

This communication protocol is mainly used by developers who need to separate from visualization tools for secondary development. The Xen102 hardware communicates with the outside world through a serial port. The serial port outputs the radar data processed by the algorithm by frame. The default baud rate of the radar serial port is 256000, 1 stop bit and no parity bit.

5.1 Protocol Format

5.1.1 Protocol data format

Rd-03E data communication uses little-end format, all data in the following table is in hexadecimal.

5.1.2 Frame format of module transmission data protocol

Table 5-1 shows the data format of a frame of commands in the protocol, where the distance information is small-end hexadecimal, two bytes, in cm. Table 5-2 shows the values of the target states and the corresponding target states. When the target velocity is non-zero Doppler, it is determined as a moving target, and when it is zero Doppler, it will additionally determine whether it is a micro-motion target or a low-speed moving target, and if it is a low-speed moving target, it is considered a moving target.

Table 5-1 Data Protocol Frame Format

Frame Header	Target Status	Distance information	End of Frame
AA AA	1byte	2byte	55 55

Table 5-2 Target Status Description

Target state value	Description
0x00	No target
0x01	movement target
0x02	Micro-motion target

5.2 Send Command and ACK

5.2.1 Read Firmware Version Command

This command reads the radar firmware version information.

Command word: 0x0000

Command Value: None

Return value: 2-byte ACK status (1 successful, 0 failed) +2-byte major version number +2-byte minor version number +2-byte patch version number.

Send data:

Frame Header	Intra-frame data length	Command Word	End of Frame
FD FC FB FA	02 00	00 00	04 03 02 01

Radar ACK (Success):

Frame Header	Intra-frame data length	ACK	Protocol Version	End of Frame	Frame Header	Intra-frame data length
FD FC FB FA	08 00	00 01	0x ⁴ 00	0x 00	0x 00	04 03 02 01

5.2.2 The enable configuration command

Any other commands issued to the radar can only be executed after this command is issued, otherwise it is invalid.

Command Word: 0x00FF

Command value: 0x0001

Return value: 2 bytes ACK status (1 success, 0 failure) +2 bytes protocol version (0x0001)

Send data:

Frame Header	Intra-frame data length	Command Word	End of Frame	Frame Header
FD FC FB FA	04 00	FF 00	01 00	04 03 02 01

Radar ACK (Success):

Frame Header	Intra-frame data length	ACK	Protocol Version	End of Frame
FD FC FB FA	04 00	FF 01	01 00	04 03 02 01

5.2.3 End Configuration Command

Perform the rear radar recovery mode. If you need to issue other commands again, you need to send the enable configuration command first.

Command Word: 0x00FE

Command Value: None

Return value: 2 bytes ACK status (1 success, 0 failure)

Send data:

Frame Header	Intra-frame data length	Command Word	End of Frame
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FD FC FB FA	02 00	FE 00	04 03 02 01
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Radar ACK (Success):

Frame Header	Intra-frame data length	ACK	Protocol Version	End of Frame
FD FC FB FA	04 00	FE 01	01 00	04 03 02 01

5.2.4 Distance calibration parameter configuration command

This command configures the distance calibration parameters in the algorithm.

Command word: 0x0072

Command value: 2 bytes distance calibration parameter number +4 bytes distance calibration parameter (int32 type)

Return value: 2 bytes ACK status (1 success, 0 failure)

Table 5-3 0x 0072 protocol number

Parameter Name	Reference Number
Distance calibration parameters	0x0000

Send data: (distance calibration parameter: 0)

Frame Header	Intra-frame data length	Command Word	Distance calibration parameter number	Distance calibration parameter value	End of Frame
FD FC FB FA	08 00	72 00	00 00	00 00 00 00	04 03 02 01

Radar ACK (Success):

Frame Header	Intra-frame data length	ACK	Protocol Version	End of Frame
FD FC FB FA	04 00	72 01	01 00	00 00

5.2.5 Maximum and minimum distance and unmanned duration parameter configuration commands

This command sets the radar maximum and minimum detection range (motion/inching), motion configuration range (30~717), inching configuration range (30~425), and unmanned duration parameters (configuration range 0~65535, unit: 50 ms).

Command Word: 0x0067

Command value: 2 bytes maximum moving distance word +4 bytes maximum moving distance parameter (uint32_t) +2 bytes minimum moving distance word +4 bytes minimum moving

distance parameter (uint32_t) +2 bytes maximum jog distance word +4 bytes maximum jog distance parameter (uint32_t) +2 bytes maximum jog distance word +4 bytes maximum jog distance parameter (uint32_t) +2 bytes unattended duration word +4 bytes unattended duration parameters (uint32_t)

Return value: 2 bytes ACK status (1 success, 0 failure)

Table 5-4 0x 0067 protocol number

Parameter Name	Reference Number
Maximum movement distance	0x0000
Minimum movement distance	0x0001
Maximum fretting distance	0x0002
Minimum fretting distance	0x0003
No one duration	0x0004

Send data: (maximum movement distance 717, minimum movement distance 30, maximum fretting distance 425, minimum fretting distance 30, unmanned duration 1s(20*50 ms))

Frame Header	Intra-frame data length	Command Word	Maximum movement distance parameter value	Maximum movement distance value	Minimum motion distance parameter	Minimum movement distance value
FD FC FB FA	20 00	67 00	00 00	CD 02 00 00	01 00	1E 00 00 00
Maximum fretting distance	Maximum jog distance value	Minimum motion distance parameter	Minimum movement distance value	No Man Duration Number	No Man Duration (* 50ms)	End of Frame
02 00	A9 01 00 00	03 00	1E 00 00 00	04 00	14 00 00 00	04 03 02 01

ACK Data (Success):

Frame Header	Intra-frame data length	ACK	Protocol Version	End of Frame
FD FC FB FA	04 00	67 01	01 00	04 03 02 01

Note: All the following commands are advanced parameter configurations, involving key functions of the algorithm. Improper settings may cause abnormal operation of the algorithm, which is only for users with radar expertise to modify carefully.

5.2.6 Noise floor parameter configuration command

This command configures the Noise parameter in the algorithm. The Noise parameter is a parameter used in the algorithm to participate in the calculation of the noise floor, and is of the float type in the protocol. It is automatically converted by the upper computer, and the configurable range is $-3.40E+38 \sim +3.40E+38$. When the coefficient is increased, the bottom noise becomes larger, and when the coefficient is decreased, the bottom noise becomes smaller.

Command word: 0x0068

Command value: 2 bytes of proximal motion Noise parameter +4 bytes of proximal motion

Noise parameter (float)+2 bytes of distal motion Noise parameter +4 bytes of distal motion

Noise parameter (float)+2 bytes of proximal jog Noise parameter +4 bytes of proximal jog Noise parameter (float)+4 bytes of distal jog Noise parameter +4 bytes of distal jog Noise parameter (float)

Return value: 2 bytes ACK status (1 success, 0 failure)

Table 5-5 0x 0068 protocol parameter number

Parameter Name	Reference Number
Noise coefficient of proximal motion	0x0000
Distal Motion Noise Coefficient	0x0001
Noise Coefficient of Proximal Fretting	0x0002
Distal micro-motion Noise coefficient	0x0003

Sending data: (Noise coefficient of proximal motion 40, Noise coefficient of distal motion 6, Noise coefficient of proximal micro-motion 40, Noise coefficient of distal micro-motion 9)

Frame Header	Intra-frame data length	Command Word	Proximal Motion Noise Parameter	Noise coefficient value of proximal motion	Distal Motion Noise Numeric
FD FC FB FA	0E 00	68 00	00 00	00 00 20 42	01 00
Distal Motion Noise coefficient value	Proximal Micro Noise Parameter	Proximal Micro Noise Coefficient Value	Distal Micro Noise Parameter	Distal Micro Noise Coefficient Value	End of Frame
00 00 C0 40	02 00	00 00 20 42	03 00	00 00 10 41	04 03 02 01

Radar ACK (Success):

Frame Header	Intra-frame data	ACK	Protocol Version	End of Frame
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	length			
FD FC FB FA	04 00	68 01	01 00	04 03 02 01

5.2.7 Clutter Suppression Coefficient Configuration Command

This command configures the clutter suppression parameters in the algorithm. Clutter suppression parameters are parameters used for clutter suppression in the algorithm and are of uint32_t type in the protocol. Automatic conversion by the upper computer, configurable range of 0~255. When the coefficient is increased, the ability to filter the static background becomes weaker, and when the coefficient is decreased, the ability to filter the static background becomes stronger.

Command word: 0x0069

Command value: 2-byte motion branch clutter suppression parameter number +4-byte motion branch clutter suppression parameter (uint32_t)+2-byte micro-motion branch clutter suppression parameter number +4-byte micro-motion branch clutter suppression parameter (uint32_t)

Return value: 2 bytes ACK status (1 success, 0 failure)

Table 5-6 0x 0069 protocol number

Parameter Name	Reference Number
moving branch clutter suppression coefficient	0x0000
Micro-motion branch clutter suppression coefficient	0x0001

Sending data: (motion branch clutter suppression coefficient 2, fretting branch clutter suppression coefficient 8)

Frame Header	Intra-frame data length	Command Word	moving branch clutter suppression reference number	moving branch clutter suppression coefficient	micromotion branch clutter suppression reference number	Micro-motion branch clutter suppression coefficient	End of Frame
FD FC FB FA	0E 00	69 00	00 00	02 00 00 00	01 00	08 00 00 00	04 03 02 01

Radar ACK (Success):

Frame Header	Intra-frame data length	ACK	Protocol Version	End of Frame
FD FC FB FA	04 00	69 01	01 00	04 03 02 01

5.2.8 FRAME Sliding Window Length Parameter Configuration Command

This command configures the FRAME sliding window length parameter in the algorithm. The FRAME sliding window length is a parameter used to set the window length of the sliding average in the algorithm, and is a uint32_t type in the protocol. Automatic conversion by the upper computer, configurable range of 0~255. In the firmware, the default maximum motion sliding window is 5 and the maximum micro-motion sliding window is 10. The maximum range can be set by modifying the macro definition of bodysensing_type.h, and the maximum range cannot exceed 255.

Command Word: 0x0070

Command value: 2-byte motion branch FRAME sliding window length parameter +4-byte motion branch FRAME sliding window length parameter (uint32_t)+2-byte micro branch FRAME sliding window length parameter +4-byte micro branch FRAME sliding window length parameter (uint32_t)

Return value: 2 bytes ACK status (1 success, 0 failure)

Table 5-7 0x 0070 protocol parameter numbers

Parameter Name	Reference Number
Motion Branch FRAME Window Length	0x0000
fretting branch FRAME window length	0x0001

Sending data: (FRAME sliding window length of motion branch 5, FRAME sliding window length of micro-motion branch 10):

Frame Header	Intra-frame data length	Command Word	Motion branch FRAME sliding window length parameter	Motion branch FRAME sliding window length value	FRAME sliding window length parameter	FRAME sliding window length value of fretting branch	End of Frame
FD FC FB FA	0E 00	70 00	00 00	05 00 00 00	01 00	0A 00 00 00	04 03 02 01

Radar ACK (Success):

Frame Header	Intra-frame data length	ACK	Protocol Version	End of Frame
FD FC FB FA	04 00	70 01	01 00	04 03 02 01

5.2.9 α - β filter coefficient configuration command

This command configures the alpha-B filtering parameters in the algorithm. The alpha-B filter parameter is the parameter used for alpha B filtering in the algorithm and is of float type in the protocol. It is automatically converted by the upper computer, and the configurable range is $-3.40E+38 \sim +3.40E+38$. The coefficient is two pairs, used in combination, for α -B. The filter coefficient 1 and the filter coefficient 2 are a pair, and the filter coefficient 3 and the filter coefficient 4 are a pair. The larger the α and β parameters, the faster the filtering will be, but the noise will also increase; the smaller the α and β parameters, the smoother the filtered value, but the dynamic response becomes worse and the delay becomes longer.

Command Word: 0x0071

Command value: 2 bytes of α -B filter 1 parameter +4 bytes of α -B filter 1 parameter (float type) +2 bytes of α - β filter 2 parameter +4 bytes of α -B filter 2 parameter (float type) +2 bytes of α - β filter 3 parameter +4 bytes of α -B filter 3 parameter (float type) +2 bytes of α -B filter 4 parameter +4 bytes of α -B filter 4 parameter (float type)

Return value: 2 bytes ACK status (1 success, 0 failure)

Table 5-8 0x 0071 Protocol Parameter Numbers

Parameter Name	Reference Number
α - β filter coefficient 1	0x0000
α - β filter coefficient 2	0x0001
α - β filter coefficient 3	0x0002
α - β filter coefficient 4	0x0003

Send data:(α - β filter coefficient 1: 0.5, α - β filter coefficient 2: 0.5, α -B filter coefficient 3:0.85, α -B filter coefficient 4: 0.15)

Frame Header	Intra-frame data length	Command Word	α -Beta filter 1 parameter	α -Beta filter coefficient 1 value	α -Beta filter 2 parameter number
FD FC FB FA	1A 00	71 00	00 00	00 00 00 3F	01 00
α -Beta filter coefficient 2 value	α -Beta filter 3-parameter number	α -Beta filter coefficient 3 value	α -Beta filter 4-parameter number	α -Beta filter coefficient 4 value	End of Frame
00 00 00 3F	02 00	99 99 59 3F	03 00	99 99 59 3E	04 03 02 01

Radar ACK (Success):

Frame Header	Intra-frame data length	ACK	Protocol Version	End of Frame
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FD FC FB FA	04 00	71 01	01 00	04 03 02 01
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5.2.10 Algorithm parameter configuration read command

This command can read algorithm parameters. Command word: 0x0073

Command Value: None

Return value: 2 bytes ACK status (1 success, 0 Failure) +2 Byte Configuration Maximum

Motion Distance +2 Byte Configuration Minimum Motion Distance +2 Byte Configuration

Maximum Micro Motion Distance +2 Byte Configuration Minimum Micro Motion Distance +2

Byte Unmanned Duration +4 Byte Proximal Motion Noise Coefficient 1(float) +4 Byte Distal

Motion Noise Coefficient 2(float) +4 Byte Proximal Micro Noise Coefficient 3(float) +4 Byte

Distal Micro Noise Coefficient 4 float) +1 byte motion clutter suppression coefficient +1 byte

micro clutter suppression coefficient +1 byte motion sliding window length +1 byte micro

sliding window length +4 bytes α β filter coefficient 1(float) +4 bytes α - β filter coefficient

2(float) +4 bytes α - β filter coefficient 3(float) +4 bytes α - β filter coefficient 4 (float) +4

bytes distance calibration parameter (int32)

Send data:

Frame Header	Intra-frame data length	Command Word	End of Frame
FD FC FB FA	02 00	73 00	04 03 02 01

Radar ACK (Success):

Frame Header	Intra-frame data length	ACK	Maximum movement distance value	Minimum movement distance value	Maximum jog distance value	Minimum jog distance value
FD FC FB FA	30 00	73 01	CD 02	1E 00	A 9 01	1E 00
No Man Duration Value	Noise Coefficient of Proximal Motion 1 Value		Distal Motion Noise Coefficient 2 Value		Proximal Micro-motion Noise Coefficient 3 Value	
14 00	00 00 20 42		00 00 C0 40		00 00 20 42	
Distal Micro	coefficient of	fretting clutter	Length value of	Length	α -Beta filter coefficient 1 value	α -Beta filter coefficient 2 value

Motion Noise Coefficient 4 Value	motion clutter suppression	suppression coefficient	motion sliding window	value of micro sliding window		
00 00 10 41	2	8	5	10	00 00 00 3F	00 00 003F
a -Beta filter coefficient 3 value	a -Beta filter coefficient 4 value				Distance calibration parameter value	End of Frame
99 99 59 3F	99 99 59 3E				00 00 00 00	04 03 02 01

6 Installation and detection range

When installing the module, it is recommended that the installation position be 1.3 m higher than the ground, and the wall-mounted installation method is adopted. The antenna surface of the radar module is perpendicular to the ground, as shown in Figure 6-1. When installing, pay attention to the antenna direction. When the azimuth angle is narrow, ensure that the patch direction of the antenna is horizontal.