



UFM-01

Ultrasonic Flow Sensing Module

UFM-01 Datasheet

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The UFM-01 is a complete unit including the sensor electronics, spool piece, connectors with standard ½” thread, and a cable connector supporting single-wire and UART interfaces.

The module is based on SciSense contactless ultrasonic flow sensor technology, which does away with the rotors and other mechanical parts in traditional Hall sensor-based flow sensors. By contrast, the ultrasonic UFM-01 contains no moving parts and offers an unlimited lifetime when operated according to datasheet specifications.

The UFM-01 is suitable for use with food-grade material, and can directly measure drinking water flows. Accurate to at least $\pm 5\%$ at flow rates above 60 l/hr, the UFM-01 enables precise control of liquid flow and - via a built-in temperature sensor - liquid temperature in the control systems of products such as boilers, smart taps, beverage brewing machines and more.

Key Features & Benefits

- **Long-time reliability**
Solve the pain point, no movable parts, no risk of getting stuck
- **High accuracy**
Up to 5% accuracy at wide range (can be even better with customization)
- **Wide sensing range**
0 to 3125 l/h
- **Low power**
2mA average current with single 5 V power supply
- **Standard interface**
UART, 1-wire communication supported and industrial standard mechanical interface
- **Cost effective**
Simplified system design and automatic production to optimize the overall cost
- **Food grade material**
Can be used for drinking water directly

Applications

- **Boilers**
- **Water purifiers**
- **Coffee Machines**
- **Smart toilets**

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1 Block diagram

The internal block diagram of UFM-01 is shown in [Figure 1](#).

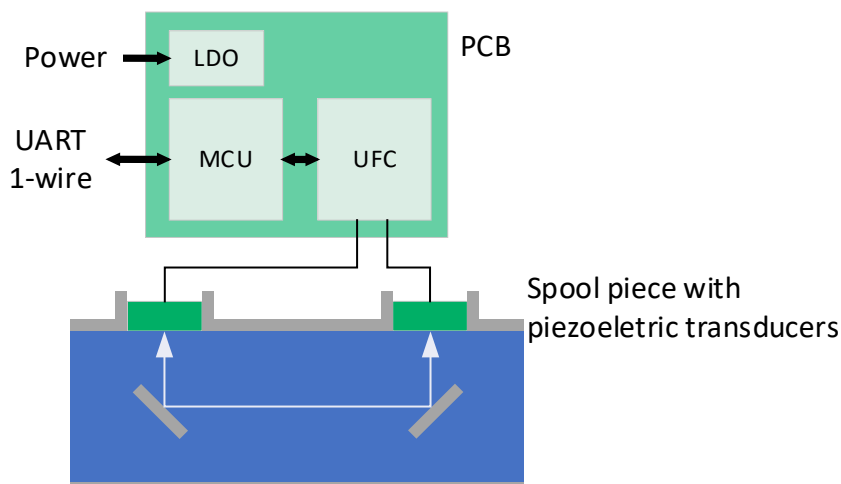


Figure 1: Functional blocks

2 Absolute maximum ratings

Stresses beyond those listed in this section may cause permanent damage to the device. These are - each at a time - stress ratings only. Functional operation of the device at these or any other conditions beyond those indicated under [Electrical characteristics](#) is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. The UFM-01 should be protected against constant exposure to direct sunlight and high humidity. It's also not designed for application submerge into water.

Table 1: UFM-01 absolute maximum ratings

| Symbol | Parameter | Min | Max | Units | Comments |
|----------------------------------|-----------------------------|-------|-----|-------|--------------------------|
| Electrical Parameters | | | | | |
| V _{DD} | Supply voltage | -0.30 | 6.0 | V | |
| V _{IO} | IO voltage level | -0.30 | 5.5 | V | UART_RX, UART_TX, 1-Wire |
| Electrostatic Discharge | | | | | |
| ESD _{HBM} | Contact discharge, all pins | ±4000 | | V | IEC 61000-4-2 |
| Water Pressure | | | | | |
| p _{Watr} | Maximum water pressure | 4.0 | | MPa | |
| Operating and Storage Conditions | | | | | |
| T _{STRG} | Storage temperature | -25 | 100 | °C | |

| | | | | | |
|-------------|-------------------------------------|-----|------|-----|------------|
| T_A | Operating ambient temperature | -25 | 85 | °C | |
| T_{Water} | Operating water temperature | 0 | 60 | °C | Not frozen |
| H_A | Operating ambient relative humidity | 0 | 100 | %RH | |
| p_{Water} | Operating water pressure | | 1.75 | MPa | |

The UFM-01 should be protected against constant exposure to direct sunlight, high humidity and it's not designed for application submerge into water.

3 Electrical characteristics

All limits are guaranteed. The parameters with min and max values are guaranteed with production tests or SQC (Statistical Quality Control) methods. All values refer to $T_A = 25\text{ °C}$ and at 5V supply voltage, unless otherwise specified.

Table 2: Electrical characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|-------------|--------------------------|----------------|---------------------|-----|----------------|------|
| V_{DD} | Supply voltage | | 4.5 | 5.0 | 5.5 | V |
| I_{DDavg} | Average Supply current | 25 °C 85 °C | | 2 | t.b.d. | mA |
| I_{DDpk} | Peak Supply current | 25 °C 85 °C | | 2.6 | 3 | mA |
| V_{IH} | High-level input voltage | | $0.7 \times V_{DD}$ | | $V_{DD} + 0.3$ | V |
| V_{IL} | Low-level input voltage | | -0.5 | | 0.7 | V |

4 Sensor characteristics

Table 3: Electrical characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|-------------|----------------------------------|----------------|-----|-----|-------------------|------|
| F_{range} | Flow sensing range | | 10 | | 3125 ¹ | l/h |
| F_{acc} | Flow sensing accuracy of reading | 10 to 60 l/h | | | ±10 | % |
| | | 60 to 2000 l/h | | ±3 | ±5 | |

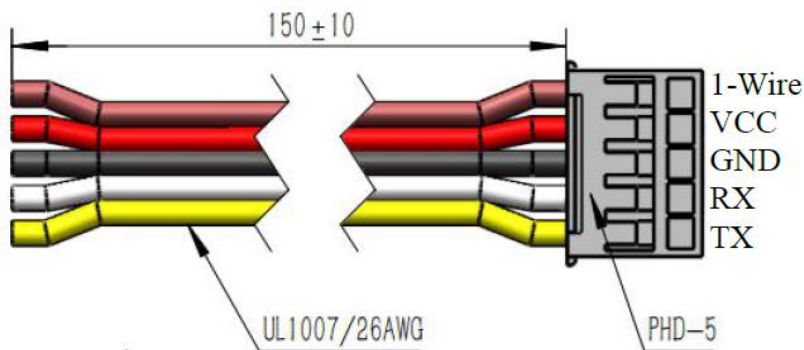
¹ Above this maximum flow an error flag will be set and the precision is no longer guaranteed.

| | | | | | | |
|--------------------|-------------------------------------|--|---|---------|----|----|
| T_{range} | Water temperature measurement range | | 1 | | 60 | °C |
| T_{acc} | Water temperature accuracy | | | ± 1 | | °C |
| f_{data} | Data output rate | | | 1 | 4 | Hz |

5 Interface Description

Table 4: Electrical characteristics

| Pin Number | Pin Name | Description | |
|------------|----------|----------------|--|
| 1 | 1-Wire | 1-Wire output | Connector: CWB (https://www.cwb.com.cn/ TJC2004-5Y Counterparts (e.g. TJC2004-5A) Counter parts: e.g. Molex 55932-0530 and 55935-0510 |
| 2 | VCC | Power supply | |
| 3 | GND | Ground | |
| 4 | UART_RX | UART RX input | |
| 5 | UART_TX | UART TX output | |



6 Mechanical Outline

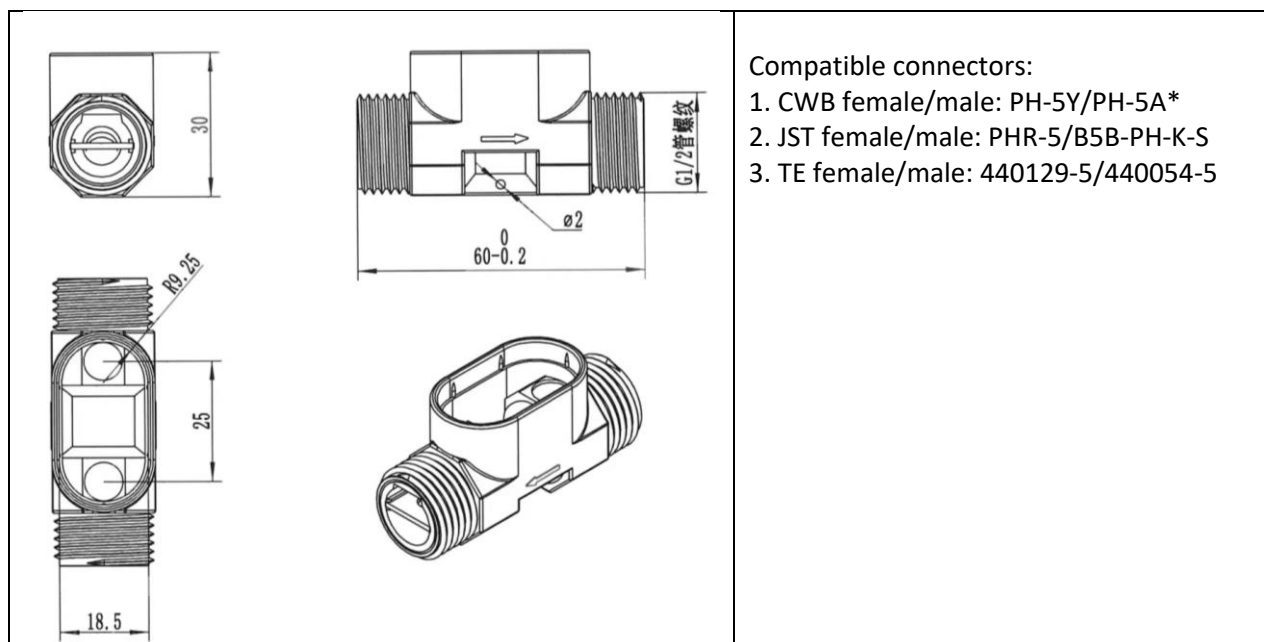


Figure 2: mechanical drawings

7 Application Information

7.1 UART

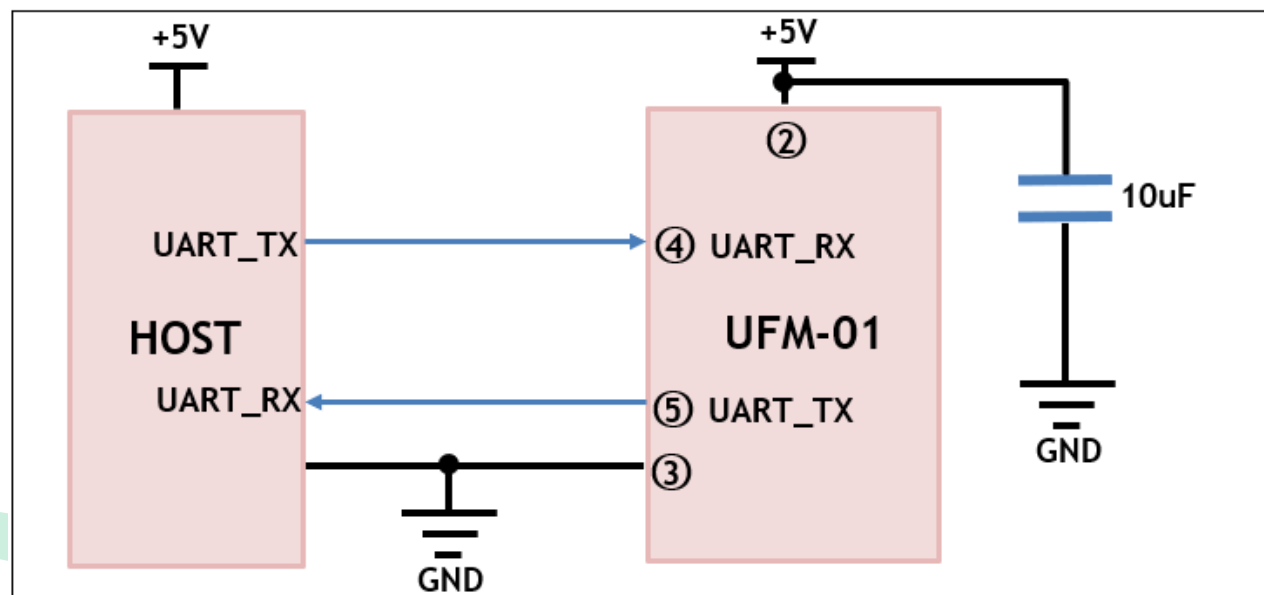


Figure 3: UFM-01 typical Application with UART connection

7.2 1-wire Connection

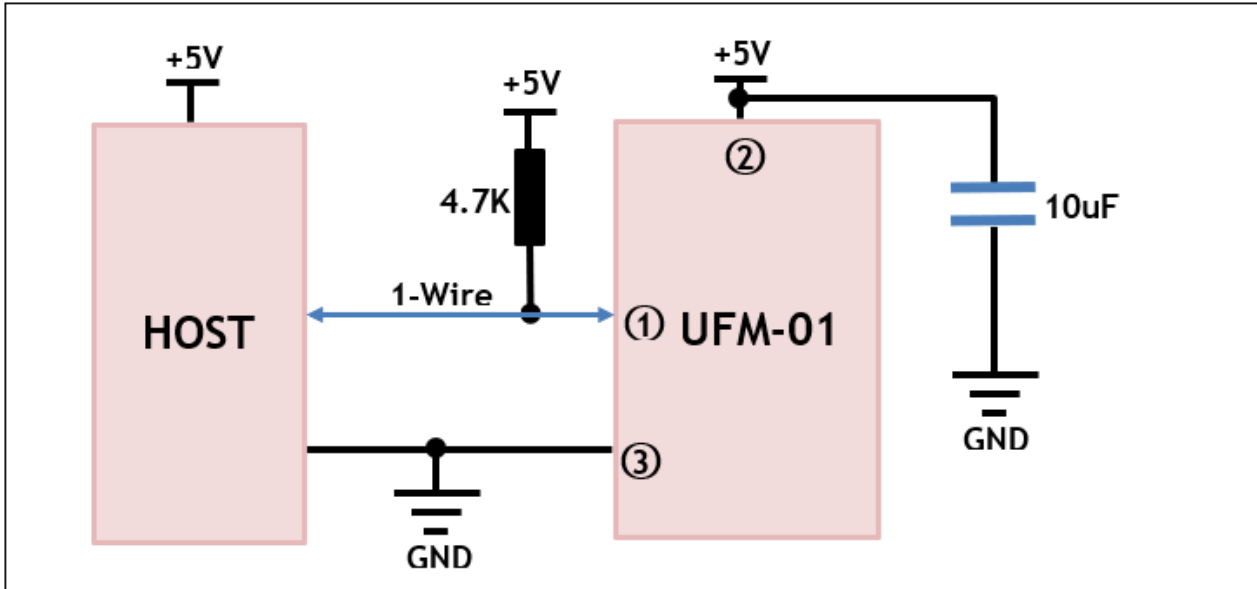


Figure 4: UFM-01 typical Application with 1-wire connection

8 UART Protocol

The UART protocol is based on

- Baude rate: 2400 bit/s
- Data bits: 8
- Parity: Even
- Stop bit: 1

8.1 Host Protocol

Table 5: Host protocol

| Prefix Byte 1 | Prefix Byte 2 | Start Byte 1 | Command Byte | Command para Byte | Checksum Byte | Stop Byte |
|---------------|---------------|--------------|--------------|-------------------|---------------|-----------|
| 0xFE | 0xFE | 0x11 | CMD | DATA | CS | 0x16 |

CS =(Command Byte +Command para byte n) & 0xFF

8.2 Command Definition

Table 6: Command definition

| CMD | DATA1 | Note |
|-------------------|--|---|
| 0x5A | 0xFD | Clear accumulated flow |
| 0x5C | 0x00- active 0x01- passive | <p>Change passive/active mode:</p> <p>Passive mode: device only send data when the host send a read command, data format according to the Table 8: Data output(Passive Mode, Data report when read all data including ID) and Table 9: Data output(Passive Mode, Data report when read data without ID).</p> <p>Active mode: device send data automatically every second, data format according to the Table 7.</p> <p>Default: Active mode</p> |
| 0x5B | 0xCB 0x0F | <p>Read sensor data:</p> <p>0xCB: Read all data including ID.</p> <p>0x0F: Read data without ID.</p> <p>Data format defined in Table 8 and Table 9.</p> |
| 0x5D | 0xFD | Reset the device |
| 0x5E ² | 0x62 | Read out Software Version |
| 0x60 ² | 0xA0 0x00 0xA1 0x00 0x10 0x00 0x10 0x00 0x10 0xA2 + frequency 0xA3 + start flow 0xA4 0x00 0x00 0x00 | <p>Reserved data</p> <p>Reserved data</p> <p>Reserved data</p> <p>Frequency Flag 0xA2 Frequency: 0x01 Hz, 0x02 = 2 Hz, 0x04 = 4Hz, 0x08 = 8 Hz³</p> <p>Start flow: flow in 0.1l/h lowest byte e.g. 0x15 for 1.5l/h middle byte 0x00 highest byte 0x00</p> <p>Reserved</p> |

² only available at Software Version >= 24210810 and Production Date >= 2024.08.05

³ 8 Hz not supported by UART

8.3 Host / Device protocol Examples

- a) Clear accumulated flow
Host 0xFE 0xFE 0x11 0x5A 0xFD 0x57 0x16
Device 0xE5
- b) Change passive/active mode
Change to passive mode:
Host 0xFE 0xFE 0x11 0x5C 0x01 0x5D 0x16
Device 0xE5

Change to active mode:
Host 0xFE 0xFE 0x11 0x5C 0x00 0x5C 0x16
Device 0xE5
- c) Read sensor data(WithOut ID):
Host 0xFE 0xFE 0x11 0x5B 0x0F 0x6A 0x16
Device Data out defined in 8.4. Data output format
- d) Read sensor data(With ID):
Host 0xFE 0xFE 0x11 0x5B 0xCB 0x26 0x16
Device Data out defined in 8.4. Data output format
- e) Reset the module:
Host 0xFE 0xFE 0x11 0x5D 0xFD 0x5A 0x16
Device 0xE5
- f)² Set frequency 4Hz & start flow 1.5l/h:
Host 0xFE 0xFE 0x11 0x60 0xA0 0x00 0xA1 0x00 0x10 0x00 0x10 0x00 0x10 0xA2 0x04
0xA3 0x15 0x00 0x00 0xA4 0x00 0x00 0x00 0xBE 0x16
Device Data out defined in 8.5.
- g)² Readout Software Version:
Host 0xFE 0xFE 0x11 0x5D 0xFD 0x5A 0x16
Device Data out defined in 8.6

8.4 Data Output Format

Table 7: Data output(Active Mode)

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|-------------|-------------|--|------|------|------|------|----------|
| Start Byte1 | Start Byte2 | Device ID, fox example 2307140001 Data: 230714 SerialNum:0001 | | | | | Reserved |
| 0x3C | 0x32 | 0x01 | 0x00 | 0x14 | 0x07 | 0x23 | 0x01 |

| 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---------------|--|------|------|------|------|------|-------------------|
| Acc Flow Flag | If Flag is 0x0A, then Acc Flow is 331023456.789l LSB:0.001L If Flag is 0x1A, then Acc Flow is 331023456.789m3 LSB:0.001m3 | | | | | | Instant Flow Flag |
| 0x0A 0x1A | 0x89 | 0x67 | 0x45 | 0x23 | 0x10 | 0x33 | 0x0B |

| 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
|--|------|------|------|------|----------|----|----|
| Instant Flow is -234567.89 l/h, LSB:0.01l/h Bit20:0x80,Negative Value | | | | | Reserved | | |
| 0x89 | 0x67 | 0x45 | 0x23 | 0x80 | 0x0C | | |

| 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
|-----------|--|------|------|-----|-----|---|-----------|
| Temp Flag | Measured water temperature in degree, for example 56.34 °C | | | ST1 | ST2 | Checksum | Stop Byte |
| 0x0D | 0x34 | 0x56 | 0x00 | | | CS =(Byte 0 + Byte 1 + ... +ST2) & 0xFF | 0x16 |

Table 8: Data output(Passive Mode, Data report when read all data including ID)

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|-------------|-------------|---|------|------|------|------|----------|
| Start Byte1 | Start Byte2 | Device ID, fox example 2307140001 Data: 230714 SerialNum:0001 | | | | | Reserved |
| 0x3C | 0x96 | 0x01 | 0x00 | 0x14 | 0x07 | 0x23 | |

| 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---------------|--|------|------|------|------|------|----------|
| Acc Flow Flag | If Flag is 0x0A, then Acc Flow is 331023456.789l LSB:0.001L If Flag is 0x1A, then Acc Flow is 331023456.789m3 LSB:0.001m3 | | | | | | Reserved |
| 0x0A/0x1A | 0x89 | 0x67 | 0x45 | 0x23 | 0x10 | 0x33 | |

| 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
|----------|----|----|----|----|----|-------------------|------|
| Reserved | | | | | | Instant Flow Flag | |
| | | | | | | 0x0B | 0x89 |

| 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
|---|------|------|------|----------|----|----|-----------|
| -234567.89 l/h,LSB:0.01l/h Bit20:0x80,Nagetive Value | | | | Reserved | | | Temp Flag |
| 0x67 | 0x45 | 0x23 | 0x80 | | | | 0x0D |

| 32 | 33 | 34 | 35 | 36 | 37 | 38 |
|--|------|------|-----|-----|---|-----------|
| Measured water temperature in degree, for example 56.34 °C | | | ST1 | ST2 | Checksum | Stop Byte |
| 0x34 | 0x56 | 0x00 | | | CS =(Byte 0 + Byte 1 + ... + ST2) & 0xFF | 0x16 |

Table 9: Data output(Passive Mode, Data report when read data without ID)

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|-------------|-------------|---------------|--|------|------|------|------|
| Start Byte1 | Start Byte2 | Acc Flow Flag | If Flag is 0x0A, the Acc Flow is 331023456.789l LSB:0.001L If Flag is 0x1A, the Acc Flow is 331023456.789m3 LSB:0.001m3 | | | | |
| 0x3C | 0x64 | 0x0A/0x1A | 0x89 | 0x67 | 0x45 | 0x23 | 0x10 |

| 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|------|-------------------|---|------|------|------|------|-----------|
| | Instant Flow Flag | -234567.89 l/h, LSB:0.01l/h Bit20:80, Negative Value | | | | | Temp Flag |
| 0x33 | 0x0B | 0x89 | 0x67 | 0x45 | 0x23 | 0x80 | 0x0D |

| 16 | 17 | 18 | 19 | 20 | 21 | 22 |
|--|------|------|-----|-----|--|-----------|
| Measured water temperature in degree, for example 56.34 °C | | | ST1 | ST2 | Checksum | Stop Byte |
| 0x34 | 0x56 | 0x00 | | | CS =(Byte 0 + Byte 1 + ... + ST2) & 0xFF | 0x16 |

Status bytes ST1 & ST2 are used for error code:

| ST2 | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|-----|------|------|----------------|------|----------------------|------------------------|------|------|
| | | | UFC chip error | | Flow direction wrong | Flow rate out of range | | |

| ST1 | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|-----|------|------|------------|------|------|------|------|------|
| | | | Empty tube | | | - | - | |

UFC chip error:

Flow direction wrong:

Empty tube:

Flow rate out of range:

UFC not detected or abnormal.

Negative flow detected.

No water detected in the tube.

Big flow rate out of range continuously detected for 5s.

8.5 Answer Set Frequency & Start Flow

Table 10: Answer

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|------|----------|---|------|---|---|---|---|---|---|
| ACK | Reserved | | | | | | | | |
| 0xE5 | 0xA0 | / | 0xA1 | / | / | / | / | / | / |

| 10 | 11 | 12 | 13 | 14 | 15 |
|----------------|-------------------|------------------------|---|------|------|
| Frequency Flag | Frequency is 4 Hz | Startup Flow Rate Flag | The Startup Flow Rate is 1.5l/h, LSB:0.1l | | |
| 0xA2 | 0x04 | 0xA3 | 0x15 | 0x00 | 0x00 |

| 16 | 17 | 18 | 19 | 20 | 21 |
|----------|----------|----|----|------------------------------------|-----------|
| Reserved | Reserved | | | Checksum Byte | Stop Byte |
| 0xA4 | / | / | / | CS =(Byte 3 +... + Byte 22) & 0xFF | 0x16 |

8.6 Answer Software Version

Table 111: Answer

| 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|------|----------------------------|------|------|------|------------------------------------|-----------|
| ACK | Software Version: 23380315 | | | | Checksum Byte | Stop Byte |
| 0xE5 | 0x15 | 0x03 | 0x38 | 0x23 | CS =(Byte 0 + ... + Byte 4) & 0xFF | 0x16 |

9 1-wire Protocol

9.1 Protocol Description

The read and write operation of 1-wire protocol is low bit first and high bit last. The 1-wire interface of UFM-01 receives the reading time sequence and sends out measurement data. If the data is not ready, all the data will be zero. UFM-1 is a slave, which transmits data at a rate of 16.3k bit/s.

The sequence parameters in the figures in this section are from the general standard, and the brackets are the parameters implemented by the slave. In addition to standard function mode (NM), UFM-1 has added a simplified mode (SM) to reduce data flow.

As 1-wire interface is simulated via MCU's GPIO, it is not fully compatible with the hardware interface and some parameters are limited, pls refer to the following description for details.

9.1.1 BUS Initialization (1WRST)

The slave will pull the BUS down 60-240 μ s within 15-60 μ s after receiving the effective jump. During this period, the host will sample the bus to determine whether the slave is connected to the current BUS.

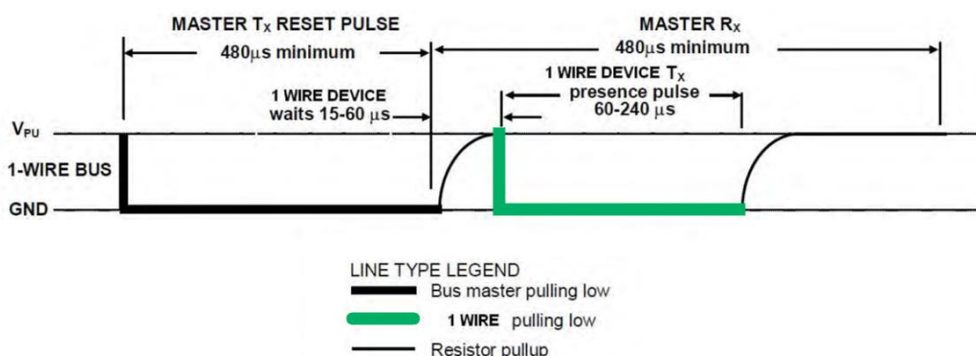


Figure 5: 1-wire bus reset timing

9.1.2 Master Write Operation

It needs at least 60 μ s for the master to write one bit to the bus, and there is more than 1 μ s interval for continuous write operations.

The operation steps of the master when writing data are as follows:

- 1) The master pulls down the bus by 1 μ s.
- 2) The master releases the bus within 15 μ s (routine is 3 μ s), and then puts the data immediately.
- 3) The master waits (routine is 50 μ s) for the end of this receiving cycle of 60 μ s, and then releases the bus.

4) If the data is not sent completely, wait for 1 us, repeat the above steps, and prepare to send the next bit.

The operation steps of the slave when writing data are as follows:

- 1) When there are 1-15 us low pulses on the slave detection bus, it is ready to receive data.
- 2) The slave reads the bus data in a time window of 15-60 us (20 us is recommended).

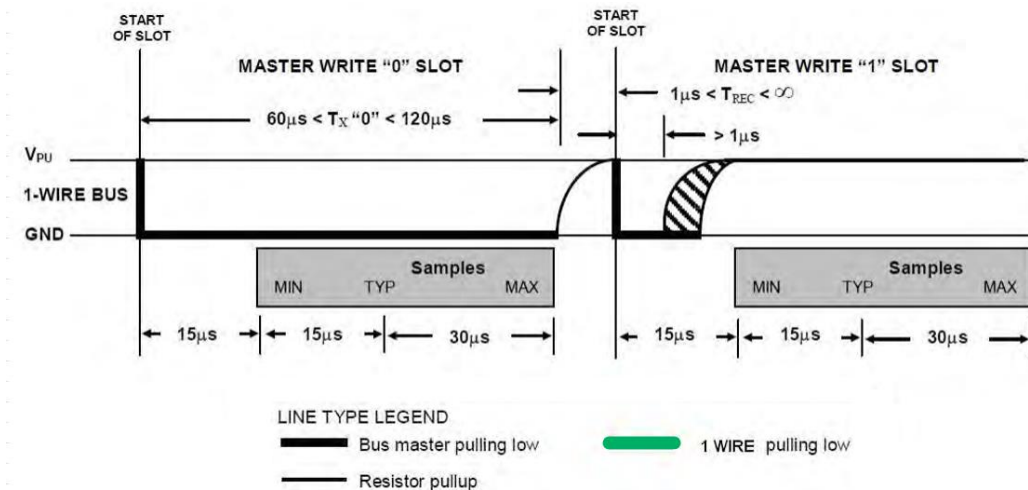


Figure 6: 1-wire write timing

9.1.3 Master Read operation

The master needs at least 60 us to read one bit from the bus, and the interval between two consecutive read operations is more than 1 us.

When reading data, the master operation steps are as follows:

- 1) The master pulls down the bus by 1-15 us (routine is 4 us) and then releases it.
- 2) The host reads the bus value within 15 us, with a routine of 11 us.
- 3) The master waits (routine 40 us) for the end of this receiving cycle of 60 us, and then releases the bus.
- 4) If the data is not received completely, wait for 1 us or more (routine is 1 us), repeat the previous steps, and prepare to receive the next bit.

When reading data, the slave operation steps are as follows:

- 1) The slave detects the bus, data is immediately inserted when there are 1-15 us low pulses or at the falling edge.

Note: If the low pulse of the host is as low as 1 us, the slave may not be able to detect the accurate pulse width. A compromise method can be considered: after the slave detects the falling edge, it detects the high level arrival time t through interrupts or scans greater than 1 us

and less than 10 us. If t is less than 10 us, the slave will input data; If t is greater than 10 us, continue to detect and determine whether it is a 1WRST signal.

- 2) Hold the data to 60 us and then release the bus.
- 3) If the data is not sent completely, repeat the above steps to prepare to send the next bit.

9.2 1-wire Command

The command format is: command [parameters] [checksum], and the content of [] can be omitted, and the checksum is the 8-bit cumulative value of the parameter.

Table 12: 1-wire Command format

| Command | Function |
|----------------------------|---|
| 0x5a | Clear accumulated flow |
| 0x5b, REG, data1,data2 ... | Continuously read data from address register (REG), with REG and read range from 0x30 to 0x3b |
| 0x5d | Reset module |

Notes:

1. [para] is the data read, with low bytes leading and can be omitted. After omission, the function of the command is the same as 0xaa.
2. The NM mode can be switched directly by command. When switching between SM mode and NM mode, or between SM modes, initialization (1WRST) must be executed first.
3. When already in SM mode, there is no need to issue a command to read data. Instead, initiate a read operation and return the last requested type data from the slave.

9.3 1-wire registers

| Address | Symbol |
|---------|-----------|
| 0x30 | InFL_L |
| 0x31 | InFL_M |
| 0x32 | InFL_H |
| 0x33 | InFL_CRC8 |
| 0x34 | T_L |
| 0x35 | T_M |
| 0x36 | T_H |
| 0x37 | T_CRC8 |
| 0x38 | CuFL_L |
| 0x39 | CuFL_M |
| 0x3a | CuFL_H |
| 0x3b | CuFL_CRC8 |

Example 1: 0x30 to 0x32 are sequentially 0x40, 0x0d, and 0x03, indicating an instantaneous flow of $200000 \times 0.01 = 2000$ l/h.

Example 2: 0x34 to 0x36 are sequentially 0x70, 0x17, and 0x00, indicating a temperature of $6000 \times 0.01 = 60\text{ }^{\circ}\text{C}$.

Example 3: 0x38 to 0x3a are sequentially 0xff, 0xff, and 0xff, indicating a cumulative flow of $16777215 \times 1677721.5\text{ l}$ (1677.7 m3). 1-wire parameters

9.4 CRC-8 calculation

CRC-8 calculation of array 'val' with a length of 'length'

```
uint8_t crc8( uint8_t *val, uint8_t length )
{
    uint8_t CRC=0xFF;
    uint8_t i,t;
    for(i=0;i<length;i++)
    {
        CRC^=val[i];
        for(t=8;t>0;--t)
        {
            if(CRC&0x80) { CRC=(CRC<<1)^0x31u;}
            Else { CRC=(CRC<<1); }
        }
    }
    return CRC;
}
```



10 Ordering information

Table 13: Ordering information

| Ordering Code | Material ID | Package | Description | Delivery Quantity |
|---------------|-------------|---------|-----------------------------|-------------------|
| UFM-01 | 501911001 | - | Ultrasonic flow module DN10 | 50 pc |

11 RoHS Compliance & ScioSense Green Statement

RoHS: The term RoHS compliant means that Sciosense B.V. products fully comply with current RoHS directives. Our semiconductor products do not contain any chemicals for all 6 substance categories, including the requirement that lead does not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, RoHS compliant products are suitable for use in specified lead-free processes.

ScioSense Green (RoHS compliant and no Sb/Br): ScioSense Green defines that in addition to RoHS compliance, our products are free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material).

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13 Document status

Table 14: Document status

| Document Status | Product Status | Definition |
|-----------------------|----------------|--|
| Preliminary Datasheet | Pre-Production | Information in this datasheet is based on products in the design, validation or qualification phase of development. The performance and parameters shown in this document are preliminary without any warranty and are subject to change without notice. |
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14 Revision information

Table 15: Revision history

| Revision | Date | Comment | Page |
|----------|------------|---|-----------------------|
| 1 | 2023-03-21 | Preliminary Version – Product Launch | All |
| 2 | 2023-06-12 | Update UART protocol Update power consumption Add 1-wire protocol | 8, 9 2, 5 12ff |
| 3 | 2023-11-04 | Maximum flow extended, note added Sample rate added New connectors, compatible with JST or TE Chapter 8.2 & 8.3 references corrected, Set Frequency and start flow rate added Chapter 8.5 added | 2, 5 5 6 8ff |
| 4 & 5 | 2024-11 | Internal revisions only, not released | |
| 6 | 2024-11-25 | Sample rate and start flow setting added | 9 |
| 7 | 2024-03-07 | Command Software Version Read added Footnote added for Add note for Valid Features Section 8.6 Answer Software Version added | 9 9 13 |
| 8 | 2024-03-10 | Formatting / Dates corrected | |
| 9 | 2024-05-22 | Use case protection definition added | 4 |

Notes:

1. Page and figure numbers for the previous version may differ from page and figure numbers in the current revision.
2. Correction of typographical errors is not explicitly mentioned.

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