

60G Millimeter Wave Radar Module

R60ABD2-Sleep monitoring radar module

User manual (Ver.3.1)

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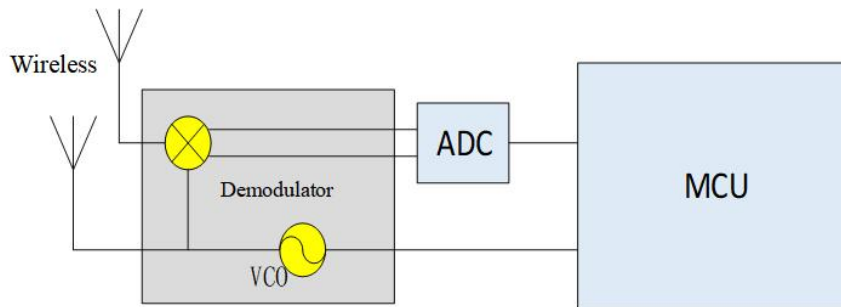
Overview

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.

1. Working principle



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.

2. 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 $\leq 100\text{mv}$.

2.1. The power supply can refer to the following circuit design

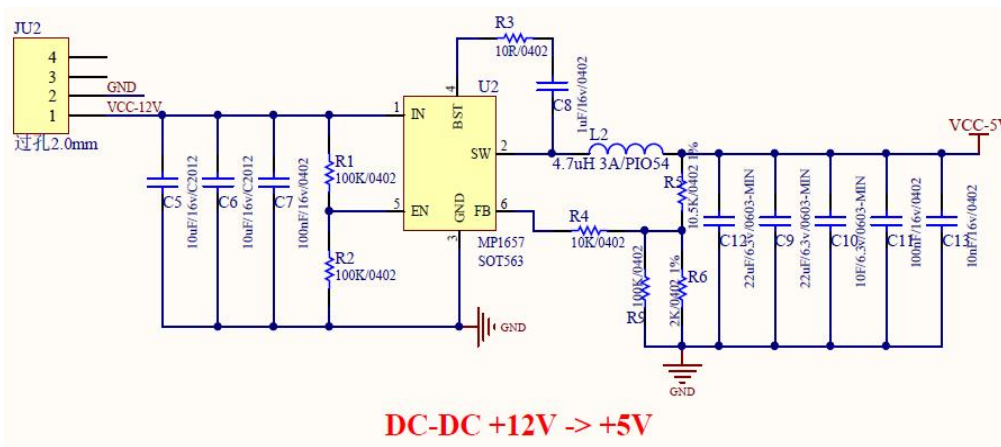


figure 1

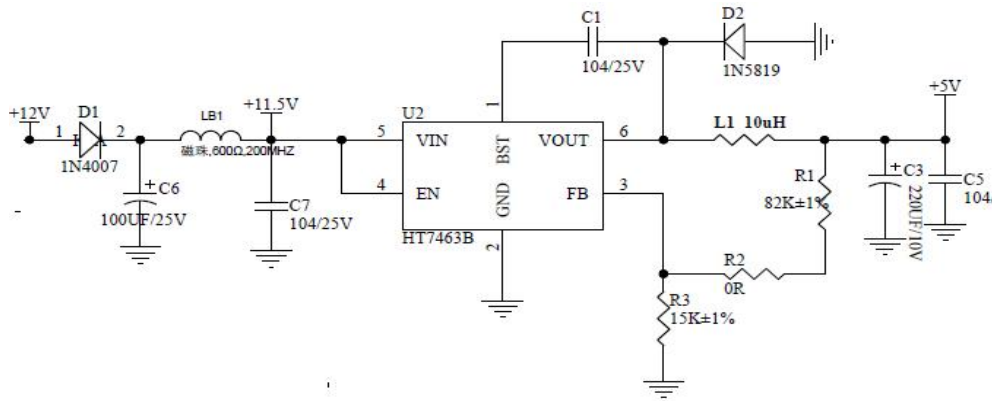


figure 2

2.2. Use wiring diagrams

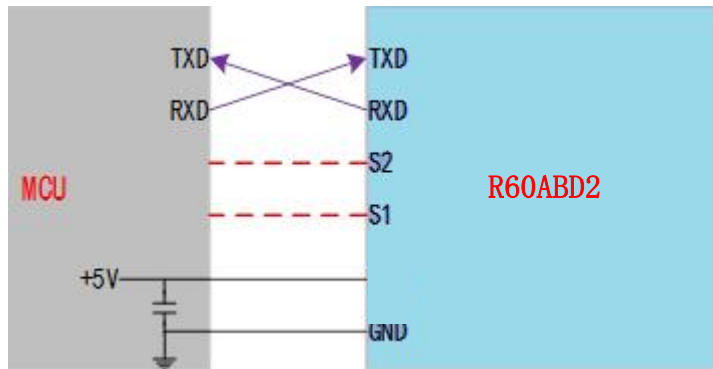


Figure 3 Schematic diagram of the connection between the radar module and the peripherals

3. 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

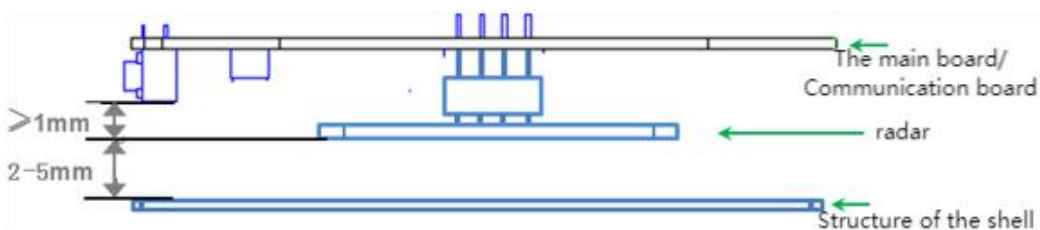


Figure 4

4. 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.

5. Detailed function

5.1. Function point description

| function points | State change time/function explanation |
|--|--|
| DP1: Someone/Nobody | No one to someone, report within 0.5s 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 0 – 100 | Output data once every 5 seconds [Reference: Description of Body 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 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 |

6. 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

7. Communication command and parameter definition

7.1. Frame structure definition and description

A. frame structure definition

| frame header | control word | Command word | length identification | | data | check code | 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

a. Frame header: 2Byte, fixed at 0X53, 0X59;

b. 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)

c. Command word : 1Byte (identify the current data content)

d. Length identification : 2Byte, equal to the specific byte length of the data

e. Data: nByte, defined according to the actual function

f. Check code: 1 Byte,

(Check code calculation: frame header + control word + command word + length identifier + data) After summing, take the lower eight bits)

g. Frame end : 2 Byte, fixed at 0X54, 0X43;

7.2. 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 model report | report | 5359 | 02 | 03 | len | len B hardware model | sum | 5443 | |
| | Firmware version report | report | 5359 | 02 | 04 | len | len B firmware version | sum | 5443 | |
| | Information query | | | | | | | | | |
| | Product model query | Issued | 5359 | 02 | A1 | 0001 | OF | sum | 5443 | |
| | | Reply | 5359 | 02 | A1 | len | len B Product Information | sum | 5443 | |
| | product | Issued | 5359 | 02 | A2 | 0001 | OF | sum | 5443 | |

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| | | | | | | | | | | |
|-----------------------------------|--|--------|------|-----|------|------------------------------------|----------------------------------|------|------|---|
| product information | id query | Reply | 5359 | 02 | A2 | len | len B product id | sum | 5443 | |
| | Hardware model query | Issued | 5359 | 02 | A3 | 0001 | OF | sum | 5443 | |
| | | Reply | 5359 | 02 | A3 | len | len B hardware model | sum | 5443 | |
| | Firmware version query | Issued | 5359 | 02 | A4 | 0001 | OF | sum | 5443 | |
| Reply | | 5359 | 02 | A4 | len | len B firmware version | sum | 5443 | | |
| working status | Initialization complete information | report | 5359 | 05 | 01 | 0001 | OF | sum | 5443 | |
| | Whether the initialization completes the query | Issued | 5359 | 05 | 81 | 0001 | OF | sum | 5443 | |
| Reply | | 5359 | 05 | 81 | 0001 | 01: Completed 02: Not completed | sum | 5443 | | |
| Radar detection range information | Location out-of-bounds status report | report | 5359 | 07 | 07 | 0001 | 00: Out of range 01: In range | sum | 5443 | Reporting method: when the status changes |
| | | Issued | 5359 | 07 | 87 | 0001 | OF | sum | 5443 | |
| | Location out-of-bounds status query | Reply | 5359 | 07 | 87 | 0001 | 00: Out of range 01: In range | sum | 5443 | |
| human body report | | | | | | | | | | |
| | Switch the | Issued | 5359 | 8 0 | 00 | 0001 | 01: On 00: Off | sum | 5443 | |

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| | | | | | | | | | | |
|--------------------------|--|--------|------|-----|----|-------|--|-----|------|---|
| | human presence function | Reply | 5359 | 8 0 | 00 | 0001 | 01: On 00: Off | sum | 5443 | |
| human body function | Actively report existence information | report | 5359 | 80 | 01 | 0001 | 00: no one 01: no one | sum | 5443 | Reporting method: report when the status changes |
| | Active reporting of sports information | report | 5359 | 80 | 02 | 0001 | 00: None 01: Still 02: Active | sum | 5443 | Reporting method: report 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 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 Value range: 0-65535 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 Unit: cm 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 | sum | 5443 | |

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|-----------------------------------|--|--|--------|------|----|------|--|-------------------|------|---|--|
| | | | | | | | 00: Off | | | | |
| Human existence information query | Existence information query | Issued | 5359 | 80 | 81 | 0001 | OF | sum | 5443 | | |
| | | Reply | 5359 | 80 | 81 | 0001 | 00: no one 01: no one | sum | 5443 | | |
| | Sports information query | Issued | 5359 | 80 | 82 | 0001 | OF | sum | 5443 | | |
| | | Reply | 5359 | 80 | 82 | 0001 | 00: None 01: Still 02: Active | sum | 5443 | | |
| | Body Motion Parameter Query | Issued | 5359 | 80 | 83 | 0001 | OF | sum | 5443 | | |
| | | Reply | 5359 | 80 | 83 | 0001 | 1B Body Movement Parameters | 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 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 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 | Issued | 5359 | 85 | 00 | 0001 | 01: On 00: Off | sum | 5443 | |
| Reply | | | 5359 | 85 | 00 | 0001 | 01: On 00: Off | sum | 5443 | | |

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|--------------------------|--|--------|------|----|----|------|------------------------|-----|------|---|
| | off | | | | | | | | | |
| | Heart rate value | report | 5359 | 85 | 02 | 0001 | 1B Heart rate value | sum | 5443 | Reporting method: Report once every 3 s 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 Value range: 0-2 28 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 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 Value range: 0-255 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 | | | | | | | | | | |
|--|---|--------|------|----|----|------|---|-----|------|---|
| Breath detection function | Switch breathing monitoring function on and off | Issued | 5359 | 81 | 00 | 0001 | 01: On 00: Off | sum | 5443 | |
| | | Reply | 5359 | 81 | 00 | 0001 | 01: On 00: Off | sum | 5443 | |
| | breathing information | report | 5359 | 81 | 01 | 0001 | 01: Normal 02: Breathing too high 03: Breathing too low 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 Value range: 0- 25 |
| | Respiratory waveform | report | 5359 | 81 | 05 | 0005 | 5B Respiratory waveform | sum | 5443 | Reporting method: report once every 1 second Value range: 0-255 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 respiratory monitoring | Issued | 5359 | 81 | 80 | 0001 | OF | sum | 5443 | |
| | | Reply | 5359 | 81 | 80 | 0001 | 01: On 00: Off | sum | 5443 | |

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|---|---|--------|------|----|----|------|---|-----|------|--------------------|
| | g switch | | | | | | | | | |
| | Respiratory information query | Issued | 5359 | 81 | 81 | 0001 | OF | sum | 5443 | |
| | | Reply | 5359 | 81 | 81 | 0001 | 01: Normal 02: Breathing too high 03: Breathing too low 04: None | sum | 5443 | |
| | Respiratory value query | Issued | 5359 | 81 | 82 | 0001 | OF | sum | 5443 | |
| | | Reply | 5359 | 81 | 82 | 0001 | 1B Respiratory value | sum | 5443 | Value range: 0-30 |
| | Respiratory waveform query | Issued | 5359 | 81 | 85 | 0001 | OF | sum | 5443 | |
| | | Reply | 5359 | 81 | 85 | 0005 | 5B Respiratory waveform | sum | 5443 | Value range: 0-255 |
| Active reporting and setting of sleep monitoring | | | | | | | | | | |
| | Switch the sleep monitoring function on and off | Issued | 5359 | 84 | 00 | 0001 | 01: On 00: Off | sum | 5443 | |
| | | Reply | 5359 | 84 | 00 | 0001 | 01: On 00: Off | sum | 5443 | |

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|--------------------------|----------------------|--------|------|----|----|------|--|-----|------|---|
| Sleep detection function | Bed in / out of bed | report | 5359 | 84 | 01 | 0001 | 0x00: get out of bed 0x01: get into bed 0x02: None (displayed in real-time detection mode) | sum | 5443 | Reporting method: report when the status changes |
| | Sleep state | report | 5359 | 84 | 02 | 0001 | 0x00: deep sleep 0x01: light sleep 0x02: awake 0x03: none (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. Value range: 0-65535 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. Value range: 0-65535 Unit: minutes |

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

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|--|--------------------------|--------|------|----|----|------|--|-----|------|---|
| | | | | | | | duration 1B Getting out of bed1B Number of getting out of bed1B Number of turning over1B Average breathing1B Average heartbeat1B Number of apnea (reserved parameter) | | | Numerical range: 0~100 1B Light Value range of sleep duration ratio: 0~100 1B Value range of deep sleep duration ratio: 0~100 1B Value range of time out of bed: 0~ 255 1B Value range of number of getting out of bed: 0~ 255 255 1B Value range of average respiration: 0~ 25 1B Value range of average heartbeat: 0~1 0 0 1B Value range of apnea times: 0~10 (not available) |
| | Abnormal sleep report | report | 5359 | 84 | 0E | 0001 | 0x00 Sleep time is less than 4 hours 0x01 Sleep time is more than 12 hours 0x02 Abnormal long time none 0x03 None | sum | 5443 | When the sleep duration is less than 4 hours or more than 12 hours, the abnormal sleep state is reported and there is no one detected for a long time, and the abnormality is reported. |
| | Reporting mode selection | Issued | 5359 | 84 | 0F | 0001 | 0x00: Real-time data transmission 0x01: Sleep state transmission | sum | 5443 | |

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|--|--------|------|----|----|------|--|-----|------|-------------------------------|
| | 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 0x01 High sleep quality 0x02 medium sleep quality 0x03 Poor sleep quality | sum | 5443 | Output when sleep status ends |
| Abnormal struggling status report | Report | 5359 | 84 | 11 | 0001 | 0x00 None 0x01 Normal status 0x02 Abnormal struggling status | sum | 5443 | |
| Unoccupied timing status report | Report | 5359 | 84 | 12 | 0001 | 0x00 None 0x01 Normal 0x02 Abnormal | sum | 5443 | |
| Abnormal struggling state switch setting | Issued | 5359 | 84 | 13 | 0001 | 0x00 On 0x01 Off | sum | 5443 | |
| | Reply | 5359 | 84 | 13 | 0001 | 0x00 On 0x01 Off | sum | 5443 | |
| Unoccupied timing status report switch setting | Issued | 5359 | 84 | 14 | 0001 | 0x00 Off 0x01 On | sum | 5443 | |
| | Reply | 5359 | 84 | 14 | 0001 | 0x00 Off 0x01 On | sum | 5443 | |

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|--|--------|------|----|----|------|--|-----|------|---|
| Timing duration setting in unoccupied situations | Issued | 5359 | 84 | 15 | 0001 | 1B Time | sum | 5443 | Value range: 30-180 Unit: minute Duration: 10 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 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 00: Off | sum | 5443 | |
| Enquiry of bed entry/exit status | Issued | 5359 | 84 | 81 | 0001 | OF | sum | 5443 | |
| | Reply | 5359 | 84 | 81 | 0001 | 0x00: get out of bed 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 0x01: light sleep 0x02: awake 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 | Issued | 5359 | 84 | 84 | 0001 | OF | sum | 5443 | |

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|--|---------------------------------|--------|------|----|----|------|--|-----|------|--|
| | sleep duration query | 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 transmission 0x01: Sleep state transmission | sum | 5443 | |
| | Sleep comprehensive state query | Issued | 5359 | 84 | 8D | 0001 | OF | sum | 5443 | |
| | | Reply | 5359 | 84 | 8D | 0008 | 1B Existing 1B Sleeping state 1B Average breathing 1B Average heartbeat 1B Turnover times 1B Large-scale body movements 1B Small-scale movements 1B Apnea times | sum | 5443 | |

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

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|----------------------------|---------|--------|------|----|------|--|--|------|------|---|
| statistics query | | | | | | | 1B Sleep quality score 2B Total sleep duration 1B Awake duration 1B Light sleep duration 1B Deep sleep duration 1B Getting out of bed 1B Number of getting out of bed 1B Number of turning over 1B Average breathing 1B Average heartbeat 1B Number of apnea (reserved parameter) | | | When it is judged to wake up and get out of bed, start reporting the sleep statistics of the whole night 1B Sleep quality score numerical range: 0~100 2B Numerical range of total sleep duration: 0~65535 Unit: minutes 1B Numerical range of awake time proportion: 0~100 1B Value range of light sleep duration: 0~100 1B Value range of deep sleep duration: 0~100 1B Value range of time out of bed: 0~100 Range: 0~40 1B Average respiration range: 0~30 1B Average heartbeat range: 0~150 1B Apnea count range: 0~10 |
| | Reply | 5359 | 84 | 8F | 000C | sum | 5443 | | | |
| | | Issued | 5359 | 84 | 90 | 0001 | OF | sum | 5443 | |
| Sleep Quality Rating Query | Reply | 5359 | 84 | 90 | 0001 | 0x00 None 0x01 High sleep quality 0x02 normal sleep quality 0x03 weak sleep quality | sum | 5443 | | |
| | Abnorma | Issued | 5359 | 84 | 91 | 0001 | OF | sum | 5443 | |

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|---|--------|------|----|----|------|---|-----|------|------------------------------------|
| I struggelli ng status query | Reply | 5359 | 84 | 91 | 0001 | 0x00 None 0x01 Normal status 0x02 Abnormal struggelling status | sum | 5443 | |
| | Issued | 5359 | 84 | 92 | 0001 | OF | sum | 5443 | |
| Timing status query in unoccupi ed status | Reply | 5359 | 84 | 92 | 0001 | 0x00 None 0x01 normal 0x02 Abnormal | sum | 5443 | |
| | Issued | 5359 | 84 | 93 | 0001 | OF | sum | 5443 | |
| Abnorma l strugglin g status switch query | Reply | 5359 | 84 | 93 | 0001 | 0x00 Off 0x01 On | sum | 5443 | |
| | Issued | 5359 | 84 | 94 | 0001 | OF | sum | 5443 | |
| Inquiry of timing function switch in unoccupi ed state | Reply | 5359 | 84 | 94 | 0001 | 0x00 Off 0x01 On | sum | 5443 | |
| | Issued | 5359 | 84 | 95 | 0001 | OF | sum | 5443 | Value range 30-180 Unit: minute |
| Query the timing duration of no one state | Reply | 5359 | 84 | 95 | 0001 | 1B Time | sum | 5443 | |
| | Issued | 5359 | 84 | 96 | 0001 | OF | sum | 5443 | Value range 5~120 Unit: minute |
| Inquiry of time of entering stop-slee ping state | Reply | 5359 | 84 | 96 | 0001 | 1B Time | sum | 5443 | |

R60ABD2-Sleep monitoring radar module

| OTA | | | | | | | | | | |
|-------------|--------------------------------|--------|------|----|----|--------|--|-----|------|--|
| O T A | Start OTA upgrade | Issued | 5359 | 03 | 01 | 0013 | 4B firmware package size + 15B firmware version number | sum | 5443 | |
| | | Reply | 5359 | 03 | 01 | 0004 | 4B Transfer upgrade package size per frame | sum | 5443 | The host computer will determine how long the firmware package information needs to be sent for each frame according to the size of the reply here |
| | Upgrade package transfer | Issued | 5359 | 03 | 02 | len+4 | 4B packet offset address + len B packet | sum | 5443 | |
| | | Reply | 5359 | 03 | 02 | 0001 | 01: Received successfully 02: Received failed | sum | 5443 | |
| | End OTA upgrade | Issued | 5359 | 03 | 03 | 0x0001 | 01: Firmware package sending completed 02: Firmware package sending not completed | sum | 5443 | |
| | | 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: 0X0F

Check code: 1Byte (SUM)

Frame end: 0X54 0X43

Combined into a complete command:

53 59 80 81 00 01 0F sum 54 43

Check code sum:

$(0X53+0X59+0X80+0X81+0X00+0X01+0X0F) = 0X01BD$

Take the low byte to get sum = 0XB

Therefore, the complete existence information query command is: 53 59 80 81 00 01 0F BD 54 43

8. 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 2、 Modified the length identification of "human body orientation query" and "human body orientation active reporting" to "0006" 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 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; 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) |