

KUS-W33 Underwater Obstacle Avoidance Sensor



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1.Measurement principle

Ultrasonic waves are emitted from the sensor surface. During propagation, when they encounter an interface between different media or an obstacle within the same medium, they are reflected and received by the sensor.

Because the circuit knows the time of transmission and the time of reception,

The distance from the ultrasonic wave to the interface or the obstacle is calculated as follows:

Distance = travel time x speed of sound in the medium/2

The unit of distance is meters, abbreviated as m;

The unit of sound speed is meters per second, abbreviated as m/s;

The unit of propagation time is seconds, abbreviated as s.

Because the speed of sound in liquids or solids is directly related to temperature, temperature compensation is required in specific locations to determine the specific speed of sound in meters per second based on different temperatures.

2.Usage Environment

(1) Liquids:

The liquid must be non-corrosive to aluminum or aluminum alloys and effectively conduct ultrasonic waves.

Liquids not suitable for ultrasonic wave transmission include:

- ① Liquids with a bubble content exceeding 0.1%;
- ② Liquids with a solid particle content exceeding 0.1%;
- ③ Liquids with a suspended solids content exceeding 1%.

The aforementioned liquids not suitable for ultrasonic wave transmission only apply to this product.

Using a larger ultrasonic underwater ranging sensor will allow measurement in liquids with higher concentrations of bubbles, solid particles, or suspended solids.

(2) Solids:

The solid must be non-corrosive to aluminum or aluminum alloys and effectively conduct ultrasonic waves. The solid must be dense and free of bubbles.

Liquids not suitable for ultrasonic wave transmission include:

- ① Solids containing bubbles;
- ② Solids containing solid particles or fibers;
- ③ Solids with linings or interlayers.

The sensor cannot properly measure the liquid level through the following solids. For example: fiberglass, PE, enamel, metal cans with rubber lining, metal cans with anti-corrosion coating, metal cans with PTFE lining, metal cans with wear-resistant lining, etc.

3.Technical Parameters

General parameters	
Detection range	Water Temperature: 0°C to +60°C 1MHz (measured directly in clean water): ≤8000mm 1MHz (measured in clean water through a 3mm thick steel plate): ≤2000mm 2MHz (measured directly in clean water): ≤3000mm 2MHz (measured in clean water through a 3mm thick steel plate): ≤1000mm

Operating frequency	1MHz operating frequency: 1MHz $\pm$ 100KHz; 2MHz operating frequency: 2MHz $\pm$ 150KHz;
Blind area	1MHz (measured directly in clean water): $\leq$ 100mm; 1MHz (measured in clean water through a 3mm thick steel plate): $\leq$ 200mm; 2MHz (measured directly in clean water): $\leq$ 50mm; 2MHz (measured in clean water through a 3mm thick steel plate): $\leq$ 100mm;
Electrical characteristics	
Power supply range	DC 11.0-26.0V, with reverse polarity protection
Operating current	No-load current $\leq$ 15mA, rated operating current $\leq$ 100mA
Voltage drop	Required current $<$ 2.5V
Startup delay	$<$ 5.0s
Power source	Powered by pure battery or AC-DC switching power supply
Power requirements	No electromagnetic interference, ripple $<$ 1.0%
Output characteristics	
Output type	The standard configuration includes one RS485 output, using the Modbus-RTU protocol.
Optional output	One 4-20mA output, which cannot be used simultaneously with the RS485 output.
Repeat accuracy	$\pm$ 0.5% (in clean water at room temperature)
Measurement accuracy	$\pm$ 0.5% to 1.0% (in clean water at room temperature)
Environmental requirements	
Cable length	The standard range is 2 meters $\pm$ 0.3 meters
Process pressure	The short version has a maximum water pressure of 50 meters (when the sensor is submerged in water) The long version has a maximum water pressure of 50 meters (when the sensor is submerged in water)
Storage pressure	Standard atmospheric pressure
Process temperature	-20°C to +60°C (the measured liquid must not solidify or must be in a colloid state)
Storage temperature	-40°C to +85°C
Storage humidity	0 to 95% RH, non-condensing
Mechanical characteristics	
Casing material	Aluminum or PPSU
Outlet type	4-core shielded cable
Cable length	2m $\pm$ 0.30m
Dimensions	See drawing for details
Protection level	IP68

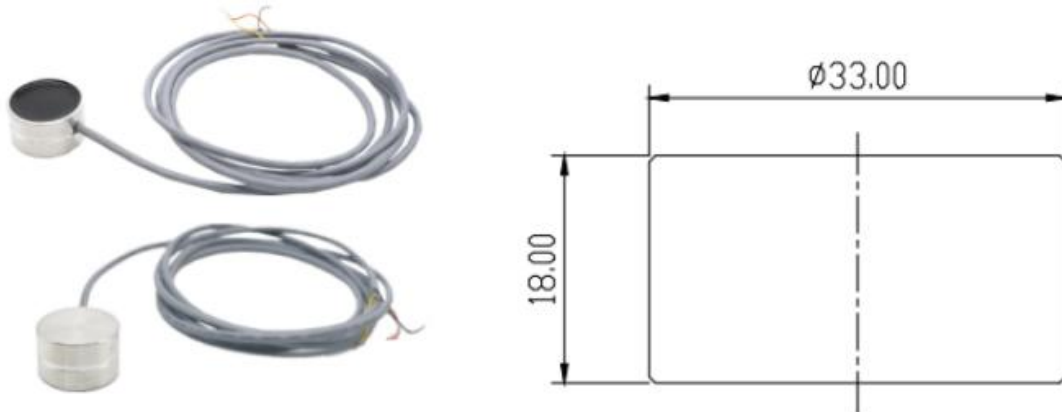
4.Wiring

Red-----Power +
Black-----Power -

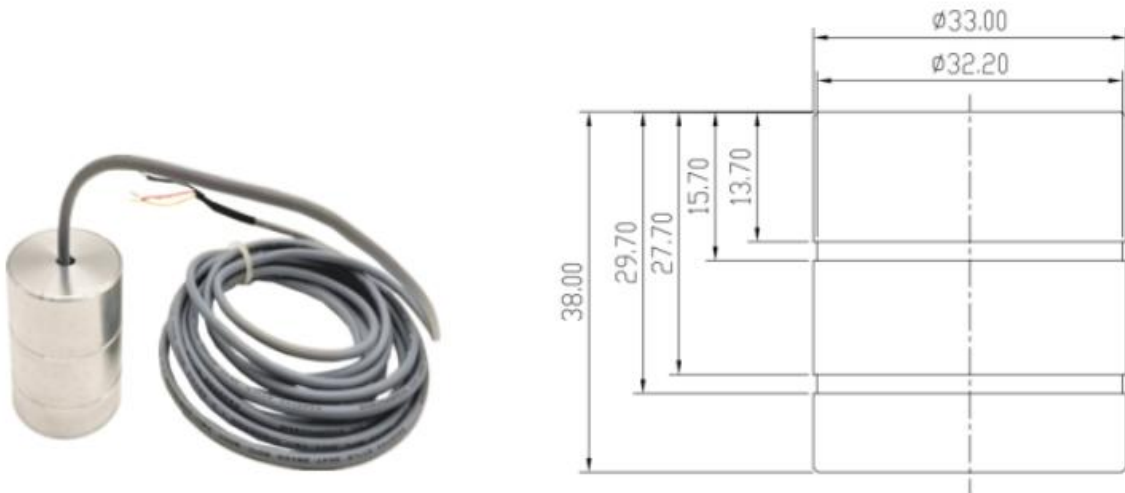
White (blue wire)----485A
Yellow (yellow-green wire)-----485B

5.Dimension

(1) KUS-W33 Ultrasonic liquid level sensor--Short



(2) KUS-W33 Ultrasonic liquid level sensor--Long



6.Installation

Measurements without direct contact with liquids:

1. Installation with external accessories

- If external accessories are used, such as fixtures, straps, or clamps, secure the sensor.
- A coupling agent should be applied between the sensor's emitting surface and the bottom of the container being measured.
- Common coupling agents include medical petroleum jelly, 704 silicone, and automotive grease (paste-like).
- Silicone gaskets can also be used as a coupling agent. Using a silicone gasket as a coupling agent will attenuate the signal more than the paste-like coupling agents mentioned above.

Tip: If the operating environment is subject to temperatures of 0°C or below, do not use petroleum jelly.

This is because petroleum jelly contains a certain amount of water. When the temperature reaches or falls below 0°C, this water will turn into ice, causing significant signal attenuation or even failure to measure.

2. Installation without external accessories

- A coupling agent with sufficient viscosity should be applied between the sensor's emitting surface and the bottom of the container being measured.
- Common coupling agents include 704 silicone, jelly glue, and two-component glue.

Tip: Different glues have different signal attenuation effects after solidification.

3. Selecting the sensor installation location:

Because the ultrasonic wave emitted by the sensor is similar to the light emitted by a flashlight, it forms a cone and has a wider illumination range at greater distances. Therefore, ensure that the sensor's beam reaches the highest liquid level without hitting any obstacles.

4. The ultrasonic beam emitted by the sensor must be perpendicular to the surface of the liquid being measured.

5. The cable between the sensor and the computer, host computer, or PLC must be enclosed in protective tubing to prevent wear and damage in the field. Wear and tear of the sensor cable can cause signal errors or even damage the sensor.

6. In environments with strong electromagnetic interference, the cable between the sensor and the computer, host computer, or PLC must be enclosed in protective tubing. Use either flexible metal tubing or rigid metal tubing to shield electromagnetic interference radiated from the air.

7. In environments with strong electromagnetic interference, the power supply must include a DC-DC isolation power supply module to shield electromagnetic interference from the power supply.

8. If connected to a host computer such as a PLC or DCS, interference may be transmitted from the 485 cable, requiring a 485 signal isolator.

9. If the cable is not long enough and an extension cable is used, ensure proper wiring and that no liquid enters the connection points.

10. Measurement accuracy will be lower in a vibrating environment than in a vibration-free environment.

Measurements with direct contact with liquid:

1. The sensor must be secured at the measurement location using a fastener. The sensor cable must also be secured to prevent it from swaying in the liquid or being impacted by the flowing liquid.

2. Because the sensor's transmitting surface is in direct contact with the liquid, coupling compound is not required.

3. The ultrasonic beam emitted by the sensor must be perpendicular to the measured liquid surface.

4. Sensor mounting location: Because the ultrasonic wave emitted by the sensor is like the light from a flashlight, it forms a cone, with a wider range of illumination at greater distances. Therefore, ensure that the sensor's beam does not encounter any obstacles between the highest liquid level and the measured liquid level.

5. In environments with strong electromagnetic interference, the cable between the sensor and the computer, host computer, or PLC should be protected with a metal hose or rigid metal tube to shield electromagnetic interference radiated from the air.

6. In environments with strong electromagnetic interference, the power supply should be equipped with a DC-DC isolated power supply module to shield electromagnetic interference from the power supply.

7. If connected to a host computer such as a PLC or DCS, interference may be transmitted from the 485 cable, so a 485 signal isolator should be added between them.

8. Because the sensor is immersed in liquid, ensure that the sensor and cable are protected from corrosion and abrasion.

9. If the cable is not long enough, since both the sensor and cable are immersed in liquid, extension cables are not allowed. Contact the manufacturer to select a cable of sufficient length.

Precautions

- The sensor must be mounted in a location that is protected from liquid impact and collision with any hard objects.
- The sensor and cable must be protected from direct impact by the flowing liquid.
- The measurement location must be away from the inlet and outlet.
- Bubbles, solid particles, or suspended matter in the liquid can affect the measurement, for example, causing the maximum measurement distance to fall short of the specified specifications. For example, if suspended matter is measured, the distance to the suspended matter will also be output.
- Ensure that the sensor and cable are protected from corrosion, abrasion, or damage by the liquid.

7.MODBUS Communication Protocol

7.1 Serial Port Parameters

- (1) The hardware adopts RS-485, master-slave half-duplex communication, the master calls the slave address, and the slave responds to the communication
- (2) Data frame 10 bits, 1 start bit, 8 data bits, 1 stop bit, no check;
- (3) Baud rate: 4800 9600 19200 38400 115200 (default is 115200).

Note: The baud rate setting 00 is 4800, 01 is 9600 and so on.

7.2 Read Single Register

Function code: 03H

Host sends							
1	2	3	4	5	6	7	8
ADDR	03H	Start register high byte	Start register low byte	Register number high byte	Register number low byte	CRC code low byte	CRC code high byte

Byte 1 ADDR: slave address code (0x01~0xFE);

Byte 2 03H: function code;

Bytes 3 and 4: register address to be read;

Bytes 5 and 6: number of registers to be read, 0x0001 for reading a single register;

Bytes 7 and 8: CRC16 checksum from byte 1 to byte 6.

Slave receives						
1	2	3	4	5	6	7
ADDR	03H	Total bytes	Data high byte	Data low byte	CRC code low byte	CRC code high byte

Byte 1 ADDR: slave address code (0x01~0xFE);

Byte 2 03H: function code;

Byte 3: The total number of data bytes received. If a single register is read, the total number of bytes is 02;

Bytes 4 and 5: register data, each data occupies 2 bytes;

Bytes 6 and 7: CRC16 check code from byte 1 to byte 5.

7.3 Read multiple registers

Function code: 03H

Host sends							
1	2	3	4	5	6	7	8
ADDR	03H	Start register high byte	Start register low byte	Register number high byte	Register number low byte	CRC code low byte	CRC code high byte

Refer to the method of [reading a single register](#). When reading distance and temperature at the same time, the number of registers is 0x0002;

Slave receives									
1	2	3	4、5		...	N-1、N		N+1	N+2
ADDR	03H	Total bytes	Data1 high byte	Data1 low byte	...	Data N high byte	Data N low byte	CRC code low byte	CRC code high byte

Refer to the method of [reading a single register](#). Data 1 is the starting register value to be read. Each data occupies 2 bytes. The number of data returned depends on the number of registers read by the user.

7.4 Write Single Register

Function code: 06H

Host sends							
1	2	3	4	5	6	7	8
ADDR	06H	Register address high byte	Register address low byte	Data high byte	Data low byte	CRC code low byte	CRC code high byte

Byte 1 ADDR: slave address code (0x01~0xFE);

Byte 2 06H: function code;

Bytes 3 and 4: the written register address;

Bytes 5 and 6: register data corresponding to the register address;

Bytes 7 and 8: CRC16 check code from byte 1 to byte 6.

Slave receives							
1	2	3	4	5	6	7	8
ADDR	06H	Register high byte	Register low byte	Data high byte	Data low byte	CRC code low byte	CRC code high byte

Byte 1 ADDR: slave address code (0x01~0xFE);

Byte 2 06H: function code;

Bytes 3 and 4: the register address written;

Bytes 5 and 6: the register data corresponding to the register address;

Bytes 7 and 8: the CRC16 checksum from byte 1 to byte 6.

7.5 Error Code

1	2	3	4	5
ADDR	Function code	Error code	CRC code low byte	CRC code high byte

Byte 1 ADDR: slave address code (0x01 ~ 0xFE);

Byte 2 83H or 86H: function code (83H means an error is reported for the read command, 86H means an error is reported for the write command);

Byte 3: Reference [error message code table](#);

Bytes 4 and 5: CRC16 check code from byte 1 to byte 3.

Error message code table	
Information Code	Remarks
01H	Illegal function code
02H	Illegal data address
03H	Illegal data value
04H	CRC16 check error
05H	Received correctly
06H	Received incorrectly
07H	Parameter error

7.6 Register Definition Table

Register Definition Table									
Register address	Description			Read only	Register address	Description			Read only
0000	0	1	Distance	√	0001	2	3	Reserved	√
0002	4	5	Temperature	√	0003	6	7	Reserved	√
0032	100	101			0033	102	103		
0034	104	105			0035	106	107		
005C	184	185	(185)RX-MOD //Active upload mode is 2		005D	186	187		
005E	188	189			005F	190	191		

0060	192	193			0061	194	195	Factory reset System reset	
0062	196	197	Baud rate setting METERWORK		0063	198	199	Pulse quantity	
0068	208	209			0069	210	211		
006A	212	213			006B	214	215	Meter type ✓ Instrument address	
006C	216	217			006D				

7.7 Routines

Single-beam underwater ultrasonic distance sensor			
Commands	Send	Receive	Notes
Read command	01 03 00 00 00 01 84 0A	01 03 02 07 D0 BB E8	Distance value: 2000mm//Large range 2000cm
	01 03 00 02 00 01 25 CA	01 03 02 0B 31 7E A0	Temperature value: 28.65℃
	01 03 00 00 00 02 C4 0B	01 03 04 07 D0 0B 31 3C 5A	Read two register data at the same time
Write command	01 06 00 5C 00 02 C8 19	01 06 00 5C 00 02 C8 19	Change to active upload mode
	01 06 00 5C 00 00 49 D8	01 06 00 5C 00 00 49 D8	Change to passive upload mode
	01 06 00 6B 00 02 79 D7	01 06 00 6B 00 02 79 D7	Known that the current instrument address is 01, change to 02
	01 06 00 62 01 00 29 84	01 06 00 62 01 00 29 84	Change the baud rate to 9600
	01 06 00 61 01 00 D9 84	01 06 00 61 01 00 D9 84	System restores factory settings
	01 06 00 61 00 01 19 D4	01 06 00 61 00 01 19 D4	System reset
	01 06 00 5C 00 02 C8 19	01 06 00 5C 00 02 C8 19	Change to active upload mode
Error command	01 03 00 0C 00 01 44 09	01 83 02 C0 F1	02 indicates error message code: illegal data address

7.8 Protocol Description

7.8.1 Temperature value (REG_ADDR: 0001H)

The temperature value is represented by 2-byte unsigned data. The read value divided by 100 is the temperature value, unit: °C. The highest bit of the high byte is the sign bit, 0 for positive, 1 for negative.

7.8.2 Query/set error compensation (REG_ADDR: 0004H)

The error compensation value is represented by 2-byte unsigned data, unit: mm. When the distance measurement error exceeds the maximum allowable range, this value can be used for slight compensation. The default compensation value is 0. The compensation value is to split the int16_t type

data into two bytes, with the high byte in front and the low byte in the back. The format is the storage format of the value in the computer.

Negative compensation value = 65535-error value.

For example: if the error value is 35mm, the compensation value is 65500, which is converted to hexadecimal: 0xFFDC

The modification command is 01 06 00 04 FF DC 88 62

The positive compensation value can be a hexadecimal number.

For example: if the error value is 25mm, it is converted to hexadecimal: 0x0019

The modification command is 01 06 00 04 00 19 09 C1

Protocol Supplement

Special Rules:

0103FF010105: Reads the full waveform data in ASCII format

0103FF010106: Reads the full waveform data in hexadecimal format