | Reporting method: report once every 1 second<br>Value range: 0-255<br>5 bytes represent 5 values within 1 second in real time, the waveform is sine wave data, and the central axis is 128, which means that when the heart rate intensity is equal to 0, it will be displayed as 128 |
|                           | Information query                          |        |      |    |    |      |                                                                           |     |      |                                                                                                                                                                                                                                                                                       |
|                           | Querying the respiration monitoring switch | Issued | 5359 | 81 | 80 | 0001 | OF                                                                        | sum | 5443 |                                                                                                                                                                                                                                                                                       |
|                           |                                            | Reply  | 5359 | 81 | 80 | 0001 | 01: On<br>00: Off                                                         | sum | 5443 |                                                                                                                                                                                                                                                                                       |
|                           | Respiratory information query              | Issued | 5359 | 81 | 81 | 0001 | OF                                                                        | sum | 5443 |                                                                                                                                                                                                                                                                                       |

|                                                  |                                                              |        |      |    |    |      |                                                                                                                                  |     |      |                                                     |
|--------------------------------------------------|--------------------------------------------------------------|--------|------|----|----|------|----------------------------------------------------------------------------------------------------------------------------------|-----|------|-----------------------------------------------------|
|                                                  |                                                              | Reply  | 5359 | 81 | 81 | 0001 | 01:<br>Normal<br><br>02:<br>Breathing<br>too high<br><br>03:<br>Breathing<br>too low<br><br>04: None                             | sum | 5443 |                                                     |
|                                                  | Respirator<br>y value<br>query                               | Issued | 5359 | 81 | 82 | 0001 | OF                                                                                                                               | sum | 5443 |                                                     |
|                                                  |                                                              | Reply  | 5359 | 81 | 82 | 0001 | 1B<br>Respirator<br>y value                                                                                                      | sum | 5443 | Value range: 0-30                                   |
|                                                  | Respirator<br>y<br>waveform<br>query                         | Issued | 5359 | 81 | 85 | 0001 | OF                                                                                                                               | sum | 5443 |                                                     |
|                                                  |                                                              | Reply  | 5359 | 81 | 85 | 0005 | 5B<br>Respirator<br>y<br>waveform                                                                                                | sum | 5443 | Value range: 0-255                                  |
| Active reporting and setting of sleep monitoring |                                                              |        |      |    |    |      |                                                                                                                                  |     |      |                                                     |
|                                                  | Switch the<br>sleep<br>monitorin<br>g function<br>on and off | Issued | 5359 | 84 | 00 | 0001 | 01: On<br><br>00: Off                                                                                                            | sum | 5443 |                                                     |
|                                                  |                                                              | Reply  | 5359 | 84 | 00 | 0001 | 01: On<br><br>00: Off                                                                                                            | sum | 5443 |                                                     |
|                                                  | Bed in /<br>out of bed                                       | report | 5359 | 84 | 01 | 0001 | 0x00: get<br>out of bed<br><br>0x01: get<br>into bed<br><br>0x02:<br>None<br>(displayed<br>in<br>real-time<br>detection<br>mode) | sum | 5443 | Reporting method: report<br>when the status changes |

|                          |                      |        |      |    |    |      |                                                                                                                                                                 |     |      |                                                                                                                                                                                       |
|--------------------------|----------------------|--------|------|----|----|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Sleep detection function | Sleep state          | report | 5359 | 84 | 02 | 0001 | 0x00:<br>deep sleep<br><br>0x01:<br>light sleep<br><br>0x02:<br>awake<br><br>0x03:<br>none<br>( reported when getting out of bed /in real-time detection mode ) | sum | 5443 | Reporting method: report every ten minutes                                                                                                                                            |
|                          | Awake time           | report | 5359 | 84 | 03 | 0002 | 2Byte awake time                                                                                                                                                | sum | 5443 | Reporting method: In the state of bed, follow the sleep state of 10 minutes to output the latest data of the corresponding duration.<br><br>Value range: 0-65535<br><br>Unit: minutes |
|                          | light sleep duration | report | 5359 | 84 | 04 | 0002 | 2Byte light sleep duration                                                                                                                                      | sum | 5443 | Reporting method: In the state of bed, follow the sleep state of 10 minutes to output the latest data of the corresponding duration.<br><br>Value range: 0-65535<br><br>Unit: minutes |
|                          | deep sleep time      | report | 5359 | 84 | 05 | 0002 | 2Byte deep sleep time                                                                                                                                           | sum | 5443 | Reporting method: In the state of bed, follow the sleep state of 10 minutes to output the latest data of the corresponding duration.<br><br>Value range: 0-65535<br><br>Unit: minutes |

|  |                               |        |      |    |    |      |                                                                                                                                                                                    |     |      |                                                                                                                                                                                                                                                                                                                                                                                                                |
|--|-------------------------------|--------|------|----|----|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | Sleep Quality Score           | report | 5359 | 84 | 06 | 0001 | 1B Sleep Score                                                                                                                                                                     | sum | 5443 | Reporting method: report at the end of the sleep process<br>Value range: 0-100<br>Unit: minutes                                                                                                                                                                                                                                                                                                                |
|  | Sleep status report           | report | 5359 | 84 | 0C | 0008 | 1B Existing<br>1B Sleeping state<br>1B Average breathing<br>1B Average heartbeat<br>1B Turnover times<br>1B Large-scale body movement<br>1B Small-scale movement<br>1B Apnea times | sum | 5443 | Status reporting method: report once every ten minutes<br>Existence: 1 someone 0 no one<br>Sleeping: 3 getting out of bed (no one) 2 awake 1 light sleep 0 deep sleep<br>The number of rollovers in sleep or deep sleep<br>The ratio of large-scale body movements: the value is 0~100<br>The ratio of small-scale body movements: the value is 0~100<br>Apnea times: output the number of apnea in 10 minutes |
|  | Sleep quality analysis report | report | 5359 | 84 | 0D | 000C | 1B Sleep quality score<br>2B Total sleep duration<br>1B Awake duration<br>1B Light sleep duration<br>1B Deep sleep                                                                 | sum | 5443 | When it is judged that the sleep process is over, report the sleep statistics of the whole night<br>1B Sleep quality score numerical range: 0~100<br>2B Numerical range of total sleep duration: 0~65535<br>Unit: minute<br>1B Awake time proportion Numerical range: 0~100<br>1B Light Value range of sleep duration ratio: 0~100<br>1B                                                                       |

|  |                             |        |      |    |    |      |                                                                                                                                                                                                                                         |     |      |                                                                                                                                                                                                                                                                                                                                     |
|--|-----------------------------|--------|------|----|----|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  |                             |        |      |    |    |      | duration<br>1B<br>Getting<br>out of<br>bed1B<br>Number<br>of getting<br>out of<br>bed1B<br>Number<br>of turning<br>over1B<br>Average<br>breathing<br>1B<br>Average<br>heartbeat1<br>B Number<br>of apnea<br>(reserved<br>parameter<br>) |     |      | Value range of deep sleep<br>duration ratio: 0~100 1B<br>Value range of time out of<br>bed: 0~ 255 1B Value range<br>of number of getting out of<br>bed: 0~ 255 255 1B Value<br>range of average<br>respiration: 0~ 25 1B Value<br>range of average heartbeat:<br>0~1 0 0 1B Value range of<br>apnea times: 0~10 (not<br>available) |
|  | Abnormal<br>sleep<br>report | report | 5359 | 84 | 0E | 0001 | 0x00<br>Sleep time<br>is less<br>than 4<br>hours<br>0x01<br>Sleep time<br>is more<br>than 12<br>hours<br>0x02<br>Abnormal<br>long time<br>no one<br>0x03<br>None                                                                        | sum | 5443 | When the sleep duration is<br>less than 4 hours or more<br>than 12 hours, the abnormal<br>sleep state is reported and<br>there is no one detected for<br>a long time, and the<br>abnormality is reported.                                                                                                                           |

|  |                                   |        |      |    |    |      |                                                                                              |     |      |                               |
|--|-----------------------------------|--------|------|----|----|------|----------------------------------------------------------------------------------------------|-----|------|-------------------------------|
|  | Reporting mode selection          | Issued | 5359 | 84 | OF | 0001 | 0x00: Real-time data transmission 0x01: Sleep state transmission                             | sum | 5443 |                               |
|  |                                   | Reply  | 5359 | 84 | OF | 0001 | 0x00: Real-time data transmission 0x01: Sleep state transmission                             | sum | 5443 |                               |
|  | Sleep quality rating report       | Report | 5359 | 84 | 10 | 0001 | 0x00 None<br>0x01 High sleep quality<br>0x02 medium sleep quality<br>0x03 Poor sleep quality | sum | 5443 | Output when sleep status ends |
|  | Abnormal struggling status report | Report | 5359 | 84 | 11 | 0001 | 0x00 None<br>0x01 Normal status<br>0x02 Abnormal struggling status                           | sum | 5443 |                               |

|  |                                                  |        |      |    |    |      |                                                            |     |      |                                                            |
|--|--------------------------------------------------|--------|------|----|----|------|------------------------------------------------------------|-----|------|------------------------------------------------------------|
|  | Unoccupied timing status report                  | Report | 5359 | 84 | 12 | 0001 | 0x00<br>None<br><br>0x01<br>Normal<br><br>0x02<br>Abnormal | sum | 5443 |                                                            |
|  | Abnormal struggling state switch setting         | Issued | 5359 | 84 | 13 | 0001 | 0x00 On<br>0x01 Off                                        | sum | 5443 |                                                            |
|  |                                                  | Reply  | 5359 | 84 | 13 | 0001 | 0x00 On<br>0x01 Off                                        | sum | 5443 |                                                            |
|  | Unoccupied timing status report switch setting   | Issued | 5359 | 84 | 14 | 0001 | 0x00 Off<br>0x01 On                                        | sum | 5443 |                                                            |
|  |                                                  | Reply  | 5359 | 84 | 14 | 0001 | 0x00 Off<br>0x01 On                                        | sum | 5443 |                                                            |
|  | Timing duration setting in unoccupied situations | Issued | 5359 | 84 | 15 | 0001 | 1B Time                                                    | sum | 5443 | Value range: 30-180<br>Unit: minute Duration: 10<br>minute |
|  |                                                  | Reply  | 5359 | 84 | 15 | 0001 | 1B Time                                                    | sum | 5443 |                                                            |
|  | Enter stop-sleeping state timing setting         | Issued | 5359 | 84 | 16 | 0001 | 1B Time                                                    | sum | 5443 | Value range: 5~120<br>Unit: Minute                         |
|  |                                                  | Reply  | 5359 | 84 | 16 | 0001 | 1B Time                                                    | sum | 5443 |                                                            |
|  | Information query                                |        |      |    |    |      |                                                            |     |      |                                                            |
|  | Query the sleep monitoring switch                | Issued | 5359 | 84 | 80 | 0001 | OF                                                         | sum | 5443 |                                                            |
|  |                                                  | Reply  | 5359 | 84 | 80 | 0001 | 01: On<br>00: Off                                          | sum | 5443 |                                                            |
|  | Enquiry of                                       | Issued | 5359 | 84 | 81 | 0001 | OF                                                         | sum | 5443 |                                                            |

|  |                            |        |      |    |    |      |                                                                    |     |      |  |
|--|----------------------------|--------|------|----|----|------|--------------------------------------------------------------------|-----|------|--|
|  | bed entry/exit status      | Reply  | 5359 | 84 | 81 | 0001 | 0x00: get out of bed<br>0x01: get into bed                         | sum | 5443 |  |
|  | Sleep state query          | Issued | 5359 | 84 | 82 | 0001 | OF                                                                 | sum | 5443 |  |
|  |                            | Reply  | 5359 | 84 | 82 | 0001 | 0x00: deep sleep<br>0x01: light sleep<br>0x02: awake<br>0x03: none | sum | 5443 |  |
|  | awake time query           | Issued | 5359 | 84 | 83 | 0001 | OF                                                                 | sum | 5443 |  |
|  |                            | Reply  | 5359 | 84 | 83 | 0002 | 2Byte awake time                                                   | sum | 5443 |  |
|  | Light sleep duration query | Issued | 5359 | 84 | 84 | 0001 | OF                                                                 | sum | 5443 |  |
|  |                            | Reply  | 5359 | 84 | 84 | 0002 | 2Byte light sleep duration                                         | sum | 5443 |  |
|  | Deep sleep time query      | Issued | 5359 | 84 | 85 | 0001 | OF                                                                 | sum | 5443 |  |
|  |                            | Reply  | 5359 | 84 | 85 | 0002 | 2Byte deep sleep time                                              | sum | 5443 |  |
|  | Sleep quality score query  | Issued | 5359 | 84 | 86 | 0001 | OF                                                                 | sum | 5443 |  |
|  |                            | Reply  | 5359 | 84 | 86 | 0002 | 1B Sleep Score                                                     | sum | 5443 |  |
|  | Report mode query          | Issued | 5359 | 84 | 8C | 0001 | OF                                                                 | sum | 5443 |  |
|  |                            | Reply  | 5359 | 84 | 8C | 0001 | 0x00: Real-time data                                               | sum | 5443 |  |

|  |                                 |        |      |    |    |       |                                                                                                                                                                                      |     |      |  |
|--|---------------------------------|--------|------|----|----|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------|--|
|  |                                 |        |      |    |    |       | transmission 0x01: Sleep state transmission                                                                                                                                          |     |      |  |
|  | Sleep comprehensive state query | Issued | 5359 | 84 | 8D | 0001  | OF                                                                                                                                                                                   | sum | 5443 |  |
|  |                                 | Reply  | 5359 | 84 | 8D | 000 8 | 1B Existing<br>1B Sleeping state<br>1B Average breathing<br>1B Average heartbeat<br>1B Turnover times<br>1B Large-scale body movements<br>1B Small-scale movements<br>1B Apnea times | sum | 5443 |  |
|  | Sleep                           | Issued | 5359 | 84 | 8E | 0001  | OF                                                                                                                                                                                   | sum | 5443 |  |

|  |                    |        |      |    |      |      |                                                                                                                                                                                |     |      |                                                                                                                                                                                                           |
|--|--------------------|--------|------|----|------|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | exception<br>query |        |      |    |      |      | 0x00<br>Sleep<br>duration is<br>less than 4<br>hours<br>0x01<br>Sleep<br>duration is<br>greater<br>than 12<br>hours<br>0x02<br>Abnormal<br>long time<br>no one<br>0x03<br>None |     |      | When the sleep duration is<br>less than 4 hours or more<br>than 12 hours, the abnormal<br>sleep state is reported and<br>there is no one detected for<br>a long time, and the<br>abnormality is reported. |
|  | Reply              | 5359   | 84   | 8E | 000C |      |                                                                                                                                                                                | sum | 5443 |                                                                                                                                                                                                           |
|  | Sleep              | Issued | 5359 | 84 | 8F   | 0001 | OF                                                                                                                                                                             | sum | 5443 |                                                                                                                                                                                                           |

|  |                     |        |      |    |    |      |                                                         |     |      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|--|---------------------|--------|------|----|----|------|---------------------------------------------------------|-----|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | statistics<br>query |        |      |    |    |      | 1B Sleep<br>quality<br>score                            |     |      | When it is judged to wake<br>up and get out of bed, start<br>reporting the sleep statistics<br>of the whole night 1B Sleep<br>quality score numerical<br>range: 0~100 2B Numerical<br>range of total sleep<br>duration: 0~65535 Unit:<br>minutes 1B Numerical<br>range of awake time<br>proportion: 0~100 1B Value<br>range of light sleep<br>duration: 0~100 1B Value<br>range of deep sleep<br>duration: 0~100 1B Value<br>range of time out of bed:<br>0~100 Range: 0~40 1B<br>Average respiration range:<br>0~30 1B Average heartbeat<br>range: 0~150 1B Apnea<br>count range: 0~10 |
|  |                     | Reply  | 5359 | 84 | 8F | 000C | 2B Total<br>sleep<br>duration                           |     |      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|  |                     |        |      |    |    |      | 1B Awake<br>duration                                    |     |      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|  |                     |        |      |    |    |      | 1B Light<br>sleep<br>duration                           |     |      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|  |                     |        |      |    |    |      | 1B Deep<br>sleep<br>duration                            |     |      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|  |                     |        |      |    |    |      | 1B<br>Getting<br>out of bed                             |     |      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|  |                     |        |      |    |    |      | 1B<br>Number<br>of getting<br>out of bed                | sum | 5443 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|  |                     |        |      |    |    |      | 1B<br>Number<br>of turning<br>over                      |     |      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|  |                     |        |      |    |    |      | 1B<br>Average<br>breathing                              |     |      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|  |                     |        |      |    |    |      | 1B<br>Average<br>heartbeat                              |     |      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|  |                     |        |      |    |    |      | 1B<br>Number<br>of apnea<br>(reserved<br>parameter<br>) |     |      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|  |                     | Issued | 5359 | 84 | 90 | 0001 | OF                                                      | sum | 5443 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

|  |                                                       |        |      |    |    |      |                                                                                                                                 |     |      |  |
|--|-------------------------------------------------------|--------|------|----|----|------|---------------------------------------------------------------------------------------------------------------------------------|-----|------|--|
|  | Sleep<br>Quality<br>Rating<br>Query                   | Reply  | 5359 | 84 | 90 | 0001 | 0x00<br>None<br><br>0x01 High<br>sleep<br>quality<br>0x02<br>normal<br>sleep<br>quality<br><br>0x03<br>weak<br>sleep<br>quality | sum | 5443 |  |
|  | Abnormal<br>struggellin<br>g status<br>query          | Issued | 5359 | 84 | 91 | 0001 | OF                                                                                                                              | sum | 5443 |  |
|  |                                                       | Reply  | 5359 | 84 | 91 | 0001 | 0x00<br>None<br><br>0x01<br>Normal<br>status<br>0x02<br>Abnormal<br>struggelli<br>ng status                                     | sum | 5443 |  |
|  | Timing<br>status<br>query in<br>unoccupie<br>d status | Issued | 5359 | 84 | 92 | 0001 | OF                                                                                                                              | sum | 5443 |  |
|  |                                                       | Reply  | 5359 | 84 | 92 | 0001 | 0x00<br>None<br><br>0x01<br>normal<br><br>0x02<br>Abnormal                                                                      | sum | 5443 |  |
|  | Abnormal<br>struggling<br>status<br>switch<br>query   | Issued | 5359 | 84 | 93 | 0001 | OF                                                                                                                              | sum | 5443 |  |
|  |                                                       | Reply  | 5359 | 84 | 93 | 0001 | 0x00 Off<br><br>0x01 On                                                                                                         | sum | 5443 |  |
|  | Inquiry of                                            | Issued | 5359 | 84 | 94 | 0001 | OF                                                                                                                              | sum | 5443 |  |

|     |                                                          |        |      |    |    |       |                                                                             |     |      |                                                                                                                                                                   |
|-----|----------------------------------------------------------|--------|------|----|----|-------|-----------------------------------------------------------------------------|-----|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|     | timing<br>function<br>switch in<br>unoccupied state      | Reply  | 5359 | 84 | 94 | 0001  | 0x00 Off<br>0x01 On                                                         | sum | 5443 |                                                                                                                                                                   |
|     | Query the<br>timing<br>duration<br>of no one<br>state    | Issued | 5359 | 84 | 95 | 0001  | OF                                                                          | sum | 5443 | Value range 30-180<br>Unit: minute                                                                                                                                |
|     |                                                          | Reply  | 5359 | 84 | 95 | 0001  | 1B Time                                                                     | sum | 5443 |                                                                                                                                                                   |
|     | Inquiry of<br>time of<br>entering<br>stop-sleeping state | Issued | 5359 | 84 | 96 | 0001  | OF                                                                          | sum | 5443 | Value range 5~120<br>Unit: minute                                                                                                                                 |
|     |                                                          | Reply  | 5359 | 84 | 96 | 0001  | 1B Time                                                                     | sum | 5443 |                                                                                                                                                                   |
|     | OTA                                                      |        |      |    |    |       |                                                                             |     |      |                                                                                                                                                                   |
| OTA | Start OTA<br>upgrade                                     | Issued | 5359 | 03 | 01 | 0013  | 4B<br>firmware<br>package<br>size +<br>15B<br>firmware<br>version<br>number | sum | 5443 |                                                                                                                                                                   |
|     |                                                          | Reply  | 5359 | 03 | 01 | 0004  | 4B<br>Transfer<br>upgrade<br>package<br>size per<br>frame                   | sum | 5443 | The host computer will<br>determine how long the<br>firmware package<br>information needs to be sent<br>for each frame according to<br>the size of the reply here |
|     | Upgrade<br>package<br>transfer                           | Issued | 5359 | 03 | 02 | len+4 | 4B packet<br>offset<br>address +<br>len B<br>packet                         | sum | 5443 |                                                                                                                                                                   |

|  |                    |        |      |    |    |        |                                                           |     |      |  |
|--|--------------------|--------|------|----|----|--------|-----------------------------------------------------------|-----|------|--|
|  |                    | Reply  | 5359 | 03 | 02 | 0001   | 01:<br>Received<br>successfully                           | sum | 5443 |  |
|  |                    |        |      |    |    |        | 02:<br>Received<br>failed                                 |     |      |  |
|  | End OTA<br>upgrade | Issued | 5359 | 03 | 03 | 0x0001 | 01:<br>Firmware<br>package<br>sending<br>completed        | sum | 5443 |  |
|  |                    |        |      |    |    |        | 02:<br>Firmware<br>package<br>sending<br>not<br>completed |     |      |  |
|  |                    | Reply  | 5359 | 03 | 03 | 0x0001 | OF                                                        | sum | 5443 |  |

## Appendix 1 : About Data Command Generation Routines

Example: Existence information query:

The data structure that confirms the existence of information query through the above protocol table is:

- Frame header: 0X53 0X59
- Control word: 0X80
- Command word: 0X81
- Length identification: 0X00 0X01
- Data: 0XOF
- Check code: 1Byte (SUM)
- Frame end: 0X54 0X43
- Combined into a complete command: 53 59 80 81 00 01 OF sum 54 43
- Check code sum:  $(0X53+0X59+0X80+0X81+0X00+0X01+0XOF) = 0X01BD$
- Take the low byte to get sum = 0XBD
- Therefore, the complete existence information query command is: 53 59 80 81 00 01 OF BD 54 43

## 9. Historical version update instructions

| Revision  | Release Date | Summary                                                                                                                                                                                                                                                                                                                                            |
|-----------|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| V1.0_0623 | 2022/06/23   | first draft                                                                                                                                                                                                                                                                                                                                        |
| V1.1_0720 | 2022/7/20    | Added detection mode query command, adjusted detection mode setting command                                                                                                                                                                                                                                                                        |
| V1.2_0720 | 2022/7/20    | Fix the problem of the active reporting protocol of human body orientation                                                                                                                                                                                                                                                                         |
| V1.3_0729 | 2022/7/29    | 1: Added "Sleep Synthetic Status Query" to Sleep Radar<br>2: Modified the length identification of "human body orientation query" and "human body orientation active reporting" to "0006"<br>3: Modified the data content of "sleep state" and "sleep state query", from the original "0x02 deep sleep 0x00 awake" to "0x02 awake 0x00 deep sleep" |
| V1.4_0801 | 2022/8/1     | Modify the protocol for initializing query replies<br>Change the original "01 not completed 02 completed" to "00 not completed 01 completed"                                                                                                                                                                                                       |
| V1.5_0905 | 2022/9/5     | 1: Increase the state value "0x03---None" in the abnormal sleep state;<br>2: Added sleep abnormal state query function                                                                                                                                                                                                                             |
| V1.6_1008 | 2022/10/8    | Added human presence switch settings and query functions                                                                                                                                                                                                                                                                                           |
| V1.7_1115 | 2022/11/15   | Revise the instructions on the display of the respiratory and heartbeat waveform values. The value is a sine wave value, and the central axis is 128 [0~128   128~255]                                                                                                                                                                             |
| V1.8_1128 | 2022/11/28   | Added a heartbeat packet active reporting command, which requires firmware version 1.0.7 or newer to apply.                                                                                                                                                                                                                                        |
| V1.9_1204 | 2022/12/4    | Optimize the protocol problem of heartbeat packet query command                                                                                                                                                                                                                                                                                    |
| V2.0_0221 | 2023/2/21    | Adjust typography                                                                                                                                                                                                                                                                                                                                  |
| V2.1_0405 | 2023/4/5     | Added functions such as unmanned timing/abnormal struggle/sleep rating                                                                                                                                                                                                                                                                             |
| V2.2_0527 | 2023/5/27    | Added sleep cut-off time setting and query                                                                                                                                                                                                                                                                                                         |

|           |           |                                                                                                                     |
|-----------|-----------|---------------------------------------------------------------------------------------------------------------------|
| V2.3_0728 | 2023/7/28 | Added product information (product model, product id, hardware version, firmware version active reporting protocol) |
|-----------|-----------|---------------------------------------------------------------------------------------------------------------------|