

60G Millimeter Wave Radar Module

R60AMP1 Multi-person Trajectory Tracking

User manual (Ver.1.1)

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1. Product introduction

This document mainly describes the use of radar, the problems that may be encountered at different stages, to minimize the design costs and increase the stability of the product, and to improve the efficiency of the project.

Hardware circuit reference design, radar antenna and housing layout requirements, how to distinguish between interference and multi-functional UART protocol output.

The radar is a self-contained space sensing sensor, which is composed of RF antenna, radar chip and high speed main frequency MCU. It relies on stable and flexible algorithm architecture core to provide solution for scene detections. It's equipped with upper computer or host computer to output detection status and data, and meet several groups of GPIO for user customization and development.

2. Theory of operation

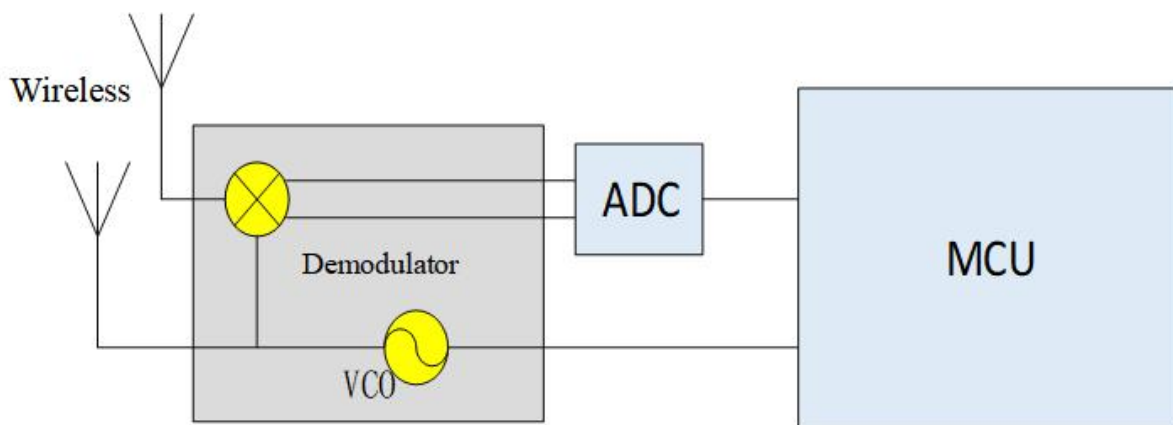


Figure 1

The radar transmits 60G band millimeter wave signal, the measured target reflects the electromagnetic wave signal, and demodulates the transmitted signal, which is then amplified, filtered, and processed by ADC to obtain the echo demodulated signal data. Information about the amplitude, frequency, and phase of the echo signal is calculated in the MCU unit, thereby completing target parameter (fall, static stationary, motion, and micro-motion) measurement and scene evaluation.

3. Notes for hardware design

The rated supply voltage of this radar shall be 4.9 - 6V, and in normal circumstances, the rated current shall be at least 200mA. Power supply design, power supply ripple shall be $\leq 100\text{mv}$.

3.1 For the power supply, refer to the circuit design below

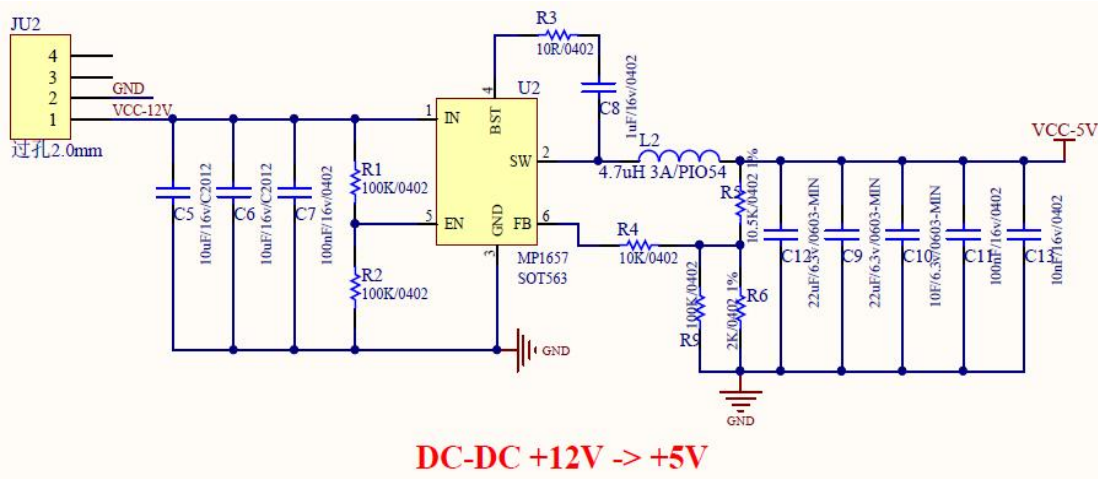


Figure 2

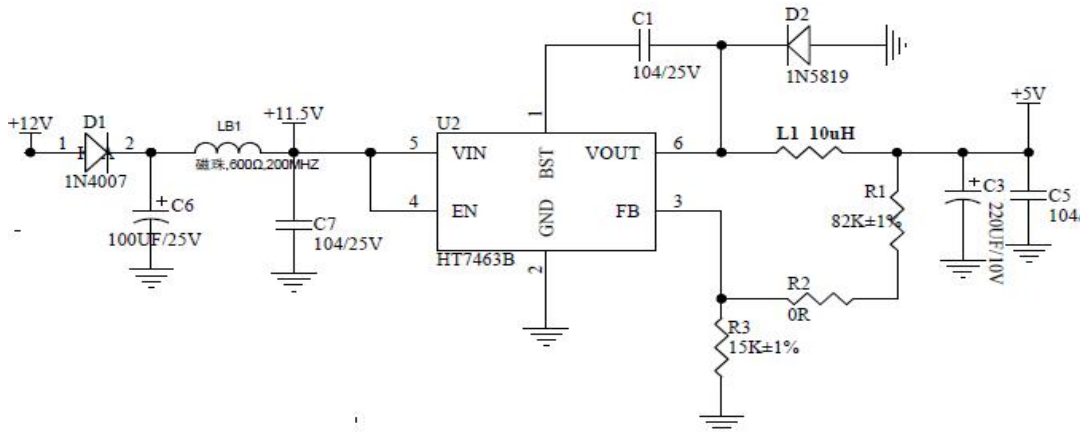


Figure 3

4. Requirements for antenna and housing layout

PCBA: Mounting height for radar shall be $\geq 1\text{mm}$ compared with other components

Housing structure: Radar antenna surface and housing surface shall be kept at a distance of 2 - 5mm

Housing detection surface: Non-metallic shell shall be flat, otherwise it may affect the performance of the entire scanning surface

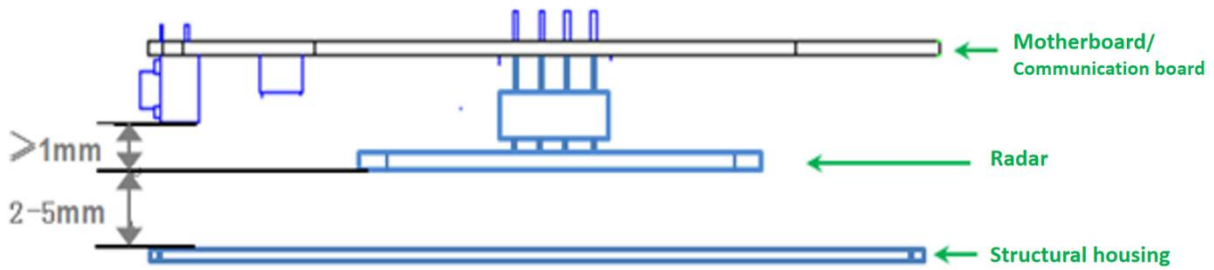


Figure 4

5. Electrostatic protection

Radar products contain electrostatic sensitive circuits, and shall be protected from static electricity during transportation, storage, working and picking up. Do not touch the radar module antenna surface and connector pins. Hold the components by their edge.

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

6. Function description

6.1 Description of function point

Function point	State change time/function explanation
DP1: Presence/Non-presence	Report within 0.5s from non-presence to presence If there is no output in 30s, presence changes to non-presence
DP2: Trajectory information	The radar reports target size, target characteristics, position, altitude, and speed when it detects the movement of the target

7. Protocol description

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

This protocol outlines the radar workflow, gives a brief introduction to the interface protocol composition architecture, and explains the control commands and data required for radar operation. The serial communication is defined as follows:

- Interface level: TTL
- Baud rate: 115200bps
- Stop bit: 1
- Data bit: 8
- Parity check: N/A

8. Definition of communication command and parameter

8.1 Definition and description of frame structure

Definition of frame structure

Frame	Control word	Command word	Length identification		Data	Check digit	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: 2Byte, fixed to 0X53,0X59;
- Control word: 1 Byte
(0x01-heartbeat packet identification, 0x02-product information, 0x03-OTA upgrade, 0x05-working status, 0X06-installation method, 0x80-human presence, 0X83-fall detection)
- Command word: 1Byte (identification of current data)
- Length identification: 2Byte, equal to the specific byte length of data
- Data: nByte, defined according to the actual function
- Check digit: 1Byte (check digit calculation: (frame header + control word + command word + length identifier + data) take the lowest eight bits after summation)
- Frame end: 2Byte, fixed to 0X54,0X43;

8.2 Description of address assignment and data information

Category	Function description	Transmission direction	Frame header	Control word	Command word	Length identification	Data	Verification field	Frame tail	Remarks
System functions	Heartbeat package query	Issue	5359	01	01	0001	0F	sum	5443	
		Reply	5359	01	01	0001	0F	sum	5443	

	Module reset	Issue	5359	01	02	0001	0F	sum	5443		
		Report	5359	01	02	0001	0F	sum	5443		
Information query											
Product Info	Product model query	Issue	5359	02	A1	0001	0F	sum	5443		
		Reply	5359	02	A1	len	len B product information	sum	5443		
	Product id query	Issue	5359	02	A2	0001	0F	sum	5443		
		Reply	5359	02	A2	len	len B product id	sum	5443		
	Hardware model query	Issue	5359	02	A3	0001	0F	sum	5443		
		Reply	5359	02	A3	len	len B hardware model	sum	5443		
	Firmware version query	Issue	5359	02	A4	0001	0F	sum	5443		
		Reply	5359	02	A4	len	len B firmware version query	sum	5443		
Working status	Message of initialization complete	Report	5359	05	01	0001	0f	sum	5443		
	Upload of radar failure	Report	5359	05	02	0001	01: Radar chip exception 02: Encryption exception ---	sum	5443		
		Reply	5359	05	07	0x0001	00: Default 01: Living room 02: Bedroom 03: Bathroom	sum	5443		
	Parameter query										
	Initialization progress query	Issue	5359	05	81	0001	0F	sum	5443		
Reply		5359	05	81	0001	01: Completed	sum	5443			

							00: Not completed				
Human presence report											
Human presence function	Enable/disable human presence function	Issue	5359	80	00	0001	01: Enable 00: Disable	sum	5443		
		Reply	5359	80	00	0001	01: Enable 00: Disable	sum	5443		
	Human presence information report	Report	5359	80	01	0001	00: Non-presence 01: Presence	sum	5443	Report method: Report on status changes	
	Movement information report	Report	5359	80	02	0001	00: No 01: Static 02: Active	sum	5443	Report method: Report on status changes	
	Body movement parameter report	Report	5359	80	03	0001	1B body movement parameters	sum	5443	Report method: Report every 1s Value range: 0-100	
	Information query										
	Human presence switch query	Issue	5359	80	80	0001	0F	sum	5443		
		Reply	5359	80	80	0001	01: Enable 00: Disable	sum	5443		
	Presence information query	Issue	5359	80	81	0001	0F	sum	5443		
		Reply	5359	80	81	0001	00: Non-presence 01: Presence	sum	5443		
Movement information	Issue	5359	80	82	0001	0F	sum	5443			

	query						00: No 01: Static 02: Active	sum	5443	
	Reply	5359	80	82	0001					
	Body movement parameter query	Issue	5359	80	83	0001	0F	sum	5443	
		Reply	5359	80	83	0001	1B body movement parameters	sum	5443	Value range: 0-100
Track information report and query										
Track function	Track information	Report	5359	82	02	len	Report trajectory information of multiple target points, each target point has 1B index, 1B target size, 1B target characteristics, 2B X-axis position information, 2B Y-axis position information, 2B height information, and 2B velocity)	sum	5443	<p>Location information has positive and negative value, if the first 16 bits of data is 0, it indicates positive, if the first bit is 1, it indicates positive</p> <p>Index: Distinguish different trajectory signal index</p> <p>Target size: 0-100 This function is unavailable at the moment</p> <p>Target characteristics: 0x00 Stationary 0x01: Motion</p> <p>X-axis data: -32767 cm~32767 cm</p> <p>Y-axis data: -32767 cm~32767 cm</p> <p>Height data: 0 cm~65535 cm (not applicable at the moment)</p> <p>Velocity:-32767 cm~32767 cm/s, positive if moving towards the target, negative if moving away</p> <p>(not applicable at the moment)</p>
	Track information query	Issue	5359	82	82	0001	0F	sum	5443	

		Reply	5359	82	82	len	Report multiple target points, each target point has 1B index, 1B target size, 1B target characteristics, 2B X-axis position information, 2B Y-axis position information, 2B height information, and 2B velocity	sum	5443	
OTA										
O T A	Start OTA upgrade	Issue	5359	03	01	0004	4B firmware package size	sum	5443	For example, when the firmware size is 150K (150*1024byte), the content of 4B is: 00 02 58 00 (Big endian in front)
		Reply	5359	03	01	0004	4B transmission upgrade packet size per frame	sum	5443	The host computer will determine the size of the firmware packet information to be issued per frame according to the reply
	Upgrade package transmission	Issue	5359	03	02	len+4	4B packet offset address + len B packet	sum	5443	
		Reply	5359	03	02	0001	01: Received 02: Failed to receive	sum	5443	
	Stop OTA upgrade	Issue	5359	03	03	0x0001	01:Firmware package transmission completed 02:Firmware package transmission not completed	sum	5443	

		Reply	5359	03	03	0x0001	01	sum	5443	
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Appendix 1: Example of data instruction generation

Example: Presence information query:

The data structure for confirming the presence information query according to the protocol form above:

Frame header: 0X53 0X59

Control word: 0X80

Command word: 0X81

Length identification: 0X00 0X01

Data: 0X0F

Check digit: 1Byte (SUM)

Frame end: 0X54 0X43

Combined to a complete command as:

53 59 80 81 00 01 0F sum 54 43

Check digit sum:

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

Take the lower byte to get sum = 0XBD

So the complete presence information query command is: 53 59 80 81 00 01 0F BD 54 43

9. Updates history

Revision	Release Date	Summary	Author
V1.0_0423	2023/04/23	First draft	Jason
V1.1_0802	2023/8/2	1. Deleted occlusion and width values from trajectory information 2. Improved OTA protocol issues	Mark