

60G Millimeter Wave Fall Alarm Radar

R60BFD1

User Manual_v1.2

Contents

1. Product Overview	2
2. Operating Principle	2
3. Precautions for Hardware Design	2
3.1 The power supply can refer to the following circuit designs	3
3.2 Wiring diagram in service	4
4. Layout Requirements for Antenna and Shell	4
5. Electrostatic Protection	4
6. Functional Details	5
6.1 Description of function points	5
7. Protocol Description	5
8. Communication Command and Parameter Definition	5
8.1 Definition and description of frame structure	6
8.2. Description of address assignment and data information	6
Appendix 1: About Data Instruction Generation Routine	13
9. Revision History	13

1. Product Overview

This document mainly describes precautions for using the radar and problems needing attention at each stage, so as to minimize the design cost, and improve the product stability and the project completion efficiency.

This document covers the reference design of hardware circuits, the layout requirements for radar antenna and shell, the way of interference discrimination and multi-functional standard UART protocol output.

This radar is a self-contained distance sensing sensor, which is a module composed of a radio frequency antenna, a radar chip and a high-clock rate MCU. Depending on a stable, flexible and superior algorithm framework core, it intends to satisfy various scene detection needs of users, and supports a master computer or a host computer to flexibly output detection status and data. The number of available GPIO groups can be customized and developed by users.

2. Operating Principle

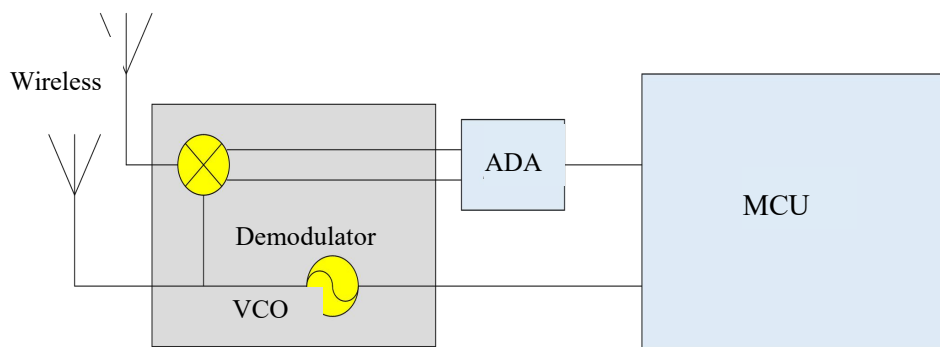


FIG. 1

The radar transmits a 60G band millimeter wave signal, and the detected target reflects an electromagnetic wave signal, which is demodulated according to the transmitted signal, and then processed by amplification, filtering, ADC, etc., to obtain the demodulated echo signal data. The MCU calculates information of amplitude, frequency and phase of the echo signal, and finally achieves measurement of target parameters (e.g., fall, standstill, motion, fine motion) and scene evaluation.

3. Precautions for Hardware Design

The rated power supply voltage of the radar should be 4.9V to 6V. Under normal working conditions, it requires a

rated input current of more than 200 mA. For power supply design, the power supply ripple should be not more than 100 mv.

3.1 The power supply can refer to the following circuit designs

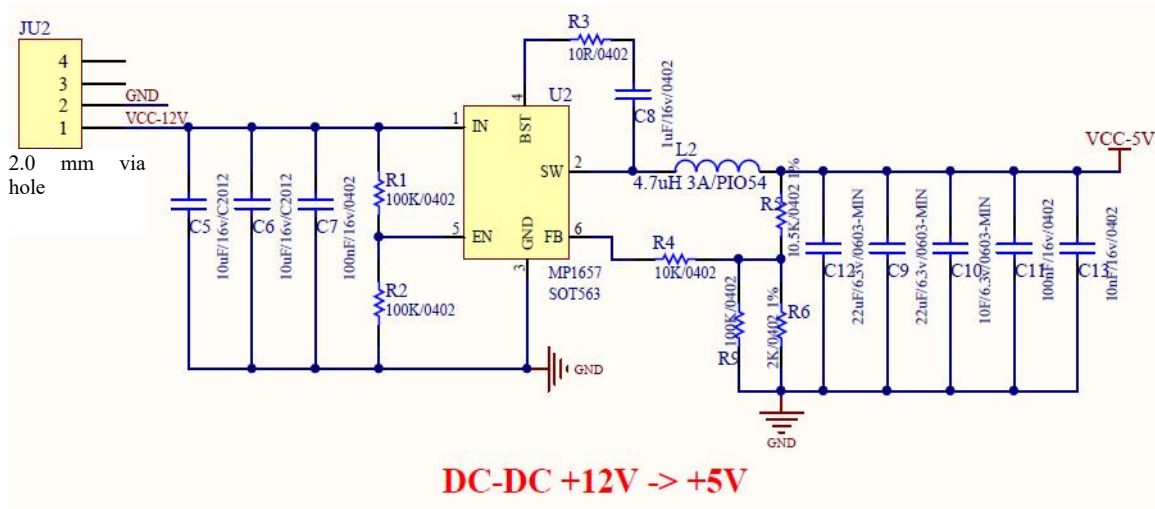


FIG. 2

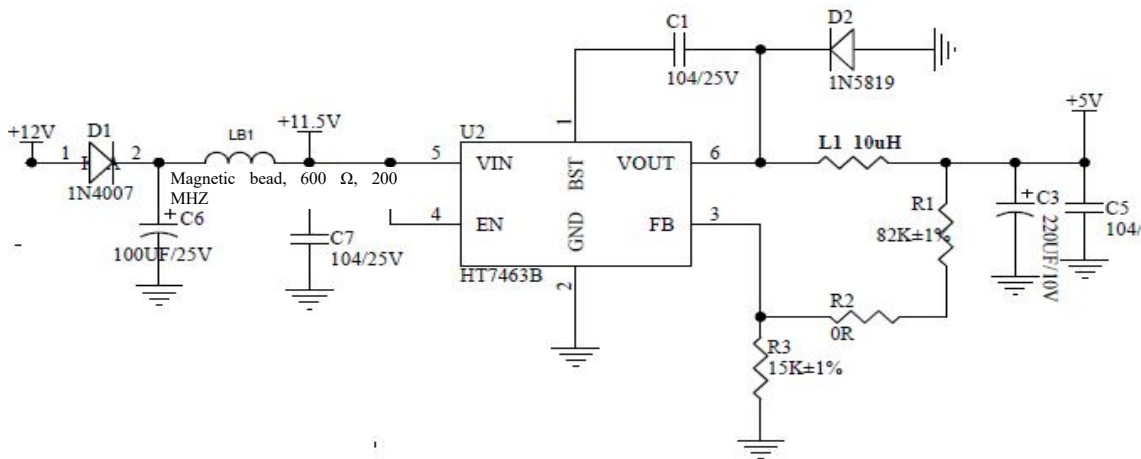


FIG. 3

3.2 Wiring diagram in service

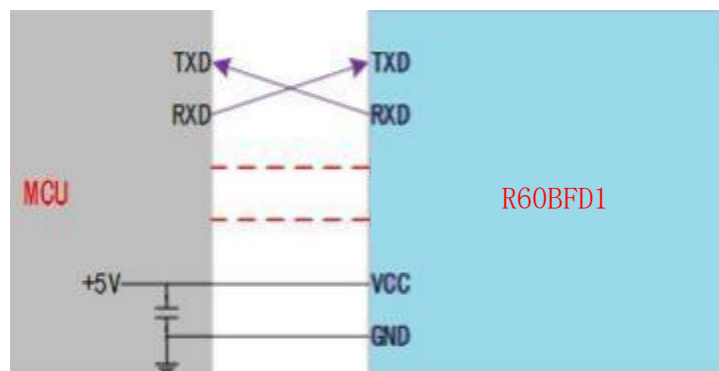


FIG. 4 Wiring schematic diagram of radar module and peripherals

4. Layout Requirements for Antenna and Shell

PCBA: It is necessary to keep the radar at least 1 mm higher than other surface mounting technology (SMT) devices.

Shell structure: it is necessary to keep the radar antenna surface 2 mm to 5 mm away from the shell surface.

Shell detection surface: a non-metallic shell, requiring a flat surface rather than a curve surface that affects the performance of the whole scanning area.

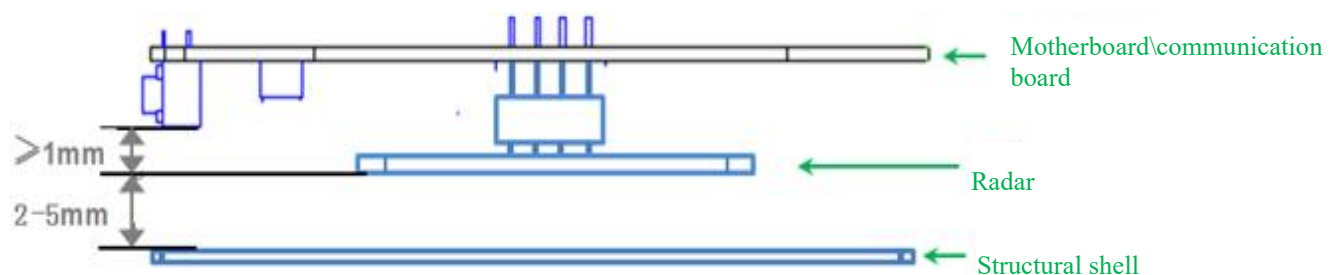


FIG. 5

5. Electrostatic Protection

The radar product has a built-in electrostatic-sensitive circuit, which are vulnerable to electrostatic hazards. Hence, it is necessary to take adequate measures for electrostatic protection during transportation, storage, operation and taking. You cannot touch or grasp the antenna surface and connector pins of the radar module by hand, but only touch the corners.

When operating the radar sensor, please wear anti-static gloves when possible.

6. Functional Details

6.1 Description of function points

Function points	State change time/function explanation
DP1: presence/absence	<p>It reports 0.5 s after detecting a presence state from the previous absence state</p> <p>It outputs an absence state about 30 s after detecting an absence state from the previous presence state</p>
DP2: fall alarm	It sends the alarm immediately in case that the fall alarm condition is met at its discretion.
DP3: standstill alarm	It sends the alarm in case of an abnormal standstill for 5 mins.
DP4: people counting	It detects people in the detection area in real time.

7. Protocol Description

This protocol is applicable to communication between the 60G millimeter-wave fall detection radar and the master computer.

This protocol provides an overview of the radar's work flow, briefly introduces the interface protocol architecture framework, and gives control commands and data necessary for related radar works. The serial communication is defined as follows:

- Interface level: TTL
- Baud rate: 115200 bps
- Stop bit: 1
- Data bit: 8
- Parity check: none

8. Communication Command and Parameter Definition

8.1 Definition and description of frame structure

Frame structure definition

Frame	Control field	Command field	Length identifier		Data	Check code	Frame tail
0X53 0X59	Control	Command	Lenth_H	Lenth_H	Data	sum	0X54 0X43
2 Byte	1 Byte	1 Byte	1 Byte	1 Byte	n Byte	1 Byte	2 Byte

Description of frame structure

- Frame header: 2 Byte, constant 0X53, 0X59;
- Control field: 1 Byte
(0X01- heartbeat identifier, 0X02- product information, 0X03-OTA upgrade, 0X05- working status, 0X06- installation method, 0X80- presence of human body, 0X83- fall detection)
- Command field: 1 Byte (identifying the current data content)
- Length identifier: 2 Bytes, equal the specific byte length of data
- Data: n Byte, defined based on practical function
- Check code: 1 Byte (check code calculation: frame header + control field + command field + length identifier + data, and take the lower eight bits after summation)
- Frame tail: 2 Byte, constant 0X54, 0X43;

8.2. Description of address assignment and data information

Product category	Function description	Transmission direction	Frame header	Control field	Command field	Length identifier	Data	Check field	Frame tail	Remarks
System functions	Actively sending a heartbeat (1 min)	Reporting	5359	01	01	0001	0F	sum	5443	
	Module reset	Distribution	5359	01	02	0001	0F	sum	5443	
		Reporting	5359	01	02	0001	0F	sum	5443	
Information query										
Product information	Product model query	Distribution	5359	02	A1	0001	0F	sum	5443	
		Reply	5359	02	A1	len	len B product information	sum	5443	
	Product id query	Distribution	5359	02	A2	0001	0F	sum	5443	
		Reply	5359	02	A2	len	len B product id	sum	5443	

	Hardware model query	Distribution	5359	02	A3	0001	0F	sum	5443	
		Reply	5359	02	A3	len	len B hardware model	sum	5443	
	Firmware version query	Distribution	5359	02	A4	0001	0F	sum	5443	
		Reply	5359	02	A4	len	len B firmware version	sum	5443	
Working status	Information of initialization completion	Reporting	5359	05	01	0001	0F	sum	5443	
	Radar fault uploading	Reporting	5359	05	02	0001	00: Normal operation 01: abnormal radar chip 02: encryption exception ---	sum	5443	
Parameter query										
	Initialization completion query	Distribution	5359	05	81	0001	0F	sum	5443	
		Reply	5359	05	81	0001	01: completed 00: uncompleted	sum	5443	
Parameter setting										
Radar installation information	Mounting angle	Distribution	5359	06	01	0x0006	2B X-axis angel + 2B Y -axis angel + 2B Z -axis angel	sum	5443	
		Reply	5359	06	01	0x0006	2B X-axis angel + 2B Y -axis angel + 2B Z -axis angel	sum	5443	
	Mounting height	Distribution	5359	06	02	0002	2B height information	sum	5443	The height is in cm the step length is 1 cm
		Reply	5359	06	02	0002	2B height information	sum	5443	
Parameter query										
Radar installation information	Mounting angle query	Distribution	5359	06	81	0001	0F	sum	5443	Mounting angle query
		Reply	5359	06	81	0006	2B X-axis angel + 2B Y -axis angel + 2B Z -axis angel	sum	5443	
	Mounting height query	Distribution	5359	06	82	0001	0F	sum	5443	
		Reply	5359	06	82	0002	2B height information	sum	5443	
Active reporting of human body										

Presence function	On/off of presence function	Distribution	5359	80	00	0001	01: on 00: off	sum	5443	
		Reply	5359	80	00	0001	01: on 00: off	sum	5443	
	Active reporting of presence information	Reporting	5359	80	01	0001	00: absence 01: presence	sum	5443	Reporting method: report when state changes.
	Active reporting of motion information	Reporting	5359	80	02	0001	00: none 01: stationary 02: active	sum	5443	Reporting method: report when state changes.
	Active reporting of body movement parameter	Reporting	5359	80	03	0001	1B body movement parameter	sum	5443	Reporting method: report at an interval of 1 s Numerical range:0-100
Information query										
Presence on/off query	Distribution	5359	80	80	0001	0F		sum	5443	
	Reply	5359	80	80	0001	01: on 00: off		sum	5443	
Presence information query	Distribution	5359	80	81	0001	0F		sum	5443	
	Reply	5359	80	81	0001	00: absence 01: presence		sum	5443	
Motion information query	Distribution	5359	80	82	0001	0F		sum	5443	
	Reply	5359	80	82	0001	00: none 01: stationary 02: active		sum	5443	
Body movement parameter query	Distribution	5359	80	83	0001	0F		sum	5443	Numerical range:0-100
	Reply	5359	80	83	0001	1B body movement parameter		sum	5443	
Body movement parameter on/off query	Distribution	5359	80	94	0001	0F		sum	5443	
	Reply	5359	80	94	0002	01: on 00: off		sum	5443	
Active reporting and setting of fall detection										

Fall detection function	Fall on/off monitoring function	Distribution	5359	83	00	0001	01: on 00: off	sum	5443	
		Reply	5359	83	00	0001	01: on 00: off	sum	5443	
	Fall state	Reporting	5359	83	01	0001	00: not fallen down 01: fallen down	sum	5443	Reporting method: report when state changes.
	Fall duration setting	Distribution	5359	83	0C	0004	4B length of time	sum	5443	Numerical range:0-3600 Unit: second
		Reply	5359	83	0C	0004	4B length of time	sum	5443	
	Standstill state	Reporting	5359	83	05	0x00 01	00: no standstill 01: standstill exists	sum	5443	Report when state changes.
	Standstill duration setting	Distribution	5359	83	0A	0004	4B length of time	sum	5443	Numerical range: 60-72000 Unit: second
		Reply	5359	83	0A	0004	4B length of time	sum	5443	
	Standstill on/off setting	Distribution	5359	83	0B	0001	1B on/off	sum	5443	0: off 1: on
		Reply	5359	83	0B	0001	1B on/off 01: on 00: off	sum	5443	
	Fall position reporting	Reporting	0x53 0x59	83	16	00 04	2B X-axis position information, 2B Y-axis position information	sum	5443	Unit: cm
	Cancellation of fall position reporting	Reporting	0x53 0x59	83	17	00 04	2B X-axis position information, 2B Y-axis position information	sum	5443	Unit: cm
	Automatic detection range limit setting	Distribution	5359	07	08	0001	01: turn on automatic detection 00: turn off automatic detection	sum	5359	Report the points in the unit time.
		Reply	5359	07	08	0001	01: turn on automatic detection 00: turn off automatic detection	sum	5359	
	Radar detection range setting	Distribution	5359	07	09	0008	2B (positive-half X axis)+2B (negative-half X axis)+2B (positive-half Y axis)+2B (negative-half Y axis)	sum	5359	Unit: cm
		Reply	5359	07	09	0008	2B (positive-half X axis)+2B (negative-half X axis)+2B (positive-half Y axis)+2B (negative-half Y axis)	sum	5359	

Foreign object size setting in detection range	Distribution	5359	07	0A	len	Distribute a plurality of foreign objects, and each target point has 1B index, 1B foreign object type, 1B filtering or not (00: completely filtering 01: not filtering), 2B positive-half X axis, 2B negative-half X axis, 2B positive-half Y axis and 2B negative-half Y axis.	sum	5359	Foreign object type: 00: door 01: window 02: desk 03: bed 04: couch 05: interference source 06: appliances
	Reply	5359	07	0A	len	Distribute a plurality of foreign objects, and each target point has 1B index, 1B foreign object type, 1B filtering or not (00: completely filtering 01: not filtering), 2B positive-half X axis, 2B negative-half X axis, 2B positive-half Y axis and 2B negative-half Y axis.	sum	5359	Foreign object type: 00: door 01: window 02: desk 03: bed 04: couch 05: interference source 06: appliances
Automatic detection range limit setting	Automatic reporting	5359	07	0B	len	n*(2B X-axis position information + 2B Y-axis position information)	sum	5359	Report the points in the unit time.
Automatic detection range on/off setting	Distribution	5359	07	0C	0001	01: on 00: off	sum	5359	
	Reply	5359	07	0C	0001	01: on 00: off	sum	5359	
Information query									
Fall monitoring on/off query	Distribution	5359	83	80	0001	0F	sum	5443	
	Reply	5359	83	80	0001	01: on 00: off	sum	5443	
Fall state query	Distribution	5359	83	81	0001	0F	sum	5443	
	Reply	5359	83	81	0001	00: not fallen down 01: fallen down	sum	5443	
Fall duration query	Distribution	5359	83	8C	0001	0F	sum	5443	
	Reply	5359	83	8C	0004	4B length of time	sum	5443	
Standstill state query	Distribution	5359	83	85	0001	0F	sum	5443	
	Reply	5359	83	85	0001	00: no standstill 01: standstill exists	sum	5443	

Standstill duration query	Distribution	5359	83	8A	0001	0F	sum	5443		
	Reply	5359	83	8A	0004	4B length of time	sum	5443		
Standstill on/off query	Distribution	5359	83	8B	0001	0F	sum	5443		
	Reply	5359	83	8B	0001	1B on/off 01: on 00: off	sum	5443		
Radar detection range query	Distribution	5359	07	89	0001	0F	sum	5443		
	Reply	5359	07	89	0008	2B (positive-half X axis)+2B (negative-half X axis)+2B (positive-half Y axis)+2B (negative-half Y axis)	sum	5443	Unit: cm	
Foreign object size query in detection range	Distribution	5359	07	8A	0001	0F	sum	5443		
	Reply	5359	07	8A	len	Distribute a plurality of foreign objects, and each target point has 1B index, 1B foreign object type, 1B filtering or not (00: completely filtering 01: not filtering), 2B positive-half X axis, 2B negative-half X axis, 2B positive-half Y axis and 2B negative-half Y axis.	sum	5443	Foreign object type: 00: door 01: window 02: desk 03: bed 04: couch 05: interference source 06: appliances	
Automatic detection range limit query	Distribution	5359	07	8B	0001	0F	sum	5443		
	Reply	5359	07	8B	len	n*(2B X-axis position information + 2B Y-axis position information)	sum	5443	Report the points in the unit time.	
Trace reporting and setting										
Trace tracking function	Trace tracking on/off function	Distribution	5443	82	00	0001	01: on 00: off	sum	5443	
		Reply	5443	82	00	0001	01: on 00: off	sum	5443	
	Total number of traces	Reporting	5443	82	01	0001	1B total number of traces	sum	5443	Reporting method: report at an interval of 2 s Numerical range:0-255 Unit: trace

	Trace information	Reporting	5443	82	02	len	Report a plurality of target points, and each target point has 1B index, 1B target size, 1B target feature, 2B X-axis position information, 2B Y-axis position information, 2B height information, 2B velocity and reserved information.	sum	5443	The position information may be positive or negative. If the first bit of 16-bit data is 0, it indicates positive; and the first bit is 1, it indicates positive.
Information query										
	Trace tracking on/off query	Distribution	5443	82	80	0001	0F	sum	5443	
		Reply	5443	82	80	0001	01: on 00: off	sum	5443	
	Query of total number of traces	Distribution	5443	82	81	0001	0F	sum	5443	
		Reply	5443	82	81	0001	1B total number of traces	sum	5443	
	Trace information query	Distribution	5443	82	82	0001	0F	sum	5443	
		Reply	5443	82	82	len	Report a plurality of target points, and each target point has 1B index, 1B target size, 1B target feature, 2B X-axis position information, 2B Y-axis position information, 2B height information and 2B velocity.	sum	5443	The position information may be positive or negative. If the first bit of 16-bit data is 0, it indicates positive; and the first bit is 1, it indicates positive. Note: 1. Refer to the 2B height information for the height. 2. The number of people is calculated by dividing the total data length by the data length of one frame.
OTA										
OTA	Start OTA upgrade	Distribution	5359	03	01	0004	4B firmware package size	sum	5443	
		Reply	5359	03	01	0004	4B upgrade package size transmitted per frame	sum	5443	The master computer will determine the length of firmware package information to be distributed per frame according to the size replied here.
	Upgrade package transmission	Distribution	5359	03	02	len+4	4B package offset address + lenB data packet	sum	5443	

	Reply	5359	03	02	0001	02: Receiving failed 01: Receiving succeeded	sum	5443	
Finish OTA upgrade	Distribution	5359	03	03	0001	01: firmware package is sent 02: firmware package is not sent	sum	5443	
	Reply	5359	03	03	0001	0F	sum	5443	

Appendix 1: About Data Instruction Generation Routine

For instance: presence information query:

According to the above protocol table, the data structure for presence information query is confirmed as follows:

Frame header: 0X53 0X59

Control field: 0X80

Command field: 0X81

Length identifier: 0X00 0X01

Data: 0X0F

Check code: 1 Byte (sum)

Frame tail: 0X54 0X43

Combined into a complete instruction as follows:

53 59 80 81 00 01 0F sum 54 43

Check code sum:

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

Take low byte to obtain sum = 0XBBD

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

9. Revision History

Revision	Release Date	summary	Author
V1.0	November, 24, 2023	First draft	Jason
V1.1	January 22, 2024	Revision and supplementary of the problem of reporting the trace protocol	Jason
V1.2	June 4, 2024	Addition of protocol interface protocol	Jason