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 | 0x4 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: 0xO0FF

Command value: 0x0001

Return value: 2 bytes ACK status (1 success, 0 failure) +2 bytes protocol version (Ox0001) 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: OxO0FE

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 |
| FD FC FB FA | 02 00 | FE 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 | 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: Ox0067

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 ~ + 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: Ox0068

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 |
|  | 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-fr ame data length | Command  Word | moving branch clutter suppressi on reference number | moving branch clutter suppression coefficient | micromotion branch clutter suppression reference number | Micro-moti on branch  clutter suppression coefficient | End  of  Fram  e |
| 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: Ox0070

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 a-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 ~ + 3.40E +38. The coefficient is two pairs, used in combination, for a-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 and β parameters, the faster the filtering will be, but the noise will also increase; the smaller the and β parameters, the smoother the filtered value, but the dynamic response becomes worse and the delay becomes longer.

Command Word: Ox0071

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 a-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 |
| a-β filter coefficient 1 | 0x0000 |
| a-β filter coefficient 2 | 0x0001 |
| a-β filter coefficient 3 | 0x0002 |
| a-β filter coefficient 4 | 0x0003 |

Send data:(aβ 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 | a -Beta filter  1 parameter | a -Beta filter coefficient 1 value | a -Beta filter  2 parameter number |
| FD FC FB FA | 1A 00 | 71 00 | 00 00 | 00 00 00 3F | 01 00 |
| a -Beta filter coefficient 2 value | a -Beta filter  3-parameter number | a -Beta filter coefficient 3 value | a -Beta filter  4-parameter number | a -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 |
| FD FC FB FA | 04 00 | 71 01 | 01 00 | 04 03 02 01 |

# 5.2.10 Algorithm parameter configuration read command

This command can read algorithm parameters. Command word: ox0073

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 aβ 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 | | Maximu m  moveme nt  distance value | Minimu m  moveme nt  distance value | Maximu m jog  distance value | Minimu m 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 | coeffici  ent of | fretting  clutter | Length value of | Lengt h | a -Beta filter coefficient 1 value | | a -Beta filter coefficient 2 value | |
| Motion  Noise  Coefficien t 4 Value | motion clutter suppres sion | suppre ssion  coeffic ient | motion sliding  window | value of  micro  slidin g  windo w |  | |  | |
| 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 | |

# 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.