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Delta-3A communication interface protocol

[Delta-3A]

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one. Introduction to Radar Communication

Delta-3A lidar communicates with external devices through UART TTL level and supports full duplex Communication, external equipment can switch radar working mode, start/stop measurement, read valid data, adjust Radar rotation speed, etc., all data in the communication frame are data in hexadecimal format.

According to the communication protocol defined in this article, the communication data can be parsed, and the real-time measurement information and Health status information.

two. Communication frame structure

The communication frame consists of frame header, frame length, protocol type, command word, parameter length, parameter, and check code. Mainly used for communication between external equipment and lidar, uploading of measurement information and fault information.

Frame Header	Frame Length	Protocol Version	Command Word	Parameter Length	Parameter	Check Code	

Frame header: fixed to 0xAA.

Frame length: is the length of the communication frame, the frame length is calculated from the frame header to the byte before the check digit (16-bit unsigned number, low-order first, high-order last).

Protocol Version: The current protocol version number (8-bit unsigned number).

Command word: The command word occupies 1 Byte.

Bit7: Communication error flag.

Bit6: Communication direction flag: 0: Host--->Radar; 1: Radar--->Host.

Bit0 ~ Bit6: is the command identifier.

Parameter length: The length of the parameter in the communication frame (16-bit unsigned number, low-order first, high-order last).

Parameters: Valid data for the command.

Check digit: It is the exclusive OR from the beginning of the frame to the byte before the check digit. (16-bit unsigned number, low before, high behind)

The returned frame format is as follows:

Frame Header	Frame Length	Protocol Version	Command Word	Parameter Length	Parameter	Check Code	

The meaning of each field is as follows:

Frame header: the meaning is the same as the frame structure

Frame length: meaning same as frame structure

Protocol version: The meaning is the same as the frame structure.

Command word: When there is a communication error, it should be: 0xC0 + command identifier

When the communication is normal, it should be: 0x40 + command identifier

Parameter length: The meaning is the same as the frame structure.

Parameter: Valid parameter or communication error code.

error code:

0x00: The command was executed successfully.

0x01: Command word error.

0x02: parameter length error

0x03: parameter error

0x04: Check digit error

Check digit: The meaning is the same as the frame structure.

Command word list:

command word	description	Parameter length	parameter description
0x01	Set the radar working mode	1 Byte	Radar working mode setting (8 bits unsigned data) 0x00: idle mode 0x01: Low-speed scan mode (ie 6.8K measurement mode) 0x02~0x07: Invalid parameter 0x08: Lidar reset
0x04	Adjust radar speed	10 bytes	Adjust radar speed 0 ~ 7 bytes: Fixed parameters must be written, see below: 0x23, 0x01, 0x67, 0x45, 0xAB, 0x89, 0xEF, 0xCD 8 ~ 9 bytes: Set the radar speed, the accuracy is 0.01r/S (16 bits unsigned number, low-order first, high-order last)
0x14	Report scanning distance information	2N + 6 Bytes	0 ~ 1 Bytes: radar speed, accuracy 0.01r/S (16 bits unsigned number, low order first, high order last) 2 ~ 3 Bytes: The starting angle value of this frame (0 ~ 360), the precision is 0.01° (16 bits unsigned number, high-order first, low-order last) 4 ~ 5 Bytes: the end angle value of this frame (0 ~ 360), the precision is 0.01° (16 bits unsigned number, high-order first, low-order last) 6 ~ 7 Bytes: distance value of measuring point 1, resolution 1mm (16 bits unsigned number, low order first, high order last) .... (2N + 6) ~ (2N + 7)Bytes: N distance value of measuring point, resolution 1mm (16 bits unsigned number, low order first, high order last) The angle corresponding to the distance m[1:N] = (the starting angle value of this frame + m*((the ending angle value of this frame - the starting angle value of this frame)/(N - 1)))
0x16	report device accident details	3 bytes	0 Byte: Device fault code Bit0 = 1 Radar speed failure Bit1 = 1 Calibration parameter error

			Other fault codes to be determined 1 ~ 2 Bytes: radar speed, accuracy 0.01r/S (16 bits unsigned number, low order first, high order last)

three. Check code calculation

The communication frame check algorithm of this protocol adopts 16-bit cumulative sum. The following is the routine for calculating the check code.

for reference.

```
//==============================================
================================================
=

// The return value of the function is an unsigned 16bits check value

//        ptr: , the message to be checked and calculated

//        len: the length of the packet to be verified

//==============================================
================================================
=

unsigned short cal_checksum(unsigned char *ptr, unsigned int len)

{

unsigned short checksum = 0x00;

while (len--)
```

```
{
checksum += *ptr++;
}
return checksum ;
}
```

Four. Communication frame instance analysis

1. Set the radar idle mode (stop scanning):

AA 08 00 10 01 01 00 00 C4 00

2. Set the radar low-speed sampling:

AA 08 00 10 01 01 00 01 C5 00

3. Set the radar reset:

AA 08 00 10 01 01 00 08 CC 00

4. Set the speed to 5r/s:

AA 11 00 10 04 0A 00 23 01 67 45 AB 89 EF CD F4 01 8E 05

5. Set the speed to 6r/s:

AA 11 00 10 04 0A 00 23 01 67 45 AB 89 EF CD 58 02 F3 04

6. Set the speed to 7r/s:

AA 11 00 10 04 0A 00 23 01 67 45 AB 89 EF CD BC 02 57 05

7. Set the speed to 8r/s:

AA 11 00 10 04 0A 00 23 01 67 45 AB 89 EF CD 20 03 BC 04

8. Set the speed to 9r/s:

AA 11 00 10 04 0A 00 23 01 67 45 AB 89 EF CD 84 03 20 05

9. Set the speed to 10r/s:

AA 11 00 10 04 0A 00 23 01 67 45 AB 89 EF CD E8 03 84 05

10. Set the speed to 11r/s:

AA 11 00 10 04 0A 00 23 01 67 45 AB 89 EF CD 4C 04 E9 04

11. Set the speed to 12r/s:

AA 11 00 10 04 0A 00 23 01 67 45 AB 89 EF CD B0 04 4D 05

12. Set the speed to 13r/s:

AA 11 00 10 04 0A 00 23 01 67 45 AB 89 EF CD 14 05 B2 04

13. Set the speed to 14r/s:

AA 11 00 10 04 0A 00 23 01 67 45 AB 89 EF CD 78 05 16 05

14. Set the speed to 15r/s:

AA 11 00 10 04 0A 00 23 01 67 45 AB 89 EF CD DC 05 7A 05

Analyze the measurement data frame:

AA B5 00 10 54 AE 00 F3 01 4F 28 57 DC 00 00 40 01 40 01 3A 01 43 01 45

01 44 01 4D 01 44 01 3E 01 3C 01 42 01 46 01 46 01 00 00 00 00 00 00 00

00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

00 00 00 00 00 00 00 F3 06 D6 06 AD 06 81 06 55 06 4E 06 4A 06 42 06 41

06 40 06 3A 06 36 06 31 06 34 06 31 06 27 06 2A 06 22 06 27 06 20 06 1E

06 27 06 22 06 1C 06 14 06 0E 06 2F 06 07 06 02 06 FF 05 04 06 0D 06 FE

05 FB 05 F4 05 E9 05 F5 05 F2 05 E9 05 EB 05 00 00 01 08 F9 07 E9 07 F0

07 E3 07 D8 07 DB 07 C1 07 CA 07 B7 07 39 21

AA: frame header

B5 00: frame length, 16-bit unsigned number, low-order first, high-order last, that is, 181

10: Protocol version

54: Communication direction (0x40) + command word (0x14), i.e. LD->PC, report scanning distance information

AE 00: Effective data length, i.e. 174

F3 01: Radar speed 0x01F3, the low position is in the front and the high position is in the back, that is, 499*0.01 = 4.99r/s

4F 28: The starting angle is 0x4F28, the high position is in the front and the low position is in the back, that is, 20264*0.01=202.64°,

Minimum resolution 0.01°

57 DC: the end angle is 0x57DC, the high position is in the front and the low position is in the back, that is, 22492*0.01=224.92°,

Minimum resolution 0.01°

* First of all, the following information can be obtained from the above information:

Number of points sent in this frame: (174-6)/2 = 84 points

Angular offset between points in this frame: (224.92-202.64)/(84-1) = 0.27°

The angle of the first point is: 202.64°

The angle of the second point is: 202.64+0.27 = 202.91°

...

The angle of the 84th point is: 224.92°

00 00: Distance value 1, low order first, high order last, 16-bit unsigned number, namely 0x0000, unit 1mm

40 01: Distance value 2, low order in front, high order in back, 16-bit unsigned number, ie 0x0140, unit 1mm

....

B7 07 The distance value is 84, the low order is in the front, the high order is in the back, 16-bit unsigned number, that is, 0x07B7, the unit is 1mm,

That is, at the position of 224.92°, there is an object with a distance of 1975*1mm = 1975mm.

39 21: Check code

Analyze radar failure frames:

AA 0A 00 10 56 03 00 01 CC 03 ED 01

AA: Frame header identification.

0A 00: The frame length is 0x000A (ie 10) bytes (not including the check digit)

10: Protocol version

56: Communication direction (0x40) + command word (0x16)

03 00: Valid data length 0x0003

01: Fault code stall abnormality

CC 03: radar speed 0x03CC, that is, 972*0.01 = 9.72r/s

ED 01: Check code