YDLIDAR

YDLIDAR G4

DEVELOPMENT MANUAL
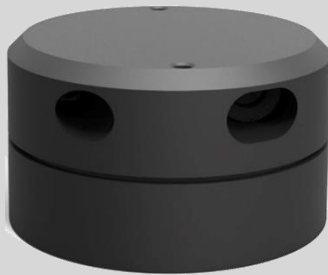
CONTENTS

WORKING MECHANISM

The YDLIDAR G4 (hereafter referred to as G4) system has 3 working modes: idle mode, scan mode, stop mode.

➢ **Idle mode:** When G4 is powered on, the default mode is idle mode. In idle mode, the G4's ranging unit does not work and the laser is not lit.

➢ **Scan mode:** When G4 is in scanning mode, the ranging unit turns on the laser. When the G4 starts to work, it continuously samples the external environment and outputs it in real time after background processing.

➢ **Stop mode:** When G4 runs with an error, such as turning on the scanner, the laser is off, the motor does not rotate, etc., G4 will automatically turn off the distance measuring unit and feedback the error code.
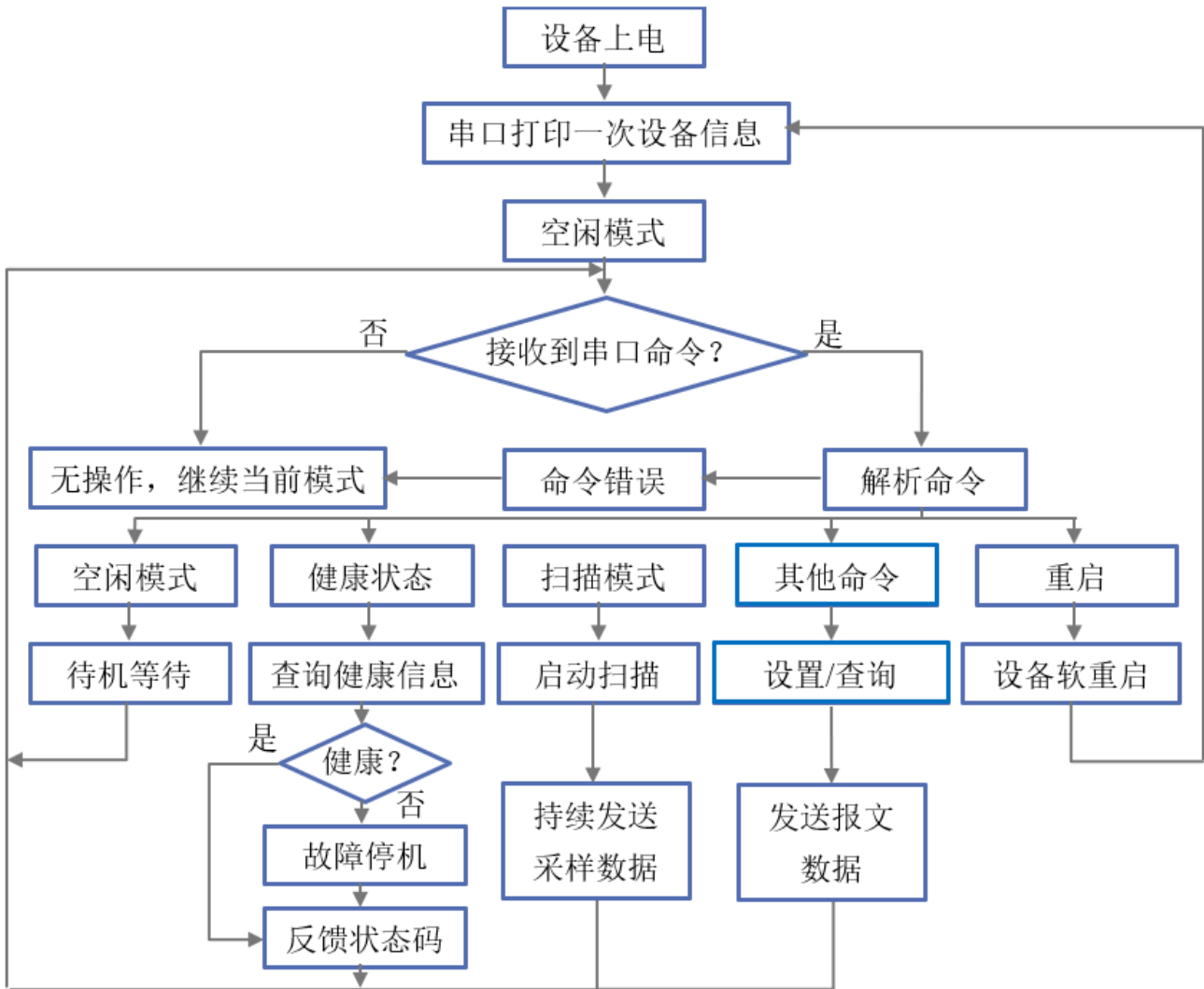
System workflow

FIG 1 YDLIDAR G4 WORKFLOW

SYSTEM COMMUNICATION

Communication mechanism

G4 communicates commands and data with external devices through the serial port. When an external device sends a system command to G4, G4 resolves the system command and returns a corresponding reply message. According to the command content, G4 switches the corresponding working status. According to the content of the message, the external system can parse the message and obtain the response data.
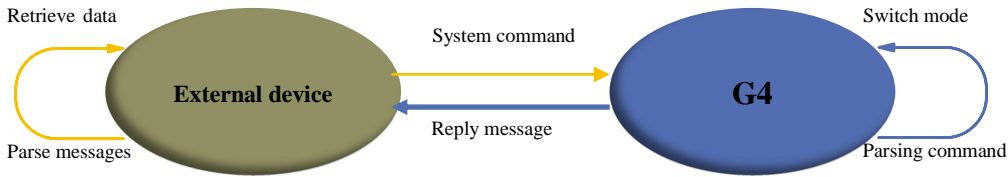

FIG 2 YDLIDAR G4 SYSTEM COMMUNICATION

System command

The external system can set the corresponding working status of G4 and send corresponding data by sending related system commands. The G4 system command is unified to 2 bytes, where the start byte is 0xA5 and the second byte is the command content. The system commands issued by G4 are as follows:

CHART 1 YDLIDAR G4 SYSTEM COMMAND

System command		Description	Mode Switching	Answer mode
0xA5 （Start）	0x60	Start scanning and export point cloud data	Scan mode	Sustained response
	0x65	Stop and stop scanning	Stop mode	No answer
	0x90	Get device information (model, firmware, hardware version)	-	Single response
	0x91	Get device status	-	Single response
	0x01	Low power consumption enabled. After the G4 is turned on, the motor and ranging unit do not work in idle mode.	-	Single response
	0x02	After low power consumption is switched off, G4 still operates in idle mode with the motor and distance measuring unit.	-	Single response
	0x05	Get current motor and module status	-	Single response
	0x09	Increase the current scan frequency of 0.1Hz	-	Single response
	0x0A	Reduce the current scan frequency of 0.1Hz	-	Single response
	0x0B	Increase the current scan frequency of 1Hz	-	Single response
	0x0C	Reduce the current scan frequency of 1Hz	-	Single response
	0x0D	Get the currently set scan frequency	-	Single response
	0x0E	Turn on constant frequency function, constant motor speed (default on)	-	Single response
	0x0F	Turn off the constant frequency function	-	Single response

0xD0	Ranging frequency setting	-	Single response
0xD1	Get the current ranging frequency	-	Single response
0x40	Soft restart	-	No response

System messages

The system message is a response message that the system feeds back based on the received system command. According to different system commands, the reply mode and response content of the system message are also different. There are three kinds of response modes: no response, single response, continuous response.

No response means that the system does not return any messages. A single reply indicates that the system's message length is limited, and the response ends once. Sustained response means that the system's message length is infinite and needs to send data continuously, such as when entering the scan mode.

The one-time response and continuous response messages use the same data protocol. The contents of the protocol are: start sign, response length, response mode, type code and response content, and are output through the serial port hexadecimal system.

FIG 2 YDLIDAR G4 SYSTEM MESSAGE DATA PROTOCOL

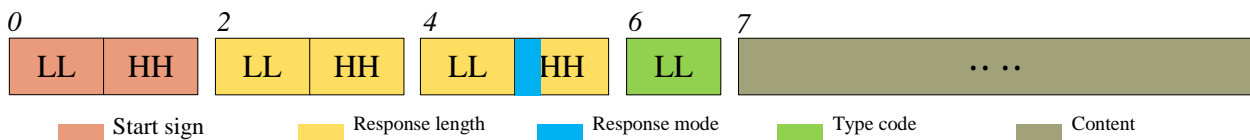| Start sign	Response length	Response mode	Type code	Content
16bits	30bits	2bits	8bits	-

FIG 3 YDLIDAR G4 SYSTEM MESSAGE DATA PROTOCOL

- ➢ **Start sign:** G4's message sign is unified as 0xA55A.
- ➢ **Response length:** When the answer mode is continuous, the length should be infinite, so this value is invalid.
- ➢ **Response mode:** This bit is only 2 bits, which means this time it is a single response or continuous response. Its value and corresponding mode are as follows:

CHART 3 YDLIDAR G4 RESPONSE VALUE

Mode	0x0	0x1	0x2	0x3
Response mode	Single response	continuous response	Undefined	

- ➢ **Type code:** Different system commands correspond to different types codes.
- ➢ **Content:** Different system commands, feedback different data content, and their data protocols are also different.

Note 1: The G4 data communication adopts the little-endian mode and the low-order mode.

Note 2: In the response message, the lower 6 bits of the 6th byte belong to the response length and the upper 2 bits belong to the response mode.

DATA PROTOCOL

Different system commands have different packet contents. In the packets of different types of codes, the data protocol of the response content is also not the same. Therefore, the user needs to parse the data in the response content according to the corresponding data protocol, such as point cloud data, device information, and the like.

Scan command [A5 60]

When an external device sends a scan command to G4, G4 enters scan mode and feeds back point cloud data. The reply message is:

A5	5A	05	00	00	40	81	. . . .

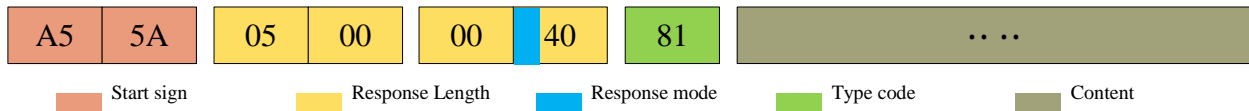| Start sign | Response Length | Response mode | Type code | Content |

FIG 4 YDLIDAR G4 SCAN COMMAND

The sixth byte of the sixth high is 01, so the answer mode value is 0x1, which is a continuous response. Ignore response length, type code is 0x81.

The response content is the point cloud data scanned by the system. According to the following data structure, the data is sent to the external device in hexadecimal to the serial port.
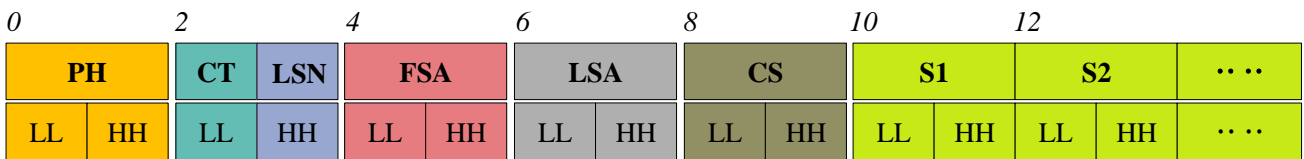
Byte offset:

0		2		4		6		8		10		12		
PH		CT	LSN	FSA		LSA		CS		S1		S2		. . . .
LL	HH	LL	HH	LL	HH	LL	HH	LL	HH	LL	HH	LL	HH	. . . .

FIG 5 SCAN COMMAND RESPONSE CONTENT DATA STRUCTURE

CHART 4 SCAN COMMAND RESPONSE CONTENT DATA STRUCTURE DESCRIPTION

Content	Name	Description
PH(2B)	Packet header	2B in length, fixed at 0x55AA, low in front, high in back
CT(1B)	Package type	Indicates the current packet type. 0x00: Point cloud packet 0x01: Zero packet.
LSN(1B)	Sample quantity	Indicates the number of sampling points contained in the current packet. There is only one zero point of data in the zero packet. The value is 1.
FSA(2B)	Starting angle	The angle data corresponding to the first sample point in the sampled data
LSA(2B)	End angle	The angle data corresponding to the last sample point in the sampled data

CS(2B)	Check code	The check code of the current data packet uses a two-byte exclusive OR to check the current data packet.
Si(2B)	Sampling data	The system test sampling data is the distance data of the sampling point.

➢ Zero resolution:

The zero-bit data is in a zero-bit packet with LSN = 1, that is, the number of Si is 1, and S1 = zero-distance data. FSA = LSA = zero angle data. For the analysis of the specific values of distance and angle, see the analysis of distance and angle.

➢ Distance resolution:

Distance solution formula: $Distance_i = \frac{Si}{4}$

Among them, Si is sampling data. Set the sampling data to E5 6F. Since this system is a small-endian mode, the sampling point S = 0x6FE5, and it is substituted into the distance solution formula, which yields Distance = 7161.25mm.

➢ Angle analysis:

Angle data is stored in FSA and LSA. Each angle data has the following data structure. C is the check digit and its value is fixed at 1.

Starting angle solution formula: $Angle_{FSA} = \frac{Rshiftbit(FSA,1)}{64} +$ AngCorrect$_1$

| Ang_q2[14:7] | | LL |
| Ang_q2[6:0] | C | HH |

FIG 6 ANGLE DATA STRUCTURE

End angle solution formula: $Angle_{LSA} = \frac{Rshiftbit(LSA,1)}{64} + AngCorrect_{LSN}$

Middle corner solution formula: $Angle_i = \frac{diff(Angle)}{LSN-1} * (i-1) + Angle_{FSA} + AngCorrect_i$

AngCorrect is an angle correction value, and its calculation formula is as follows. tand^(-1) is an inverse trigonometric function and returns an angle value:

IF $Distance_i == 0$ $\quad$ AngCorrect$_i = 0$

ELSE $\quad$ $AngCorrect_i = tand^{-1}(21.8 * \frac{155.3 - Distance_i}{155.3 * Distance_i})$

$Rshiftbit(data, 1)$ means to shift data right by one bit. Diff (Angle) represents the clockwise angle difference from the starting angle to the ending angle. LSN indicates the number of packets sampled in this frame.

Let the 4th to 8th bytes of the packet be 28 E5 6F BD 79，$Distance_1 = 1000$，$Distance_{LSN} = 8000$，LSN = 0x28 = 40(dec)，FSA = 0x6FE5，LSA = 0x79BD，

$Angle_{FSA} = 223.78° + AngCorrect_1 = 223.78° - 6.7622° = 217.0178°$

$$Angle_{LSA} = 243.47° + \overline{AngCorrect_{LSN}} = 243.47° - 7.8374° = 235.6326°$$

Therefore $diff(Angle) = 18.6148°$, and according to this, the angle data of each sample point in the data packet of this frame can be obtained.

➢ **Check code parsing:**

The check code uses a two-byte exclusive OR to verify the current data packet. It does not participate in XOR operations itself, and the XOR order is not strictly in byte order, as shown in the XOR order. Therefore, the check code solution formula is:

$$CS = XOR_1^{end}(C_i) \qquad i = 1,2,...,end$$

XOR_1^{end} is an XOR formula that XORs the number of elements in the element from subscript 1 to end. But the XOR satisfies the commutative law, and the actual solution may not need to follow the XOR order.
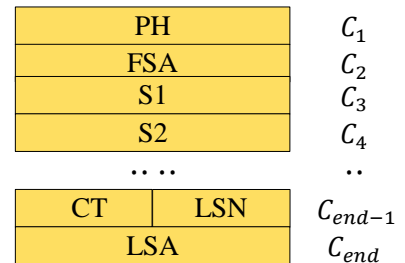
PH		C_1
FSA		C_2
S1		C_3
S2		C_4
..	..	..
CT	LSN	C_{end-1}
LSA		C_{end}

FIG 7 CS XOR SEQUENCE DIAGRAM

Stop command [A5 65]

When the system is in the scanning state, G4 always sends point cloud data. If you need to close the scan at this time, you can send this command to stop the system from scanning. After the stop command is sent, the system will be in the standby state. At this time, the ranging unit of the device is in the low power consumption mode and the laser is off.

The command is unresponsive, so the system will not reply with any message after receiving the command.

Device Information [A5 90]

When the external device sends a Get Device Information command (A5 90) to the G4, G4 will feedback the device model, firmware version and hardware version, and the device's factory serial number. The reply message is:

A5	5A	14	00	00	00	04	. . ..

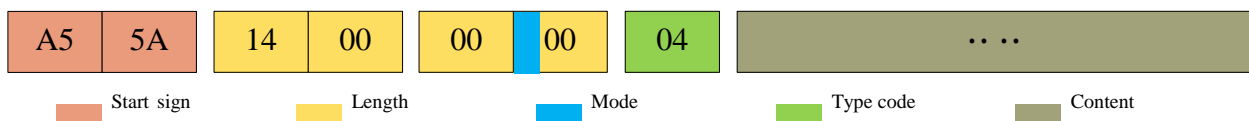Start sign | Length | Mode | Type code | Content

FIG 8 YDLIDAR G4 DEVICE INFORMATION

According to the protocol resolution: response length = 0x00000014, answer mode = 0x0, type code = 0x04.

That is, the number of response content bytes is 20. The response is a single response and the type code is 04. This type of response content satisfies the following data structure:

Byte offset	0	1	2	3	4	5	..	19

Model number | Firmware version | Hardware version | Serial number

➢ **Model number**：One byte device model, such as the G4 model code is 04.
➢ **Firmware Version**：2 bytes, the low byte is the major version number, and the high byte is the minor version number.
➢ **Hardware version**：1 byte, representing the hardware version.
➢ **Serial number**：16 bytes, the only factory serial number.

Health status [A5 91]

When an external device sends a Get Device Health Status command (A5 91) to G4, G4 will feedback the device's status code. The reply message is:

A5	5A	03	00	00	00	06	· · ·

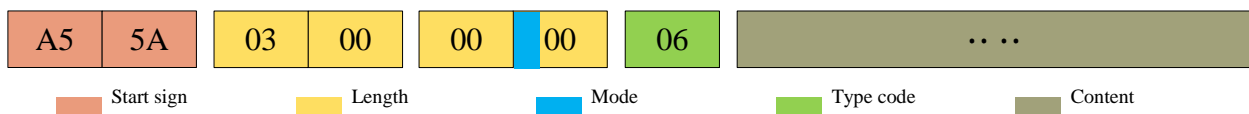Start sign　　Length　　Mode　　Type code　　Content

FIG 10 YDLIDAR G4 SCHEMATIC DIAGRAM OF DEVICE HEALTH MESSAGES

According to the protocol resolution: response length = 0x00000003, answer mode = 0x0, type code = 0x06.

That is, the number of response content bytes is 3; this response is a single response and the type code is 06. The type of response content satisfies the following data structure:
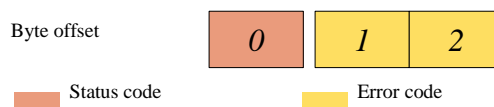
Byte offset

0	1	2

Status code　　Error code

FIG 11 YDLIDAR G4 DEVICE HEALTH STATUS RESPONSE CONTENT DATA STRUCTURE DIAGRAM

➢ **Status code:** 1 byte, 0x0 indicates that the device is running normally, 0x1 indicates a device error warning, and 0x2 indicates a device running error.
➢ **Error code**：2 bytes. When a warning or error status occurs, the specific error code will be recorded in this field. 0x00 indicates that the device is operating without error.

Low power consumption [A5 01]

When an external device sends a low-power enable command (A5 01) to G4, G4 automatically enters a low-power state in idle mode (in standby: the motor is stopped and the distance-measuring unit is powered down), reducing standby power consumption. The reply message is:

A5	5A	01	00	00	00	04	01

Start sign　　Length　　Mode　　Type code　　Content

FIG 12 YDLIDAR G4 LOW POWER CONSUMPTION PACKETS

According to the protocol resolution: response length = 0x00000001, answer mode = 0x0, type code = 0x04.

That is, the number of response content bytes is 1. This response is a single response and the type code is 04. The command response is fixed at 0x01, indicating that the system is enabled for a low-power state. G4 defaults to low power consumption.

Low-power mode shutdown [A5 02]

When an external device sends a low-power mode shutdown command (A5 02) to G4, G4 does not automatically enter a low-power state in idle mode (in standby: the motor runs and the ranging unit does not lose power). The reply message is:

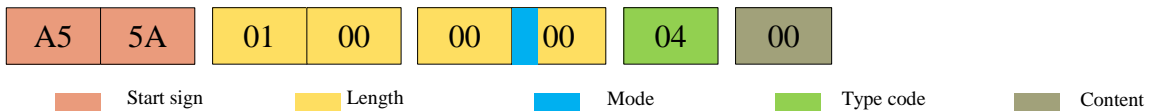| A5	5A	01	00	00	00	04	00
Start sign		Length		Mode		Type code	Content

FIG 13 YDLIDAR G4 LOW-POWER SHUTDOWN MESSAGE

According to the protocol resolution: response length = 0x00000001, answer mode = 0x0, type code = 0x04.

That is, the number of response content bytes is 1. This response is a single response and the type code is 04. The command response is fixed at 0x00, indicating that the low-power state of the system is turned off.

Low-power query [A5 05]

When the external device sends a low power consumption query command (A5 05) to G4, the system will feedback the current standby power consumption status of the system, and its response message is:

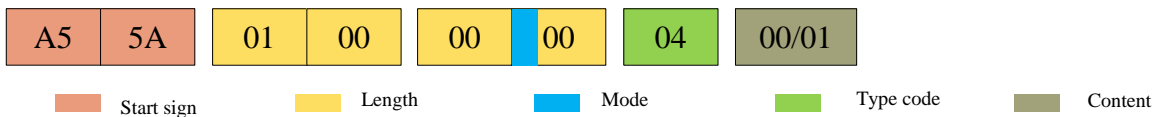| A5	5A	01	00	00	00	04	00/01
Start sign		Length		Mode		Type code	Content

FIG 14 YDLIDAR G4 LOW POWER CONSUMPTION QUERY MESSAGE

According to the protocol resolution: response length = 0x00000001, answer mode = 0x0, type code = 0x04.

That is, the number of response content bytes is 1. This response is a single response and the type code is 04. The command response content is 0x00 or 0x01.

0x00：The current standby state is a non-low power state.

0x01：The current standby state is a low power state.

Scan frequency setting [A5 09/0A/0B/0C]

G4 provides multiple command interfaces for scanning frequency settings to increase or decrease the system scan frequency, as follows:

CHART4 SCAN FREQUENCY SETTING COMMAND DESCRIPTION

Commands	Description

0xA509	Increase the current scan frequency of 0.1Hz
0xA50A	Reduce the current scan frequency of 0.1Hz
0xA50B	Increase the current scan frequency of 1Hz
0xA50C	Reduce the current scan frequency of 1Hz

The above commands are the same type of commands and have the same message structure. The scan frequency setting command has the following message structure:

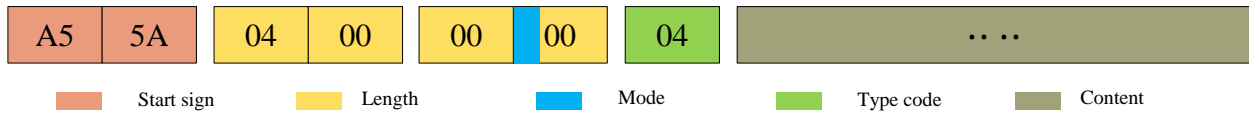| A5	5A	04	00	00	00	04	. . . .

Start sign   Length   Mode   Type code   Content

FIG 15 YDLIDAR G4 SCAN FREQUENCY SETTING MESSAGE

According to the protocol resolution: response length = 0x00000004, answer mode = 0x0, type code = 0x04.

That is, the number of response content bytes is 4; this response is a single response, and the type code is 04. The response content represents the currently set scanning frequency, and its solution formula is:

$$F = \frac{AnswerData}{10}$$

Among them, AnswerData is converted to decimal data for response content (small-endian mode) in Hertz (Hz).

Scan frequency acquisition [A5 0D]

This command is used to get the scan frequency (note that it is not a real-time frequency). The message structure and response content are consistent with the scan frequency setting command. The user can refer to the scan frequency setting [A5 09/0A/0B/0C]. This section does not describe it.

Constant frequency enable [A5 0E]

This command is used to enable the constant frequency of the system. After being enabled, when the lidar is in scanning mode, it will automatically adjust the speed so that the scanning frequency will be stabilized at the currently set scanning frequency. G4 defaults to constant frequency.

The command message is as follows:

A5	5A	01	00	00	00	04	01

Start sign   Length   Mode   Type code   Content

FIG 16 YDLIDAR G4 CONSTANT FREQUENCY ENABLED PACKET

According to the protocol resolution: response length = 0x00000001, answer mode = 0x0, type code = 0x04.

That is, the number of response content bytes is 1. This response is a single response and the type code is 04. The command response is fixed to 0x01, indicating that the system is enabled to have a constant frequency.

Constant frequency off [A5 0F]

This command is used to shut down the system constant frequency. After the radar is turned off, the lidar does not perform automatic speed adjustment in the scanning mode. The command's message is as follows:：

A5	5A	01	00	00	00	04	00

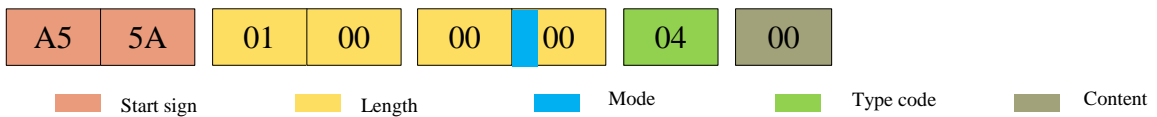■ Start sign   ■ Length   ■ Mode   ■ Type code   ■ Content

FIG 17 YDLIDAR G4 CONSTANT FREQUENCY TURN OFF MESSAGE

According to the protocol resolution: response length = 0x00000001, answer mode = 0x0, type code = 0x04.

That is, the number of response content bytes is 1. This response is a single response and the type code is 04. The command response is fixed at 0x00, indicating that the system constant frequency is turned off.

Ranging frequency setting [A5 D0]

This command is used to set the system's ranging frequency and switch the ranging frequency between 4 KHz, 8 KHz and 9 KHz. The default ranging frequency is 9 KHz. The command's message is as follows:

A5	5A	01	00	00	00	04	00/01/02

■ Start sign   ■ Length   ■ Mode   ■ Type code   ■ Content

FIG 18 YDLIDAR G4 RANGING FREQUENCY SETTING MESSAGE

According to the protocol resolution: response length = 0x00000001, answer mode = 0x0, type code = 0x04.

That is, the number of response content bytes is 1. This response is a single response and the type code is 04. The response content of this command corresponds to the system ranging frequency. The details are as follows:

CHART 5 RANGING FREQUENCY SETTING RESPONSE CONTENT DESCRIPTION

Content	0x00	0x01	0x02
Ranging frequency (KHz)	4	8	9

Ranging frequency acquisition [A5 D1]

This command is used to obtain the current ranging frequency of the system. The message structure and response content of the command are consistent with the ranging frequency setting. The user can refer to the section on setting the ranging frequency. This section does not elaborate.

Restart command [A5 40]

When an external device sends a Get Device command (A5 40) to G4, G4 enters a soft reboot and the system restarts. This command does not answer.

Standby control

The G4 integrates the power control of the system into the command interface of the system, not the hardware interface. Therefore, the user only needs to send the corresponding control command (A5 01/02) to enable/disable the low-power state of the system. See the section on low power consumption for details. This section does not elaborate.

Motor speed control

The G4 integrates the system's speed control into the system's command interface, not the hardware interface. The user can change the speed of the motor by adjusting the scan frequency. See the section on scanning frequency settings for details. This section does not elaborate.

USE CAUTION

When interacting with the G4 command, other than stopping the scan command (A5 65), other commands cannot be interacted in the scan mode. This can easily result in packet parsing errors.