YDLIDAR TW3 DEVELOPMENT MANUAL

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1 WORKING MECHANISM

The YDLIDAR TW3 (hereinafter referred to as TW3) system has 3working modes: idle mode, scan mode, stop mode, Power-down protection mode.

- **Idle mode:** When the TW3 is powered on, it defaults to the idle mode. In the idle mode, the TW3's ranging unit does not work and the laser does not light up.
- **Scan mode:** When TW3 enters the scan mode, the ranging unit lights up the laser andstarts to work, continuously sampling the external environment, and outputting it in real time after background processing.
- **Stop mode:** When there is an error in TW3 operation, such as when scanning is turned on, the laser is not bright, the motor does not rotate, etc., TW3 will automatically turn off the ranging unit and feedback the error code.

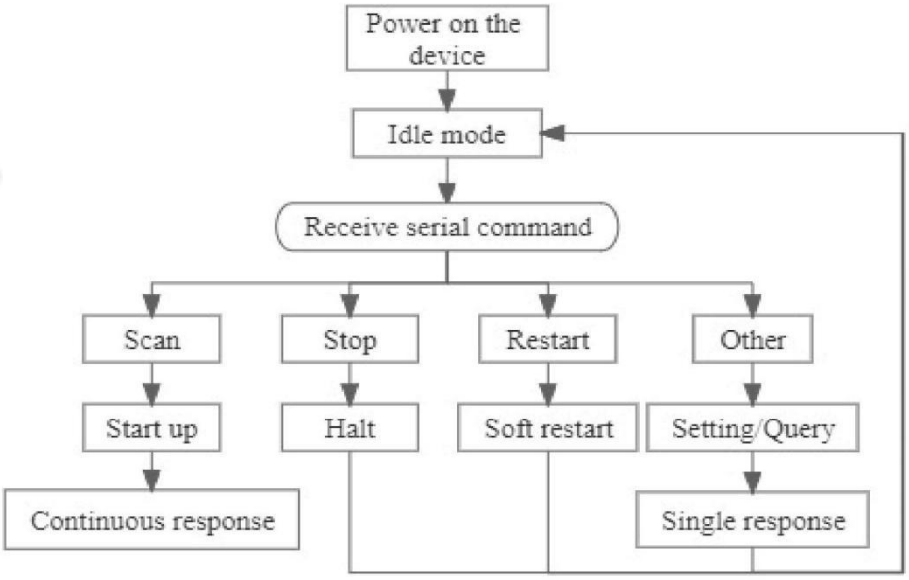

FIG 1 YDLIDAR TW3 SYSTEM WORKFLOW

2 SYSTEM COMMUNICATION

2.1 Communication Mechanism

TW3 uses the serial port to interact with external devices for commands and data. When an external device sends a system command to TW3, TW3 resolves the system command and returns a corresponding reply message. According to the command content, TW3 switches the corresponding working status. According to the content of the message, the external system can parse the message and obtain the response data.

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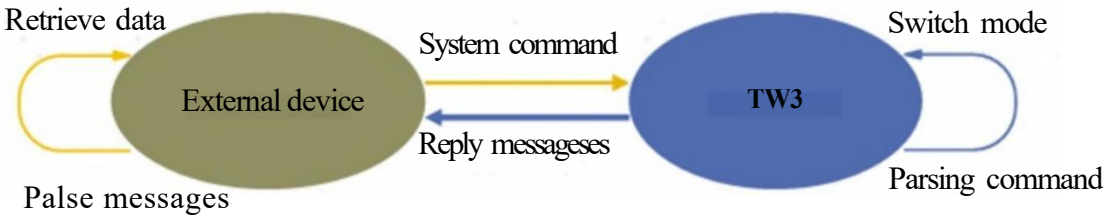

FIG 2 YDLIDARTW3 SYSTEM COMMUNICATION

2.2 System Command

By sending relevant system commands, the external system can set the corresponding working status of TW3 and obtain corresponding data. The system commands of TW3 consist of two bytes. The fr st byte is OxAS and the second byte is the command content. The system commands issued by TW3 are as follows:

CHART 1 YDLIDAR TW3 SYSTEM COMMAND

System Command		Description	Mode switching	Answer mode
0xA5 (Start)	0x60	Start scanning, output point cloud data	Scan mode	Continuous response
	0x65	Stop and stop scanning	Stop mode	No answer
	0x90	Get device information (model, firmware, hardware version)	No	Single response
	0x92	Get device health status	No	Single response
	0x09	Increase the current scan frequency of 0.1Hz	No	Single response
	0x0A	Reduce the current scan frequency of 0.1Hz	No	Single response
	0x0B	Increase the current scan frequency of 1Hz	No	Single response
	0x0C	Reduce the current scan frequency of 1Hz	No	Single response
	0x0D	Get the currently set scan frequency	No	Single response
	0x40	Soft restart	/	No answer

2.3 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 response 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:

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The single 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.

CHART 2 YDLIDAR TW3 SYSTEM MESSAGE DATA PROTOCOL

Start Sign	Response Length	Response Mode	Type Code	Content
16bits	30bits	2bits	8bits	/

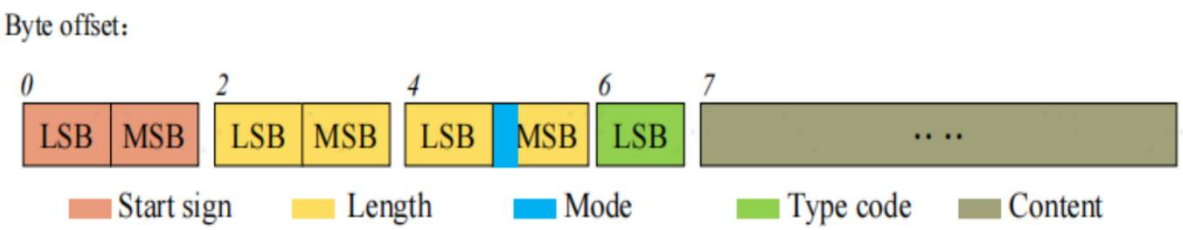

FIG 3 YDLIDAR TW3 SYSTEM MESSAGE DATA PROTOCOL

Start sign: TW3's message sign is unified as 0xA55A.

Response length: The response length indicates the length of the response content, 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 TW3 RESPONSE VALUEAND MODE

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 T-mini Plusdata 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.

3 DATA PROTOCOL

Different system commands have different packet contents. In the packets of different types of codes, the data protocol of the response content isalso not the same. Therefore, the users need to parse the data in the response content according to the corresponding data protocol, such as point cloud data, device information, etc

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3.1 Scan Command [A5 60]

When an external device sends a scan command to TW3, TW3 goes into scan mode and feeds back point cloud data. The reply message is:

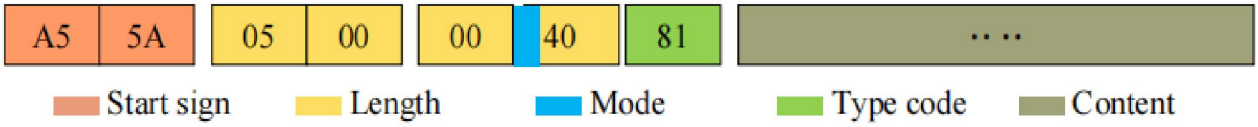

FIG 4 YDLIDAR TW3 SCAN COMMAND

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:

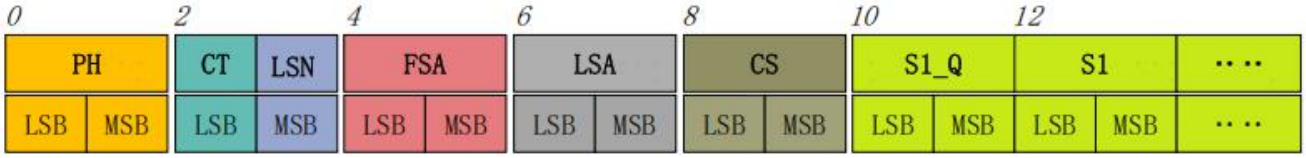

FIG 5 SCAN COMMAND RESPONSE CONTENT DATA STRUCTURE

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	CT&0x01 is point cloud type information: CT&0x01=0x00: is point cloud data package CT&0x01=0x01: is start packet CT&0xFE indicates other information: CT&0x01=0x01, current data is a zero-point packet: CT&0xFE represents the radar-calculated frequency, which can range from 4.0Hz to 12.0Hz. The specific calculation method is Freq=((CT&0xFE)>>1)+30)/10Hz. For example, if CT=0x3D, the current packet is the start packet, and the rotation speed is 6.0Hz.
LSN(1B)	Sample quantity	Indicates the number of sampling points contained in the current data packet; if the starting data packet contains only one starting point, the value is 1
FSA(2B)	Start angle	The angle data corresponding to the first sampling point in the sampling data
LSA(2B)	End angle	The angle data corresponding to the last sampling point in the sampling data
CS(2B)	Check code	The check code of the current data packet uses double-byte XOR to check the current data packet
SiQ(2B)	Signal quality	Receive signal quality information. The larger the value, the better the signal quality.
Si(2B)	Sample data	The sampling data of the system test is the distance data of the sampling points

3.1.1 Start Bit Analysis

When CT[bit(0)] =1 is detected, it indicates that the packet data is the start packet, representing the beginning of a cycle of data. In this packet, LSN=1, that is, the number of Si is 1; for the specific value analysis of the distance and angle, please refer to the following;

When CT[bit(0)] = 0 is detected, it indicates that the packet data is a point cloud data packet.

Note: CT [bit (7:1)] is a reserved bit and will be used for other purposes in future versions. Therefore, in the process of parsing CT, only the start frame of bit (0) needs to be determined.

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3.1.2 Signal quality analysis

Signal quality calculation formula: Quality_i = si_Q

Si_Q is the signal quality data. Assume the sampled data is 6F 00. Since this system uses little-endian mode, the current sampling point S = 0x00 6F. Substituting this into the signal quality calculation formula,
we get Quality = 111.

Note: the value range is 0~65535。

3.1.3 Distance Analysis

Distance solution formula: $Distance_i$ $Di = [7:0] + Di[15:8] * 256$ Unit:mm

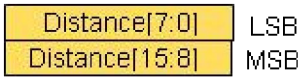

FIG 6 S-NODE DATA STRUCTURE DIAGRAM

Where Di is the first and second bytes of the sampled data Si. Assuming the sampled data is E803, since this system is in little-endian mode, the sampled point D = 0x03E8. Substituting this into the distance calculation formula, we get Distance = 1000mm.

3.1.4 Angle analysis

Angle data is stored in FSA and LSA, and each angle data has the following data structure, where C is the check bit and its value is fixed to 1. The specific process is as follows:

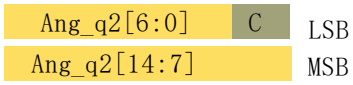

FIG 7 ANGLE DATA STRUCTURE SCHEMATIC

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

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

3.1.5 Check Code Parsing

The check code uses double-byte XOR to check the current data packet. It does not participate in the XOR operation itself, and the XOR order is not strictly in byte order. The XOR order is shown in the figure. Therefore, the check code solution formula is :

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

$XOR^{end}$is the XOR formula, which represents the XOR of the numbers in the elements from subscript 1 to end. However, XOR is commutative, so the order of XOR in this article does not need to be followed in actual calculations.

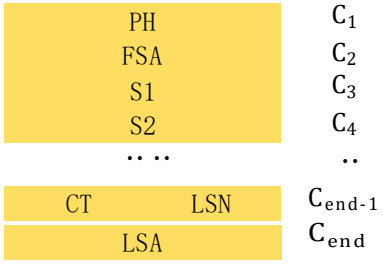

Fig 8 CS XOR sequence diagram

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3.2 Stop Command [A5 65]

When the system is in the scan mode, TW3 always sends point cloud data to the outside. If user s 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 off.

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

3.3 Device Information [A5 90]

When an external device sends a Get Device Information command to (A5 90), T-mini Plus will feedback the device's model, firmware version, and hardware version, and the device's factory serial number. The reply message is:

FIG 10 YDLIDAR TW3 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 11 YDLIDAR TW3 DEVICE INFORMATION RESPONSE CONTENT DATA STRUCTURE

- **Model number:** One byte device model, such as the model code of T-mini Plus is 151;
- **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.

3.4 Health Status [A5 92]

When an external device sends a health status command (A5 92) to TW3, TW3 will give back the status code of the device. The reply message is:

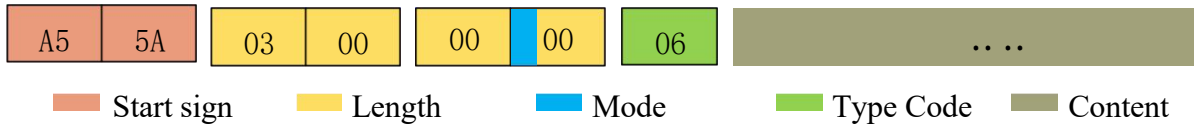

FIG 12 SCHEMATIC DIAGRAM OF YDLIDAR TW3 LIDAR EQUIPMENT HEALTH STATUS MESSAGE

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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 reply content satisfies the following data structure:

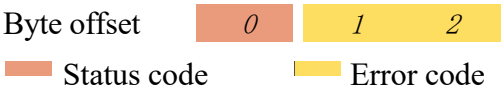

FIG 13 SCHEMATIC DIAGRAM OF DATA STRUCTURE OF HEALTH STATUS RESPONSE CONTENT OF YDLIDAR TW3 EQUIPMENT

- Status code: 1 byte, each bit of this byte corresponds to the health information of different modules, details as follows:

CHART 5 HEALTH STATUS CODE BIT DESCRIPTION

Bit	Description
Bit0	Sensor status bit, used to judge the state of the image sensor:1 abnormal,0 normal
Bit1	Encode status bit, used to judge the status of the angle detection module:1 abnormal,0 normal
Bit2	WiPwr status bit, used to judge the status of the wireless power supply module:1 abnormal,0 normal
Bit3	PD status bit, used to judge the status of the laser feedback voltage:1 abnormal,0 normal
Bit4	LD status bit, used to judge the state of the laser drive current:1 abnormal, 0 normal
Bit5	Data status bit, used to judge whether the lidar data is normal:1 abnormal,0 normal
Bit[6:7]	Reserved status bit

- **Error code:** 2 bytes, when there is a warning or error state, error code will output the abnormal information of the corresponding module.

Note1: When obtaining health information, users only need to pay attention to the status code, not the error code.

Note2: This information can be obtained once at the beginning of power-on, and the real-time health information ofthe lidar can be obtained by parsing and scanning data packets.

3.5 Scan Frequency Setting [A5 09/0A/0B/0C]

TW3 provides multiple command interfaces for scanning frequency settings to increase or decrease the system scan frequency.

CHART 6 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

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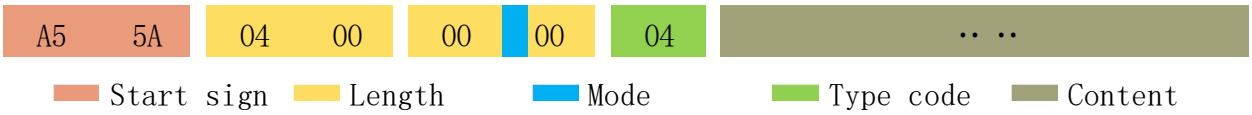

FIG 14 YDLIDAR TW3 SCAN FREQUENCY SETTING MESSAGE

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 (Unit: H z), and its solution formula is:

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

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

3.6 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 users can refer to the scan frequency setting [A5 09/0A/0B/0C]. This section does not describe it.

3.7 Restart Command [A5 40]

When the external device sends the Get Restart command (A5 40) to TW3, TW3 will enter a soft restart and the system restarts. There is no response to this command.

4 MOTOR SPEED CONTROL

The TW3 integrates the system's speed control into the system's command interface, not the hardware interface. Users can change the speed of the motor by adjusting the scan frequency. See the section on Scan Frequency Setting [A5 09/0A/0B/0C]for details. This section does not elaborate.

5 ATTENTION

1) During command interaction with TW3， except for the stop scan command (A5 65), other commands cannot be interacted in scan mode, which may easily lead to message parsing errors.
2) TW3 will not rotate when powered on, the user needs to send a command (A5 60) to enter the scan mode, and send A5 65 to stop the scan mode;
3) When TW3 is blocked, the laser will be turned off, and the serial port will still output the distance measurement package (the distance in the distance measurement package is 0 at this time, that is, the invalid distance), and output Health information on the index corresponding to CT (Encode error).

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4) When TW3 is blocked during scanning and can't find the distance at all, the health information of the point cloud data packet of the serial port will alarm for data abnormalities and other errors.

6 REVISION

Date	Version	Content
2025-09-04	1.0	The 1st release

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