Shenzhen Hi-Link Electronic Co., Ltd

HLK-LD2412
Human Presence Sensing Module
Serial Communication Protocol

Version：V1.03 Revise date：2024-4-26

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1 Introduction of Communication Interfaces

1.1 Pin definition

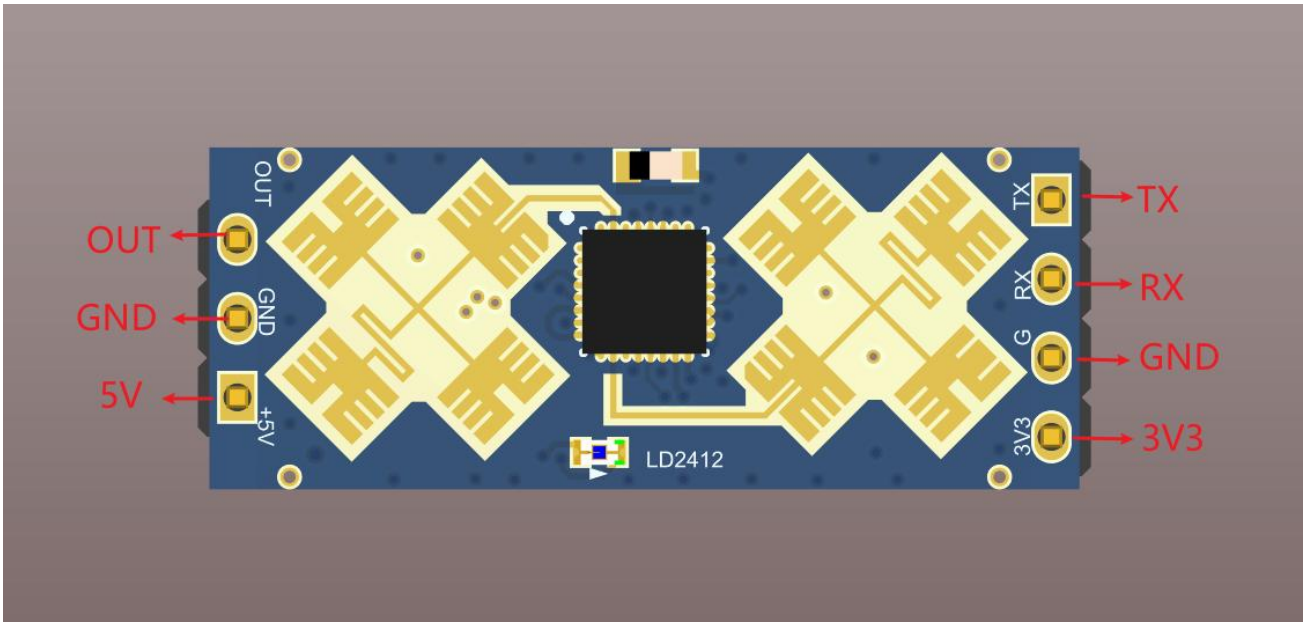


Figure 1 Module pin definition diagram

Symbol	Name	Function
OUT	Target status output	**Default as:** Human presence detected: output high level No human presence: output low level The output level can be configured through instructions
TX	Serial port Tx	Serial port Tx pin
RX	Serial port Rx	Serial port Rx pin
+5V	5V power input	Power input 5V; Either 5V or 3.3V power supply is optional
3V3	3.3V power input	Power input 3.3V； Either 5V or 3.3V power supply is optional
GND	Power ground	Power ground
G	Power ground	Power ground

Table 1 Pin Definition Table

1.2 Use and configuration

1.2.1 Typical application circuit

The LD2412 module directly outputs the detected target status through an IO pin (the level can be configured, default to manned high level, unmanned low level), and can also output detection result data through the serial port according to the specified protocol. The serial port output data includes target status and distance auxiliary information, etc. Users can flexibly use it according to specific application scenarios.

The module power supply voltage can be selected as 5V or 3.3V, and the input power supply capacity is required to be greater than 200mA.

The IO output level of the module is 3.3V. The default baud rate for the serial port is 115200, with 1 stop bit and no parity check bit.

1.2.2 The role of configuration parameters

The user can modify the configuration parameters of the module through the serial port of the LD2412 to adapt to different application requirements.

The configurable radar detection parameters include the following:

- **Maximum distance gate**

Set the farthest detection distance, only human targets that appear within this farthest range will be detected and output results.

Set in units of distance gates, with each distance gate being 0.75m.

The range can be set from 1 to 14. For example, if the farthest door is set to 2, only when there is a human body within 1.5 meters can it be effectively detected and output results.

- **Minimum distance gate**

Set the nearest detection distance so that the radar module can detect and output results only when the human target is greater than this distance.

Set in units of distance gates, with each distance gate being 0.75m.

The range can be set to 1-14, for example, if the farthest distance door is set to 2, only human bodies with a distance to the lightning module greater than 1.5m will have access to it

Detect and output results effectively

- **Sensitivity**

When the detected target energy value (ranging from 0 to 100) is greater than the sensitivity value, it will be judged as the presence of the target; otherwise, it will be ignored.

The sensitivity value can be set within the range of 0 to 100. Each distance gate can independently set sensitivity, allowing for precise adjustment of detection within different distance ranges, local precise detection, or filtering of interference sources in specific areas.

Additionally, if the sensitivity of a certain distance gate is set to 100, it can achieve the effect of not recognizing targets below this distance gate. For example, if the sensitivity of distance gates 3 and 4 is set to 20, and the sensitivity of other distance gates is set to 100, it can only detect human bodies within the range of 2.25-3.75m from the distance module.

- **Unmanned duration**

During the output of the radar from manned to unmanned, it will continue to report manned for a period of time. If unmanned continues within the radar testing range during this period, the radar will report unmanned; If the radar detects someone during this time period, it will refresh this time in seconds, with a minimum value of 5. Equivalent to the unmanned delay time, after the person leaves, the output status will be unmanned only after the duration of unmanned has exceeded.

1.2.3 Visual configuration tool description

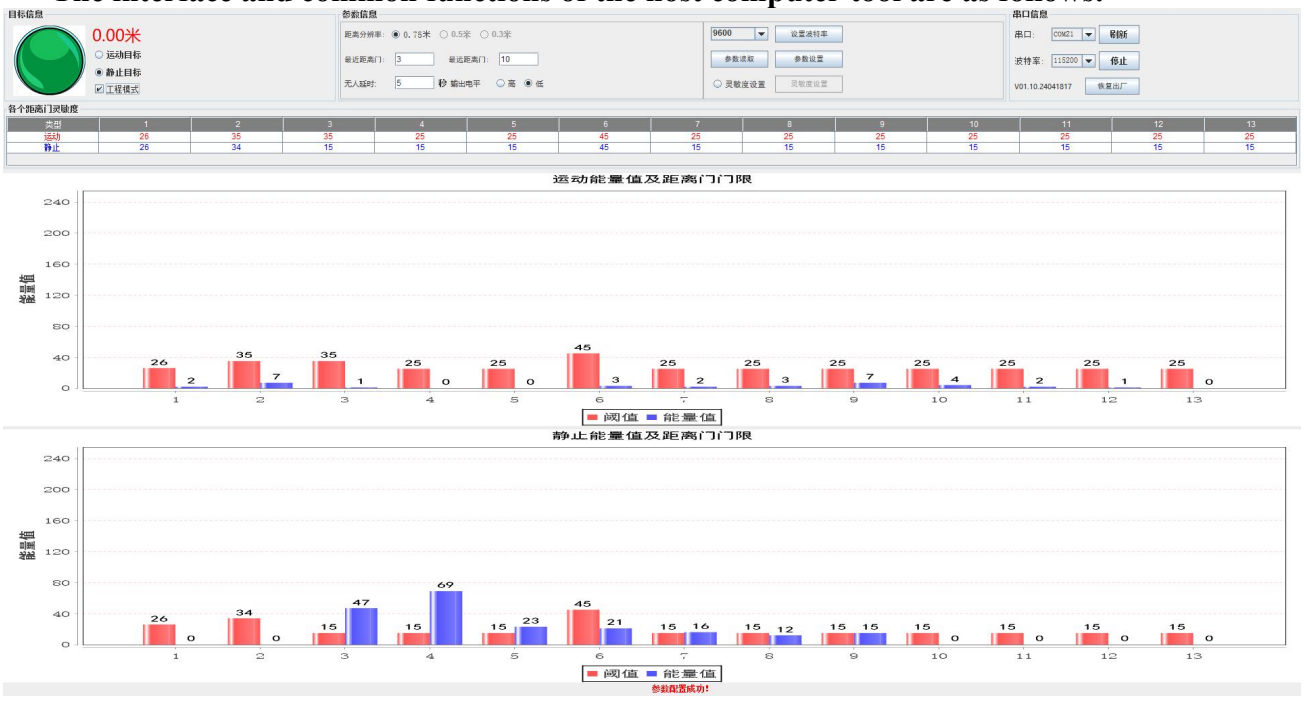
For the convenience of users to quickly and efficiently test and configure modules, a PC based upper computer configuration tool is provided. Users can use this tool software to connect the serial port of the module, read and configure the parameters of the module, receive detection result data reported by the module, and perform real-time visualization display, greatly facilitating user use。

Instructions for using host computer tools:

1. Connect the module serial port correctly using the USB to serial port tool;
2. Select the corresponding serial port number in the host computer tool, set the baud rate to 115200, select the engineering mode, and click to connect the device;
3. After successful connection, click the start button, and the graphical interface on the right will display the detection results and data;
4. After connecting, if the start button is not clicked, or if the stop button is clicked after starting, the mode parameter information can be read or set;

Note: After clicking start, parameters cannot be read and configured. Configuration can only be performed after stopping.

The interface and common functions of the host computer tool are as follows:



2. Communication Protocol

This communication protocol is mainly used by users who are detached from visualization tools for secondary development. LD2412 communicates with the outside world through a serial port (TTL level). The data output and parameter configuration commands of the radar are carried out under this protocol. The default baud rate for the radar serial port is 115200, with 1 stop bit and no parity check bit.

2.1 Protocol format

2.1.1 Protocol data format

The serial data communication of LD2412 uses small end format, and all data in the table below are in hexadecimal format

2.1.2 Command protocol frame format

The radar configuration command and ACK command format defined by the protocol are shown in Table 1 to Table 4.

Table 2 Send command protocol frame format

Frame header	Intra-frame data length	Intra-frame data	End of frame
FD FC FB FA	2 bytes	See Table 3	04 03 02 01

Table 3 Send intra-frame data format

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

Table 4 ACK command protocol frame format

Frame header	Intra-frame data length	Intra-frame data	End of frame
FD FC FB FA	2 bytes	See Table 5	04 03 02 01

Table 5 ACK intra-frame data format

Send command word | 0x0100 (2 bytes)	Return value (N bytes)

2.2 Send command with ACK

2.2.1 Enable configuration command

Any other command issued to the radar must be issued before it can be executed, otherwise it is invalid.

Command word: 0x00FF

Command value: 0x0001

Return value: 2-bytes ACK status (0 successful, 1 failed)+2-byte protocol version (0x0001)+2-byte

Send data：

FD FC FB FA	**04 00**	**FF 00**	**01 00**	**04 03 02 01**

Radar ACK (success)：

FD FC FB FA	**08 00**	**FF 01**	**00 00**	**01 00**	**00 00**	**04 03 02 01**

2.2.2 End configuration command

End the configuration command and resume radar operation mode after execution. If you need to issue another command, you need to send the enable configuration command first.

Command word：0x00FE

Command value：None

Return value：2-bytes ACK status (0 successful, 1 failed)

Send data：

FD FC FB FA	**02 00**	**FE 00**	**04 03 02 01**

Radar ACK (success)：

FD FC FB FA	**04 00**	**FE 01**	**00 00**	**04 03 02 01**

2.2.3 Basic parameter configuration command

Command word：0x0002

Command value：5 bytes, 1 byte minimum distance gate+1 byte maximum distance gate+2 bytes unmanned duration (in seconds)+1 byte out pin output polarity configuration (0 manned output high level, 1 unmanned output low level)

Return value：2-bytes ACK status (0 successful, 1 failed)

Send data：

FD FC FB FA	**07 00**	**02 00**	**01 0C 05 00 00**	**04 03 02 01**

0x0C represents a maximum distance gate of 13; 0x0005 represents an unmanned duration of 5 seconds, and 0x00 represents an out pin with someone outputting a high level

Radar ACK (success)：

FD FC FB FA	**04 00**	**02 01**	**00 00**	**04 03 02 01**

2.2.4 Read basic parameter command

This command can read the current basic parameters of the radar.

Command word：0x0012

Command value：None

Return value：2-bytes ACK status (0 successful, 1 failed)+1-byte minimum distance gate+1-byte maximum distance gate+2-bytes unmanned duration (in seconds)+1-byte out pin output polarity configuration (0 manned output high level, 1 unmanned output low level)

Send data：

FD FC FB FA	02 00	12 00	04 03 02 01

Radar ACK：(success，The minimum distance gate is 1, the maximum distance gate is 13, the unmanned duration is 5 seconds, and the out pin has someone outputting a high level)

FD FC FB FA	09 00	12 01	00 00	01 0C 05 00 00	04 03 02 01

2.2.5 Enable engineering mode command

This command opens radar engineering mode. After opening the engineering mode, the energy values of each distance gate will be added to the radar report data. For detailed format, please refer to 2.3.2 Target Data Composition. After the module is powered on, the engineering mode is turned off by default, and this configuration value is lost due to power failure。

Command word：0x0062

Command value：None

Return value：2-bytes ACK status (0 successful, 1 failed)

Send data：

FD FC FB FA	02 00	62 00	04 03 02 01

Radar ACK (success)：

FD FC FB FA	04 00	62 01	00 00	04 03 02 01

2.2.6 Close engineering mode command

This command turns off radar engineering mode. After shutdown, please refer to 2.3.2 Target Data Composition for the format of radar report data.

Command word：0x0063

Command value：None

Return value：2-bytes ACK status (0 successful, 1 failed)

Send data：

FD FC FB FA	**02 00**	**63 00**	**04 03 02 01**

Radar ACK (success)：

FD FC FB FA	**04 00**	**63 01**	**00 00**	**04 03 02 01**

2.2.7 Motion sensitivity configuration command

This command configures the motion sensitivity of each distance gate, and the configured value is not lost when powered off. Supports separate configuration for each distance gate

Command word：0x0003

Command value：14 bytes sensitivity value, each byte corresponds to the motion sensitivity value of a distance gate

Return value：2-bytes ACK status (0 successful, 1 failed)

Send data：

FD FC FB FA	**10 00**	**03 00**	**00 23 23 23 19 19 19 19 19 19 19 19 19**	**04 03 02 01**

Radar ACK (success)：

FD FC FB FA	**04 00**	**03 01**	**00 00**	**04 03 02 01**

2.2.8 Motion sensitivity query command

This command queries the motion sensitivity of each distance gate

Command word：0x0013

Command value：None

Return value：2-bytes ACK status (0 successful, 1 failed)+ 14 byte sensitivity value, each byte corresponds to the motion sensitivity value of a distance gate

Send data：

FD FC FB FA	**02 00**	**13 00**	**04 03 02 01**

Radar ACK (success)：

FD FC FB FA	**12 00**	**13 01**	**00 00**	**00 23 23 23 19 19 19 19 19 19 19 19 19**	**04 03 02 01**

				19	

2.2.9 Motionless sensitivity configuration command

This command configures the static sensitivity of each distance gate, and the configured value is not lost when power -off. Supports separate configuration for each distance gate

Command word：0x0004

Command value：14 byte sensitivity value, each byte corresponds to the motion sensitivity value of a distance gate

Return value：2-bytes ACK status (0 successful, 1 failed)

Send data：

FD FC FB FA	**10 00**	**04 00**	**00 23 23 23 19 19 19 19 19 19 19 19 19 19**	**04 03 02 01**

Radar ACK (success)：

FD FC FB FA	**04 00**	**04 01**	**00 00**	**04 03 02 01**

2.2.10 Motionless sensitivity query command

This command queries the static sensitivity of each distance gate

Command word：0x0014

Command value：None

Return value：2-bytes ACK status (0 successful, 1 failed)+ 14 byte sensitivity value, each byte corresponds to the motion sensitivity value of a distance gate

Send data：

FD FC FB FA	**02 00**	**14 00**	**04 03 02 01**

Radar ACK (success)：

FD FC FB FA	**12 00**	**14 01**	**00 00**	**00 23 23 23 19 19 19 19 19 19 19 19 19 19**	**04 03 02 01**

2.2.11 Static energy coefficient configuration command

This command configures the static energy coefficient for each distance gate, and the configured value is not lost when power -off. Support separate configuration for each distance gate

Command word：0x0005

Command value: A static energy coefficient value of 4 bytes per distance gate, 14 * 4=56 bytes in total

Return value: 2-bytes ACK status (0 successful, 1 failed)

Send data:

FD FC FB FA	**3A 00**	**05 00**	**01 00 00 00 FF 00 00 00 01 00 00 00 01 00 00 00 01 00 00 00 01 00 00 00 01 00 00 00 01 00 00 00 01 00 00 00 01 00 00 00 01 00 00 00 01 00 00 00 01 00 00 00 01 00 00 00**	**04 03 02 01**

Radar ACK (success):

FD FC FB FA	**04 00**	**05 01**	**00 00**	**04 03 02 01**

2.2.12 Static energy coefficient query command

This command queries the static energy coefficient of each distance gate

Command word: 0x0015

Command value: None

Return value: 2-bytes ACK status (0 successful, 1 failed)+ 56 bytes of sensitivity value, 4 bytes of static energy coefficient value for each distance gate

Send data:

FD FC FB FA	**02 00**	**15 00**	**04 03 02 01**

Radar ACK (success):

FD FC FB FA	**3C 00**	**15 01**	**00 00**	**01 00 00 00 FF 00 00 00 01 00 00 00 01 00 00 00 01 00 00 00 01 00 00 00 01 00 00 00 01 00 00 00 01 00 00 00 01 00 00 00 01 00 00 00 01 00 00 00 01 00 00 00 01 00 00 00**	**04 03 02 01**

2.2.13 Enter dynamic background correction mode command

After receiving the command, the module will enter calibration mode after 10 seconds

Command word: 0x000B

Command value: None

Return value: 2-bytes ACK status (0 successful, 1 failed)

Send data:

FD FC FB	**02**	**0B**	**04 03 02 01**

FA	**00**	**00**	

Radar ACK (success):

FD FC FB FA	**04 00**	**0B 01**	**00 00**	**04 03 02 01**

2.2.14 Query dynamic background correction mode command

This command queries whether the current state is in dynamic background correction mode

Command word：0x001B

Command value：None

Return value：2-bytes ACK status (0 successful, 1 failed)+ 2-byte status value (0x0001 in progress, 0x0000 not in progress)

Send data:

FD FC FB FA	**02 00**	**1B 00**	**04 03 02 01**

Radar ACK (success):

FD FC FB FA	**04 00**	**1B 01**	**00 00**	**01 00**	**04 03 02 01**

2.2.15 Read firmware version command

This command reads the radar firmware version information.

Command word：0x00A0

Command value：None

Return value：2-bytes ACK status (0 successful, 1 failed) + 2-bytes firmware type (0x2412)+2-bytes major version number+4-bytes minor version number

Send data:

FD FC FB FA	**02 00**	**A0 00**	**04 03 02 01**

Radar ACK (success):

FD FC FB FA	**0B 00**	**A0 01**	**00 00**	**12 24**	**10 01**	**10 18 04 24**	**04 03 02 01**

Corresponding version number is V1.10.24041810

2.2.16 Set the serial port baud rate

This command is used to set the baud rate of the module serial port. The configuration value is not lost

when power is lost, and takes effect after restarting the module

Command word：0x00A1

Command value：2-byte baud rate selection index

Return value：2-bytes ACK status (0 successful, 1 failed)

Table 6 Serial Port Baud Rate Selection

Baud rate selection index value	Baud rate
0x0001	9600
0x0002	19200
0x0003	38400
0x0004	57600
0x0005	115200
0x0006	230400
0x0007	256000
0x0008	460800

The factory default value is 0x0005, which is 115200

Send data：

FD FC FB FA	**04 00**	**A1 00**	**07 00**	**04 03 02 01**

Radar ACK (success)：

FD FC FB FA	**04 00**	**A1 01**	**00 00**	**04 03 02 01**

2.2.17 Restore factory settings

This command is used to restore all configuration values to their original factory values, which take effect after restarting the module

Command word：0x00A2

Command value：None

Return value：2-bytes ACK status (0 successful, 1 failed)

Send data：

FD FC FB FA	**02 00**	**A2 00**	**04 03 02 01**

Radar ACK (success)：

FD FC FB FA	**04 00**	**A2 01**	**00 00**	**04 03 02 01**

The default factory configuration values are as follows:

Table 7 Factory default configuration values

Configuration items	Default values
Minimum distance gate	1
Maximum distance gate	14
Unmanned duration	5
Serial baud rate	115200

2.2.18 Restart module

The module receives this command and will automatically restart after the response is sent

Command word: 0x00A3

Command value: None

Return value: 2-bytes ACK status (0 successful, 1 failed)

Send data:

FD FC FB FA	**02 00**	**A3 00**	**04 03 02 01**

Radar ACK (success):

FD FC FB FA	**04 00**	**A3 01**	**00 00**	**04 03 02 01**

2.3 Radar Data Output Protocol

LD2412 outputs radar detection results through a serial port, with default output of basic target information, including target status, motion energy value, stationary energy value, motion distance, stationary distance, and other information. If the radar is configured in engineering mode, it will output additional energy values for each distance gate (motion&rest). Radar data is output in the specified frame format.

2.3.1 Report data frame format

The format of radar reporting message frames defined by the protocol is shown in Tables 8 and 9. The definition of reported data type values under normal working mode and engineering mode is shown in Table 10

Table 8 Reporting Data Frame Format

Frame header	Intra-frame data length	Intra-frame data	End of Frame
F4 F3 F2 F1	2 bytes	Table 9	F8 F7 F6 F5

Table 9 Intra-frame data frame format

Data Type	Head	Target data	End	Check
1byte (see teble 0)	0xAA	See table 1，table 13	0x55	0x00

Table 10 Data type description

Data type value	Description
0x01	Engineering mode data
0x02	Target basic information

2.3.2 Target data composition

The target data content reported by the radar will change according to the working mode of the radar. Under normal working mode, the radar outputs basic information data of the target by default; After being configured in engineering mode, the radar will add energy value information for each distance gate after the basic information data of the target. Therefore, the basic information of the target will always be output in the radar report data, and the energy value information of the range gate will only be output after the command is enabled.

In the normal working mode, the composition of target data reported by the radar is shown in Table 11, and the definition of target status values is shown in Table 12. The composition of target data frames in engineering mode is shown in Table 13, and some additional data has been added to the data reported in normal working mode.

Table 11 Composition of Target Data Frames

Target state	Movement target distance (cm)	Exercise target energy value	Stationary target distance (cm)	Stationary target energy value
1 byte (see Table 12)	2 bytes	1 byte	2 bytes	1 byte

Table 12 Explanation of Target State Values

Target state values	Description
0x00	No target
0x01	Movement target
0x02	Stationary target
0x03	Movement&Stationary target

Table 13 Target Data(Project Mode) Frame Composition

...	Maximum moving distance gate N	Maximum static distance gate N	Movement distance gate 0 energy value	...	Movement distance gate N energy value	Static distance gate 0 energy value	...	Static distance gate N energy value
...	1 byte	1 byte	1 byte	...	1 byte	1 byte	...	1 byte

Example of reporting data:

Reporting data in normal working mode:

Frame header	Intra-frame data length	Intra-frame data	End of frame
F4 F3 F2 F1	0B 00	02 AA 02 51 00 00 00 00 3B 55 00	F8 F7 F6 F5

Reporting data in engineering mode:

Frame header	Intra-frame data length	Intra-frame data	End of frame
F4 F3 F2 F1	29 00	01 AA 02 00 00 00 00 00 00 0D 0D 00 03 02 01 00 00 00 00 02 02 02 00 00 00 00 00 00 04 7E 61 0D 0F 05 05 04 02 01 02 01 55 00	F8 F7 F6 F5

2.4 Radar command configuration method

2.4.1 Radar command configuration steps

The process of executing a configuration command for LD2412 radar includes two steps: "send command" by the host computer and "reply command ACK" by the radar. If there is no ACK reply from the radar or fails to reply ACK, it indicates that the radar has failed to execute the configuration command.

As mentioned earlier, before sending any other commands to the radar, developers need to first send the "enable configuration" command, and then send the configuration command within the specified time. After completing the command configuration, send the "End Configuration" command to inform the radar that the configuration has been completed.

For example, to read radar configuration parameters, the upper computer first sends the "enable configuration" command; After receiving a successful radar ACK, send the "Read Parameters" command again; After receiving a successful radar ACK, send the "End Configuration" command at the end; After the radar ACK is successful, it indicates that the complete parameter reading operation is over.

The radar command configuration process is shown in the figure below:

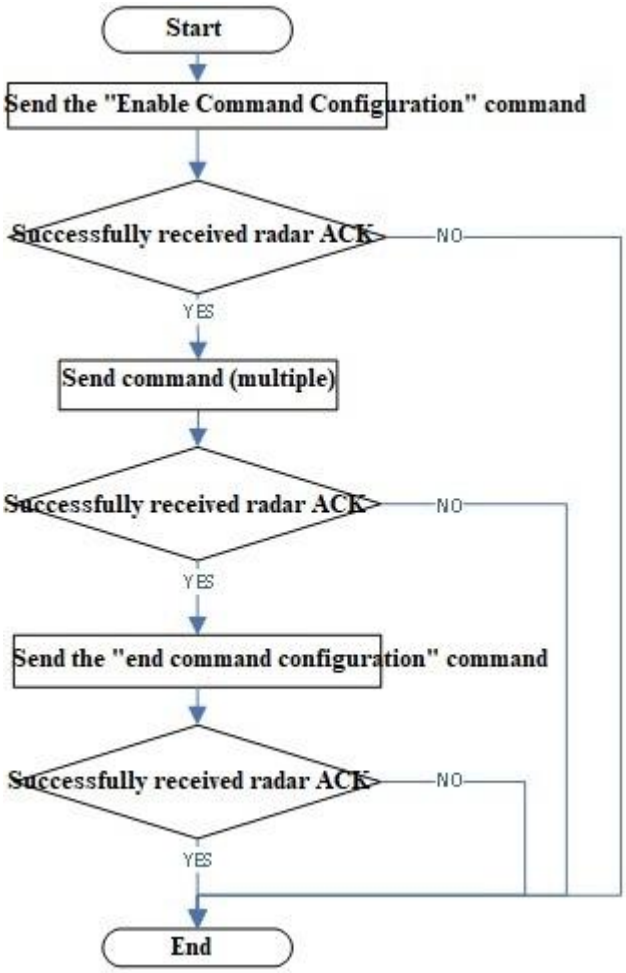


Figure 2 Radar command configuration process

3. Revision Record

Date	Version	Modify the content
2024-4-18	1.01	Initial version
2024-4-23	1.02	Add query command for static energy coefficient setting, Add enter dynamic background correction mode and status query command
2024-4-26	1.03	Modify the format description of data within the reported data frame

4.Technical support and contact

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