YDLIDAR G2

DEVELOPMENT MANUAL
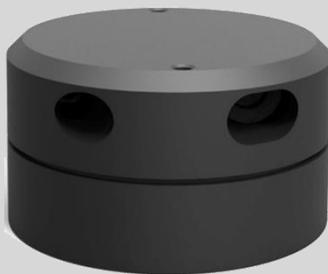
CONTENTS

WORKING MECHANISM

The YDLIDAR G2 (hereafter referred to as G2) system has 4 working modes: idle mode, scan mode, stop mode.

➢ **Idle mode:** When G2 is powered on, the default mode is idle mode. In idle mode, the G2's ranging unit does not work and the laser is not lit.

➢ **Scan mode:** When G2 is in scanning mode, the ranging unit turns on the laser. When the G2 starts to work, it continuously samples the external environment and outputs it in real time after background processing.

➢ **Stop mode:** When G2 runs with an error, such as turning on the scanner, the laser is off, the motor does not rotate, etc., G2 will automatically turn off the distance measuring unit and feedback the error code.

➢ **Power-down protection mode**: In this mode, Lidar needs to continuously receive the scan commands with a less than 3 second's transmission interval so that it will keep working. If the Lidar does not receive a continuous scan command, the system will automatically stop. This mode is not enabled by default.
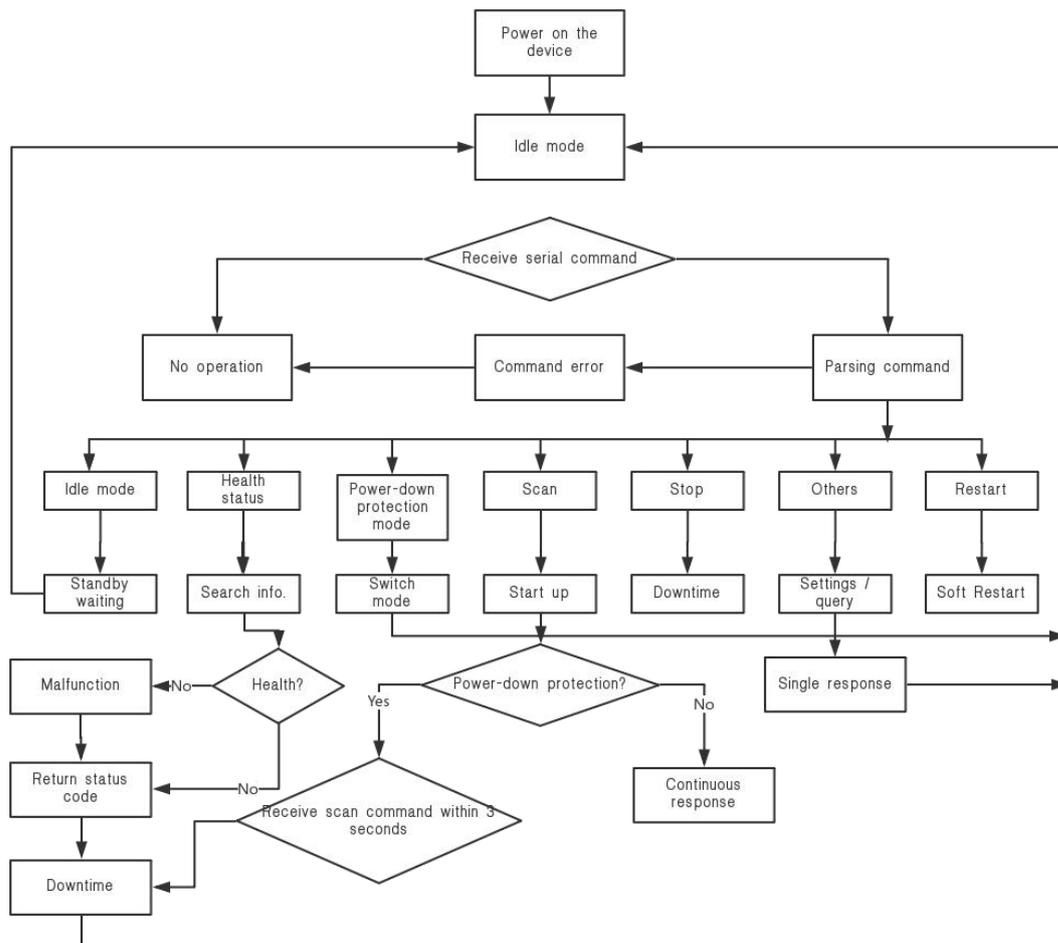
System workflow

FIG 1 YDLIDAR G2 WORKFLOW

SYSTEM COMMUNICATION

Communication mechanism

G2 communicates commands and data with external devices through the serial port. When an external device sends a system command to G2, G2 resolves the system command and returns a corresponding reply message. According to the command content, G2 switches the corresponding working status. According to the content of the message, the external system can parse the message and obtain the response data.
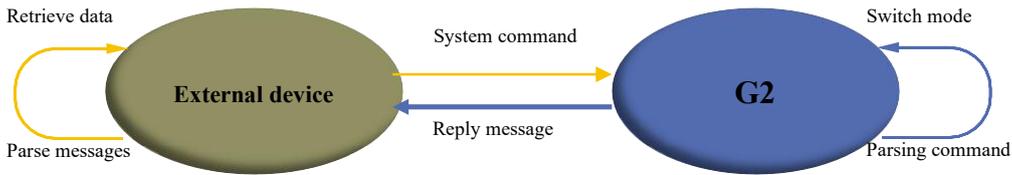

FIG 2 YDLIDAR G2 SYSTEM COMMUNICATION

System command

The external system can set the corresponding working status of G2 and send corresponding data by sending related system commands. The G2 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 G2 are as follows:

CHART 1 YDLIDAR G2 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 G2 is turned on, the motor and ranging unit do not work in idle mode.	-	Single response
	0x02	After low power consumption is switched off, G2 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
0xD9	Power-down protection mode switch (off by default)	-	Single response
0x80	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 G2 SYSTEM MESSAGE DATA PROTOCOL

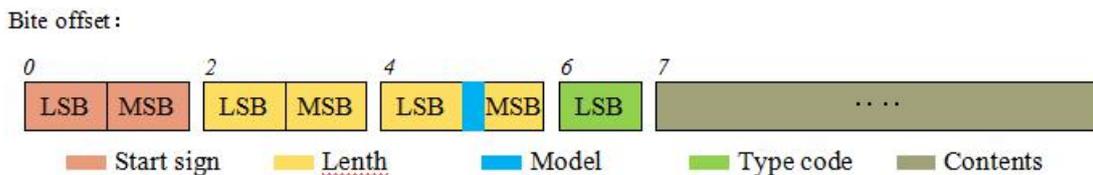| Start sign	Response length	Response mode	Type code	Content
16bits	30bits	2bits	8bits	-

FIG 3 YDLIDAR G2 SYSTEM MESSAGE DATA PROTOCOL

- ➢ **Start sign:** G2'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 G2 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 G2 data communication adopts the little-endian mode and the low-order mode.

Note 2: In the reply 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, etc.

Scan command [A5 60]

When an external device sends a scan command to G2, G2 goes into scan mode and feeds back point cloud data. The reply message is:
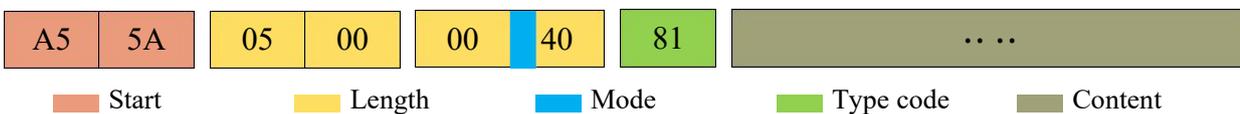

FIG 4 YDLIDAR G2 SCAN COMMAND

The 6th byte high 2 is 01, so the response mode takes 0x1, which is a continuous response, ignoring the response length, and the 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.
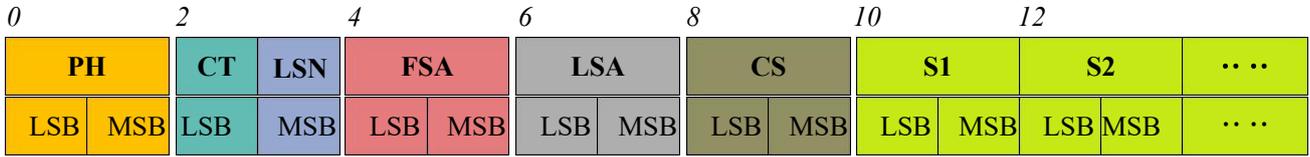
Byte offset:

0		2		4		6		8		10		12		
PH		**CT**	**LSN**	**FSA**		**LSA**		**CS**		**S1**		**S2**		···
LSB	MSB	LSB	MSB	LSB	MSB	LSB	MSB	LSB	MSB	LSB	MSB	LSB	MSB	···

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(3B)	Sampling data	S node, used to store sampling data and Quality data of system ranging

➢ **F&C:**

F：Scan frequency at the current time,

$$F = \frac{Rshiftbit\ (data,1)}{10}$$

Data is the byte data, Rshiftbit (data, 1) means shifting the data right by 1 bit

C: current packet type, C=data & 0x01

When C = 0, it is the point cloud data packet;

When C = 1, the frame data is the starting data packet. In this data packet, LSN = 1, Si = 1.

Note: F is invalid in the point cloud data packet (C = 0), the default output is 0 while valid in the zero data packet (C = 1).

➢ **Light intensity analysis:**

Formula：

$$Intensity_i = Intensity[7:0] + IH * 256$$

The light intensity indicates the strength and weakness of the laser signal, which is stored in bytes 1 and 2 of the Si node. Among them, Si (1) stores the lower 8 bits of Intensity, and Si (2) stores the lower two

bits, (IH)stores the top two of Intensity (ranges from 0 to 1023).

Among them, Si is sampling data, Si (j) represents the jth byte of Si.

Set the sampled data to 64 E5 6F, so this sampling point S (1) = 0x64 = 100 (dec), S (2) = 0xE5,

so Intensity [7: 0] = 100, IH = 1,

According to the above formula, Intensity = 100 + 1 * 256 = 356.

➢ **Distance analysis:**

Distance solution formula:

$$Distance_i = Lshiftbit(Si(3),6) + Rshiftbit(Si(2),2)$$

Si is sampling data. *Lshiftbit(data,1)* means shifting the data data one bit to the left. *Rshiftbit(data,1)* means shifting the data data one bit to the right. Set the sampled data to 64 E5 6F, since the system is in the little-endian mode, according to the formula,

$$Distance = dec(Lshiftbit(0x6F,6)) + dec(Rshiftbit(0xE5,2)) = 7161mm$$

➢ **Angle analysis:**

First level analysis：

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

Starting angle solution formula： $Angle_{FSA} = \dfrac{Rshiftbit(FSA,1)}{64}$

End angle solution formula： $Angle_{LSA} = \dfrac{Rshiftbit(LSA,1)}{64}$

Intermediate angle solution formula：

$$Angle_i = \frac{diff(Angle)}{LSN - 1} * (i - 1) + Angle_{FSA} \qquad (i = 2,3,...,LSN - 1)$$

Rshiftbit(data,1) means shifting the data to the right by one bit.diff(Angle) means the clockwise angle difference from the starting angle (uncorrected value) to the ending angle (uncorrected value), and LSN represents the number of packet samples in this frame.

Second-level analysis：

Angle correction formula： $Angle_i = Angle_i + AngCorrect_i \qquad (i = 1,2,...,LSN)$

AngCorrect is the angle correction value, and its calculation formula is as follows, $tand^{-1}$ is an inverse trigonometric function, and the return angle value is:

IF $Distance_i == 0$ $\qquad\qquad$ $AngCorrect_i = 0$

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

In the data packet, the 4th to 8th bytes are 28 E5 6F BD 79, so LSN = 0x28 = 40(dec), FSA = 0x6FE5, LSA = 0x79BD, and bring in the first-level solution formula, and get：

$Angle_{FSA} = 223.78°$，$Angle_{LSA} = 243.47°$，$diff(Angle) = 19.69°$

$$Angle_i = \frac{19.69°}{39} * (i - 1) + 223.78° \qquad (i = 2,3,...,39)$$

Assume that in the frame data, $\text{Distance}_1 = 1000$，$\text{Distance}_{LSN} = 8000$，and bring in the second-level solution formula, you get:

$\text{AngCorrect}_1 = -6.7622°$，$\text{AngCorrect}_{LSN} = -7.8374°$, so:

$\text{Angle}_{FSA} = \text{Angle}_1 + \text{AngCorrect}_1 = 217.0178°$

$\text{Angle}_{LSA} = \text{Angle}_{LSA} + \text{AngCorrect}_{LSA} = 235.6326°$

Similarly, Angle_i ($i = 2,3,...,\text{LSN} - 1$)，can be obtained sequentially.

➢ **Check code parsing：**

The check code uses a two-byte exclusive OR to verify the current data packet and itself does not participate in XOR operations. XOR order is not strictly in byte order.

Since the sampled data Si has 3 bytes, you need to XOR the first 8 bytes of the first byte of Si and then XOR. As the C_3 and C_5 shown in the above sequence picture.

Therefore, the check code solution formula is:

$$CS = \text{XOR}_1^{en}(C_i) \qquad i = 1,2,...,end$$

XOR_1^{end} indicates the XOR of the element from subscript 1 to end. However, XOR satisfies the exchange law, and the actual solution may not need to follow the XOR sequence.

Stop command [A5 65]

When the system is in the scanning state, G2 always sends point cloud data to the outside. If you need to turn off scanning 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 mode, and the laser is not lit.

The command is unresponsive, so the system will not respond to any messages after receiving the command.

Device Information [A5 90]

When an external device sends a Get Device Information command to A4 (A5 90), G2 will feedback the device's model, firmware version, and hardware version, and the device's factory serial number. The reply message is:

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

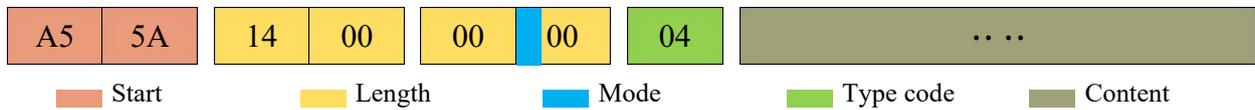Start　　Length　　Mode　　Type code　　Content

FIG 8 YDLIDAR G2 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　　Firmware version　　Hardware version　　Serial number

FIG 9 YDLIDAR G2DEVICE INFORMATION RESPONSE CONTENT DATA STRUCTURE

➢ **Model number**：One byte device model, such as the G2 model code is 05.
➢ **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 for hardware version.
➢ **Serial number**：16 bytes, the only factory serial number.

Health status [A5 91]

When the external device sends the Get Device Health Status command (A5 91) to G2, G2 will feedback the device's status code. The reply message is:

A5	5A	03	00	00	00	06	. . ..

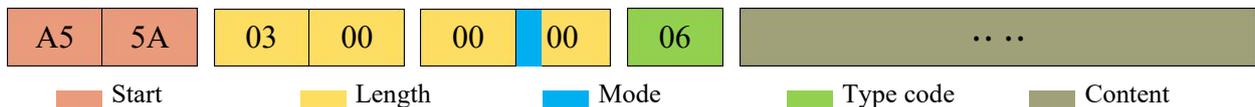Start　　Length　　Mode　　Type code　　Content

FIG 10 YDLIDAR G2 DEVICE HEALTH

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

That is, the number of response content bytes is 3. The response is a single response and the type code is 06. This type of response content satisfies the following data structure:
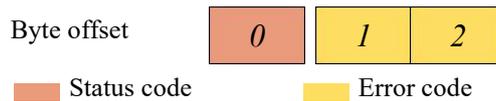
FIG 11 YDLIDAR G2 DEVICE HEALTH STATUS

➢ **Status code**：1 byte. 0x0 indicates that the device is running normally; 0x1 indicates that the device is running; 0x2 indicates that the device is running incorrectly.

➢ **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.

FIG 9 YDLIDAR G2 DEVICE INFORMATION RESPONSE CONTENT DATA STRUCTURE DIAGRAM

➢ **Model number**：One byte device model, such as the G2 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.

Low power consumption [A5 01]

When an external device sends a low-power enable command (A5 01) to G2, G2 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:
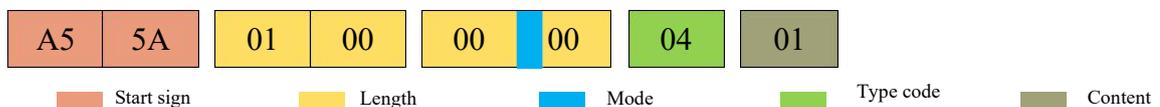

FIG 12 YDLIDAR G2 LOW POWER CONSUMPTION PACKETS

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. G2 defaults to low power consumption.

Low-power mode turn-off [A5 02]

When an external device sends a low-power mode shutdown command (A5 02) to G2, G2 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:
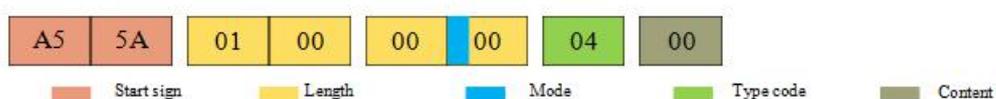

FIG 13 YDLIDAR G4 LOW-POWER SHUTDOWN MESSAGE

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.

Motor rotation direction setting [A5 06/07/08]

G2 supports motor forward and reverse can be set, the default is clockwise rotation. The related commands are described as follows:

Chart 5 Motor Direction Setting Command Description

System command	Description
0xA506	Clockwise
0xA507	Counterclockwise
0xA508	Get the direction of motor rotation

The above commands are the same type of commands and have the same message structure. The motor rotation direction is set with the following message structure:

A5	5A	01	00	00	00	04	00/01

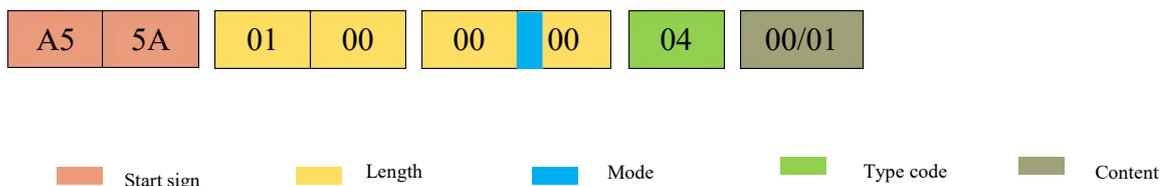■ Start sign ■ Length ■ Mode ■ Type code ■ Content

FIG 14 YDLIDAR G2 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.
00 indicates clockwise rotation and 01 indicates counterclockwise rotation.

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

G2 provides multiple command interfaces for scanning frequency settings to increase or decrease the system scan frequency.

CHART6 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	· · ··

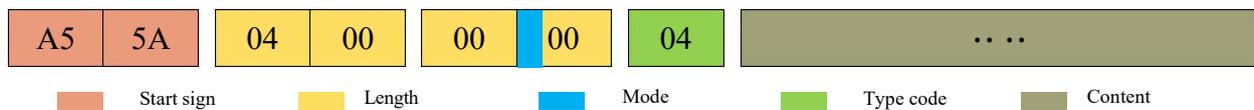Start sign — Length — Mode — Type code — Content

FIG 15 YDLIDAR G2 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:

$$F = \frac{AnswerData}{100}$$

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. G2 defaults to constant frequency.

The command message is as follows:

A5	5A	01	00	00		00	04	01

FIG 16 YDLIDAR G2 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 Lidar 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 |

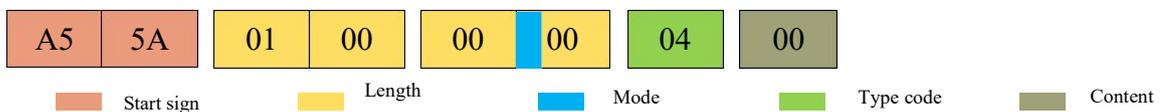| Start sign | Length | Mode | Type code | Content |

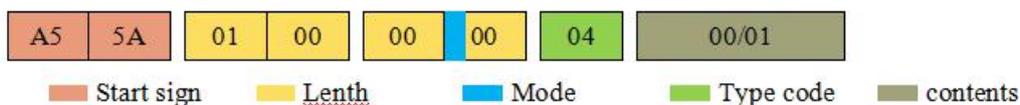FIG 17 YDLIDAR G2 CONSTANT FREQUENCY TURN OFF MESSAGE

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.

Power-down protection switching [A5 D9]

If the Lidar power supply and external equipment is not a shared power supply system, please turn on the power-down protection mode to protect the Lidar.

Under this model, the scan command needs to be sent continuously and the transmission interval should be less than 3s. If the command is sent interrupted or the transmission interval is too long, the system will judge that the control terminal has been powered down, which will trigger the power failure protection and stop the Lidar. This command is a switch command. The message of the command is as follows:

| A5 | 5A | 01 | 00 | 00 | 00 | 04 | 00/01 |

| Start sign | Lenth | Mode | Type code | contents |

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 the command corresponds to the power-on protection mode being turned on and off, 00 means that the power-down protection is enabled, and 01 means that the power-down protection is turned off.

Note: In the power-down protection mode, the message structure of the scan command changes slightly. Only when the scan command is sent for the first time in the stop state, there will be a complete message structure. There is no start flag in the subsequent scan command. The response length, response mode, and type code are only the response content.

Restart command [A5 80]

When an external device sends a Get Device command (A5 80) to G2, G2 enters a soft reboot and the system restarts. This command does not answer.

Standby control

The G2 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 G2 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.

Attention

When interacting with the G2 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.