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**HLK-LD2451**

Serial communication protocol

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# 1 Communication protocol

This communication protocol is mainly used by users who are separated from visual tools for secondary development. The LD2451 communicates with the outside world through a serial port (TTL level). Radar data output and parameter configuration commands are carried out under this agreement. The radar serial port has a default baud rate of 115200, 1 stop bit and no parity bit.

## 1.1 Protocol Format

### 1.1.1 Protocol data format

Serial port data communication of LD2451 uses the small-end format. All data in the following table is hexadecimal.

### 1.1.2 Command protocol frame format

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

**Table2 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

**Table3 Send frame data format**

Command word (2 bytes)	Command value (N bytes)
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**Table4 ACK command protocol frame format**

Frame Header	Data length in frame	Intra-frame data	Frame end
FD FC FB FA	2 bytes	See Table5	04 03 02 01

**Table5 ACK frame data format**

Send command word & 0x0100 (2 bytes)	Return value (N bytes)
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## 1.2 Send command and ACK

### 1.2.1 Enable configuration command

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

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
-------------	-------	-------	-------	-------	-------	-------------

## 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)

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
-------------	-------	-------	-------	-------------

## 1.2.3 Target detection parameter configuration commands

Command word: 0x0002

Command Value:4 bytes

Maximum detection distance	Movement direction setting	Minimum motion 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)

Send 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-byte configuration value (same format as setting command)

Send 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
1-0A: The alarm information will be reported only after 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)

Send data:

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

Configure the effective trigger times to 2 times, set 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 parameters inquire command

This command queries the motion sensitivity of each distance gate.

Command word: 0x0013

Command Value: none

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

Send 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 bytes ACK status(0 Success,1 Failure)+ 2 bytes firmware type(0x2451)+2 byteshostversion number +4Byte 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	51 24	01 01	10 15 05 24	04 03 02 01
-------------	-------	-------	-------	-------	-------	-------------	-------------

The corresponding version number is V1.01.24051510

### 1.2.8 Set the serial port baud rate

This command used to set the baud rate of the module's 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 bytes baud rate selection index

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

**Table6 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 is 0x0005, that 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
-------------	-------	-------	-------	-------------

## 1.2.9 Restoring Factory Settings

Using this command, you can restore all configuration values to their default values. 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)

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
-------------	-------	-------	-------	-------------

### 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)

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
-------------	-------	-------	-------	-------------

## 1.3 Radar data output protocol

LD2451 output radar detection results through serial port, default output target basic information, including target status, moving energy value, stationary energy value, moving distance, stationary distance and other information. If the radar is configured in engineering mode, the radar will output additional range gate energy values (moving & stationary). Radar data is output in the specified frame format.

### 1.3.1 Reporting data frame format

Table 8 and Table 9 show the format of radar report message frames defined by the protocol. Table 10 describes the definitions of reported data type values in normal working mode and engineering mode.

**Table8 Reporting data frame format**

Frame Header	Data length in frame	Intra-frame data	Frame tail
F4 F3 F2 F1	2 bytes	See Table9	F8 F7 F6 F5



Table9 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	SNR 1 byte	Same as left	Same as left
	01: There is a target approaching 00: No approach target	Unit: Degree  Actual angle value=Report value - 0x80	Unit: m 0 ~ 100	00: Close 01: Stay away	Unit:km/h 0 ~ 120	0 ~ 255	Same as left	Same as left

### Data example:

**F4 F3 F2 F1 110003 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 bit 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 bit 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 bit is 60km/h

Signal-to-noise ratio: 0x0F

## 1.4 Radar command configuration method

### 1.4.1 Radar command configuration steps

The process of executing a configuration command by the LD2451 radar includes two links: "send command" by the upper computer and "reply command ACK" by the radar. If the radar does not respond with an ACK or fails to respond with an ACK, it indicates 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, and then send the configuration command within the specified time. After the command configuration is complete, send the "End configuration" command to inform the radar that the configuration is complete.

For example, to read the radar configuration parameters, the host computer first sends the "enable configuration" command; After receiving the radar ACK successfully, send the "Read parameters" command. After receiving the radar ACK successfully, send the End configuration command. After the radar ACK succeeds, it indicates that the complete parameter reading operation is complete.

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

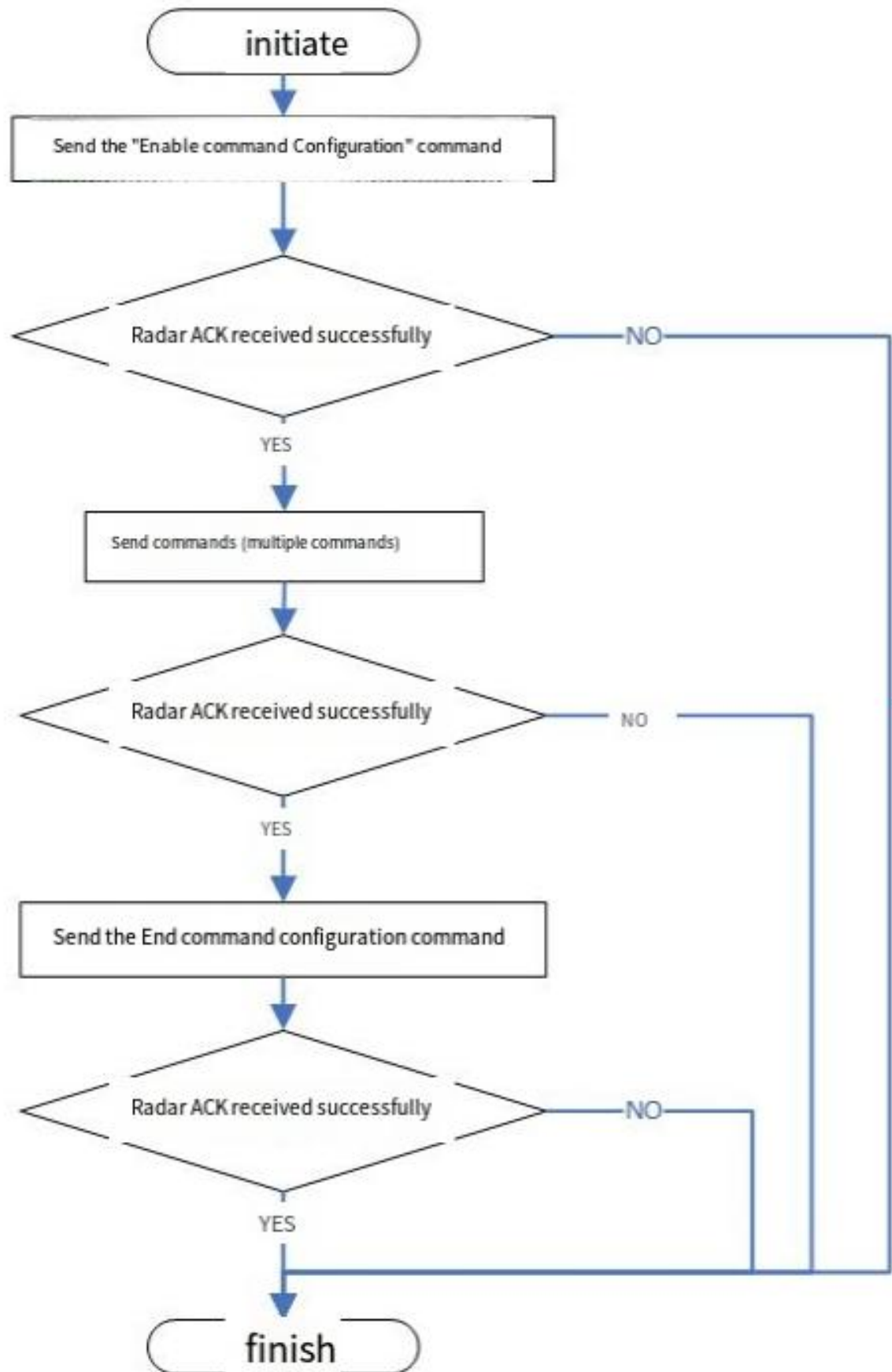


Figure2 Radar command configuration process

## 2 Revision History

Date	Version	Modifications
2024-5-15	1.01	initial version
2024-5-20	1.02	Modify some error descriptions
2024-7-1	1.03	Modify some error descriptions

## 3 Technical support and contact information



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