Shenzhen Hailingke Electronics Co., Ltd.

HLK-LD2451

Serial communication protocol

Version: V1.03 Modification date: 2024-7-1

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1 Communication Protocol

This communication protocol is mainly used by users who need to carry out secondary development without visualization tools. LD2451 communicates with the outside world through the serial port (TTL level). The radar data output and parameter configuration commands are all carried out under this protocol. The default baud rate of the radar serial port is 115200, 1 stop bit, no Parity bit.

1.1 Protocol Format

1.1.1 Protocol data format

The serial data communication of LD2451 uses the little-endian format. All data in the following table are in hexadecimal.

1.1.2 Command protocol frame format

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

Table 2 Send command protocol frame format

Frame Header	Data length in frame	Intra-frame data	Frame end
FD FC FB FA	2 bytes	See Table 3	04 03 02 01

Table 3 Data format in the transmission frame

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

Table 4 ACK command protocol frame format

Frame Header	Data length in frame	Intra-frame data	Frame end
FD FC FB FA	2 bytes	See Table 5	04 03 02 01

Table 5 ACK frame data format

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

1.2 Send command and ACK

1.2.1 Enabling Configuration Commands

Any other command issued to the radar must be executed after this command is issued, otherwise it will be invalid.

Command word: 0x00FF

Command value: 0x0001

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

Sending 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**

1.2.2 End configuration command

End the configuration command, and the radar will resume working mode after execution. 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)

Sending 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**

1.2.3 Target detection parameter configuration commands

Command word: 0x0002

Command value: 4 bytes

Maximum detection distance	Movement direction setting	Minimum movement speed setting	No target delay time setting
1 byte	1 byte	1 byte	1 byte
(0A-FF): Unit: m	00: Only detect away; 01: Only detect approach; 02: All detected	(00-0x78): Unit: km/h	00~FF: unit s

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

Sending data:

FD FC FB FA	**06 00**	**02 00**	**64 01 05 02**	**04 03 02 01**

Maximum detection distance: 0x64 100 meters

Movement direction setting: 0x01 (only detect approach)

Minimum movement speed setting: 0x05 5km/h

No target delay time setting: 0x02 2s

Radar ACK (success):

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

1.2.4 Read target detection parameter command

This command can read the radar's current target detection parameters.

Command word: 0x0012

Command value: None

Return value: 2 bytes ACK status (0 success, 1 failure) + 4 bytes configuration value (format is the same as the setting command)

Sending data:

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

Radar ACK:

FD FC FB FA	**08 00**	**12 01**	**00 00**	**64 01 05 02**	**04 03 02 01**

1.2.5 Radar sensitivity parameter configuration command

Command word: 0x0003

Command value: 4-byte sensitivity value

Cumulative effective trigger times	Signal-to-noise ratio threshold level	Extended Parameters	Extended Parameters
1 byte	1 byte	1 byte	1 byte
1-0Aÿ The alarm information will be reported only when the number of consecutive detections is met. (The program defaults to 1)	00: The program default parameter is 4; 3-8: The larger the value, the lower the sensitivity and the more difficult it is to detect the target.	00	00

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

Sending data:

FD FC FB FA 06 00	**03 00**		**02 08 00 00**	**04 03 02 01**

Set the effective trigger times to 2 and the signal-to-noise ratio threshold level to 8

Radar ACK (success):

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

1.2.6 Radar sensitivity parameter query command

This command queries the motion sensitivity of each range gate.

Command word: 0x0013

Command value: None

Return value: 2-byte ACK status (0 for success, 1 for failure) + 4-byte sensitivity value (same format as setting command)

Sending data:

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

Radar ACK (success):

FD FC FB FA	**08 00**	**13 01**	**00 00**	**01 00 00 00**	**04 03 02 01**

Note: The current configuration has a valid trigger count of 1; the program default signal-to-noise ratio threshold of 4 is used.

1.2.7 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 (0x2451) + 2-byte major version number + 4-byte minor version number

Sending 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**	**51 24**	**01 01**	**10 15 05 24**	**04 03 02 01**

The corresponding version number is V1.01.24051510

1.2.8 Setting the serial port baud rate

This command is used to set the baud rate of the module serial port. The configuration value will not be lost when the power is off. The configuration value will take effect after the module is restarted.

Command word: 0x00A1

Command value: 2-byte baud rate selection index

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

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

Sending 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**

1.2.9 Restoring factory settings

This command is used to restore all configuration values to factory settings. The configuration values take effect after the module is restarted.

Command word: 0x00A2

Command value: None

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

Sending 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**

1.2.10 Restart module

When the module receives this command, it will automatically restart after the response is sent.

Command word: 0x00A3

Command value: None

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

Sending 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**

1.3 Radar Data Output Protocol

LD2451 outputs radar detection results through the serial port. By default, if no target is detected, the frame header, frame length, and frame tail are output.

The radar will additionally output information such as the number, angle, distance, speed, etc. of detected targets. The radar data is output in the specified frame format.

1.3.1 Reporting data frame format

The radar reporting message frame formats defined by the protocol are shown in Tables 8 and 9.

Table 8 Reporting data frame format

Frame Header	Data length in frame	Intra-frame data	Frame tail
F4 F3 F2 F1	2 bytes	See Table 9	F8 F7 F6 F5

Table 9 Intra-frame data frame format

Target quantity	alarm information	Target 1 Information					Target 2 Information	Target N Information
1 byte	1 byte	5 bytes					5 bytes	5 bytes
		Angle 1 byte	Distance 1 byte	Speed direction 1 byte	Speed value 1 byte	Signal-to-noise ratio 1 byte	Same as left	Same as left
	01: There is a target approaching 00: No approach target	Unit: degree Actual angle value = reported value - 0x80	Unit: meter 0ÿ100	01: Approach 00: Move away	Unit:km/h 0ÿ120	0 to 255	Same as left	Same as left

Data example:

F4 F3 F2 F1 11 00 03 01 8A 28 00 3C 15 8A IE 01 3C 0F 76 5F 00 3C 0F F8 F7 F6 F5

Analysis:

Data length: 0x11 17 bytes

Alarm information: 0x01 There is a target approaching

Target number: 0x03

Objective 1 Information:

Angle: 0x8A, 10 degrees (0x8A-0x80)

Distance: 0x28,40 meters

Speed: 0x003C, the target is moving towards the radar direction, the speed is 60km/h

Signal-to-noise ratio: 0x15

Objective 2 Information:

Angle: 0x8A, 10 degrees (0x8A-0x80)

Distance: 0x1E, 30 meters

Speed: 0x013C, the target is moving away from the radar, the speed is 60km/h

Signal-to-noise ratio: 0x0F

Goal 3 Information:

Angle: 0x76, -10 degrees (0x76-0x80)

Distance: 0x5F, 95 meters

Speed: 0x003C, the target is moving towards the radar direction, the speed is 60km/h

Signal-to-noise ratio: 0x0F

1.4 Radar command configuration method

1.4.1 Radar command configuration steps

The process of LD2451 radar executing a configuration command includes two steps: the host computer "sends the command" and the radar "replies to the command ACK". If the radar does not respond with ACK or fails to respond with ACK, it means that the radar fails to execute the configuration command.

As mentioned above, before sending any other commands to the radar, the developer needs to send the "Enable Configuration" command first, and then send the configuration command within the specified time. After the command configuration is completed, send the "End Configuration" command to inform the radar that the configuration has ended.

For example, if you want to read the radar configuration parameters, first the host computer sends the "enable configuration" command; after receiving the radar ACK successfully, send the "read parameters" command; after receiving the radar ACK successfully, finally send the "end configuration" command; after the radar ACK is successful, it indicates that the complete parameter reading action is completed.

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

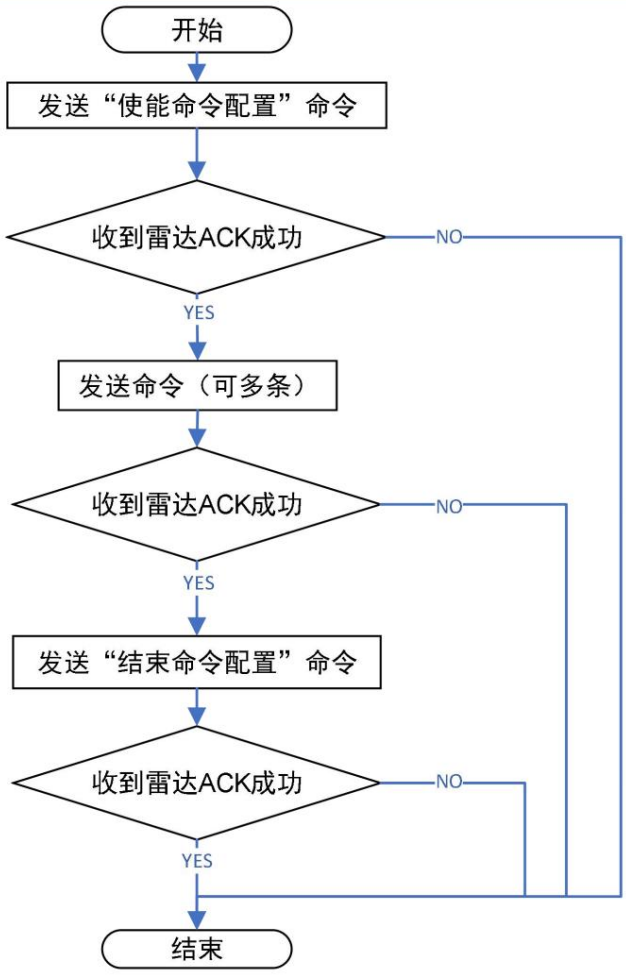

Figure 2 Radar command configuration process

2Revision History

date	Version changes
2024-5-15	1.01 Initial version
2024-5-20	1.02 Modify some error descriptions
2024-7-1	1.03 Modify some description errors

3Technical support and contact information

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