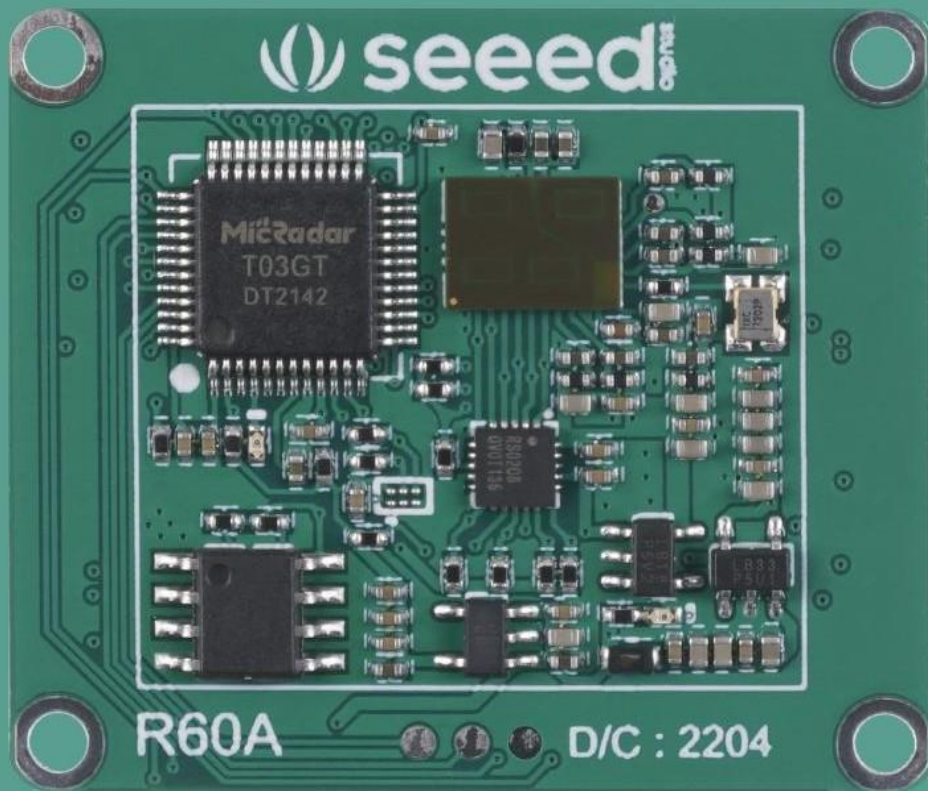


MR60FDA1

60GHz mmWave Module - Fall
Detection Pro Module

Sensor User Manual (V1.3)



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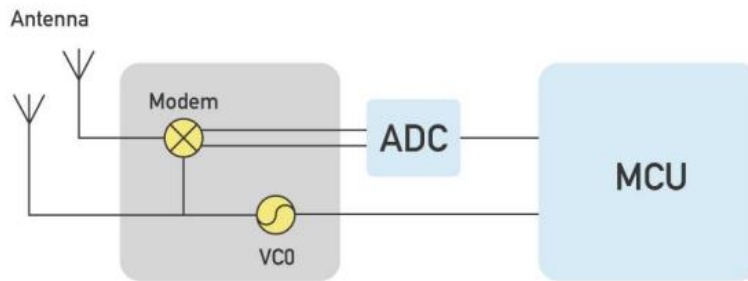
Overview

This document focuses on the use of the radar, the issues that need to be paid attention to in each phase, to minimize the design cost and increase the stability of the product, and to improve the efficiency of the project completion. This document focuses on the issues that need to be taken into account in each phase, in order to minimize the design cost and increase the stability of the product, and to improve the efficiency of the project completion.

From hardware circuit reference design, radar antenna and housing layout requirements, how to distinguish interference and multi-functional standard UART protocol output. The radar is a self-contained system.

This radar is a self-contained space sensing sensor, which consists of RF antenna, radar chip and high speed MCU. The radar is a self-contained sensor with a combination of RF antenna, radar chip and high-speed main frequency MCU. It can be equipped with a host computer or host computer to flexibly output detection status and data, and meet the needs of several groups of GPIOs. It can be equipped with a host computer or a host computer to flexibly output detection status and data, and meet several groups of GPIOs for user customization and development.

1. Working Principle



The radar transmits a 60G band millimeter wave signal, and the target reflects the electromagnetic wave signal, and demodulates it from the transmitted signal. The signal is demodulated, then amplified, filtered, ADC and other processing to obtain the echo demodulation signal data. In the MCU unit, the amplitude, frequency and phase of the echo signal are decoded, and the target signal is finally decoded. The target parameters (sleep quality, respiration, tossing, body movement, etc.) are measured and evaluated in the MCU.

2. Hardware Design Considerations

The rated supply voltage of the radar needs to meet 4.9 - 6V, and the rated current needs to be 200mA or more input is required. The power supply is designed to have a ripple of $\leq 100\text{mv}$.

2.1 Power supply can refer to the following circuit design

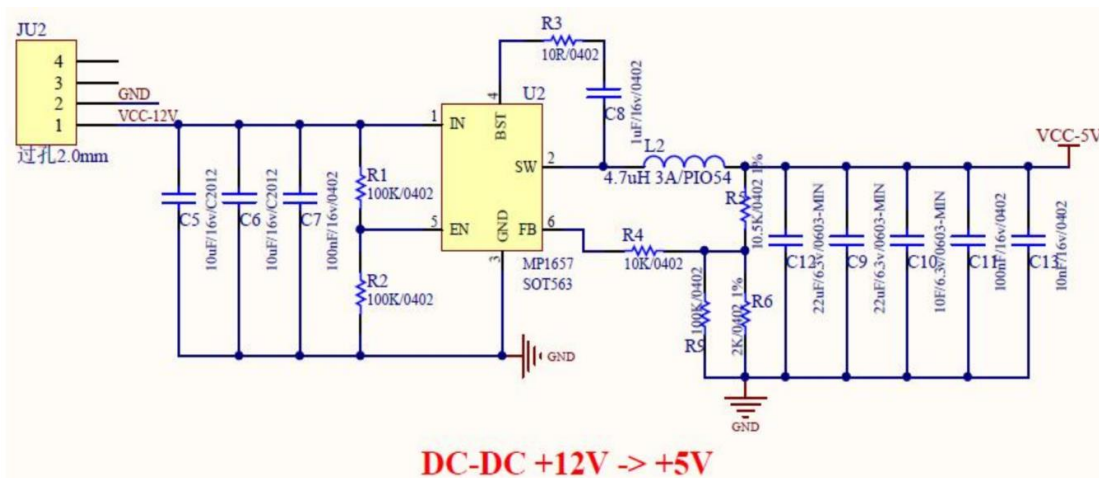


Figure 1

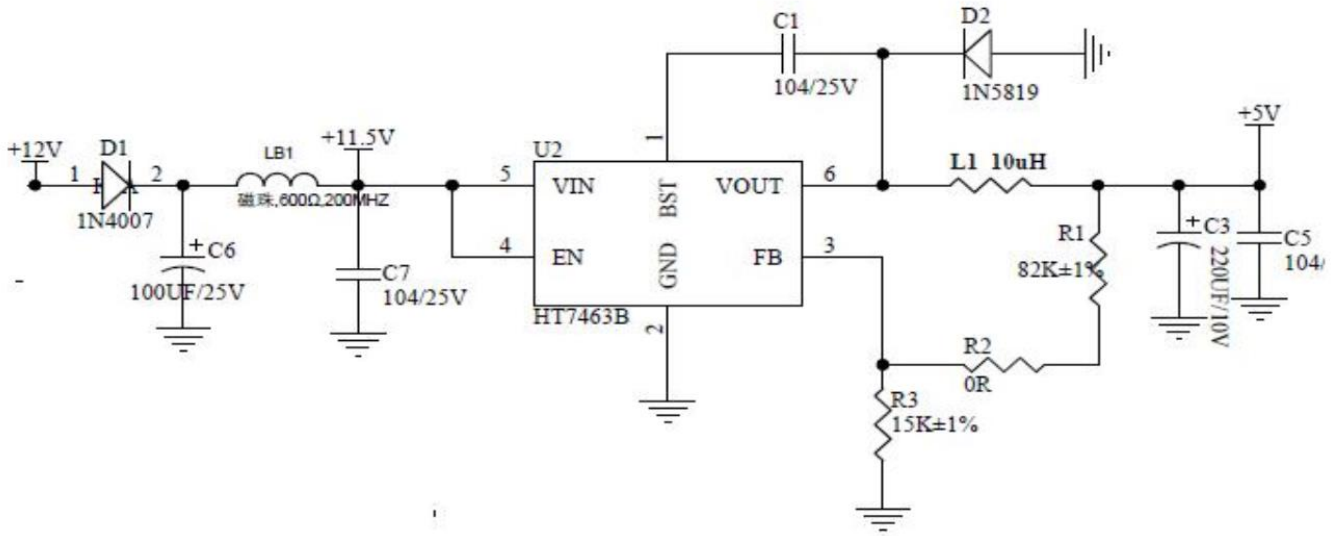


Figure 2

2.2 Wiring Diagram

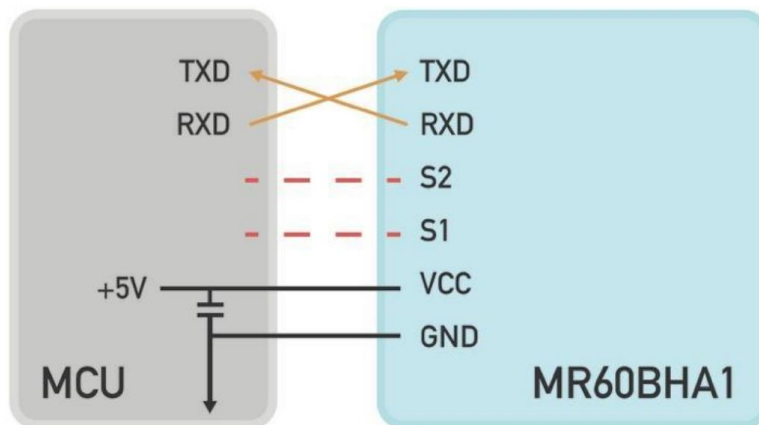


Figure 3 Module and peripheral wiring diagram

3. Antenna and housing layout requirements

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

Housing structure: need to keep the radar antenna surface and the housing surface have 2 - 5mm distance

Housing detection surface: non-metallic housing, need to be straight to avoid bending surface, affect the performance of the whole sweep surface area Performance

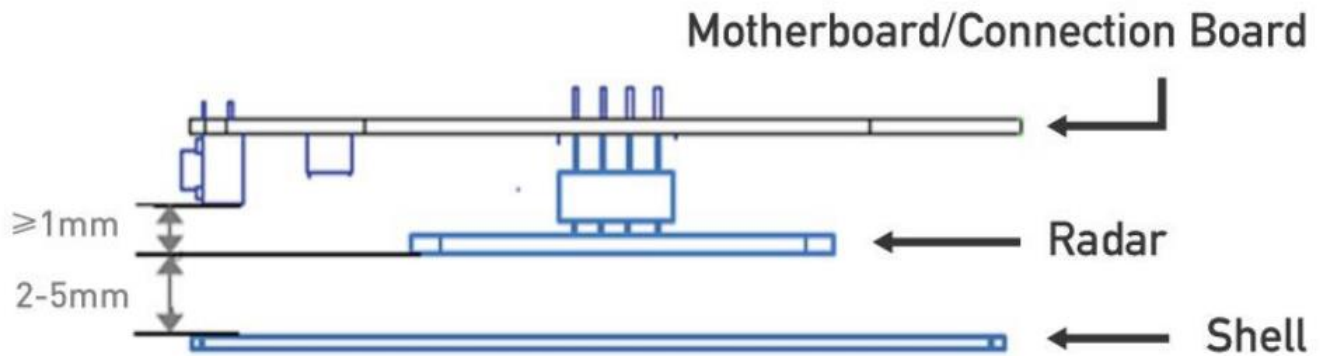


Figure 4

4. Electrostatic protection

Radar products with electrostatic sensitive circuitry inside, vulnerable to electrostatic hazards, so need to be in transport, storage, work and handling process to do a good job of electrostatic protection, do not touch the grasp of the radar hands. Therefore, it is necessary to do a good job in the transportation, storage, work and picking up process of static protection, do not touch and grab the radar module antenna surface and connector pins, only touch the corners. Do not touch the surface of the radar module antenna and connector pins with your hands, only touch the corners.

When handling the radar sensor, please wear anti-static gloves as much as possible.

5. Detailed explanation of functions

5.1 Function Description

Function	Status change time/function explanation
DP1: occupied/unoccupied	From unoccupied to occupied, report within 0.5s From occupied to unoccupied, report within 30 s
DP2: Fall Alarm	Instantly report when fall alarm conditions are met
DP3: Stationary residence alarm	Abnormal hold stationary for 5 minutes, alarm

6. Protocol Description

This protocol is applied to the communication between the 60G millimeter wave respiratory sleep detection radar and the host computer.

This protocol outlines the radar workflow, briefly introduces the interface protocol composition architecture, and The interface protocol structure is briefly introduced, and the related radar work requires control commands and data.

Interface level: TTL

Baud rate: 115200bps

Stop bit: 1

Data bits: 8

Parity check: None

7. Communication command and parameter definition

7.1 Frame structure definition and description

7.1.1 Definition of frame structure

Frame header	Control word	Command word	Length identifier		Data	Checksum	End of frame
0x53 0x59	Control	Command	Lenth_H	Lenth_L	Data	Sum	0x54 0x43
2 Byte	1 Byte	1 Byte	1 Byte	1 Byte	n Byte	1 Byte	2 Byte

7.1.2 Description of the frame structure

- a. Frame header: 2 Byte, fixed to 0x53,0x59;
- b. Control word: 1 Byte
(0x01 - heartbeat packet identification, 0x02 - product information, 0x03 - OTA upgrade, 0x05 - operation status, 0x07 - radar detection range information, 0x80 - human presence, 0x81 - breath detection, 0x84 - sleep monitoring, 0x85 - heart rate monitoring)
- c. Command word: 1 Byte (to identify the current data content)
- d. Length identification: 2 Byte, equal to the specific byte length of the data
- e. Data: n Byte, defined according to the actual function
- f. Checksum: 1 Byte. (Calculation method of checksum: “frame header + control word + command word + length identifier + data” summed to the lower eight bits)
- g. End of frame: 2Byte, fixed to 0X54,0X43;

7.2 Description of address assignment and data information

Function Category	Function Description	Transfer direction	Frame header	Control word	Command word	Length Identification		Data	Checksum field	End of frame	Note
System Functions	Heartbeat Pack Report	Report	0x53 0x59	0x01	0x01	0x00	0x01	0x0F	sum	0x54 0x43	Report per minute
	Module Reset	Send	0x53 0x59	0x01	0x02	0x00	0x01	0x0F	sum	0x54 0x43	
		Response	0x53 0x59	0x01	0x02	0x00	0x01	0x0F	sum	0x54 0x43	
Information Inquiry											
Product Information	Product Model	Send	0x53 0x59	0x02	0xA1	0x00	0x01	0x0F	sum	0x54 0x43	
		Response	0x53 0x59	0x02	0xA1	0x00	len	len B Product Info	sum	0x54 0x43	
	Product ID	Send	0x53 0x59	0x02	0xA2	0x00	0x01	0x0F	sum	0x54 0x43	
		Response	0x53 0x59	0x02	0xA2	0x00	len	len B Product ID	sum	0x54 0x43	
	Hardware Model	Send	0x53 0x59	0x02	0xA3	0x00	0x01	0x0F	sum	0x54 0x43	
		Response	0x53 0x59	0x02	0xA3	0x00	len	len B Hardware model	sum	0x54 0x43	
	Firmware Version	Send	0x53 0x59	0x02	0xA4	0x00	0x01	0x0F	sum	0x54 0x43	
		Response	0x53 0x59	0x02	0xA4	0x00	len	len B Firmware version	sum	0x54 0x43	

Function Category	Function Description	Transfer direction	Frame header	Control word	Command word	Length Identification		Data	Checksum field	End of frame	Note	
Working Status	Initialization completion message	Report	0x53 0x59	0x05	0x01	0x00	0x01	0x0F	sum	0x54 0x43		
	Radar failure report	Report	0x53 0x59	0x05	0x02	0x00	0x01	0x01: Radar chip anomaly 0x02: Encryption anomaly	sum	0x54 0x43		
	Working hours	Report	0x53 0x59	0x05	0x03	0x00	0x04	4B working hours	sum	0x54 0x43		
	Query if initialization is complete	Send	0x53 0x59	0x05	0x81	0x00	0x01	0x0F	sum	0x54 0x43		
Response		0x53 0x59	0x05	0x81	0x00	0x01	0x01: Completed 0x00: Incomplete	sum	0x54 0x43			
Radar installation information	Installation height setup	Send	0x53 0x59	0x06	0x02	0x00	0x02	2B height information	sum	0x54 0x43	Height in centimeters, step length in 1 cm	
		Response	0x53 0x59	0x06	0x02	0x00	0x02	2B height information	sum	0x54 0x43		
	Query installation height	Send	0x53 0x59	0x06	0x82	0x00	0x01	0x0F	sum	0x54 0x43		
		Response	0x53 0x59	0x06	0x82	0x00	0x02	2B height information	sum	0x54 0x43		
Proactive reporting of human presence information												
Human presence detection function	Human presence detection function switch	Send	0x53 0x59	0x80	0x00	0x00	0x01	0x01: On 0x00: Off	sum	0x54 0x43		
		Response	0x53 0x59	0x80	0x00	0x00	0x01	0x01: On 0x00: Off	sum	0x54 0x43		
	Human existence information	Report	0x53 0x59	0x80	0x01	0x00	0x01	0x00: Occupied 0x01: Unoccupied	sum	0x54 0x43	Report when status changes	
	Human movement information	Report	0x53 0x59	0x80	0x02	0x00	0x01	0x00: None 0x01: Stationary 0x02: Active	sum	0x54 0x43	Report when status changes	
	Body movement parameters	Report	0x53 0x59	0x80	0x03	0x00	0x01	1B Body movement parameters	sum	0x54 0x43	Reported once in 1 second, value range 0-100	
	Reporting of height percentage	Report	0x53 0x59	0x83	0x0E	0x00	0x06	1B: High 8 bits of the total number of heights 1B: Low 8 bits of the total number of heights 1B: 0-0.5m height ratio 1B: 0.5-1m height ratio 1B: 1-1.5m height ratio 1B: 1.5-2m height ratio	sum	0x54 0x43	The height percentage of the total percentage reaches 100, which height percentage is large, the movement is in which range.	
	Information Inquiry											
	Query human presence monitoring function switch	Send	0x53 0x59	0x80	0x80	0x00	0x01	0x0F	sum	0x54 0x43		
		Response	0x53 0x59	0x85	0x80	0x00	0x01	0x00: Occupied 0x01: Unoccupied	sum	0x54 0x43		
	Human Existence Inquiry	Send	0x53 0x59	0x80	0x81	0x00	0x01	0x0F	sum	0x54 0x43		
Response		0x53 0x59	0x80	0x81	0x00	0x01	0x00: Occupied 0x01: Unoccupied	sum	0x54 0x43			
Movement Information Inquiry	Send	0x53 0x59	0x80	0x82	0x00	0x01	0x0F	sum	0x54 0x43			
	Response	0x53 0x59	0x80	0x82	0x00	0x01	0x00: None 0x01: Stationary 0x02: Active	sum	0x54 0x43			
Body movement parameter Inquiry	Send	0x53 0x59	0x80	0x83	0x00	0x01	0x0F	sum	0x54 0x43			
	Response	0x53 0x59	0x80	0x83	0x00	0x01	1B Body movement parameters	sum	0x54 0x43	Value range 0-100		

Function Category	Function Description	Transfer direction	Frame header	Control word	Command word	Length Identification	Data	Checksum field	End of frame	Note	
Fall detection reporting and setting											
Fall detection function	Fall monitoring function switch	Send	0x53 0x59	0x83	0x00	0x00	0x01	0x01: On 0x00: Off	sum	0x54 0x43	
		Response	0x53 0x59	0x83	0x00	0x00	0x01	0x01: On 0x00: Off	sum	0x54 0x43	
	Fall status	Report	0x53 0x59	0x83	0x01	0x00	0x01	0x00: Not fallen 0x01: Fall	sum	0x54 0x43	Report when status changes
	Fall time setting	Send	0x53 0x59	0x83	0x0C	0x00	0x04	4B time	sum	0x54 0x43	Value range: 5-180 seconds, unit: seconds
		Response	0x53 0x59	0x83	0x0C	0x00	0x04	4B time	sum	0x54 0x43	
	Stationary residence state	Report	0x53 0x59	0x83	0x05	0x00	0x01	0x00: No stationary residency 0x01: There is a stationary residency	sum	0x54 0x43	Report when status changes
	Residence time setting	Send	0x53 0x59	0x83	0x0A	0x00	0x04	4B time	sum	0x54 0x43	Value range: 60-3600 seconds, unit: seconds
		Response	0x53 0x59	0x83	0x0A	0x00	0x04	4B time	sum	0x54 0x43	
	Residence switch setting	Send	0x53 0x59	0x83	0x0B	0x00	0x01	0x01: On 0x00: Off	sum	0x54 0x43	
		Response	0x53 0x59	0x83	0x0B	0x00	0x01	0x01: On 0x00: Off	sum	0x54 0x43	
	Fall sensitivity setting	Send	0x53 0x59	0x83	0x0D	0x00	0x01	1B Sensitivity	sum	0x54 0x43	Value range: 0-3
		Response	0x53 0x59	0x83	0x0D	0x00	0x01	1B Sensitivity	sum	0x54 0x43	
	Height accumulation time setting	Send	0x53 0x59	0x83	0x0F	0x00	0x04	4B time	sum	0x54 0x43	Value range: 0-300 seconds, unit: seconds
		Response	0x53 0x59	0x83	0x0F	0x00	0x04	4B time	sum	0x54 0x43	
	Information Inquiry										
	Query fall monitoring function switch	Send	0x53 0x59	0x83	0x80	0x00	0x01	0x0F	sum	0x54 0x43	
		Response	0x53 0x59	0x83	0x80	0x00	0x01	0x01: On 0x00: Off	sum	0x54 0x43	
	Query fall status	Send	0x53 0x59	0x83	0x81	0x00	0x01	0x0F	sum	0x54 0x43	
		Response	0x53 0x59	0x83	0x81	0x00	0x01	0x00: Not fallen 0x01: Fall	sum	0x54 0x43	
	Query fall time	Send	0x53 0x59	0x83	0x8C	0x00	0x01	0x0F	sum	0x54 0x43	
Response		0x53 0x59	0x83	0x8C	0x00	0x04	4B time	sum	0x54 0x43		
Query stationary residence state	Send	0x53 0x59	0x83	0x85	0x00	0x01	0x0F	sum	0x54 0x43		
	Response	0x53 0x59	0x83	0x85	0x00	0x05	0x00: No stationary residency 0x01: There is a stationary residency	sum	0x54 0x43		
Query residence time	Send	0x53 0x59	0x83	0x8A	0x00	0x01	0x0F	sum	0x54 0x43		
	Response	0x53 0x59	0x83	0x8A	0x00	0x04	4B time	sum	0x54 0x43		
Query residence switch	Send	0x53 0x59	0x83	0x8B	0x00	0x01	0x0F	sum	0x54 0x43		
	Response	0x53 0x59	0x83	0x8B	0x00	0x01	0x01: On 0x00: Off	sum	0x54 0x43		
Query fall sensitivity	Send	0x53 0x59	0x83	0x8D	0x00	0x01	0x0F	sum	0x54 0x43	Value range: 0-3	
	Response	0x53 0x59	0x83	0x8D	0x00	0x01	1B Sensitivity	sum	0x54 0x43		
Query height percentage	Send	0x53 0x59	0x83	0x8E	0x00	0x01	0x0F	sum	0x54 0x43		
	Response	0x53 0x59	0x83	0x8E	0x00	0x01	1B: High 8 bits of the total number of heights 1B: Low 8 bits of the total number of heights 1B: 0-0.5m height ratio 1B: 0.5-1m height ratio 1B: 1-1.5m height ratio 1B: 1.5-2m height ratio	sum	0x54 0x43	The height percentage of the total percentage reaches 100. which height percentage is large, the movement is in which range.	
Query Height accumulation time	Send	0x53 0x59	0x83	0x8F	0x00	0x01	0x0F	sum	0x54 0x43	Value range: 0-300 seconds, unit: seconds	
	Response	0x53 0x59	0x83	0x8F	0x00	0x01	4B time	sum	0x54 0x43		

Function Category	Function Description	Transfer direction	Frame header	Control word	Command word	Length Identification	Data	Checksum field	End of frame	Note	
OTA (Valid for version 102 and above)											
OTA	Start OTA upgrade	Send	0x53 0x59	0x03	0x01	0x00	0x13	4B Firmware package size + 15B Firmware version number	sum	0x54 0x43	
		Response	0x53 0x59	0x03	0x01	0x00	0x04	4B Transfer upgrade package size per frame	sum	0x54 0x43	The host computer will follow this the size of the response at this point to determine how long the how long a firmware packet needs to be sent information
	Upgrade package transmission	Send	0x53 0x59	0x03	0x02	0x00	len+4	4B Package offset address + len B Data Packages	sum	0x54 0x43	
		Response	0x53 0x59	0x03	0x02	0x00	0x01	0x01: Received successfully 0x02: Receive Failure	sum	0x54 0x43	
	Ending the OTA upgrade	Send	0x53 0x59	0x03	0x03	0x00	0x01	0x01: Firmware package delivery completed 0x02: Firmware package delivery not completed	sum	0x54 0x43	
		Response	0x53 0x59	0x03	0x03	0x00	0x01	0x0F	sum	0x54 0x43	

Appendix 1: About the calculation of check digit

Let's take the command to send a human presence information query as an example.

The data construction for the presence information query confirmed by the protocol table above is

Frame header: 0x53 0x59

Control word: 0x80

Command word: 0x81

Length identifier: 0x00 0x01

Data: 0x0F

Checksum: 1Byte (SUM)

End of frame: 0x54 0x43

Combined into a complete instruction as follows

53 59 80 81 00 01 0F sum 54 43

Check digit sum : 0x53 + 0x59 + 0x80 + 0x81 + 0x01 + 0x0F

(0x53 + 0x59 + 0x80 + 0x81 + 0x00 + 0x01 + 0x0F) = 0x01BD

The lower byte is sum = 0xBD

So the complete existence information query instruction is: 53 59 80 81 00 01 0F BD 54