Rd-03_V2 Serial communication protocol

Version V1.0.0

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Document Resume

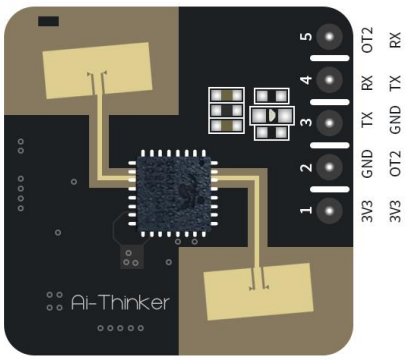
Version	Date	Develop/revise content	Formulate	Approval
V1.0.0	2025.09.03	First formulated	Zekai Qian	Hong Xu

Content

1. Communication Interface Introduction

1.1. Pin definition and wiring

The Rd-03_V2 module has a total of 5 pins, as shown in the pin diagram. The pin function definition table is the interface definition.



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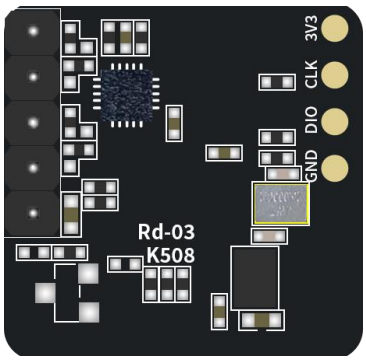

Back

Figure 1 Pin diagram

Table 1 Rd-03_V2 connected to TTL (default interface order)

Rd-03_V2	USB 转 TTL
3.3V	3.3V
GND	GND
TX	RXD
RX	TXD
OT2	Output high and low levels according to the detection results, no wiring

1.2. Configuration parameters and parameter descriptions

Users can modify the module's configuration parameters through the serial port of the Rd-03_V2 to adapt to different application requirements. The configurable radar detection parameters are shown in Table 2.

Table 2 Rd-03_V2 configuration parameters

Parameter Name	Configurable Range	Description
Minimum detection range threshold	0~15	Used to set the minimum detection distance of the radar. The length of a range gate is 70cm.
Maximum detection range threshold	0~15	Used to set the maximum detection distance of the radar. The length of a range gate is 70cm
Target disappearance delay time	0~65535	The target state switches from manned to unmanned for a period of time T: During this period, if a person is detected, the timer for this period will be restarted. The radar will switch to the unmanned state and report unmanned only after the unmanned state is detected for a full T time. The unit is seconds
Motion trigger threshold	0~(2^32)-1	Modulus squared
Motion hold threshold	0~(2^32)-1	Modulus squared
Fine motion & still threshold	0~(2^32)-1	Modulus squared
Normal mode	N/A	Serial port print output status
Report mode	N/A	The serial port reports the energy value and detection results of each distance gate (to be parsed by the host computer)
Power supply interference alarm	This parameter is read-only	Lower 16 bits: 0: Not active 1: No interference 2: Interference active Upper 16 bits: Interference frequency, range 0-256, unit kHz; only valid when the lower 16 bits are 2.

2. Communication Protocol

This communication protocol is primarily intended for users who require independent visualization tools. The Rd-03_V2 communicates with the outside world via a serial port (TTL level). Both radar data output and parameter configuration commands are performed under this protocol. The default baud rate of the radar serial port is 115200, with 1 stop bit and no parity.

2.1. Radar command configuration method

2.1.1. Radar command configuration steps

Parameter setting process: Enter command mode → Configure/get parameter command → Exit command mode

1. The host computer sends "Open Command Mode" to make the MCU enter command mode. At this time, the MCU does not perform human body detection and only waits for commands from the host computer.
2. The host computer sends commands such as parameter setting and parameter reading.
3. The host computer sends "exit command mode", at this time, the MCU enters the normal working mode and performs human body detection.

2.1.2. Radar Configuration Notes

Note：

1. The maximum data length of a single serial port command does not exceed 64 bytes (this size is subject to actual conditions and may vary from platform to platform. When the host computer sends a start command, the result returned by the slave computer includes the buffer size for command communication). Therefore, when reading or writing multiple registers, if the length exceeds 64 bytes, multiple commands need to be sent.
2. Byte order: little endian
3. Because the serial port outputs radar waveform data by default, you need to switch to command mode before issuing commands. The usual practice is divided into three steps:

(1) Send "Open Command Mode" (because the chip may still be outputting data, the data received by the serial port will contain waveform data, so the return result will not be analyzed)

(2) Clear the serial port buffer data (usually delay about 100ms to ensure that all serial port data are cleared)

(3) Send "Open Command Mode" again and analyze the returned results.

After the command mode ends, send "Close command mode" to start waveform data transmission.

4. It is recommended that the custom command ID range be between 0x0060 and 0x00A0.

2.2. Protocol Format

2.2.1. Protocol data format

The serial data communication of Rd-03_V2 uses the little-endian format. All data in the following table are in hexadecimal.

2.2.2. Command protocol frame format

The radar configuration command and ACK command formats defined by the protocol are shown in Tables 3 to 6.

Table 3 Send command protocol frame format

Frame header	Data length in frame	Intra-frame data	Frame tail
FD FC FB FA	2 bytes	Reference Table 4	04 03 02 01

Table 4 Data format content in the sending frame

Command word (2 bytes)	Command value (N bytes)

Table 5 ACK command protocol frame format

Frame header	Data length in frame	Intra-frame data	Frame tail
FD FC FB FA	2 bytes	Reference Table 6	04 03 02 01

Table 6 ACK frame data format

Send command word (2 bytes)	Command execution status (2 bytes)	Return value (N bytes)

2.3. Send command and ACK

2.3.1. Open command mode

Any other commands issued to the radar must be executed after this command; otherwise, they will be invalid.

Command Word: 0x00FF

Command Value: 0x0001

Return Value: 2-byte ACK status (0 for success, 1 for failure) + 2-byte protocol version (0x0002) + 2-byte buffer size (0x0020)

Sent Data:

Frame header	Frame data length	Command word	Command value	Frame tail
FD FC FB FA	04 00	FF 00	01 00	04 03 02 01

Radar ACK (success):

Frame header	Frame data length	Command word	ACK	Protocol version	Buffer size	Frame tail
FD FC FB FA	08 00	FF 01	00 00	02 00	20 00	04 03 02 01

2.3.2. Turn off command mode

End the configuration command. After execution, the radar resumes working mode. If you need to send other commands again, you need to send the enable configuration command first.

Command Word: 0x00FE

Command Value: None

Return Value: 2-byte ACK status (0 for success, 1 for failure)

Sent Data:

Frame header	Frame data length	Command word	Frame tail
FD FC FB FA	02 00	FE 00	04 03 02 01

Radar ACK (success):

Frame header	Frame data length	Command word	ACK	Frame tail
FD FC FB FA	04 00	FE 01	00 00	04 03 02 01

2.3.3. Configuration parameter commands

This command sets the radar's minimum detection range threshold, maximum detection range threshold, target disappearance delay, trigger threshold, and hold threshold parameters. For specific parameter values, refer to Table 7.

Command Word: 0x0007

Command Value: 2-byte parameter word + 4-byte parameter value

Return Value: 2-byte ACK status (0 for success, 1 for failure)

Table 7 0x0007 Protocol Parameter Word

Parameter name	Parameter word	Parameter range
Minimum detection distance threshold	0x0000	0~15
Maximum detection distance threshold	0x0001	0~15
Target disappearance delay time	0x0004	0 to 65535 (in seconds)
Motion trigger threshold	0x0010~0x001F	0 to (2^32)-1, modulus squared
Motion hold threshold	0x0020~0x002F	0 to (2^32)-1, modulus squared
Fine motion & inactivity threshold	0x0030~0x003F	0 to (2^32)-1, modulus squared

Power supply interference alarm	0x0005	Lower 16 bits: 0: Not active 1: No interference 2: Interference active Upper 16 bits: Interference frequency, range 0-256, unit kHz; only valid when the lower 16 bits are 2.

Send data: Maximum detection distance gate 3

Frame header	Frame data length	Command word	Parameter ID	Parameter Value	Frame tail
FD FC FB FA	08 00	07 00	01 00	03 00 00 00	04 03 02 01

Radar ACK (success):

Frame header	Frame data length	Command word	ACK	Frame tail
FD FC FB FA	04 00	07 01	00 00	04 03 02 01

Motion trigger threshold and inching & inactivity threshold setting guide:

The threshold value is the signal-to-noise ratio (S/N). The input value is S/N, and the calculation formula is 10log (S/N). The range is 0 to (2^32) - 1.

For example, if the final threshold value is 47.47, the calculation method is 47.74 = 10logX, where X = 10^4.774. The calculated X is 59,429, which is finally converted to hexadecimal E825.

2.3.4. Read parameter command

This command reads the current radar configuration parameters. Command Word: 0x0008

Command Value: (2-byte parameter ID) * N

Return Value: (4-byte parameter value) * N

Sent Data: Reads the maximum detection range threshold.

Frame header	Frame data length	Command word	Parameter ID	Frame tail
FD FC FB FA	04 00	08 00	01 00	04 03 02 01

Radar ACK: Maximum detection range gate is 3

Frame header	Frame data length	Command word	ACK	Parameter value	Frame tail
FD FC FB FA	08 00	08 01	00 00	03 00 00 00	04 03 02 01

2.3.5. Save configuration command

Save configuration command. Execute this command to save the configured parameters.

Command word: 0x00FD

Command value: None

Return value: 2-byte ACK status (0 for success, 1 for failure) + SN length (2 bytes) + SN (2 bytes)

Sent data:

Frame header	Frame data length	Command word	Frame tail
FD FC FB FA	02 00	FD 00	04 03 02 01

Radar ACK (success):

Frame header	Frame data length	Command word	ACK	Frame tail
FD FC FB FA	04 00	FD 01	00 00	04 03 02 01

2.3.6. Start automatically generating threshold commands

This command sets the parameters for automatically generating thresholds and enables the MCU to start automatically generating threshold calculations. For specific parameter words, refer to Table 8.

Table 8 Automatically generated threshold parameter table

Parameter Name	Parameter Range	Description
Trigger threshold generation coefficient	0x000A~0x00C8	10x magnification factor, for example, when the factor is 2, the parameter value is 0x0014
Hold threshold generation coefficient	0x000A~0x00C8	10x magnification factor, for example, when the factor is 2, the parameter value is 0x0014
Nudge & standstill threshold generation coefficient	0x000A~0x00C8	10x magnification factor, for example, when the factor is 2, the parameter value is 0x0014

Command Word: 0x0009

Command Value: 4-byte parameter value

Return Value: 2-byte ACK status (0 for success, 1 for failure)

Sent Data: Trigger threshold generation coefficient is 4, hold threshold generation coefficient is 1.5.

Frame header	Frame data length	Command word	Parameter value	Frame tail
FD FC FB FA	08 00	09 00	2-byte trigger threshold + 2-byte hold threshold + 2-byte static & micro-motion trigger threshold	04 03 02 01

Radar ACK：

Frame header	Frame data length	Command word	ACK	Frame tail
FD FC FB FA	04 00	09 01	00 00: Success; Other: Failure	04 03 02 01

2.3.7. Automatically generate threshold progress query commands

This command queries the progress of automatic threshold generation. The return value includes a progress percentage. A percentage of 100 indicates threshold generation is complete.

Command Word: 0x000A

Command Value: None

Return Value: 2-byte ACK status (0 for success, 1 for failure) + 2-byte percentage

Sent Data:

Frame header	Frame data length	Command word	Frame tail
FD FC FB FA	02 00	0A 00	04 03 02 01

Radar ACK: Success, percentage is 60%

Frame header	Frame data length	Command word	ACK	Percentage	Frame tail
FD FC FB FA	06 00	0A 01	00 00	3C 00	04 03 02 01

2.3.8. Report automatic threshold interference

This command reports the millimeter wave radar automatic threshold motion human interference alarm

Sending data:

Frame header	Frame data length	Command word	Frame tail
FD FC FB FA	02 00	14 00	04 03 02 01

Radar ACK：

Frame header	Frame data length	Command word	Parameter value	Frame tail
FD FC FB FA	06 00	14 01	2-byte status byte + 2-byte range gate status Status byte: 0000: Success, no interference; 0001: Failure, interference; Range gate status: Example: 0x84, converted to binary, is 1000_0100_0000_0010, corresponding to 1, 10, and 15, indicating range gate interference.	04 03 02 01

2.3.9. Configure system parameters

This command configures the radar's system parameters.

Command Word: 0x0012

Command Value: 2-byte parameter word + 4-byte parameter value

Return Value: 2-byte ACK status (0 for success, 1 for failure)

Table 9 0x0012 Protocol Parameter Word

Parameter name	Parameter value	Description
Reporting mode	0x0004	The serial port reports the energy value and detection results of each range gate.
Normal mode	0x0064	The serial port prints out the status.

Send data: Set to reporting mode

Frame header	Frame data length	Command word	Parameter ID	Parameter value	Frame tail
FD FC FB FA	08 00	12 00	00 00	04 00 00 00	04 03 02 01

Radar ACK：

Frame header	Frame data length	Command word	ACK	Frame tail
FD FC FB FA	04 00	12 01	00 00	04 03 02 01

2.4. Radar data output protocol

The Rd-03_V2 outputs radar detection results through the serial port. By default, it outputs basic target information, including target status and range. If the radar is configured in reporting mode, it also outputs the energy value of each range gate. Radar data is output in the specified frame format.

Reporting data frame format:

In the radar normal mode defined by the protocol, the reporting message frame format is shown in Table 10. In the reporting mode, the definition of the reported data type value is shown in Table 11.

Table 10 Normal mode

Target state	Movement distance
No	Range: xx（cm）
OFF	N/A

Table 11 Reporting Mode

Frame header	Data length	Test results	Target distance	Energy of each range gate	Frame tail
F4 F3 F2 F1	2 bytes, the total number of bytes of detection results, target distance and energy values of each range gate	1 byte, 00 : no one 01:someone	2 bytes	128 bytes, 32 (total number of range gates) * 4 bytes	F8 F7 F6 F5

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