Livox SDK Communication Protocol

Document Release History		
Date	**Release**	**Change Description**
2019/2/25	v1.0.1	Update 3.2 Time Stamp description
2019/1/16	v1.0.0	Initial release

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1 Summary

1.1 Data Class

There are two types of communication between the user and LiDAR unit(s), and the protocol formats of these two kinds of data are different. The specific functions and differences are as follows:

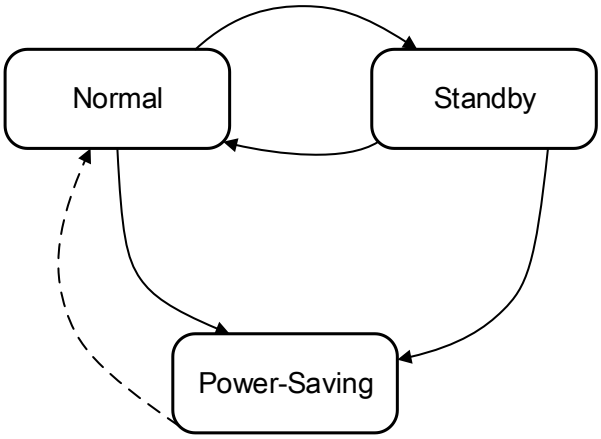
Control Command Data: Configuration and query of LiDAR parameters and status information;

Point Cloud Data: Point cloud coordinate data generated by LiDAR units;

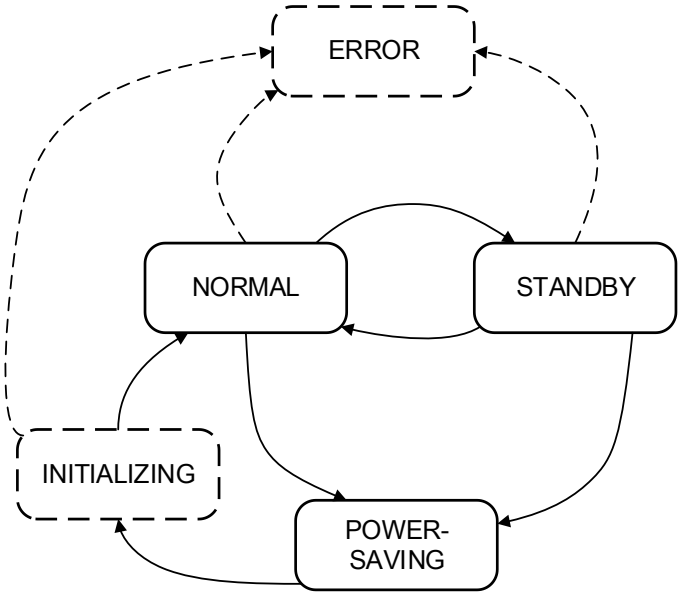
At present, both protocols are encapsulated in the data segment of the UDP package, and the data format in protocol is stored in little-endian form.

1.2 Mode and State Description

The mode in which the user can switch LiDAR:



When the user sets LiDAR mode and the mode switching is completed, the LiDAR unit(s) will be in the corresponding state:



2 Control Command

2.1 Frame Format

The Protocol Frame is the smallest unit for control command. Format is as follows:

Field	Index (byte)	Size (byte)	Description
sof	0	1	Starting Byte, Fixed to be 0xAA
version	1	1	Protocol Version, 1 for The Current Version
length	2	2	Length of The Frame, Max Value: 1400
cmd_type	4	1	Command Type: 0x00: CMD 0x01: ACK 0x02: MSG
seq_num	5	2	Frame Sequence Number
crc_16	7	2	Frame Header Checksum
data	9	n	Payload Data
crc_32	9+n	2	Whole Frame Checksum

Command type description:

CMD (request): Actively send data request - need to return a corresponding ACK;

ACK (response): Response to CMD data;

MSG (message): Actively pushed message data - no need to return response data, e.g. broadcast data, pushed message when an error occurs;

Initial value of the CRC check:

crc16 initial value	crc32 initial value
0x4c49	0x564f580a

2.2 Frame Data

2.2.1 Data Segment Format

Data segment format in Protocol Frame:

Field	Index (byte)	Size (byte)
cmd_set	0	1
cmd_id	1	1
cmd_data	2	Vary by cmd

2.2.2 CMD Set & CMD ID

There are three kinds of CMD sets:

General Command Set: All of Livox Device support General Command Set including Livox LiDAR and Livox Hub.

LiDAR Command Set: Only Livox LiDAR supports LiDAR Command Set.

Hub Command Set: Only Livox Hub supports Hub Command Set.

CMD Set	CMD ID	Function
0x00 General Command Set	0x00	Broadcast Message
	0x01	Handshake
	0x02	Query Device Information
	0x03	Heartbeat
	0x04	Start/Stop Sampling
	0x05	Change Coordinate System
	0x06	Disconnect
	0x07	Push Abnormal Status Information
	0x08	Configure Static/Dynamic IP

	0x09	Get Device IP Information
0x01 LiDAR Command Set	0x00	Set Mode
	0x01	Write LiDAR Extrinsic Parameters
	0x02	Read LiDAR Extrinsic Parameters
	0x03	Turn On/Off Rain/Fog Suppression
0x02 Hub Command Set	0x00	Query Connected LiDAR Device
	0x01	Set LiDAR Mode
	0x02	Turn On/Off Designated Slot Power
	0x03	Write LiDAR Extrinsic Parameters
	0x04	Read LiDAR Extrinsic Parameters
	0x05	Query LiDAR Device Status
	0x06	Turn On/Off Hub Calculation of Extrinsic Parameters
	0x07	Turn On/Off LiDAR Rain/Fog Suppression

2.3 SDK Connection

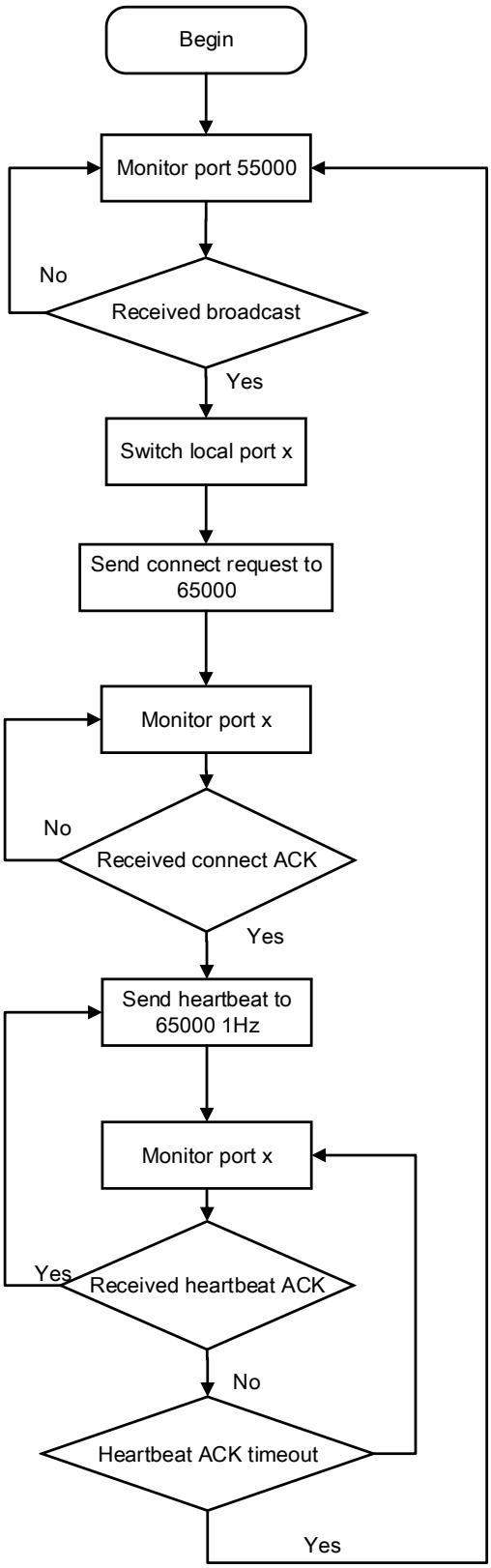
In the process of communication, LiDAR or Hub are defined as slave, and the computer which receives point cloud data is defined as master.

The communication flow between master and slave is as follows:

1. When the slave is powered on, it broadcasts the device information data to port 55000 of the master using source port 65000;
2. After receiving the broadcast data, the master sends a connection request to the slave port 65000, which contains the source port information;
3. The slave replies ACK data to this source port after receiving the master's connection request;
4. When the user receives ACK data, the handshake is completed. It can start sending heartbeat data to maintain the connection, and transmit commands and data.

NOTE: The Livox LiDAR/Hub will re-broadcast if heartbeat is timeout.

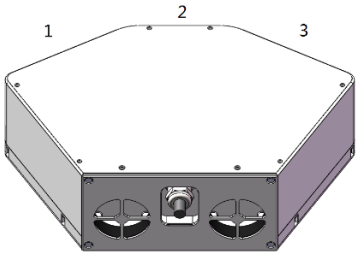
Flow Chart:



3 Point Cloud Data

3.1 Package Format

Point cloud data format output by LiDAR:

Field	Index (byte)	Size (byte)	Description
version	0	1	Packet Protocol Version, 5 for the Current Version
slot_id	1	1	ID of the Slot Connecting LiDAR Device: If LiDAR connects directly to computer without Hub, default 1; If LiDAR connects to computer through Hub, then the 'slot_id' is the corresponding slot number of the hub (range: 1 ~ 9);
LiDAR_id	2	1	LiDAR ID: 1: Mid-100 Left / Mid-40 / Tele-15 / Horizon 2: Mid-100 Middle 3: Mid-100 Right 
reserved	3	1	
status_code	4	4	LiDAR Status Indicator Information, For details, see 3.4
timestamp_type	8	1	Timestamp Type, For details, see 3.2
data_type	9	1	Point Cloud Coordinate Format: 0: Cartesian Coordinate

			1: Spherical Coordinate
timestamp	10	8	Nanosecond or UTC Format Timestamp, For details, see 3.2
data	18	--	100 Point cloud data samples

3.2 Time Stamp

LiDAR system supports three synchronization modes: IEEE 1588v2.0 PTP network protocol synchronization, pulse synchronization (only supported by LiDAR), GPS time synchronization (PPS + GPRMC, only supported by Hub).

Each packet contains a timestamp indicating the time of the first point in the packet.

Timestamp Type	Source	Data Type	Description
0	No sync source	uint64_t	Unit: ns
1	PTP	uint64_t	Unit: ns
2	Reserved		
3	GPS	UTC	UTC, only supported by Hub
4	PPS	uint64_t	Unit: ns, only supported by LiDAR

Timestamp Type 0

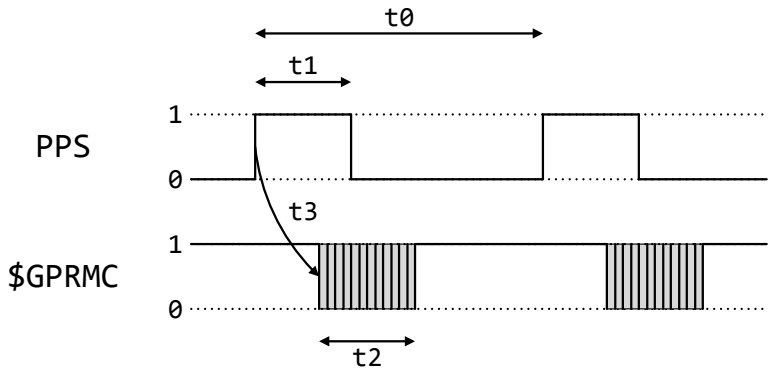
When there is no synchronization signal in the system, the time stamp indicates the time when device is powered on.

Timestamp Type 1

IEEE 1588v2.0 PTP network protocol synchronization 1588 network synchronization mode has the highest priority.

Timestamp Type 3

GPS synchronization source, using the RS485 level. The sequence diagram is as follows:




```
t0: 1000 ms
t1: 20 ms ≤ t1 ≤ 200 ms
t2: ~70 ms @9600 bps
t3: 0 ms ≤ t3 ≤ 430 ms
```

An example $GPRMC message is shown below:

$GPRMC,123519,A,4807.038,N,01131.000,E,022.4,084.4,230394,003.1,W*6A

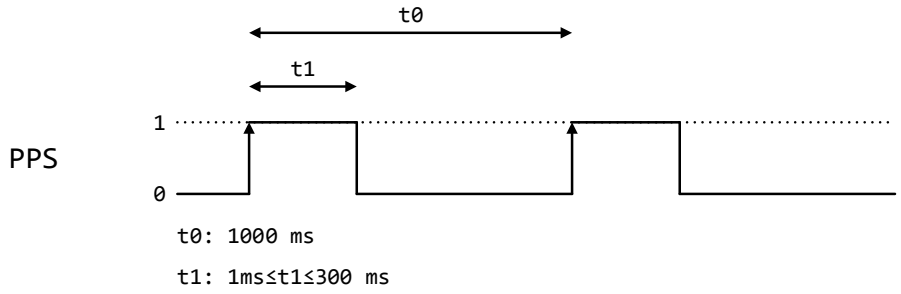
123519	Fix taken at 12:35:19 UTC
A	Status A=active or V=Void.
4807.038	Current Latitude
N	North/South
01131.000	Current Longitude
E	East/West
022.4	Speed in knots
084.4	True course
230394	Date stamp, 23rd of March 1994
003.1	Magnetic Variation
W	West/East
*6A	The checksum data, always begins with *

The timestamp in cloud point data package UTC time format:

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4 ~ 7
Year	Month	Day	Hour	Offset within the Hour, Unit: us

Timestamp Type 4

PPS synchronization source, using the RS485 level. The sequence diagram is as follows. Timestamp indicates the time from the last rising edge.



3.3 Point Cloud

There are 100 point cloud samples in each point data package. The sample data can have either one of the following formats depends on the coordinate system chosen by the user.
Cartesian coordinate format:

Field	Offset (byte)	Data Type	Description
x	0	int32_t	X axis, Unit: mm
y	4	int32_t	Y axis, Unit: mm
z	8	int32_t	Z axis, Unit: mm
reflectivity	12	uin8_t	Reflectivity

Spherical coordinate format:

Field	Offset (byte)	Data Type	Description
depth	0	uint32_t	Depth, Unit: mm
theta	4	uint16_t	Zenith angle[0, 18000], Unit: 0.01 degree
phi	6	uin16_t	Azimuth[0, 36000], Unit: 0.01 degree
reflectivity	8	uin8_t	Reflectivity

3.4 Status Code

3.4.1 LiDAR Status Code

LiDAR status_code consists of 32 bits, which has the following meanings:

Bits	Data	Description
Bit0:1	temp_status	0: Temperature in Normal State

		1: High or Low 2: Extremely High or Extremely Low
Bit2:3	volt_status	Voltage Status of Internal Module 0: Voltage in Normal State 1: High 2: Extremely High
Bit4:5	motor_status	0: Motor in Normal State 1: Motor in Abnormal State, Unable to Work
Bit6:7	dirty_warn	0: Not Dirty or Blocked 1: Dirty or Blocked
Bit8	firmware_status	0: Firmware is OK 1: Firmware is Abnormal, Need to be Upgraded
Bit9	pps_status	0: No PPS Signal 1: PPS Signal is OK
Bit10	device_status	0: Normal 1: Warning for Approaching the End of Service Life
Bit11:29	RSVD	
Bit30:31	system_status	0: Normal 1: Warning Any of the following situations will trigger warning: Temperature becomes High or Low; Voltage becomes High; Optical system is Dirty or Blocked; 2: Error, Causes the LiDAR to Shut Down and Enter the Error State Any of the following situations will trigger error: Temperature becomes Extremely High or Extremely Low; Voltage becomes Extremely High; Motor is Abnormal; Firmware is Abnormal

3.4.2 Hub Status Code

Hub Status Code consists of 32 bits, which has the following meanings:

Bits	Data	Description
Bit0:1	sync_status	0: No synchronization signal 1: 1588 synchronization 2: GPS synchronization
Bit2:3	temp_status	0: Temperature in Normal State 1: High or Low 2: Extremely High or Extremely Low
Bit4	LiDAR_status	0: LiDAR State is Normal 1: LiDAR State is Abnormal
Bit5	LiDAR_link_status	0: LiDAR Connection is Normal 1: LiDAR Connection is Abnormal
Bit6	firmware_status	0: LiDAR Firmware is OK 1: LiDAR Firmware is Abnormal, Need to be Upgraded
Bit7:29	RSVD	
Bit30:31	system_status	0: Normal 1: Warning Any of the following situations will trigger warning: Temperature becomes High or Low; 2: Error Any of the following situations will trigger error: Temperature becomes Extremely High or Extremely Low; LiDAR State is Abnormal; Firmware is Abnormal;

4 Control Command Detail

4.1 General CMD Set

0x00 Broadcast Message

message

MSG	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	General Command: 0x00
	cmd_id	1	uint8_t	Command ID: 0x00
	broadcast _code	2	uint8_t[16]	Device Broadcast Code, C-Style string end with '\0' The Broadcast Code of Each Device is UNIQUE.
	dev_type	18	uint8_t	Device Type: 0: Livox Hub 1: Mid-40 2: Tele-15 3: Horizon
	reserved	19	uint16_t	Reserved

0x01 Handshake

request

CMD	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	General Command: 0x00
	cmd_id	1	uint8_t	Command ID: 0x01

	user_ip	2	uint8_t[4]	Host IP Address Example: AA.BB.CC.DD user_ip[0] = AA user_ip[1] = BB user_ip[2] = CC user_ip[3] = DD
	data_port	6	uint16_t	Host Point Cloud Data UDP Destination Port
	cmd_port	8	uint16_t	Host Control Command UDP Destination Port

response

ACK	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	General Command: 0x00
	cmd_id	1	uint8_t	Command ID: 0x01
	ret_code	2	uint8_t	Return Code: 0x00: Success 0x01: Fail

0x02 Query Device Information

request

CMD	name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	General Command: 0x00
	cmd_id	1	uint8_t	Command ID: 0x02

response

ACK	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	General Command: 0x00

	cmd_id	1	uint8_t	Command ID: 0x02
	ret_code	2	uint8_t	Return Code: 0x00: Success 0x01: Fail
	version	3	uint8_t[4]	Firmware Version: Example: AA.BB.CC.DD version[0] = AA version[1] = BB version[2] = CC version[3] = DD

0x03 Heartbeat

The host needs to send request data at a frequency of 1 Hz to maintain normal connection with the device.

request

CMD	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	General Command: 0x00
	cmd_id	1	uint8_t	Command ID: 0x03

response

ACK	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	General Command: 0x00
	cmd_id	1	uint8_t	Command ID: 0x03
	ret_code	2	uint8_t	Return Code: 0x00: Success 0x01: Fail

	work_state	3	uint8_t	LiDAR State: 0x00: Initializing 0x01: Normal 0x02: Power-Saving 0x03: Standby 0x04: Error Hub State: 0x00: Initializing 0x01: Normal 0x04: Error
	feature_msg	4	uint8_t	LiDAR Feature Message: Bit0: Rain/Fog Suppression Switch 0x00: Turn Off 0x01: Turn On Bit1 ~ Bit7: Reserved Hub is Reserved
	ack_msg	5	uint32_t	ACK Message: Related to 'work_state': work_state is 0x00: Initialization Progress work_state is other: Status Code

0x04 Start/Stop Sampling

request

CMD	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	General Command: 0x00
	cmd_id	1	uint8_t	Command ID: 0x04
	sample_ctrl	2	uint8_t	0x00: Start Sampling 0x01: Stop Sampling

response

ACK	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	General Command: 0x00
	cmd_id	1	uint8_t	Command ID: 0x04
	ret_code	2	uint8_t	Return Code: 0x00: Success 0x01: Fail

0x05 Change Coordinate System

request

CMD	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	General Command: 0x00
	cmd_id	1	uint8_t	Command ID: 0x05
	coordinate_type	2	uint8_t	0x00: Cartesian Coordinate 0x01: Spherical Coordinate

response

ACK	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	General Command: 0x00
	cmd_id	1	uint8_t	Command ID: 0x05
	ret_code	2	uint8_t	Return Code: 0x00: Success 0x01: Fail

0x06 Disconnect

request

CMD	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	General Command: 0x00
	cmd_id	1	uint8_t	Command ID: 0x06

response

ACK	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	General Command: 0x00
	cmd_id	1	uint8_t	Command ID: 0x06
	ret_code	2	uint8_t	Return Code: 0x00: Success 0x01: Fail

0x07 Push Abnormal Status

message

When error occurs, the message is immediately pushed at 10Hz to report the abnormal information.

MSG	name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	General Command: 0x00
	cmd_id	1	uint8_t	Command ID: 0x07
	status_code	2	uint32_t	Status Code

0x08 Configure Static/Dynamic IP

request

CMD	Name	Offset (byte)	Data Type	Description

data	cmd_set	0	uint8_t	General Command: 0x00
	cmd_id	1	uint8_t	Command ID: 0x08
	ip_mode	2	uint8_t	0x00: Dynamic IP 0x01: Static IP
	ip_addr	3	uint8_t[4]	IPV4 Address IP address is valid when 'ip_mode' is 0x01 (Static IP) ip_addr[0]: 192 ip_addr[1]: 168 ip_addr[2]: 1 ip_addr[3]: Range is as follows Last bit of broadcast code: 1: 11~80 2: 81~150 3: 151~220

response

ACK	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	General Command: 0x00
	cmd_id	1	uint8_t	Command ID: 0x08
	ret_code	2	uint8_t	Return Code: 0x00: Success 0x01: Fail

0x09 Get Device IP Information

request

CMD	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	General Command: 0x00

	cmd_id	1	uint8_t	Command ID: 0x09

response

ACK	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	General Command: 0x00
	cmd_id	1	uint8_t	Command ID: 0x09
	ret_code	2	uint8_t	Return Code: 0x00: Success 0x01: Fail
	ip_mode	3	uint8_t	0x00: Dynamic IP 0x01: Static IP
	ip_addr	4	uint8_t[4]	Device IPV4 Address Example: AA.BB.CC.DD user_ip[0] = AA user_ip[1] = BB user_ip[2] = CC user_ip[3] = DD

4.2 LiDAR CMD Set

0x00 Set Mode

request

CMD	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	LiDAR Command: 0x01
	cmd_id	1	uint8_t	Command ID: 0x00
	LiDAR_mode	2	uint8_t	LiDAR Mode: User can configure as follow:

				0x01: Normal Mode 0x02: Power-Saving Mode 0x03: Standby Mode

response

ACK	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	LiDAR Command: 0x01
	cmd_id	1	uint8_t	Command ID: 0x00
	ret_code	2	uint8_t	Return Code: 0x00: Success 0x01: Fail 0x02: Switching

0x01 Write LiDAR Extrinsic Parameters

request

CMD	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	LiDAR Command: 0x01
	cmd_id	1	uint8_t	Command ID: 0x01
	roll	2	float32	Roll Angle, Unit: degree
	pitch	6	float32	Pitch Angle, Unit: degree
	yaw	10	float32	Yaw Angle, Unit: degree
	x	14	int32_t	X Translation, Unit: mm
	y	18	int32_t	Y Translation, Unit: mm
	z	22	int32_t	Z Translation, Unit: mm

response

ACK	Name	Offset	Data	Description

		(byte)	Type	
data	cmd_set	0	uint8_t	LiDAR Command: 0x01
	cmd_id	1	uint8_t	Command ID: 0x01
	ret_code	2	uint8_t	Return Code: 0x00: Success 0x01: Fail

0x02 Read LiDAR Extrinsic Parameters

request

CMD	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	LiDAR Command: 0x01
	cmd_id	1	uint8_t	Command ID: 0x02

response

ACK	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	LiDAR Command: 0x01
	cmd_id	1	uint8_t	Command ID: 0x02
	ret_code	2	uint8_t	Return Code: 0x00: Success 0x01: Fail
	roll	3	float32	Roll Angle, Unit: degree
	pitch	7	float32	Pitch Angle, Unit: degree
	yaw	11	float32	Yaw Angle, Unit: degree
	x	15	int32_t	X Translation, Unit: mm
	y	19	int32_t	Y Translation, Unit: mm

	z	23	int32_t	Z Translation, Unit: mm

0x03 Turn On/Off Rain/Fog Suppression

request

CMD	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	LiDAR Command: 0x01
	cmd_id	1	uint8_t	Command ID: 0x03
	state	2	uint8_t	Turn On/Off Rain/Fog Suppression: 0x00: Turn Off 0x01: Turn On

response

ACK	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	LiDAR Command: 0x01
	cmd_id	1	uint8_t	Command ID: 0x03
	ret_code	2	uint8_t	Return Code: 0x00: Success 0x01: Fail

4.3 Hub CMD SET

0x00 Query Connected LiDAR Device

request

CMD	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	Hub Command: 0x02
	cmd_id	1	uint8_t	Command ID: 0x00

response

ACK	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	Hub Command: 0x02
	cmd_id	1	uint8_t	Command ID: 0x00
	ret_code	2	uint8_t	Return Code: 0x00: Success 0x01: Fail
	count	3	uint8_t	Number of LiDAR Connected to the Hub Range: 0 ~ 27
	info_list	4	--	Device Information List of Connected LiDAR

In 'info_list', each LiDAR device information has the following format:

Field	Offset (byte)	Data Type	Description
broadcast_code	0	uint8_t[16]	LiDAR Broadcast Code
dev_type	16	uint8_t	Device Type: 1: Mid-40 2: Tele-15 3: Horizon
version	17	uint8_t[4]	LiDAR Firmware Version Example: AA.BB.CC.DD version[0] = AA version[1] = BB version[2] = CC version[3] = DD
slot_id	21	uin8_t	Slot Used to Install LiDAR
LiDAR_id	22	uint8_t	LiDAR ID: 1: Mid-100 Left / Mid-40 / Tele-15 / Horizon

			2: Mid-100 Middle 3: Mid-100 Right

0x01 Set LiDAR Mode

request

CMD	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	Hub Command: 0x02
	cmd_id	1	uint8_t	Command ID: 0x01
	count	2	uint8_t	Number of LiDAR to Set Range: 1 ~ 27
	config_list	3	--	LiDAR Mode Configuration List

In 'config_list', each LiDAR mode configuration has the following format:

Field	Offset (byte)	Data Type	Description
broadcast_code	0	uint8_t[16]	LiDAR Broadcast Code
LiDAR_mode	16	uint8_t	LiDAR Mode: User can configure as follows: 0x01: Normal Mode 0x02: Power-Saving Mode 0x03: Standby Mode

response

ACK	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	Hub Command: 0x02
	cmd_id	1	uint8_t	Command ID: 0x01
	ret_code	2	uint8_t	Return Code: 0x00: Success

				0x01: Fail 0x02: Switching
	count	3	uint8_t	Number of LiDAR to Set Range: 1 ~ 27
	return_list	4	--	Return Information List

In 'return_list', each return information has the following format:

Field	Offset (byte)	Data Type	Description
ret_code	0	uint8_t	LiDAR Return Code: 0x00: Success 0x01: Fail
broadcast_code	1	uint8_t[16]	LiDAR Broadcast Code

0x02 Turn On/Off Designated Slot Power

request

CMD	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	Hub Command: 0x02
	cmd_id	1	uint8_t	Command ID: 0x02
	slot_id	2	uint8_t	Slot id of Hub Range: 1 ~ 9
	power_ctrl	3	uint8_t	Power Control (Default 0x00) 0x00: Turn Off 0x01: Turn On

response

ACK	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	Hub Command: 0x02

	cmd_id	1	uint8_t	Command ID: 0x02
	ret_code	2	uint8_t	Return Code: 0x00: Success 0x01: Fail

0x03 Write LiDAR Extrinsic Parameters

request

CMD	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	Hub Command: 0x02
	cmd_id	1	uint8_t	Command ID: 0x03
	count	2	uint8_t	Number of LiDAR to Write Range: 1 ~ 27
	param_list	3	--	LiDAR Parameter Configuration List

In 'param_list', each LiDAR parameter configuration has the following format:

Field	Offset (byte)	Data Type	Description
broadcast_code	0	uint8_t[16]	LiDAR Broadcast Code
roll	16	float	Roll Angle, Unit: degree
pitch	20	float	Pitch Angle, Unit: degree
yaw	24	float	Yaw Angle, Unit: degree
x	28	int32_t	X Translation, Unit: mm
y	32	int32_t	Y Translation, Unit: mm
z	36	int32_t	Z Translation, Unit: mm

response

ACK	Name	Offset (byte)	Data Type	Description

data	cmd_set	0	uint8_t	Hub Command: 0x02
	cmd_id	1	uint8_t	Command ID: 0x03
	ret_code	2	uint8_t	Return Code: 0x00: Success 0x01: Fail
	count	3	uint8_t	Number of LiDAR to Write Range: 1 ~ 27
	return_list	4	--	Return Information List

In 'return_list', each return information has the following format:

Field	Offset (byte)	Data Type	Description
ret_code	0	uint8_t	LiDAR Return Code: 0x00: Success 0x01: Fail
broadcast_code	1	uint8_t[16]	LiDAR Broadcast Code

0x04 Read LiDAR Extrinsic Parameters

request

CMD	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	Hub Command: 0x02
	cmd_id	1	uint8_t	Command ID: 0x04
	count	2	uint8_t	Number of LiDAR to Read Range: 1 ~ 27
	code_list	3	--	LiDAR Broadcast Code Information List

In 'code_list', each LiDAR broadcast code information has the following format:

Field	Offset (byte)	Data Type	Description

broadcast_code	0	uint8_t[16]	LiDAR Broadcast Code

response

ACK	Name	Offset (byte)	Type	Description
data	cmd_set	0	uint8_t	Hub Command: 0x02
	cmd_id	1	uint8_t	Command ID: 0x04
	ret_code	2	uint8_t	Return Code: 0x00: Success 0x01: Fail
	count	3	uint8_t	Number of LiDAR to Read Range: 1 ~ 27
	param_list	4	--	LiDAR Parameter List

In ‘param_list’, each LiDAR parameter information has the following format:

Field	Offset (byte)	Data Type	Description
ret_code	0	uint8_t	LiDAR Return Code: 0x00: Success 0x01: Fail
broadcast_code	1	uint8_t[16]	LiDAR Broadcast Code
roll	17	float	Roll Angle, Unit: degree
pitch	21	float	Pitch Angle, Unit: degree
yaw	25	float	Yaw Angle, Unit: degree
x	29	int32_t	X Translation, Unit: mm
y	33	int32_t	Y Translation, Unit: mm
z	37	int32_t	Z Translation, Unit: mm

0x05 Query LiDAR Device Status

request

CMD	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	Hub Command: 0x02
	cmd_id	1	uint8_t	Command ID: 0x05

response

ACK	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	Hub Command: 0x02
	cmd_id	1	uint8_t	Command ID: 0x05
	ret_code	2	uint8_t	Return Code: 0x00: Success 0x01: Fail
	count	3	uint8_t	Number of LiDAR Connected to the Hub Range: 0 ~ 27
	info_list	4	--	LiDAR Status List

In ‘info_list’, each LiDAR status information has the following format:

Field	Offset (byte)	Data Type	Description
broadcast_code	0	uint8_t[16]	LiDAR Broadcast Code
work_state	16	uint8_t	LiDAR State: 0x00: Initializing 0x01: Normal 0x02: Power-Saving 0x03: Standby 0x04: Error

feature_msg	17	uint8_t	LiDAR Mode Message: Bit0: Rain/Fog Suppression Switch 0x00: Turn Off 0x01: Turn On Bit1 ~ Bit7: Reserved
ack_msg	18	uint32_t	ACK Message: Relevant to 'work_state': work_state is 0x00: Initialization Progress work_state is other: Status Code

0x06 Turn On/Off Hub Extrinsic Parameters Calculation

request

CMD	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	Hub Command: 0x02
	cmd_id	1	uint8_t	Command ID: 0x06
	state	2	uint8_t	Turn On/Off Parameter Calculation: 0: Turn Off 1: Turn On

NOTE: The Hub uses extrinsic parameters stored in each LiDAR for coordinate conversion. The coordinate is first rotated and then shifted. The rotation is described by Euler angles with the sequence of rotation axes being x-y-z.

response

ACK	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	Hub Command: 0x02
	cmd_id	1	uint8_t	Command ID: 0x06
	ret_code	2	uint8_t	Return Code: 0x00: Success

				0x01: Fail

0x07 Turn On/Off LiDAR Rain/Fog Suppression

request

CMD	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	Hub Command: 0x02
	cmd_id	1	uint8_t	Command ID: 0x07
	count	2	uint8_t	Number of LiDAR to Configure Range: 1 ~ 27
	config_list	3	--	LiDAR Feature Configuration List

In ‘config_list’, each LiDAR feature configuration information has the following format:

Field	Offset (byte)	Data Type	Description
broadcast_code	0	uint8_t[16]	LiDAR Broadcast Code
cmd_data	1	uint8_t	0: Turn Off 1: Turn On

response

ACK	Name	Offset (byte)	Data Type	Description
data	cmd_set	0	uint8_t	Hub Command: 0x02
	cmd_id	1	uint8_t	Command ID: 0x07
	ret_code	2	uint8_t	Return Code: 0x00: Success 0x01: Fail
	count	3	uint8_t	Number of LiDAR to Set Range: 1 ~ 27

	return_list	4	--	Return Information List

In ‘return_list’, each return information has the following format:

Field	Offset (byte)	Data Type	Description
ret_code	0	uint8_t	LiDAR Return Code: 0x00: Success 0x01: Fail
broadcast_code	1	uint8_t[16]	LiDAR Broadcast Code