

Multi-Beam Underwater Ultrasonic Ranging and Obstacle Avoidance Senso

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1.Measurement principle

During the distance measurement process, ultrasonic signals are emitted by an ultrasonic probe. After being reflected by a liquid or other solid medium, the signals bounce back and are received by the same probe. By measuring the time difference between the emission and reception of the ultrasonic waves, level measurement is achieved. The relationship between the ultrasonic transmission distance (L), sound velocity (v), and ultrasonic transmission time (t) can be expressed by the formula:

The basic calculation formula for ultrasonic ranging is as follows:
$$L = (v \times t) / 2$$

L: Distance from the ultrasonic probe to the measured material surface. Unit: meter (m);

v: Sound velocity value after temperature compensation. Unit: meter per second (m/s);

t: Travel time of the sound wave within the measurement range. Unit: second (s)

2.Product Description

The multi-beam underwater ultrasonic ranging sensor is a type of multi-beam ultrasonic ranging device that extends the ranging principle of ultrasonic self-emission and self-reception. It adopts a software-implemented round-robin testing method with multiple transmissions and single reception, enabling distance measurement in multiple directions. Coordinated testing across these directions allows the sensor to achieve the functions of underwater obstacle avoidance and underwater distance measurement. The sensor can store the detected data in its internal chip registers, communicate with the host computer via the Modbus protocol, and support adjustments between passive and active data upload modes.

3.Product Features

- Multi-channel round-robin testing
- Fast response speed and high precision
- Transducer protection class: IP68, with water pressure resistance up to 150m
- Equipped with TTL communication, supporting readable and modifiable data
- Direct wire outlet / 5-pin aviation plug connector for easy installation
- Wide voltage input: 10.8VDC ~ 26.4VDC

4.Product Applications

- Position detection and distance detection
- Obstacle avoidance and collision detection for underwater robots
- Distance-setting application for underwater robots

5.Technical Parameters

General Parameters	
Operating Voltage	10.8VDC~26.4VDC, with reverse polarity protection
Electrical Characteristics	
Voltage Drop	≤2.5V
Startup Delay	<1000ms
Output Characteristics	
Output Type	Standard TTL/RS485 output (Modbus-RTU protocol)

Rated Working Current	≤60mA (24V), with short-circuit/overload protection
Repeatability Accuracy	±0.5%
Accuracy	±0.5%
Environmental Temperature	
Operating Temperature	-20~60°C
Storage Temperature	-20~60°C
Mechanical Characteristics	
Material	Sensor: PC/Metal/ABS

6.Installation Instructions

Electrical Wiring Diagram/or Direct Wire Outlet

Blue: 485A Yellow: 485B Red: V+ Black: GND

7.Communication Protocol

7.1 Protocol Description

7.1.1 Communication Parameter Settings

- 1.The hardware adopts TTL/RS485 and master-slave half-duplex communication. The host calls the slave address, and the slave responds for communication.
- 2.The data frame has 10 bits, including 1 start bit, 8 data bits, 1 stop bit, and no parity.
- 3.Default baud rate: 115200 (00, 01, 02, 03, 04) (4800, 9600, 19200, 38400, 115200)

7.1.2 Reading Register Values

Function Code 03H: Read Register Values

Host Transmission:

1	2	3	4	5	6	7	8
ADR	03H	High Byte of Start Register	Low Byte of Start Register	High Byte of Register Quantity	Low Byte of Register Quantity	Low Byte of CRC	High Byte of CRC

1st byte ADR: Slave address code (=001~254)

2nd byte 03H: Function code for reading register values

3rd & 4th bytes: Starting address of the register to be read

5th & 6th bytes: Quantity of registers to be read

7th & 8th bytes: CRC16 checksum from byte 1 to byte 6

When the slave receives correctly, the slave returns:

1	2	3	4, 5	6, 7	...	M-1, M	M+1	M+2
ADR	03H	Byte Count	Register Data 1	Register Data 2	...	Register Data M	Low Byte of CRC	High Byte of CRC

1st byte ADR: Slave address code (=001~254)

2nd byte 03H: Return read function code

3rd byte: Total number of bytes from byte 4 to byte M (including byte 4 and byte M)

4th to Mth bytes: Register data

M+1th and M+2th bytes: CRC16 checksum from byte 1 to byte M

When the slave receives incorrectly, the slave returns:

1	2	3	4	5
ADR	83H	Information Code	Low Byte of CRC	High Byte of CRC

1st byte ADR: Slave address code (=001~254)

1st byte 83H: Error in reading register values

3rd byte Information Code: See Information Code Table

4th and 5th bytes: CRC16 checksum from byte 1 to byte 3

7.1.3 Writing Register Values

Function Code 06H: Write Register Values

Host Transmission:

1	2	3	4	5	6	7	8
ADR	6	High Byte of Register Address	Low Byte of Register Address	High Byte of Data	Low Byte of Data	Low Byte of CRC	High Byte of CRC

When the slave receives correctly, the slave returns:

1	2	3	4	5	6	7	8
ADR	6	High Byte of Register	Low Byte of Register	High Byte of Data	Low Byte of Data	Low Byte of CRC	High Byte of CRC

When the slave receives incorrectly, the slave returns:

1	2	3	4	5
ADR	86H	Error Information Code	Low Byte of CRC	High Byte of CRC

1st byte ADR: Slave address code (=001~254)

1st byte 86H: Function code for error in writing register values

3rd byte Information Code: See Information Code Table

4th and 5th bytes: CRC16 checksum from byte 1 to byte 3

7.1.4 Register Definition Table

Register Definition Table									
Register Address	Content Description			Read-only	Register Address	Content Description			Read-only
0000	0	1	Distance 1	√	0001	2	3	Distance 2	√
0002	4	5	Distance 3	√	0003	6	7	Distance 4	√
0004	8	9	Distance 5 (Temperature for 4-beam type)	√	0005	10	11	Distance 6 (Temperature for 5-beam type)	√
0006	12	13	Distance 5 (Temperature for 4-beam type)	√	0007	14	15	Distance 8 (Used for 8-beam type)	√

0008	16	17	Distance 9 (Temperature for integrated 8-beam type)	√	0009	18	19	Distance 10	√
000A	20	21	Distance 11 (Used for 16-beam type)	√	000B	22	23	Distance 12 (Used for 16-beam type)	√
000C	24	25	Distance 13 (Used for 16-beam type)	√	000D	26	27	Distance 14 (Used for 16-beam type)	√
000E	28	29	Distance 15 (Used for 16-beam type)	√	000F	30	31	Distance 16 (Used for 16-beam type)	√
0010	32	33	Temperature (for 10-beam and 16-beam)	√	0011	34	35		
0034	104	105	Level mode/General mode Test		0035	106	10	Level Value Test level (Default: 2500)	
0036	108	109	(109) KLM filtering//KLM filtering is activated when the value is not 0 (using the next byte)		0037	110	111	KLM Filtering TD Value (2 bytes, high byte first)	
005C	184	185	(185) RX-MOD//Active upload mode		005D	186	187		
005E	188	189			005F	190	19		
0060	192	193			0061	194	19	Factory Reset System Reset	
0062	196	197	Baud rate setting		0063	198	19		
0064	200	201			0065	202	20		
0066	204	205			0067	206	20		

7.1.5 Error Information Codes

Information Code	Meaning
01H	Illegal function code
02H	Illegal data address
03H	Illegal data value
04H	CRC16 checksum error
05H	Reception correct
06H	Reception error
07H	Parameter error

7.2 Communication Examples

Transmit: 01 03 00 00 00 11 85 C6 // (For 16-beam type)

Receive: 01 03 22 01 11 02 08 00 D5 00 F6 01 B5 01 B9 01 B5 01 A1 01 D6

02 26 02 9A 02 A2 02 B6 02 C3 03 C6 03 F6 08 A5 34 10

22-byte positions (34 bytes in total, with 2 bytes per data point)

01 11 Distance Value of Channel 1: 273mm 02 08 Distance Value of Channel 2: 520mm
00 D5 Distance Value of Channel 3: 213mm 00 F6 Distance Value of Channel 4: 246mm

01 B5 Distance Value of Channel 5: 437mm 01 B9 Distance Value of Channel 6: 441mm
01 B5 Distance Value of Channel 7: 437mm 01 A1 Distance Value of Channel 8: 437mm
01 D6 Distance Value of Channel 9: 470mm 02 26 Distance Value of Channel 10: 550mm
02 9A Distance Value of Channel 11: 666mm 02 A2 Distance Value of Channel 12: 674mm
02 B6 Distance Value of Channel 13: 694mm 02 C3 Distance Value of Channel 14: 707mm
03 C6 Distance Value of Channel 15: 966mm 03 F6 Distance Value of Channel 16: 1014mm
08 A5 Distance Value of Channel 17: 2213mm
34 10 CRC Check: low byte first, high byte second

Example 2: 6-beam type

Transmit: 01 03 00 00 00 07 04 08

Receive: 01 03 0E 00 AB 00 A8 00 B5 00 F6 00 77 00 B8 0A 0D 72 8E

Address, function code, 14 data bits, 1: 171mm, 2: 168mm, 3: 181mm, 4: 246mm, 5: 119mm, 6: 184mm, 7: Temperature 25.73°C, CRC check code

Example 3: 5-beam type

Transmit: 01 03 00 00 00 05 85 C9

Receive: 01 03 0C 00 AB 00 A8 00 B5 00 F6 00 77 0A 0D 70 30

Address, function code, 14 data bits, 1: 171mm, 2: 168mm, 3: 181mm, 4: 246mm, 5: 119mm, 6: Temperature 25.73°C, CRC check code

Example 4: 4-beam type

Transmit: 01 03 00 00 00 05 85 C9

Receive: 01 03 0A 00 AB 00 A8 00 B5 00 F6 0A 0D 2C C6

Address, function code, 10 data bits, 1: 171mm, 2: 168mm, 3: 181mm, 4: 246mm, 5: Temperature 25.73°C, CRC check code

Multi-Beam Underwater Ranging and Obstacle Avoidance Sensor			
Instruction Type	Transmission	Reception	Annotation
Read Instruction	01030000001840A	01 03 02 07 D0 BB E8	Distance Value of Channel 1: 2000mm
	010300010001D5CA	01 03 02 07 D0 BB E8	Distance Value of Channel 2: 2000mm
Write Instruction	0106005C0002C819	0106005C0002C819	Switch to Active Upload Mode
	0106005C000049D8	0106005C000049D8	Switch to Passive Upload Mode
	0106006B000279D7	0106006B000279D7	Current known meter address is 01, change to 02
	01 06 00 62 01 00 29 84	01 06 00 62 01 00 29 84	Modify baud rate to 9600
	010600610100D984	010600610100D984	Restore System to Factory Settings
	01060061000119D4	01060061000119D4	System Reset
Error Instruction	0103000C00014009	01 83 04 40 F3	04 indicates error code: Invalid Check Code

