HLK-LD2412

Human Presence Sensor Module

serial port communication protocol

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Chart Index

1 Communication Interface Introduction

1.1 Pin Definitions

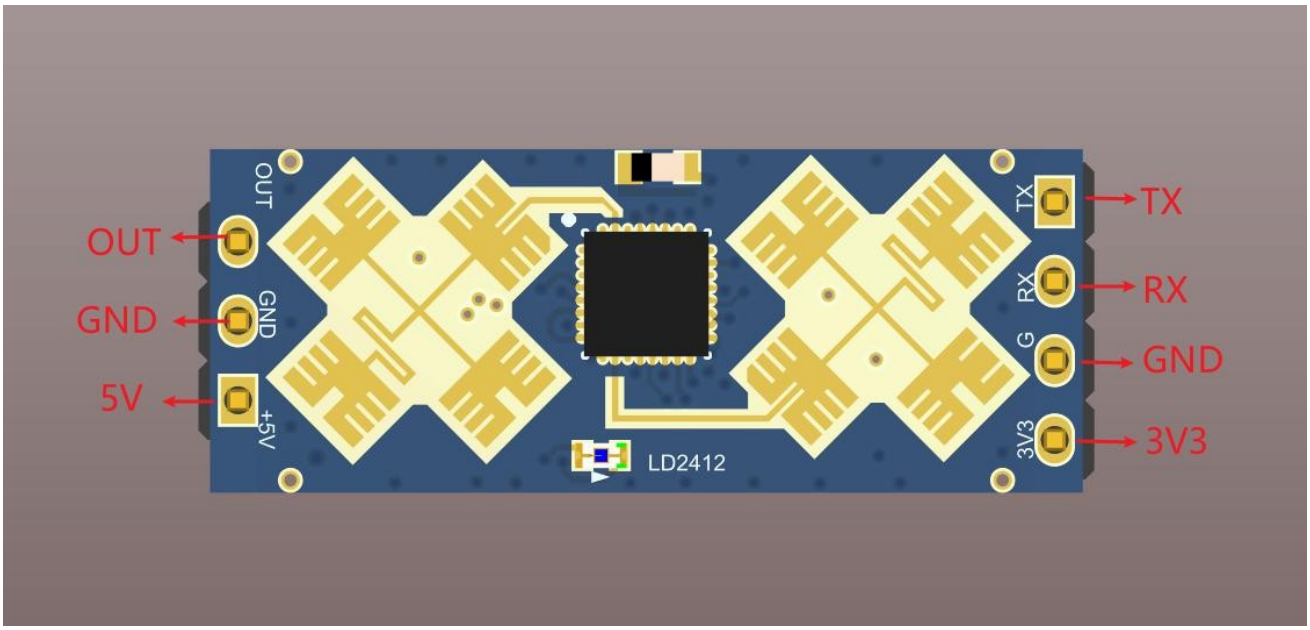

Figure 1 Module Pin Definition Diagram

Pin Symbol	name (of a thing)	functionality
OUT	target state output	default Human presence detected: output high level No human presence: output low level Output level configurable by command
TX	Serial Tx	Serial Tx Pin
RX	Serial Rx	Serial Port Rx Pin
+5V	5V power input	Power input 5V; either 5V or 3.3V power supply is available
3V3	3.3V power input	Power input 3.3V; either 5V or 3.3V power supply
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

LD2412 module directly through an IO pin output detected target state (level can be configured, the default is someone high, no one low), but also through the serial port in accordance with the prescribed protocol for the detection of the results of the data output, the serial port output data contains the target state and the distance of the auxiliary information, etc., the user can be flexible according to the specific application scenarios.

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

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

1.2.2 Role of configuration parameters

Users can modify the configuration parameters to the module through the serial port of the LD2412 to adapt to different application requirements. Configurable radar detection parameters include the following:

Maximum distance to door

Set the maximum detection distance so that only human targets appearing within this maximum distance will be detected and the results output. Setting is done in units of distance gates, each distance gate is 0.75m.

The range can be set from 1 to 13. For example, if the furthest distance gate is set to 2, the presence of a human body within 1.5m will be effectively detected and the result will be outputted only.

Minimum distance to door

Set the nearest detection distance to the radar module greater than this distance to the human target will be detected and output results. Setting is done in units of distance gates, each distance gate is 0.75m.

Can be set in the range of 1 to 13, for example, set the furthest distance gate to 2, then only to the mine module distance greater than 1.5m of the human body will be effectively detected and output results

(level of) sensitivity

The detected target energy value (range 0 to 100) is determined as target presence only when it is greater than the sensitivity value, otherwise it is ignored.

The sensitivity value can be set from 0 to 100, and the sensitivity can be set independently for each distance gate, which can be precisely adjusted for detection in

different distance ranges, localized precise detection or filtering of interference sources in specific areas.

Also if the sensitivity of a certain distance gate is set to 100, the effect of not recognizing targets under this distance gate can be achieved. For example, if the sensitivity of distance gate 3 and distance gate 4 is set to 20, and the sensitivity of all other distance gates is set to 100, it is possible to achieve the detection of the human body only within the range of 2.25 to 3.75m from the module.

Unmanned duration

Radar in the output from occupied to unoccupied results, will continue to report occupied for a period of time, if the radar test range in this time period continues to be unoccupied, the radar reported unoccupied; if the radar detects occupied in this time period, will be refreshed in this time, the unit of seconds, the minimum value of 5. Equivalent to the unoccupied delay time, the person leaves, remain unoccupied for more than this duration time before the output state for unoccupied.

1.2.3 Visual Configuration Tool Description

In order to facilitate the user to quickly and efficiently test and configure the module, provides a PC-based configuration tool, the user can use this tool to connect to the module's serial port, read and configure the parameters of the module, but also to receive the module reported detection results data, and real-time visualization of the display, which is very convenient for the user to use.

How to use the upper tool:

1. Connect the module serial port correctly with the USB to Serial tool;
2. Select the corresponding serial port number in the upper computer tool, set the baud rate 115200, select the engineering mode, and click Connect Device;
3. After successful connection, click the Start button and the test results and data will be displayed on the right graphical interface;
4. After connecting, when you have not clicked the start button, or clicked stop after starting, you can read or set the mode parameter information; Note: You cannot read or configure the parameters after clicking start, you need to stop to configure them.

The interface and common functions of the upper tool are shown below:

2 communications protocol

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

2.1 protocol format

2.1.1 Protocol Data Format

The LD2412's serial data communication uses the little end format, and all data in the following tables are in hexadecimal.

2.1.2 Command Protocol Frame Format

The protocol-defined radar configuration commands and ACK command formats are shown in Tables 2 through 4.

Table 2 Send command protocol frame format

header	In-frame data length	in-frame data	end of frame
FD FC FB FA	2 bytes	See table 3	04 03 02 01

Table 3 Transmit in-frame data format

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

Table 4 ACK Command Protocol Frame Format

header	In-frame data length	in-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 Commands

Any other commands issued to the radar must be issued after this command is issued before they can be executed, otherwise they are invalid. The module defaults to an unenabled configuration after startup. Command word: 0x00FF

Command value: 0x0001

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

End Configuration command, the radar restores the working mode after execution. 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-byte ACK status (0 success, 1 failure) 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 Radar Resolution Configuration Commands

The resolution of the radar, i.e. the distance corresponding to one distance gate, can be set. Changing this setting requires one reboot before it takes effect. Command word: 0x0001

Command value: 6 bytes, the 1st byte is the resolution value, the others are fixed to 0

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

failure)

Table 6 Resolution Configuration Values

Resolution Configuration Values	resolution (of a photo)
0	75cm/distance from door
1	50cm/distance from door
3	20cm/distance from door

Send data:

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

0x01 means set the resolution to 50cm/distance gate

Radar ACK (success):

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

2.2.4 Read Resolution Parameter Command

This command reads the current
resolution configuration of the radar.

Command word: 0x0011

Command value: none

Return value: 2 bytes ACK status (0 success, 1 failure) + 6 bytes (1st byte is resolution value)

Send data:

FD FC FB FA	02 00	11 00	04 03 02 01

Radar ACK: (Successful, resolution 50cm/distance gate)

FD FC FB FA	0A 00	11 01	00 00	01 00 00 00 00 00	04 03 02 01

2.2.5 Basic Parameter Configuration Commands

Command word: 0x0002

Command value: 5 bytes, 1 byte min distance gate + 1 byte max distance gate + 2 bytes unoccupied duration (in seconds) + 1 byte out pin output polarity configuration (0 someone outputs high, 1 someone outputs low)

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

Send data:

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

0x0C means the maximum distance gate is 13; 0x0005 means the unoccupied duration is 5s, and 0x00 means someone at the out pin outputs a high level radar ACK (success):

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

2.2.6 Read Base Parameter Command

This command reads the current

base parameters of the radar.

Command word: 0x0012

Command value: none

Return value: 2 bytes ACK status (0 success, 1 failure) + 1 byte minimum distance gate + 1 byte maximum distance gate + 2 bytes unoccupied duration (in seconds) + 1 byte out pin output polarity configuration (0 someone outputs high, 1 someone outputs low)

Send data:

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

Radar ACK: (successful, min distance gate is 1, max distance gate is 13, unoccupied duration is 5s, out pin manned output high)

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

2.2.7 Enable Engineering Mode Command

This command opens the radar engineering mode. When the engineering mode is turned on, the energy value of each distance gate will be added to the radar reported data, please refer to 2.3.2 Target Data Composition for detailed format. Engineering mode is off by default after the module is powered on, this configuration value is lost when power down.

Command

word: 0x0062

Command

value: none

Return value: 2-byte ACK status (0

success, 1 failure) 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

2.2.8 Turn off engineering mode command

This command turns off the radar engineering mode. After it is turned off, please refer to 2.3.2 Target Data Composition for radar reported data format.

Command word: 0x0063

Command value: none

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

2.2.9 Motion Sensitivity Configuration Commands

This command configures the motion sensitivity of each distance gate, and the configured value is not lost when power down. Both support individual configuration for each distance gate Command word: 0x0003

Command value: 14 bytes sensitivity value, each byte corresponds to a distance from the door movement sensitivity value Return value: 2 bytes ACK status (0 success, 1 failure)

Send data:

FD FC FB FA	10 00	03 00	00 23 23 23 23 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 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

2.2.10 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 success, 1 failure) + 14 bytes sensitivity value, each byte

corresponds to a distance from the gate motion sensitivity value

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 23 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19	04 03 02 01

2.2.11 Static Sensitivity Configuration Commands

This command configures the static sensitivity of each distance gate, and the configured value is not lost when power down. Both support individual configuration for each distance gate Command word: 0x0004

Command value: 14 bytes sensitivity value, each byte corresponds to a distance gate sensitivity value Return value: 2 bytes ACK status (0 success, 1 failure)

Send data:

FD FC FB FA	10 00	04 00	00 23 23 23 23 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 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

2.2.12 Static 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 success, 1 failure) + 14 bytes sensitivity value, each byte corresponds to a distance gate sensitivity value to 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 23 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19	04 03 02 01

2.2.13 Entering the Dynamic Background Correction Mode Command

When the module receives the command, it will start to execute the dynamic background correction after 10s, and the configuration will be stored automatically after successful correction;

During the execution of dynamic background correction, the target state value in the reported data frame will have a corresponding output to indicate the current state, please refer to **<Table 14 Description of target state** value**>.**

Command word: 0x000B

Command value: None

Return value: 2-byte ACK status (0 success, 1 failure) Send data:

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

Radar ACK (success):

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

2.2.14 Query Dynamic Background Correction Execution Status Command

This command queries whether the current mode is in dynamic background correction mode Command word: 0x001B

Command value: none

Return value: 2-byte ACK status (0 success, 1 failure) + 2-byte status value (0x0001 in execution, 0x0000 not in execution) 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-byte ACK status (0 success, 1 failure) + 2-byte firmware type (0x2412) + 2-byte major version number + 4-byte 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

The corresponding version number is V1.10.24041810

2.2.16 Setting the serial port baud rate

This command is used to set the baud rate of the serial port of the module, the configured value is not lost when power down, and the configured value takes effect after restarting the module. Command word: 0x00A1

Command value: 2-byte baud rate selection index

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

Table 7 Serial Baud Rate Selection

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

The factory default 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 factory values, and the configuration values take effect after rebooting the module. Command word: 0x00A2

Command value: none

Return value: 2-byte ACK status (0

success, 1 failure) 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 factory default configuration values are as follows:

Table 8 Factory Default Configuration Values

configuration item	default value
Minimum distance to door	1
Maximum distance to door	14
Unmanned duration	5
serial port baud rate	115200

2.2.18 Reboot Module

The module receives this command and will automatically reboot after the answer is sent.

Command word: 0x00A3

Command value: none

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

2.2.19 Bluetooth setup

This command is used to control the Bluetooth on or off, the Bluetooth function of the module is on by default. The configured value is not lost when power down, and the configured value takes effect after restarting the module.

Command word: 0x00A4

Command value: 0x0100 Turn on Bluetooth 0x0000 Turn off Bluetooth

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

Send data:

FD FC FB FA	04 00	A4 00	01 00	04 03 02 01

Indicates Bluetooth is turned on

Radar ACK (success):

FD FC FB FA	04 00	A4 01	00 00	04 03 02 01

2.2.20 Get mac address

This command is used to query the MAC address Command word: 0x00A5

Command value: 0x0001

Return Value: 2 bytes ACK status (0 success, 1 failure) + 6 bytes

MAC address (big-endian order) Send Data:

FD FC FB FA	04 00	A5 00	01 00	04 03 02 01

Radar ACK (success):

FD FC FB FA	0A 00	A5 01	00 00	8F 27	2E B8	0F 65	04 03 02 01

The queried mac address is: 8F 27 2E B8 0F 65

2.2.21 Configuration settings for light-sensitive auxiliary control functions

This module has its own photodiode, which can be used to detect the output light sensing value (please refer to Table 15 Target Data (Engineering Mode) Frame Composition), the user can also configure to turn on the Light Sense Assist Control feature;

Turning on the Light Sense Assist Control function, the output of the OUT pin is affected by both the radar detection result and the Light Sense Assist Control logic:

OUT pin output changes from unoccupied to occupied, need to satisfy: radar detects occupied and light sense auxiliary control logic conditions are satisfied;

OUT pin output changes from occupied to unoccupied, need to satisfy: radar detects unoccupied;

The light sensing control logic may select to detect a light sensing value that is less than a set light sensing threshold, or to detect a light sensing value that is greater than a set light sensing

threshold;

Command word: 0x000C

Command value: 2-byte configuration value

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

Table 9 Command values for auxiliary control function settings

first byte	clarification
0x00	Turn off the light-sensitive auxiliary control function, OUT pin output is not affected by light-sensitive
0x01	Enable the light sense auxiliary control function, when the detected light sense value is less than the set threshold auxiliary control conditions are met The second byte is the light sensing threshold to be set (range 0x00 to 0xFF)
0x02	Enable the light sense auxiliary control function, when the light sense detection value is greater than the set threshold the auxiliary control condition is satisfied; The second byte is the light sensing threshold to be set (range 0x00 to 0xFF)

The factory default is 0x00, which means that the light-sensing auxiliary control is turned off

second byte	clarification
0x00 to 0xFF	Light sensing threshold to be set (range 0 to 255), default is 0x00

For example, sending data:

FD FC FB FA	04 00	0C 00	01 50	04 03 02 01

Indicates that the setting is to turn on the light sense auxiliary control function, when the detected light sense value is less than the set threshold 0x50 when the auxiliary control conditions are met

Radar ACK (success):

FD FC FB FA	04 00	0C 01	00 00	04 03 02 01

2.2.22 Configuration Inquiry for Light Sense Assisted Control Function

This query queries the configuration value of light sense auxiliary control function

Command word: 0x001C

Command value: none

Return value: 2 bytes ACK status (0 success, 1 failure) + 2 bytes light sense auxiliary control function configuration value (refer to Table 9 Command values for auxiliary control function setting)

Send data:

FD FC FB FA	02 00	1C 00	04 03 02 01

Radar ACK (success):

FD FC FB FA	06 00	1C 01	00 00	02 A0	04 03 02 01

Indicates that the setting is to turn on the light sense auxiliary control function, when the detected light sense value is greater than the set threshold 0xA0 auxiliary control conditions are met

2.3 Radar Data Output Protocol

LD2412 outputs radar detection results through the serial port, and by default outputs 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, the radar will additionally output the energy value of each distance gate. (Motion & Stationary). Radar data is output in a defined frame format.

2.3.1 Reported data frame format

The protocol-defined radar uplink message frame format is shown in Table 10 and Table 11. The definition of the values of the reported data types in normal operating mode and engineering mode are shown in Table 12.

Table 10 Reported data frame format

header	In-frame data length	in-frame data	end of frame
F4 F3 F2 F1	2 bytes	See table 11	F8 F7 F6 F5

Table 11 Intra-frame data frame formats

data type	head	Target data	rear or tail section	calibration
1 byte (see table 12)	0xAA	See table 13	0x55	0x00

Table 12 Description of data types

data type value	clarification
0x01	Engineering model data
0x02	Basic target information data

2.3.2 Target data composition

The content of the target data reported by the radar changes according to the radar's operating mode. In normal working mode, the radar outputs the basic information of the target by default; when configured in engineering mode, the radar will add each distance gate energy value information after the basic information of the target. Therefore, the basic information of the target will always be output in the radar report data, while the distance gate energy value information needs to be enabled by the command to be output.

The composition of the target data reported by the radar in the normal working mode is shown in Table 13, and the definition of the target state value is shown in Table 14. The composition of the target data frame in engineering mode is shown in Table 15, with some

additional data based on the data reported in the normal working mode.

Table 13 Target data frame composition

target state	Movement target distance (centimeters)	Exercise target energy value	Stationary target distance (centimeters)	Static target energy value
1 byte (see table 14)	2 bytes	1 byte	2 bytes	1 byte

Table 14 Description of target status values

target state value	clarification
0x00	untargeted
0x01	campaign target
0x02	stationary target
0x03	Motion & Stationary Targets
0x04	Bottom noise detection is in progress, valid only when bottom noise detection function is executed.
0x05	Bottom Noise Detection Successful, valid only when Bottom Noise Detection is executed.
0x06	Bottom noise detection failure, valid only when bottom noise detection function is executed

Table 15 Target data (engineering mode) frame composition

...	Maximum movement distance door N	Maximum resting distance door N	Movement distance gate 0 energy value	...	Motion distance gate N energy value	Static distance gate 0 energy value	...	Static distance gate N energy value	Photoreceptor Measurements	reservations
...	1 byte	1 byte	1 byte	...	1 byte	1 byte	...	1 byte	1 byte	1 byte

The light-sensitive measurement value is the relative value of brightness measured by the photodiode on the module, which is a unitless relative value, 0x00 to 0xFF corresponds to 0 to 255, and the larger value indicates the brighter the brightness

Data Example:

Normal operating mode reporting data:

header	In-frame data length	in-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:

header	In-frame data length	in-frame data	end of frame
F4 F3 F2 F1	2B 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 01 e3 00 55 00	F8 F7 F6 F5

2.4 Radar Command Configuration Method

2.4.1 Radar Command Configuration Steps

The process of LD2412 radar executing a configuration command consists of two parts: the upper computer "sending command" and the radar "replying to command ACK". If the radar does not reply to ACK or fails to reply to ACK, it means that the radar fails to execute the configuration command.

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

For example, to read the radar configuration parameters, first the host computer sends the "enable configuration" command; after receiving the successful radar ACK, it sends the "read parameters" command; after receiving the successful radar ACK, it finally sends the "end configuration" command; after receiving the successful radar ACK, it indicates that the complete action of reading parameters is finished. After receiving the successful radar ACK, then send the "read parameters" command; after receiving the successful radar ACK, finally send the "end configuration" command; after the successful radar ACK, it indicates that the complete action of reading parameters is finished.

The radar command configuration flow is shown below.

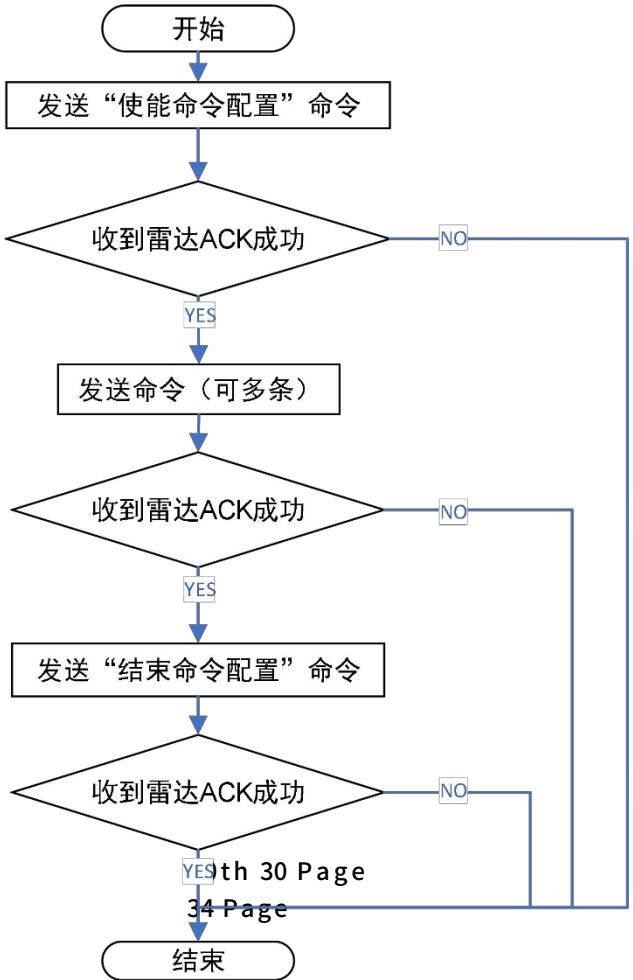

Figure 2 Radar Command Configuration Flow

3 revised record

dates	releases	Content of the modification
2024-4-18	1.01	initial version
2024-4-23	1.02	Add the query command for setting the static energy coefficient. Add commands to enter dynamic background correction mode and status query.
2024-4-26	1.03	Modify the data format description in the reported data frame
2024-5-21	1.04	Add a description of the Light Sense Detection and Light Sense Assist Control functions, the Modification of the engineering model template data reporting format
2024-8-8	1.05	Add Bluetooth switch setup command Add dynamic background correction implementation status description Add commands related to radar resolution settings

4 Technical Support and Contacts

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