

## Product Introduction

### Summary

Ultrasonic Liquid Level Sensor (ULD\_3) is designed for non-contact measurement of liquid level height in the closed container. The sensor can be installed directly under the measured container. It can accurately measure the liquid level of various toxic substances such as acids, alkalis and various pure liquids in high temperature and high pressure sealed containers. ULD may be deployed for various high-density container material such as steel, plastic, plastic, ceramics, and non-foaming plastics.

### Product Highlights

- Non-contact liquid level measurement
- Full range real-time monitoring. Live filling during monitoring is allowed.
- IP67 compliant
- Operating temperature: -15°C to +60°C
- Storage temperature: -25°C to +80°C
- Electrostatic discharge: IEC61000-4-2 compliance

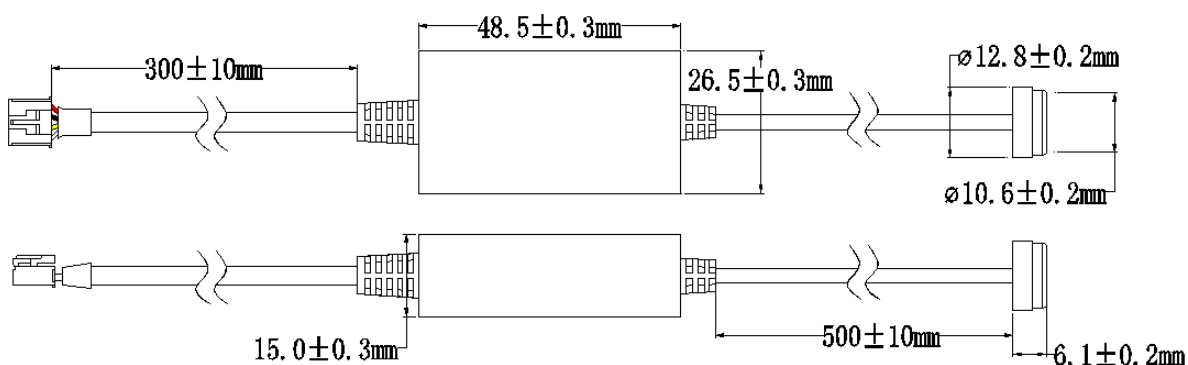
### Device Characteristics

Description	Value	Unit
Input voltage	10~36	V <sub>DC</sub>
Average current <sup>(1)</sup>	<30	mA
Detection Range <sup>(2)</sup>	40~2000	mm
Cycling Time	2	s
Output mode	UART/RS485	-
Resolution	1	mm
Room temperature accuracy <sup>(3)</sup>	±(5+H*1%)	mm

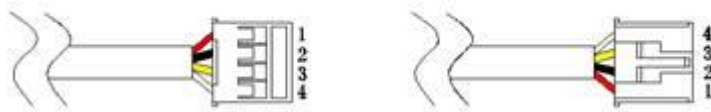
Notes:

1. Current consumption decreases with lower input voltage. The current consumption of 2s working cycle with 12V input voltage.
2. To emulate steel container, range obtained on water filled PVC container with Φ160mm placed on 2 mm thick steel plate at room temperature.
3. The data obtained under test environment as specified in note 2. "H", denotes the current liquid level height.

### Dimensions



## Pin Definition



Color	Name	Description
Red	VCC	Power Input
Black	GND	Ground
Yellow	TX/D- <sup>(1)</sup>	UART Output/RS485 data -
White	RX/D+	Reserved/RS485 data +

Note:

1. Vout max is 5V<sub>DC</sub>.

## Output Formats

Two output formats are available, UART and RS485, and must be selected with the matching model part name. UART mode actively outputs data without user input. RS485 mode will respond when instructed.

## UART

### Communication Description

Data bits	Stop bit	Parity check	Baud rate
8	1	NA	9600bps

### Data packet description

Frame data	Description	Length
Header	0xFF	1byte
Data_H	High 8 bits of distance data	1byte
Data_L	Lower 8 bits of distance data	1byte
Checksum	Checksum	1byte

### 3. UART output example

Frame head	Data_H	Data_L	SUM
0xFF	0X07	0XA1	0XA7

Notes:

Only lower 8 bits of the accumulated value are kept;  
Sum = (frame header + Data\_H + Data\_L) & 0x00ff  
= (0xFF + 0X07 + 0XA1) & 0x00FF  
= 0XA7;  
Liquid level value = Data\_H && Data\_L = 0x07a1;  
Conversion to decimal equals 1953mm;

## RS485

### Overview of Communication Protocol

Two communication protocols, Pro-Wave protocol and Modbus protocol, are supported. The sensor will determine the communication protocol based on the received data.

### Communication Protocol Parameters

Default communication format: 9600, N, 8, 1 (baud rate: 9600, no check bit, 8-bit data bit, 1-bit stop bit).

Modbus protocol must support 0x03 and 0x06 function codes.

## Application Scope of Communication Protocol

ULD\_3 supports Modbus Protocol that includes 0x03 and 0x06 function code; or PRO-WAVE protocol.

## Modbus Protocol Description

### MODBUS Register Address

Protocol: MODBUS; mode: RTU; Slave address 0x01 (default)

Modbus read function address planning, function code: 0x03			
Op	Reg Addr	Reg Info	Description
R	0x00	Processed value <sup>1</sup>	Processed average value, unit: 1mm
R	0x01	Real time value	Real time measurement, 1mm
RSVD	0x02	RSVD	RSVD
Modbus write function address planning, function code: 0x06			
RSVD	0x03	RSVD	RSVD
RW	0x04	Slave address	Default: 0x01, Applicable range: 0x01 ~ 0xF7.
RW	0x05	Liquid Type	Default 0x01: water. 0x02: oil. All other values are invalid.
RW	0x06	Cycle time per seconds	Default: 0x02 Applicable range: 0x01~0x3C

Note:

1. The processed value is the value after the sensor samples the liquid level 5 times and discarding the first and last value while the real-time value is the live value.

## Modbus Protocol Communication Example

1. Read the value (real-time value) of the register of address 0x01

Master sends: 01 03 00 01 00 01 D5 CA

01: Slave address

03: Function Code

00 01: Register address to read real time value

00 01: Report back 1 register

D5 CA: Checksum Big Endian CRC-16

Slave Replies: 01 03 02 00 D2 38 19

01: Slave address

03: Function code

02: Data length (2 bytes)

00 D2: Liquid level 210mm

38 19: Checksum Big Endian CRC-16

2. Read two data from address 0x00, processing value and real-time value.

Master sends: 01 03 00 00 02 C4 0b

01: Slave address

03: Function Code

00 00: Register address to read processed data value

00 02: Report back 2 registers (0x00 and 0x01)

C4 0B: Checksum Big Endian CRC-16

Slave Replies: 01 03 04 00 DC 00 DD FB 90

01: Slave address

03: Function code

04: Data length (4 bytes)

00 DC: Register 0x00 (processed value) Liquid level 220mm

00 DD: Register 0x01 (real time value) Liquid level 221mm  
FB 90: Checksum Big Endian CRC-16

3. Write data 0x02 to address 0x05, and set the liquid type to oil.

Master sends: 01 06 00 05 00 02 18 0A

01: Slave address

06: Function Code

00 05: Register address set liquid type

00 02: Set liquid type to 0x02 (oil)

18 0A: Checksum Big Endian CRC-16

Slave Replies: 01 06 00 05 00 02 18 0A

01: Slave address

06: Function code

00 05: Register address written is 0x05 (liquid type)

00 02: Register value written is 0x02

18 0A: Checksum Big Endian CRC-16

4. Write data 0x0a to address 0x06 and change cycle time to 10 seconds.

Master sends: 01 06 00 06 00 0A E9 CC

01: Slave address

06: Function Code

00 06: Register address set to cycle time

00 0A: Set cycle time to 10 seconds

E9 CC: Checksum Big Endian CRC-16

Reply from slave: 01 06 00 06 00 0A E9 CC

01: Slave address

06: Function Code

00 06: Register address written is 0x06 (cycle time)

00 0A: Register value written is 0x0A

E9 CC: Checksum Big Endian CRC-16

5. Write data 0x02 to address 0x04 and set Slave address to 0x02

Master sends: 01 06 00 04 00 02 49 CA

01: Slave address

06: Function Code

00 04: Register address set to Slave address

00 02: Set Slave address to 0x02

49 CA: Checksum Big Endian CRC-16

Slave Replies: 01 06 00 04 00 02 49 CA

01: Slave address

06: Function Code

00 04: Register address written to is 0x02 (Slave address)

00 02: Register value written is 0x02

49 CA: Checksum Big Endian CRC-16

6. Read the value (real-time value) of the register of address 0x01

Master sends: 02 03 00 01 00 01 D5 F9

02: Slave address (updated after last step)

03: Function Code

00 01: Register address to read real time value

00 01: Report back 1 register  
 D5 F9: Checksum Big Endian CRC-16

Slave Replies: 02 03 02 00 82 7C 25  
 02: Slave address  
 03: Function code  
 02: Data length (2 bytes)  
 00 82: Liquid level 130mm  
 7C 25: Checksum Big Endian CRC-16

## Pro-Wave Protocol Description

### Operation Instruction

Operation Description	Op code
Read processed value	0x01
Read real time value	0x02
Change slave address	0x03
Liquid medium setting <sup>1</sup>	0x04
Cycle time setting	0x05

Note:

1. Available options are 0x01: water (default) or 0x02: diesel

### Data Frame Format

	Sync word		Slave addr	Op Code	Data	Checksum
Master	0x55	0xAA	0x01	0x01	None or data <sup>1</sup>	Checksum
Slave	0x55	0xAA	0x01	0x01	Data_H   Data_L	Checksum

Note:

1. Refer following examples in section in the following section

### Checksum Calculation

Checksum value follows CheckSum8 Modulo 256.

Checksum = (frame header + address + instruction + data) & 0x00ff

Checksum failure will result in no operation and response.

### Pro-Wave Protocol Communication Examples

1. Read the processed value

Master sends: 55 AA 01 01 01

55 AA: Sync Word

01: Slave address (default)

01: Op code to read processed value

01: Checksum.  $(0x55+0xaa+0x01+0x01) \& 0x00ff = 0x01$

Slave Replies: 55 AA 01 01 02 33 36

55 AA: Sync Word

01: Slave address

01: Report received op code

02 33: Liquid level is 563mm

36: Checksum.

2. Modify slave address

Master sends: 55 AA 05 03 07

55 AA: Sync Word  
05: Updated slave address to 0x05  
03: Op code to change slave address  
07: Checksum.

Slave Replies: 55 AA 05 03 07

55 AA: Sync Word  
05: Slave address  
03: Report received op code  
07: Checksum.

### 3. Read processed value

Master sends: 55 AA 05 01 05

55 AA: Sync Word  
05: Slave address  
01: Op code to read processed value  
05: Checksum.

Slave Replies: 55 AA 05 01 02 33 3A

55 AA: Sync Word  
05: Slave address  
01: Report received op code  
02 33: Liquid level is 563mm  
3A: Checksum.

### 4. Modify measured liquid medium

Master sends: 55 AA 05 04 00 02 0A

55 AA: Sync Word  
05: Slave address  
04: Op code to change liquid medium  
00 02: Update liquid medium from 0x01(default) to 0x02 (diesel)  
0A: Checksum.

Slave Replies: 55 AA 05 04 00 02 0A

55 AA: Sync Word  
05: Slave address  
04: Report received op code  
00 02: Report received value  
0A: Checksum

### 5. Modify cycle time

Master sends: 55 AA 05 05 00 0A 13

55 AA: Sync Word  
05: Slave address  
05: Op code to change cycle time  
00 0A: Update to 10 seconds. Valid range 0x01~0x3C. Default is 0x02.  
13: Checksum

Slave Replies: 55 AA 05 05 00 0A 13

55 AA: Sync Word  
05: Slave address  
05: Report received op code  
00 0A: Report received value  
13: Checksum.

### 6. Broadcast slave bus address

Master sends: 55 AA FF 01 03

55 AA: Sync Word

FF: Slave address set to FF will force sensor to broadcast value

01: Register to broadcast

-0x01: Processed value

-0x02: Real time value

-0x03: Slave address

-0x04: Liquid medium

-0x05: Cycle time

03: Checksum

Slave Replies: 55 AA 05 01 02 45 4C

55 AA: Sync Word

05: Slave address

01: Requested reporting register (processed value)

02 45: Report requested value

Register 0x01,0x02,0x05 will report 2 bytes of data.

Register 0x03,0x04 will report only 1 byte of data.

4C: Checksum.

### External LED Indicator

Led on:

The sensor is powered but no liquid is detected.

Led slow flashing:

When the sensor detects a liquid, the LED indicator flashes at a frequency of 1 per second.

### Model Selection

Part Name	Feature
ULD_3U	UART output with fixed cycle time
ULD_38	RS485 output with user input control

### Design Consideration

- Detection range will be different pending the conditions listed.
  - Container materials such as steel, glass, iron, ceramic, non-foaming plastics, and other high-density materials.
  - Container wall thickness.
- UART output will fluctuate under the following conditions.
  - Liquid level exceeds the detection range.
  - Liquid level is tilted or changing.



### Revision History

Date	Version	Description
12/01/2019	1.0	Initial Pro-Wave release.
01/09/2019	1.1	RS485 protocol updated with Pro-Wave variation
01/15/2020	1.2	Documentation format update



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