

Five-Beam Underwater Obstacle Avoidance Sensor

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1.Measurement principle

During the distance measurement process, ultrasonic signals are emitted by an ultrasonic probe, reflected by liquids or other solid media, and then returned. The same probe receives these reflected signals. 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 ultrasonic five-channel underwater obstacle avoidance sensor is a multi-beam ultrasonic ranging sensor developed based on the self-transmitting and self-receiving ranging principle of ultrasonic waves. It adopts a round-robin testing method of "five transmissions and one reception" implemented by internal software, which enables ranging in five directions. Through the coordinated testing of these five directions, the functions of underwater obstacle avoidance and underwater ranging are achieved. The sensor can store the detected data in the internal chip register, communicate with the host computer via the Modbus protocol, and support the adjustment of the sensor's passive upload and active upload modes.

3.Product Features

- Five-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, enabling data reading and modification
- Four-pin aviation connector for easy installation
- Wide voltage input: 10.8VDC ~ 26.4VDC (different voltages affect the ranging distance)

4.Product Applications

- Position detection, distance detection
- Obstacle avoidance and anti-collision detection for robots

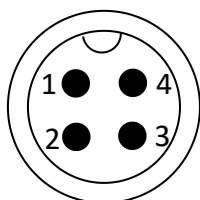
5.Technical Parameters

General Parameters	
Blind Area	< 200 mm
Detection Range	200 - 5000 mm
Transducer Frequency	Approximately 400 kHz
Electrical Characteristics	
Working Voltage	10.8 VDC - 26.4 VDC, with reverse polarity protection
No-load Current	≤ 30 mA
Voltage Drop	≤ 2.5 V

Start-up Delay	< 1000 ms
Output Characteristics	
Output Type	Standard TTL output (Modbus-RTU protocol)
Rated Working Current I_e	≤ 60 mA (24 V), with short-circuit/overload protection
Repeatability Error	$\pm 0.5\%$
Accuracy	$\pm 0.5\%$
Ambient Temperature	
Working Temperature	-20 - 60 °C
Storage Temperature	-20 - 60 °C
Mechanical Characteristics	
Output Connection Method	GX12 4-core connector (cable connection)
Sensor Fixing Thread	M6×20 (length adjustable according to bracket)
Protection Class	Sensor: IP68, Pressure Resistance: 1.5 MPa
Mass	Approximately 300 g
Material	Sensor Housing: PC
Compliance with Standards	
Standard	GB/T 14048.10 - 2016

6.Installation Instructions

Electrical Wiring Diagram/or Direct Wire Outlet



1 Power- 3 Power+
2 TTL+ 4 TTL-

4-pin Connector Sequence Diagram

Blue TTL+ Yellow TTL- Red 24V+ Black 24V-



7.Communication Protocol

7.1 Protocol Description

7.1.1 Communication Parameter Settings

- 1.The hardware adopts TTL, with master-slave half-duplex communication. The communication is conducted in a mode where the master calls the slave address and the slave responds.
- 2.Data frame: 10 bits, including 1 start bit, 8 data bits, 1 stop bit, and no parity.
- 3.Default baud rate: 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	√	0005	10	11	Temperature (Not used)	√
0006	12	13	Reserved	√	0007	14	15	Reserved	√
0008	16	17	Reserved		0009	18	19	Reserved	
0032	10	101			0033	102	103		
0034	10	105	Material Level Mode/Common Mode		0035	10	1	Material Level Value Test level Default 2500	
			(109) KLM Filtering // Enable KLM Filtering when the value is not 0 (use the next byte)						
0036	10	109			0037	11	1	KLM Filtering TD Value (2 bytes, high byte first)	
005C	18	185	(185) RX-MOD // Active Upload Mode		005D	18	1		
005E	18	189			005F	19	1		
0060	19	193			0061	19	1	Factory Reset System Reset	
0062	19	197	Baud Rate Setting METERWORK		0063	19	1		
0064	20	201			0065	20	2		
0066	20	205			0067	20	2		
0068	20	209			0069	21	2		
006A	21	213			006B	21	2	Type Word √ Instrument Address	
006C	21	217			006D				

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

Comprehensive command transmission: **01 03 00 00 00 05 85 C9**

Return: **01 03 0A 01 11 02 08 00 D5 00 F6 01 B5 90 FD**

0A Byte position (10 bytes, 2 bytes for each data)

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; **90 FD** CRC checksum (low byte first, high byte last)

Five-Beam Underwater Obstacle Avoidance Sensor			
Instruction Type	Transmission	Reception	Annotation
Read Instruction	01 03 00 00 00 01 84 0A	01 03 02 07 D0 BB E8	Distance value of channel 1: 2000mm
	01 03 00 01 00 01 D5 CA	01 03 02 07 D0 BB E8	Distance value of channel 2: 2000mm
	01 03 00 08 00 01 05 C8	01 03 02 00 04 B9 87	Current baud rate: 115200
Write Instruction	01 06 00 5C 00 02 C8 19	01 06 00 5C 00 02 C8 19	Switch to active upload mode
	01 06 00 5C 00 00 C8 19	01 06 00 5C 00 00 C8 19	Switch to passive upload mode
	01 06 00 6B 00 02 79 D7	01 06 00 6B 00 02 79 D7	Known current instrument address is 01, change to 02
	01 06 00 08 00 01 C9 C8	01 06 00 08 00 01 C9 C8	Change baud rate to 9600
	01 06 00 61 01 00 D9 84	01 06 00 61 01 00 D9 84	Restore system to factory settings
Error Instruction	01 06 00 61 00 01 19 D4	01 06 00 61 00 01 19 D4	System reset
	01 03 00 0C 00 01 40 09	01 83 04 40 F3	04 indicates error code: invalid check code

