



# **YDLIDAR TG SERIES DEVELOPMENT MANUAL**

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## WORKING MECHANISM

The YDLIDAR TG Series system has 4 working modes: idle mode, scan mode, stop mode.

- **Idle mode:** When TG Series is powered on, the default mode is idle mode. In idle mode, the TG Series's ranging unit does not work and the laser is not lit.
- **Scan mode:** When TG Series is in scanning mode, the ranging unit turns on the laser. When the TG Series starts to work, it continuously samples the external environment and outputs it in real time after background processing.
- **Stop mode:** When TG Series runs with an error, such as turning on the scanner, the laser is off, the motor does not rotate, etc., TG Series 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

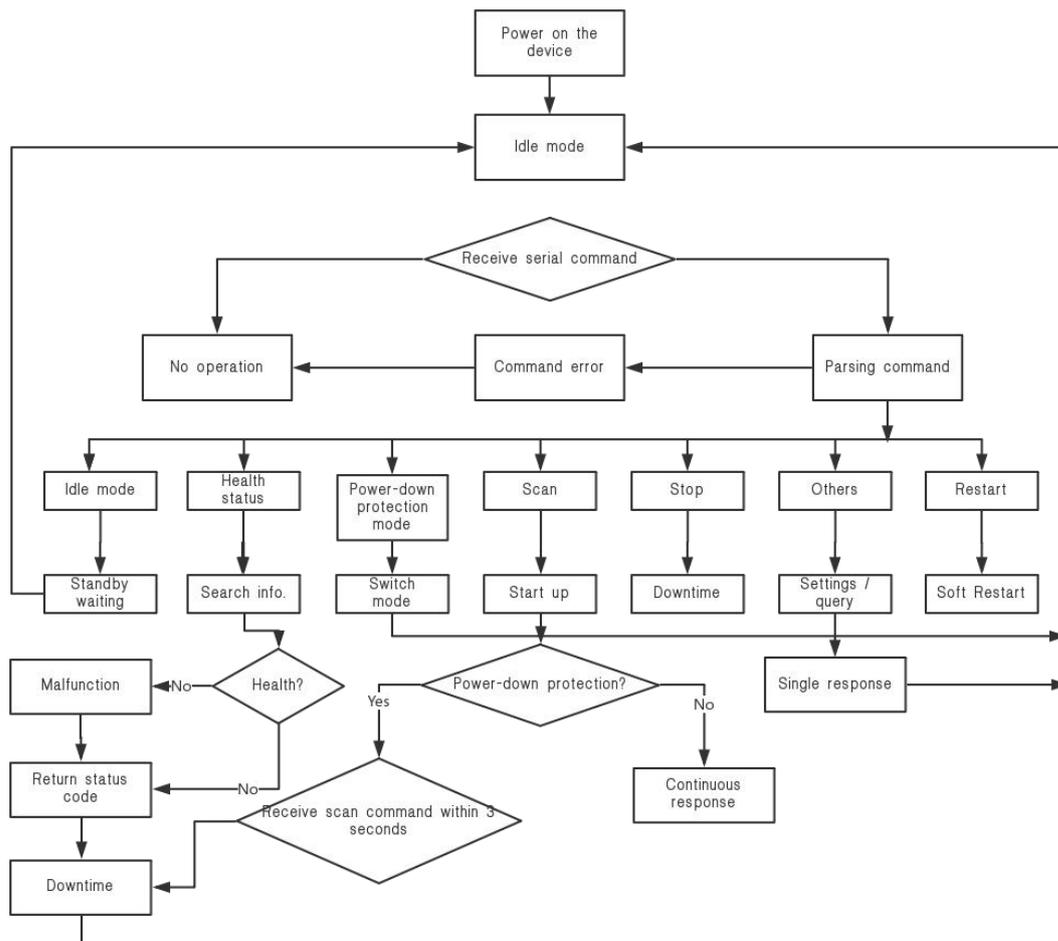


FIG 1 YDLIDAR TG Series WORKFLOW

## SYSTEM COMMUNICATION

### Communication mechanism

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

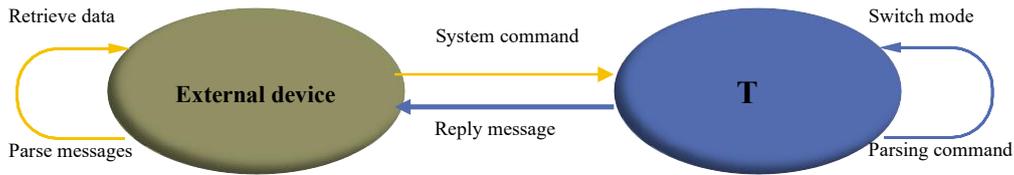


FIG 2 YDLIDAR TG Series SYSTEM COMMUNICATION

### System command

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

CHART 1 YDLIDAR TG Series SYSTEM COMMAND

System command	Description	Mode Switching	Answer mode
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 TG Series is turned on, the motor and ranging unit do not work in idle mode.	-	Single response
0x02	After low power consumption is switched off, TG Series 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

0xA5  
(Start)

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
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 TG Series SYSTEM MESSAGE DATA PROTOCOL**

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

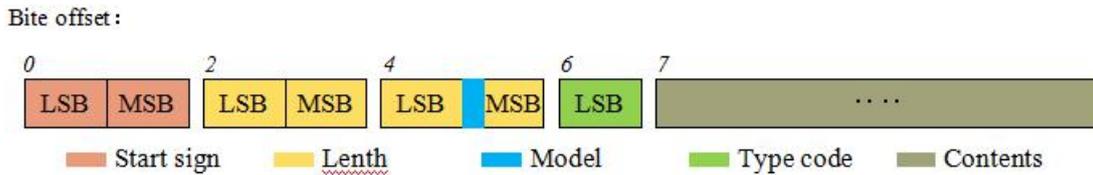


FIG 3 YDLIDAR TG Series SYSTEM MESSAGE DATA PROTOCOL

- **Start sign:** TG Series'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 TG Series 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 TG Series 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 TG Series, TG Series goes into scan mode and feeds back point cloud data. The reply message is:

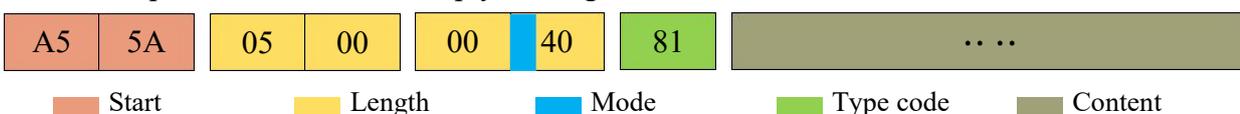


FIG 4 YDLIDAR TG Series SCAN COMMAND

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:

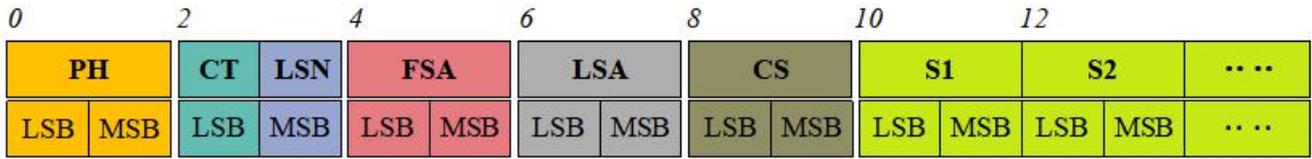


FIG 5 SCAN COMMAND RESPONSE CONTENT DATA STRUCTURE

**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:**

Start data packet: CT=1,LSN=1,Si=1

For the analysis of the specific values of distance and angle, see the analysis of distance and angle

➤ **Distance analysis:**

**Distance solution formula:**

$$\text{Distance}_i = \frac{S_i}{2}$$

Si is sampling data. Sampling data is set to E5 6F. Since the system is in the little-endian mode, the sampling point S = 0x6FE5, and it is substituted into the distance solution formula, which yields

Distance = 14322.50mm.

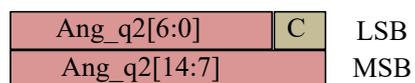


Fig 6 ANGLE

*First level analysis:*

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

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

**Intermediate angle solution formula:**

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

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:**  $Angle_i = Angle_i + AngCorrect_i \quad (i = 1,2,\dots,LSN)$

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  $Distance_i == 0$   $AngCorrect_i = 0$

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

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:

$Angle_{FSA} = 223.78^\circ$ ,  $Angle_{LSA} = 243.47^\circ$ ,  $diff(Angle) = 19.69^\circ$

$$Angle_i = \frac{19.69^\circ}{39} * (i - 1) + 223.78^\circ \quad (i = 2,3,\dots,39)$$

Assume that in the frame data,  $Distance_1 = 1000$ ,  $Distance_{LSN} = 8000$ , and bring in the second-level solution formula, you get:

$AngCorrect_1 = - 6.7622^\circ$ ,  $AngCorrect_{LSN} = - 7.8374^\circ$ , so:

$Angle_{FSA} = Angle_1 + AngCorrect_1 = 217.0178^\circ$

$Angle_{LSA} = Angle_{LSA} + AngCorrect_{LSA} = 235.6326^\circ$

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

➤ **Check code parsing:**

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

$$CS = XOR_1^{en}(C_i) \quad i = 1,2, \dots, end$$

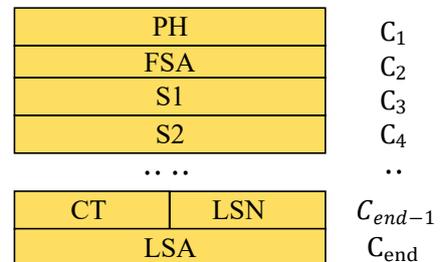


FIG 7 CS XOR SEQUENCE

$XOR_1^{end}$  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, TG Series 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), TG Series will feedback the device's model, firmware version, and hardware version, and the device's factory serial number. The reply message is:

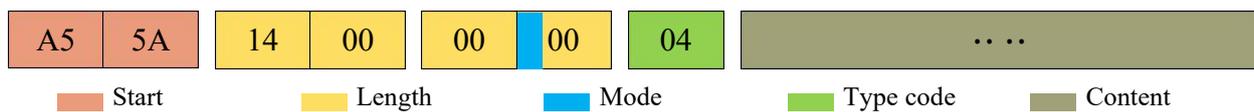


FIG 8 YDLIDAR TG Series DEVICE INFORMATION

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:



FIG 9 YDLIDAR TG Series DEVICE INFORMATION RESPONSE CONTENT DATA STRUCTURE

- **Model number:** One byte device model, such as the TG Series 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.

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. TG Series 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 TG Series, TG Series 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:

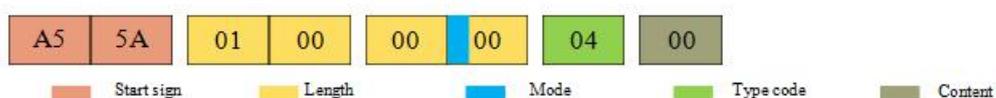


FIG 13 YDLIDAR G4 LOW-POWER SHUTDOWN MESSAGE

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]

TG Series 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:

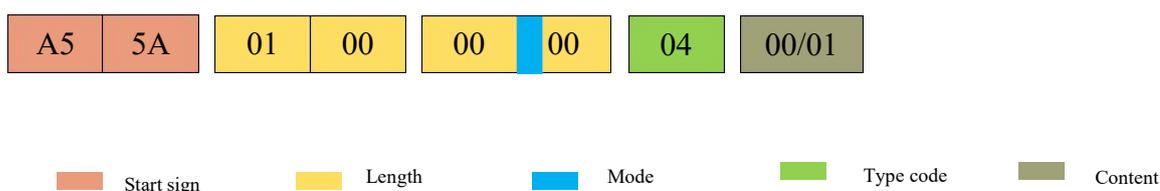


FIG 14 YDLIDAR TG Series LOW POWER CONSUMPTION QUERY MESSAGE

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]

TG Series 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:



FIG 15 YDLIDAR TG Series 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:

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

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. TG Series defaults to constant frequency.

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

CHART 7 RANGING FREQUENCY SETTING RESPONSE CONTENT DESCRIPTION

### 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.

### 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:

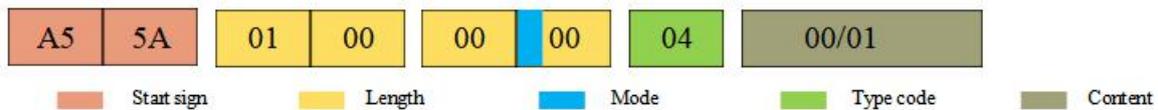


FIG 19 YDLIDAR TG Series POWER-DOWN PROTECTION MESSAGE

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 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 TG Series, TG Series enters a soft reboot and the system restarts. This command does not answer.

## **Standby control**

The TG Series 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 TG Series 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 TG Series 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.