1.1 Communication protocol

1.2 packet structure

The communication protocol of LP series laser ranging radar is an application layer protocol based on basic communication. The maximum frame length of the protocol is 8 bytes, and it uses the small-end format.

Frame structure				
1 Bytes	1 Bytes	4 Bytes	1 Bytes	1 Bytes
Frame header (0x55)	Key	Value	check (CRC8)	Frame end (0xAA)

Note: The range of verification data is the 2nd-6th byte of the frame structure, namely the Key and Value fields.

The C language sample code of CRC verification program is as follows:

```
/* CRC-8 x8+x5+x4+1 0x31(0x131) */
uint8_t crc_high_first(uint8_t *ptr, uint8_t len)
{
    uint8_t i;
    uint8_t crc = 0x00;                 /* Calculated initial CRC value */

    while(len--)
    {
        crc ^= *ptr++;                  /* XOR with the data to be calculated at first, and point to the next data after calculation. */
        for (I = 8; i > 0; --i)         /* The following calculation process is the same as calculating a byte CRC. */
        {
            if (crc & 0x80)
                crc = (crc << 1) ^ 0x31;
            else
                crc = (crc << 1);
        }
    }
    return crc;
}
```

Examples of data reception

Packet: 55 07 00 00 05 AD 9C AA

55: Frame header

07: key field, which indicates that this packet is received data.

00: the high byte of the 00： Value field, where the system status is indicated, and 0 indicates that the system is normal.

00 05 AD: indicates the measured distance value, expressed in hexadecimal, and the unit is mm. 00 05 AD is converted into decimal system, which is 1453mm.

9c: CRC check field

AA: end of frame

1.3 packet parsing connection

Key	definition	direction
0x01	Get device information	Upper computer → ranging radar
0x02	Obtain temperature information	Upper computer → ranging radar
0x03	Set the measurement frequency	Upper computer → ranging radar
0x04	Format data	Upper computer → ranging radar
0x0D	Set measurement mode	Upper computer → ranging radar
0x05	Start measurement	Upper computer → ranging radar
0x06	Stop measuring	Upper computer → ranging radar
0x07	Measurement data return	Ranging radar → upper computer
0x0E	High-speed measurement data return	Ranging radar → upper computer
0x08	Save settings	Upper computer → ranging radar
0x0A	Get serial number	Upper computer → ranging radar
0x11	Configure device address	Upper computer → ranging radar
0x12	Set baud rate	Upper computer → ranging radar

1.3.1 Obtaining Equipment Information (0x01)

functional description

The upper computer needs to obtain the current equipment information and send the < Equipment Information Request > to the ranging radar, and the ranging radar will respond and return the software and hardware version number of the equipment.

Quick instruction reference: 55 01 00 00 00 00 D3 AA

Value content description

Value content is empty.

Return data.

A total of two frames of data are returned:

The first frame: 55 01 AA BB BB BB JY AA

AA: current device model

BB: current firmware version number

JY: check bit

The second frame: 55 01 AA BB CC JY AA

AA: data format of current device output:

01: byte format

02: pixhawk format

BB: measurement mode of current equipment:

00: continuous measurement mode-power on

01: Single measurement mode

02: continuous measurement mode-starting without starting

CC: measurement frequency set by current equipment.

JY: parity bit

Fast instruction reference means that the user can directly send this instruction for control without manually calculating the CRC check value again. Applicable to instructions without Value value.

1.3.2 Obtaining temperature information (0x02)

functional description

The upper computer needs to obtain the current internal temperature of the equipment and send < Get Temperature Information > to the ranging radar, which will respond and return the software and hardware version number of the equipment.

Quick instruction reference : 55 02 00 00 00 97 AA

Value content description

Value content is empty.

Return data.

A total of one frame of data is returned:

The first frame: 55 01 AA AA AA AA JY AA

AA: current internal temperature of equipment (℃), floating-point number format

JY: check bit.

1.3.3 Set the measurement frequency (0x03)

functional description

The upper computer sends < Set Measurement Frequency > to LP40, and LP40 immediately updates the measurement frequency according to the Value of the data packet.

Parameter is lost due to power failure.

Value content description

Value(4 Bytes)
uint32
Measuring frequency
1-2000Hz

When the measurement frequency is less than or equal to ≤500Hz, the measurement data return format refers to < Measurement Data Return >.

When the measurement frequency is more than ＞500Hz, it can only be output at full speed in byte format. For high-speed data output in byte format, please refer to "Return data of high-speed measurement data".

Return data

None.

1.3.4 Set the data format (0x04)

functional description

The upper computer sends < set data format > to LP40, and LP40 immediately updates the format of the output data. Parameter is lost due to power failure. Quick instruction reference:

Byte format: 55 04 00 00 01 2eaa

Pixhawk format: 55 04 00 00 02 7daa

Value content description

Value(4 Bytes)			
1 Bytes	1 Bytes	1 Bytes	1 Bytes
reserve	reserve	reserve	data format
			0x01: Byte format 0x02: Pixhawk format

- In byte format, refer to < Measurement Data Return (0x07) > for data output.
- In Pixhawk format, the output of data refers to < measurement data return (0x07) >.

Return data

None.

Fast instruction reference means that the user can directly send this instruction for control without manually calculating the CRC check value again. Applicable to instructions without Value value.

1.3.5 Set the measurement mode (0x0D

functional description

The upper computer sends < Set Measurement Mode > to LP40, and LP40 immediately updates the measurement mode. Parameter is lost due to power failure. Quick instruction reference:

Continuous measurement-startup: 55 0D 00 00 00 00 F2 AA

Single measurement: 55 0D 00 00 00 01 C3 AA

Continuous measurement-starting or not: 55 0D 00 00 00 02 90 AA

Value content description

Value(4 Bytes)			
1 Bytes	1 Bytes	1 Bytes	1 Bytes
reserve	reserve	reserve	Measurement mode
			0x00: Continuous measurement-startup 0x01: Single measurement 0x02: Continuous measurement-starting or not 0x03: burst mode

Continuous measurement-In the startup mode, the measurement is automatically performed when the computer is turned on, and the distance value is sent out.

In the single measurement mode, the measurement is not performed when the computer is turned on, and the measurement is performed every time the user sends the < Start measurement (0x05) > command.

Continuous measurement-in the mode of starting without starting, the measurement is not automatically performed when starting, and the user sends the instruction of < Start measurement (0x05) > for continuous measurement. IN trigger mode, the ranging radar can accept external trigger signal input, input on the IN pin and output data on the TX pin.

Return data

None.

1.3.6 Start measurement (0x05)

functional description

The upper computer sends < Start Measurement > to LP40, and LP40 measures according to the corresponding data format and measurement method.

Quick instruction reference: 55 05 00 00 00 00 CC AA

Value content description

Value content is empty.

Return data

Returns the measurement data, and the format refers to the < Measurement Data Return > frame.

1.3.7 Stop measuring (0x06)

functional description

The upper computer sends < Stop Measurement > to LP40, and LP40 stops any measurement operation.

Quick instruction reference: 55 06 00 00 00 00 88 AA

Value content description

Value content is empty.

Return data

None.

1.3.8 Measurement data return (0x07)

functional description

When the LP40 completes the first measurement, the LP40 sends the instruction of < measurement data return > to the upper computer, and the distance data is stored in the Value.

Value content description

Byte format:

Value(4 Bytes)	
1 Bytes	3 Bytes
error code	Measurement data (mm)
0x00：The system is normal 0x01：The signal is too weak 0x02：The signal is too strong 0x03：Out of range 0x04：System error	

Pixhawk format:

When the LP40 is in Pixhawk format, after a measurement, the LP40 sends the distance value to the upper computer in the form of a string, ending with a carriage return (\r\n), and the unit is m.. For example, 8.23 and 38.93.

When the LP40 can't measure data or the system has an error, the LP40 still outputs data at the set measurement frequency, and the displayed distance value is 0, and the error code indicates the corresponding error. Users can judge whether LP40 is in normal working state according to the error code. Under normal system conditions, LP40 will never have false alarm and false detection. As long as the user correctly uses the error code, our design can ensure the stable operation of the LP40 system.

Return data

None.

1.3.9 High-speed measurement data return (0x0E)

functional description

When the measurement frequency is more than 500Hz, in order to ensure that the ranging data can be output at full speed, byte format must be used and the communication baud rate must be greater than 460kbps. Although other data formats can also be output quickly, there is no commitment to output at full speed for other data formats. The frame format returned by high-speed measurement data is defined as follows

Frame structure (44 Bytes)				
1 Bytes	1 Bytes	4 * 10 Bytes	1 Bytes	1 Bytes
Frame header (0x55)	0x0E	Values(10 group)	Check (CRC8)	Frame end (0xAA)

Note: The range of the verification data is the 2nd-42nd byte of the frame structure, namely the Key and Values fields.

Values definition:

Value(4 Bytes) * 10	
1 Bytes	3 Bytes
error code	Measurement data (mm)
0x00: The system is normal 0x01: The signal is too weak 0x02: The signal is too strong 0x03: Out of range 0x04: System error	

1.3.10 Save Settings (0x08)

functional description

The upper computer sends < Save Settings > to LP40, and LP40 stores the current configuration information into the internal Flash, which will be automatically loaded when it is turned on next time.
Saved parameters:
Data format \ measurement mode \ measurement frequency \ (default is byte mode (01)\ continuous measurement-power on or off (02)\50Hz)
Quick instruction reference: 55 08 00 00 00 3E AA.

Value content description

Value content is empty.

Return data

A total of one frame of data is returned:

The first frame: 55 08 AA AA AA AA JY AA

AA: all 0s indicate successful saving, and other values indicate failed saving

JY: check bit.

1.3.11 Obtain serial number (0x0A)

functional description

When the user needs to obtain the serial number of the equipment as the warranty or upgrade certificate, the upper computer sends an instruction to LP40, and LP40 returns the serial number to the upper computer after receiving the instruction.

Quick instruction reference: 55 0A 00 00 00 00 A9 AA

Value content description

Value content is empty.

Return data

A total of three frames of data are returned:

The first frame: 55 0A xx xx xx JY AA;

The second frame: 55 0A xx xx xx xx JY AA;

The third frame: 55 0A xx xx xx xx JY AA.

Xx: 12-byte serial number, with high order first and low order

JY: parity bit.

1.3.12 Configuration device address (0x11)

functional description

Each ranging radar has its own address, and the host can ask or set the address of the ranging radar. By default, the factory address is 1, but the 0 address cannot be set, and the 0 address is the broadcast address. When the devices with similar Modbus-RTU protocol, they will directly respond to the 0 address, regardless of their own address. For those devices with similar non-Modbus-RTU protocols, the address is only the function of providing similar device numbers. Parameter is lost due to power failure.

Quick instruction reference:

Get the current device address: 55 11 00 00 00 00 AF AA.

Set 2 as the device address: 55 11 00 00 00 02 CD AA.

Value content description

Value(4 Bytes)			
1 Bytes	1 Bytes	1 Bytes	1 Bytes
reserve	reserve	reserve	Device address
			0x00: Returns the local address. 0x01-0xFF: Device address

Return data

A total of one frame of data is returned:

The first frame: 55 11 00 00 00 xx JY AA

Xx: current device address

JY: check bit

1.3.13 Set baud rate (0x12)

functional description

The baud rate of each ranging radar is divided into two situations, one is adaptive baud rate, and users do not need to know the baud rate of ranging radar. One is fixed baud rate for users to choose. Parameter is lost due to power failure.

It is suggested that it is more convenient for users to use adaptive baud rate under test conditions, but it is more stable to use fixed baud rate in practical project applications.

Value content description

Value(4 Bytes)						
1 Bytes	1 Bytes	1 Bytes	1 Bytes			
reserve	reserve	reserve	Baud rate selection			
			number	UART	CAN	IIC
			0x00	Adaptive baud rate	not applicable	not applicable
			0x01	300	5K	reserve
			0x02	600	10K	reserve
			0x03	1200	20K	reserve
			0x04	2400	25K	reserve
			0x05	4800	40K	reserve
			0x06	9600	50K	reserve
			0x07	14400	62.5K	reserve
			0x08	19200	80K	reserve
			0x09	38400	100K	reserve
			0x0A	56000	125K	reserve
			0x0B	57600	200K	reserve
			0x0C	115200	250K	reserve
			0x0D	230400	400K	reserve
			0x0E	256000	500K	reserve
			0x0F	460800	800K	reserve
			0x10	921600	1M	reserve

Return data

A total of one frame of data is returned:

The first frame: 55 12 000 00 xx JYAA

Xx: the currently set baud rate number, and returning 0xFF indicates that the setting failed.

JY: parity bit