# InnovaSonic® Model 203

## Economical Ultrasonic Liquid Flow Meter

## Instruction Manual

Version IM-203, Rev. H, December 2016

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## TRADEMARKS

# Important Customer Notice

Thank you for choosing the InnovaSonic® Model 203 Economical Transit-Time Ultrasonic Flow Meter with SLSI CMOS and low-voltage wide-pulse sending technology. This manual contains important information about your meter. Before installing and operating this flow meter, please read this manual carefully and follow its instructions.

- ✓ Sierra has verified the conformity between the contents in this manual and the hardware and software described. However, errors may still exist. We regularly review the materials covered in this manual and correct errors with revisions. Any suggestions for improvement will be appreciated.
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## WARNINGS IN THIS MANUAL

Warning, attention, and note statements are used throughout this book to draw your attention to important information.

### WARNING

"Warning" statement appears with information that is important to protect people and equipment from damage. Pay very close attention to all warnings that apply to your application. **Failure to comply with these instructions may damage the meter and personal injury.**

### ATTENTION

"Attention" statements in this manual indicate that failure to comply with stated instructions **may result in damage to the meter or faulty operation of the flow meter.**
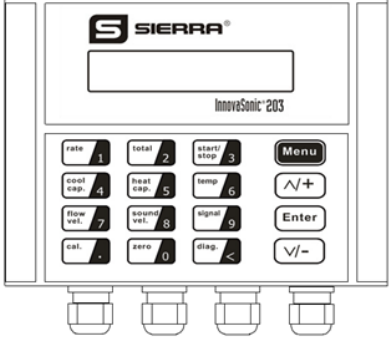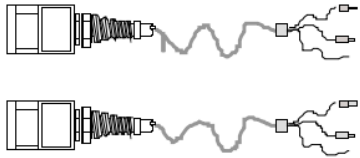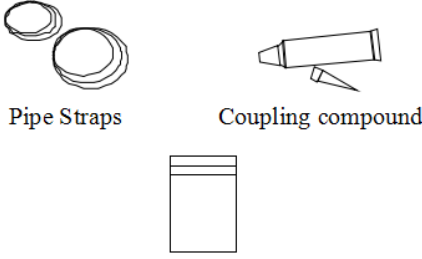
### NOTE

"Note" indicates that ignoring the relevant requirements or precautions **may result in flow meter damage or malfunction.**

# Product Components

Inspect the flow meter prior to installation. Check the parts against the packing list. Make sure that there is no transport damage.

| Transmitter | Transducers |
|---|---|
|  |  |
| **Accessories** | **Documents** |
| Pipe Straps    Coupling compound<br><br>Installation accessory | 1. Instruction Manual<br>2. Packing List<br>3. Position drawing |

# Content

1. **Transmitter Installation and Wiring** ................................................................8

   1.1. INSPECTION PRIOR TO TRANSMITTER INSTALLATION.................................................. 8

   1.2. WIRE CONNECTIONS.............................................................................................. 9

      1.2.1. **Power Supply Option** .............................................................................. 9

      1.2.2. **Transmitter Wiring** ................................................................................. 9

      1.2.3. **Longer Cables (> 9 m)** ............................................................................ 9

      1.2.4. **Junction Box Connections** ...................................................................... 10

      1.2.5. **Junction Box Requirements** ..................................................................... 10

   1.3. POWERING ON ................................................................................................... 11

   1.4. KEYPAD FUNCTIONS ........................................................................................... 11

   1.5. KEYPAD OPERATION ........................................................................................... 11

   1.6. FLOW METER MENU DESCRIPTIONS ...................................................................... 12

2. **Pipe Parameter Entry Shortcuts** .......................................................... 14

   2.1. DUAL FUNCTION KEYS MENU DESCRIPTION .......................................................... 14

   2.2. MENU SYSTEM EXAMPLES .................................................................................. 15

3. **Measurement Site Selection** ................................................................ 17

4. **Transducer Installation** ........................................................................ 18

   4.1 INSTALLING THE TRANSDUCERS ........................................................................... 18

      4.1.1 **Transducer Spacing** ............................................................................. 18

      4.1.2 **Transducer Mounting Methods** ............................................................... 18

      4.1.3 **V Method** .......................................................................................... 18

      4.1.4 **Z Method** .......................................................................................... 19

      4.1.5 **N Method (not commonly used)** .............................................................. 19

   4.2 TRANSDUCER MOUNTING INSPECTION ................................................................... 19

      4.2.1 **Signal Strength** .................................................................................... 20

      4.2.2 **Signal Quality (Q value)** ......................................................................... 20

      4.2.3 **Total Time and Delta Time** ..................................................................... 20

      4.2.4 **Transit Time Ratio** ............................................................................... 20

5 **Operating Instructions** .......................................................................... 22

   5.1 SYSTEM NORMAL IDENTIFICATION ........................................................................ 22

   5.2 ZERO SET CALIBRATION..................................................................................... 22

   5.3 SCALE FACTOR ................................................................................................. 22

   5.4 SYSTEM LOCK (UNLOCK) .................................................................................. 23

   5.5 4~20MA CURRENT LOOP VERIFICATION ............................................................... 23

   5.6 FREQUENCY OUTPUT.......................................................................................... 23
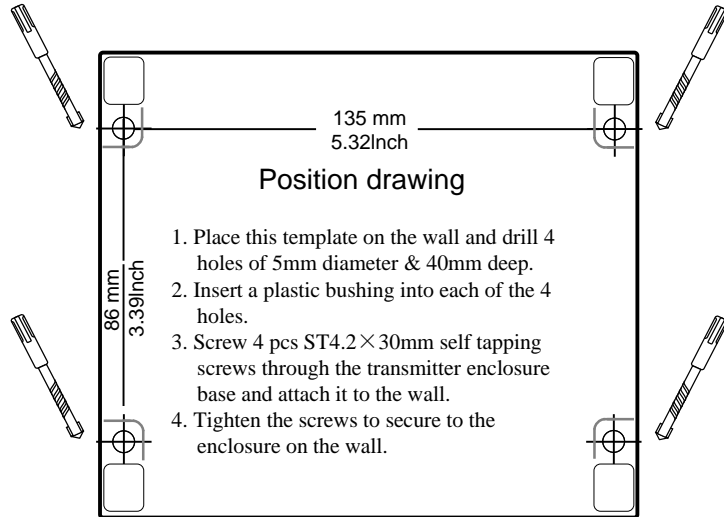
Update Information:

_____

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# 1. Transmitter Installation and Wiring

## 1.1. Inspection prior to Transmitter Installation

You will find a "Position Drawing" in the packing. Please use it as a template for flow meter installation. Drill 4 installation holes at the positions shown on the drawing (use 5.5mm drill).



135 mm
5.32Inch

86 mm
3.39Inch

### Position drawing

1. Place this template on the wall and drill 4 holes of 5mm diameter & 40mm deep.
2. Insert a plastic bushing into each of the 4 holes.
3. Screw 4 pcs ST4.2×30mm self tapping screws through the transmitter enclosure base and attach it to the wall.
4. Tighten the screws to secure to the enclosure on the wall.

Take out the enclosed screws and plastic bushings. Insert the plastic bushings into the installation holes. Put the flow meter in position and screw in the screws.



135 mm
(5.32 in)

86 mm
(3.39 in)
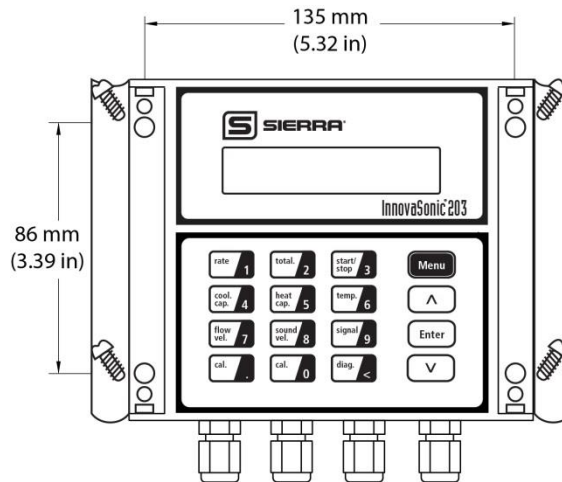
**ATTENTION**

When installing please ensure the front cover is secure and will not fall open.

## 1.2. Wire Connections

### 1.2.1. Power Supply Option

Factory standard power supply is 10 to 36 VDC at 1A max.

### 1.2.2. Transmitter Wiring

Once the electronics enclosure has been installed, the flow meter wiring can be connected.

Viewing the TB, you will find the transmitter interface labels from left to right:

Power supply, Relay output, OCT Output, Upstream transducer, Downstream transducer, 4-20mA, RS-232 (optional) or RS-485 interface.
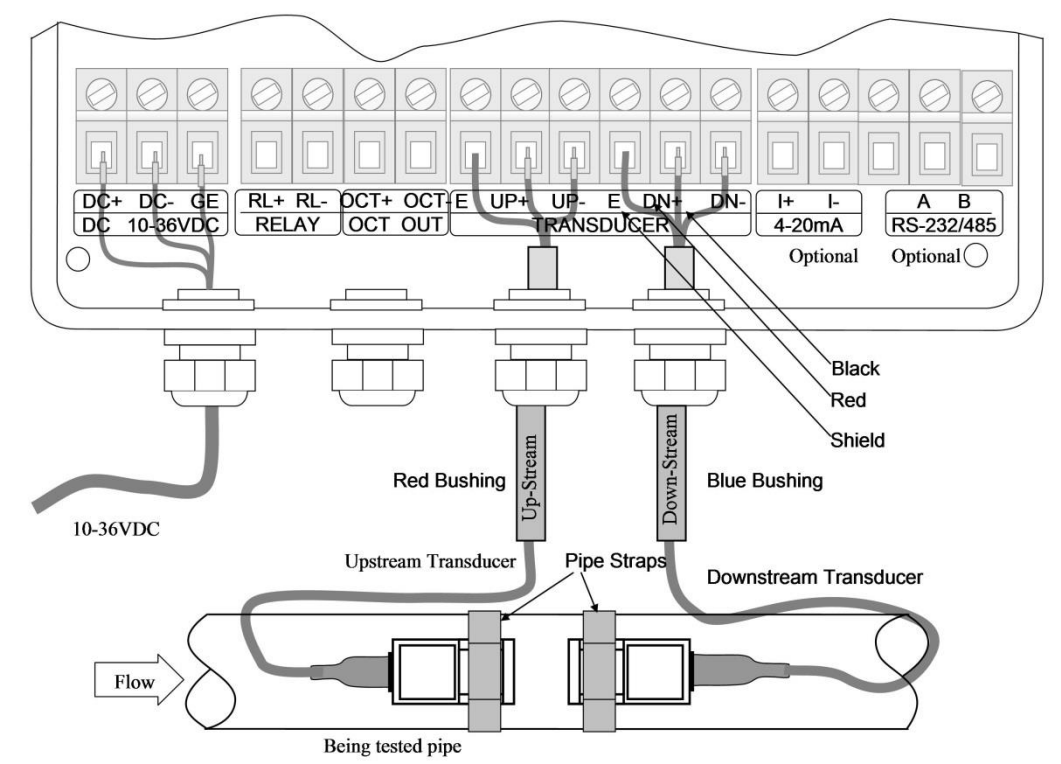


Figure 1. Transmitter Wiring

### 1.2.3. Longer Cables (> 9 m)

Standard cable length is 9 meters (30 ft); it can be lengthened to be 300 meters (984 ft) via a junction box.

## 1.2.4. Junction Box Connections
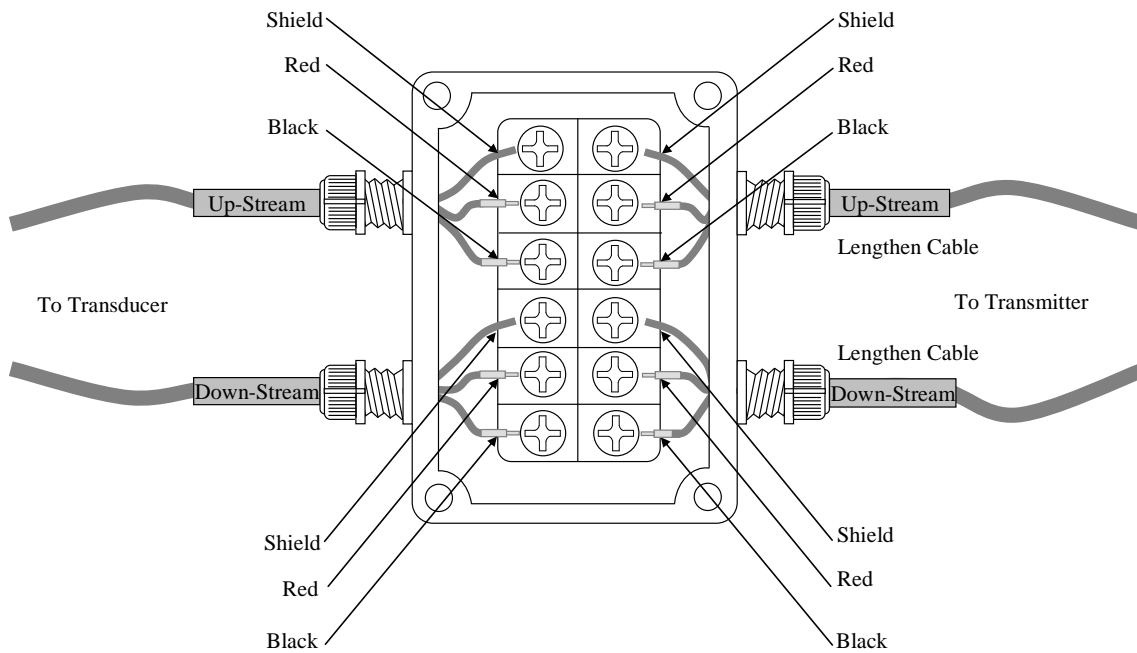


Figure 2. Junction Box Connections

## 1.2.5. Junction Box Requirements

The flow meter can use a sealed waterproof 6x2 junction box to extend the transducer wires

**Cable Specifications**

Name: Shielded Twisted Pair

Standard: JB8734.5-1998

Diameter: Φ5 mm

Twist Line Space: 50 mm

Multi Core Line: 0.4 mm$^2$/radix

Gauge: AWG 20#

Core Line Color: Red and Black

Shield Floor: 128 Intwine

**WARNING**

Wire with power off. The flow meter must have reliable grounding before installation.

## 1.3. Powering on

As soon as the flow meter is switched on, the self-diagnosis program will start to run. If any error is detected, an error code will display on the screen (Refer to Error Diagnostic section of this manual). After the self-diagnosis, the system will run automatically using the last input parameters.

When the meter is switched on, gain adjustment can be monitored in Menu M01. After S1, S2, S3, S4 are displayed on the upper left corner of the screen, the system will begin measuring.   Normal condition is indicated by code "*R" on the upper left corner of the screen.

If it is the first use or install on a new site, the customer will need to input the new installation site parameters. The system will default to the last menu settings and automatically display them at next power on.

## 1.4. Keypad Functions

The InnovaSonic 203 keypad offers 16 tactile keys with 12 dual-function keys for easy operation of the menu system and setup. The quick-key functions are enabled by pressing directly on the related key. You do not need to press the [Menu] key to enable quick-key functions.   For example, pressing [rate 1] will show flow rate and pressing [total 2] will show totalized flow.    See the Chapter 2 for detailed expalnations of all they keys.

Follow these guidelines when using the InnovaSonic 203 menu system:

Figure 3. 16 Tactile Keys With12 Dual-Function Keys

- Keys [zero 0] - [signal 9] are the menu codes to input information required for the flow measurement exercise.
- Push [diag. <] to backspace or delete characters to the left.
- Use [∧/+] and [∨\-] to return to the previous menu or to open the next menu. These keys act as "+" and "-" functions when entering numbers.
- The Menu key [Menu] is used to select a menu using two digit numbers for each menu.   To enter a selected menu, press [Menu] key first then press your selected digit numbers. Hit enter to save the selected menu. For example, to input a pipe outside diameter, press [Menu][rate 1][rate 1] keys, where "11" is the window ID to display the parameter for pipe outside diameter.

## 1.5. Keypad Operation

The flow meter uses menus to enter/display data. The operator can input parameters, modify settings or display measurement results by "visiting" a specific menu. These menus are arranged by 2-digit serial numbers (including "+" sign) from 00~99, then to +0, +1, etc. Each menu ID code has a defined meaning. For example, menu M11 indicates the pipe outside diameter, while menu M25 indicates the mounting spacing between the transducers

To visit a specific menu, press the [Menu] key, then input the 2-digit menu ID code. For example, to input or check the pipe outside diameter, press the [Menu][rate 1][rate 1] keys.

Another method to visit a particular menu is to press [∧/+] [∨\-] and [Enter] keys to scroll the screen. For example, if the current menu ID code is M02, press [∧/+] key to enter menu M01, press the [∧/+] button again to enter menu M00; then, press the [∨\-] key to go back to menu M01, and press the [∨\-] key again to enter menu M02.

Menus are separated into three types: (1) Data Type, such as M11, M12; (2) Option Type, such as M14; (3) Display Type, such as M01, M00.

You can check/enter numerical data by visiting the Data Type menus. If you want to modify the data, input the digits and press $\boxed{\text{Enter}}$ or press $\boxed{\text{Enter}}$ first, input the digits then press $\boxed{\text{Enter}}$ again to confirm.

$\boxed{\substack{\text{cool} \\ \text{cap.}} \, \boxed{4}} \, \boxed{\text{Enter}}$.
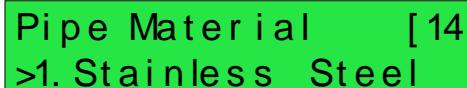
Example 1: To enter a pipe outside diameter of 219.234, the procedure is as follows:

Press $\boxed{\text{Menu}} \boxed{\substack{\text{rate} \\ 1}} \boxed{\substack{\text{rate} \\ 1}}$ keys to enter menu M11 (the numerical value displayed currently is the previous value). Now press $\boxed{\text{Enter}}$ key. The symbol ">" and the flashing cursor are displayed at the left end of the second line on the screen. Then input pipe OD and press enter to confirm. $\boxed{\substack{\text{total} \\ 2}} \boxed{\substack{\text{rate} \\ 1}} \boxed{\substack{\text{signal} \\ 9}} \boxed{\substack{\text{cal.} \\ \cdot}} \boxed{\substack{\text{total} \\ 2}} \boxed{\substack{\text{start/} \\ \text{stop} \\ 3}}$

```
Pipe Outer Diameter
>_
```

You can select various configurations by using pull down menus in the Option Type menus. If you want to modify these, press $\boxed{\text{Enter}}$ first, the symbol ">" and the flashing cursor are displayed at the left of the screen. Use $\boxed{\wedge/+}$ and $\boxed{\vee\backslash-}$ to scroll pull down menu options, then press $\boxed{\text{Enter}}$ to confirm the selected option, or enter the corresponding value directly and press $\boxed{\text{Enter}}$ to confirm.

For example, if the pipe material is not "Stainless Steel", press $\boxed{\text{Menu}} \boxed{\substack{\text{rate} \\ 1}} \boxed{\substack{\text{cool} \\ \text{cap.} \\ 4}}$ to enter menu M14, press $\boxed{\text{Enter}}$ to modify the options. Scroll to "1. Stainless Steel" option by pressing $\boxed{\wedge/+}$ and $\boxed{\vee\backslash-}$, then press $\boxed{\text{Enter}}$ to confirm the selection; It is also possible to press $\boxed{\substack{\text{rate} \\ 1}}$ key to change the selection and wait until "1.Stainless Steel" is displayed on the second line of the screen, then press $\boxed{\text{Enter}}$ to confirm.

```
Pipe Material    [14
>1.Stainless Steel
```

**ATTENTION**

Generally, press the $\boxed{\text{Enter}}$ key first if you want to change data. If there is no response ", it means that system is locked by a password. To "Unlock" it, select "Unlock" in Menu M47 and enter the original password.

## 1.6. Flow Meter Menu Descriptions

Menus are assigned as follows:

00~09      Flow Totalizer Display: display flow rate, positive total, negative total, net total, velocity, date & time, present operation and flow results today.

10~29      Initial Parameter Setup: to enter pipe outside diameter, pipe wall thickness, fluid type, transducer type, transducer mounting method and spacing, etc.

30~38      Flow Units Options: to select the flow unit such as cubic meters, liters or other units, turn totalizers on/off and reset totalizers, etc.

40~49      Setup options: set Scaling factor, system lock (Menu M47), etc.

50~89      Input and output setup: date and time, ESN, communication baud rate setting, etc.

90~94      Diagnostics: Signal strength and signal quality (Menu M90), TOM/TOS*100 (Menu M91), flow sound velocity (Menu M92), total time and delta time (Menu M93), Reynolds number and factor   (Menu M94), etc.

+0~+5    Appendix: power on/off time, total working hours, on/off times and a single-accuracy function calculator.

**Attention**

other menus not listed are for hardware adjustment (factory use).

# 2. Pipe Parameter Entry Shortcuts

## 2.1. Dual Function Keys Menu Description

Rate/1 Key

Press this key to display Maximum Flow Rate. The function is the same with Window M02. Press the key again to see Min. then Avg. Flow rates.

Total/2 Key

Press this key to display Net Totalizer. The function is the same with Window M00.

Start/Stop/3 Key

Press this key to start and stop Manual Totalizer in turn.

Cool Cap./4 Key

Reserved for future use.

Heat Cap./5 Key

Reserved for future use..

Temp./6 Key

Reserved for future use.

Flow Vel./7 Key

Press this key to display Velocity. The function is the same with Window M01.

Sound Vel./8 Key

Press this key to enter Fluid Sound Velocity in Window M92.

Signal/9 Key

Press this key to display Signal Strength and Signal Quality. The function is the same with Window M90.

Cal./. Key

Press this key to start Manual Totalizer, then press the key again to end Manual Totalizer.

Zero/0 Key

Press this key to input code 1234 to set zero.

```
Flow Max.
    360.0000  m3/h
```

```
Day Totalizer
    700.1000    m3
```

```
         60 sec
ON     10.123     m3
```

```
Flow 0.1129  m3/h*R
Vel    1.0415    m/s
```

```
Fluid Sound Velocity
   0.0000m/s
```

```
Strength + Quality [90
UP:00.0  DN:00.0  Q=00
```

```
Manual Calibrate
Press Ent When Ready
```

```
Set Zero
Please Enter PW
```

14

Diag./< Key

Press this key to display System Error Code. The function is the same with Window M08.

```
* R- - - - - - - - -
System Normal
```

## 2.2. Menu System Examples

Example, pipe has diameter of DN200, measuring water, Pipe Material is carbon steel, No Liner

Step 1. Pipe outside diameter:

Press [Menu] [rate 1] [rate 1] keys to enter menu M11, enter the pipe outside diameter of [total 2] [zero 0] [zero 0], then press the [Enter] key to confirm.

```
Pipe Outer Diameter
            200  mm
```

Step 2. Pipe wall thickness

Press [Menu] [rate 1] [total 2] key to enter menu M12, enter the pipe wall thickness of [temp 6], then press the [Enter] key to confirm.

```
Pipe Wall Thickness
              6  mm
```

Step 3. Pipe material

Press [Menu] [rate 1] [cool cap. 4] keys to enter menu M14, press the [Enter] key to bring up the scroll down options, press the [∧/+] or [∨\-] key to scroll to the correct pipe material (in this case carbon steel), then press the [Enter] key to confirm.

```
Pipe Material      [14
  0. Carbon Steel
```

Step 4. Transducers type

Although other types are available, select STANDARD transducers.

```
Transducer Type [23
   0. Standard
```

Step 5. Transducer mounting methods

Press [Menu] [total 2] [cool cap. 4] key to enter menu M24, press the [Enter] key, press the [∧/+] or [∨\-] key to select transducer-mounting method, and press the [Enter] key to confirm. IN MOST CASES, start with the V method and switch to the Z method if signal strength/quality is insufficient.

```
Transducer Mounting
   0.          V
```

Step 6. Transducer spacing

Press [Menu] [total 2] [heat cap. 5] key to enter menu M25, THE METER WILL CALCULATE THE CORRECT SPACING FOR THE MOUNTING METHOD selected in menu 24 above. Install as directed.

```
Transducer Spacing
         159.86  mm
```

Step 7. Display measurement result

Press [Menu] [zero 0] [rate 1] keys to enter menu M01 to display measurement results. *R indicates normal operation.

```
Flow   0.1129 m3/h      * R
Vel        1.0415 m/s
```

# 3. Measurement Site Selection

When selecting a measurement site, it is important to select an area where the fluid flow profile is fully developed. Use the following guidelines to select a proper installation site:

Choose a section of pipe that is always full of liquid, such as a vertical pipe with flow in the upward direction or a full horizontal pipe.

Ensure enough straight pipe length at least equal to the figure shown below for the upstream and downstream transducers installation.

| Name | Straight length of upstream piping | Straight length of downstream piping |
|---|---|---|
| 90° bend |  |  |
| Tee |  |  |
| Diffuser |  |  |
| Reduce |  |  |
| Valve | Flow controlled upstream | Flow controlled downstream |
| Pump |  | |

Figure 4. Measurement Site Selection

Ensure that the pipe surface temperature at the measuring point is within the transducer temperature limits.

Consider the inside condition of the pipe carefully. If possible, select a section of pipe where the inside is free of excessive corrosion or scaling.

# 4.Transducer Installation

## 4.1    Installing the Transducers

Before installing the transducers, clean the pipe surface where the transducers are to be mounted. Remove any rust, scale or loose paint and make a smooth surface. Choose a section of sound conducting pipe for installing the transducers. Apply a wide band of sonic coupling compound down the center of the face of each transducer as well as on the pipe surface, ensure there are no air bubbles between the transducers and the pipe wall, and then attach the transducers to the pipe with the straps provided and tighten them securely.

> **NOTE**
>
> The two transducers should be mounted at the pipe's centerline on horizontal pipes.
>
> Make sure that the transducer mounting direction is parallel with the flow.

During the installation, there should be no air bubbles or particles between the transducer and the pipe wall. On horizontal pipes, the transducers should be mounted in the 3 o'clock and 9 o'clock positions of the pipe section in order to avoid any air bubbles inside the top portion of the pipe. (Refer to Transducer Mounting). If the transducers cannot be mounted horizontally symmetrically due to limitation of the local installation conditions, it may be necessary to mount the transducers at a location where there is a guaranteed full pipe condition (the pipe is always full of liquid).

### 4.1.1  Transducer Spacing

After entering the required parameters, the spacing between the ENDS of the two transducers is considered as the standard transducer spacing (Refer to Top View on transducer mounting methods). Check the data displayed in Menu M25 and space the transducers accordingly.

### 4.1.2  Transducer Mounting Methods

Three transducer mounting methods are available. They are respectively: V method, Z method and N method. The V method is primarily used on small diameter pipes (DN100~300mm, 4″~12″). The Z method is used in applications where the V method cannot work due to poor signal or no signal detected. In addition, the Z method generally works better on larger diameter pipes (over DN300mm, 12″) or cast iron pipes.

The N method is an uncommonly used method. It is used on smaller diameter pipes (below DN50mm, 2″).

### 4.1.3  V Method

The V method is considered as the standard method. It usually gives a more accurate reading and is used on pipe diameters ranging from 50.8mm to 400mm (2~16″) approximately. Also, it is convenient to use, but still requires proper installation of the transducers, contact on the pipe at the pipe's centerline and equal spacing on either side of the centerline.
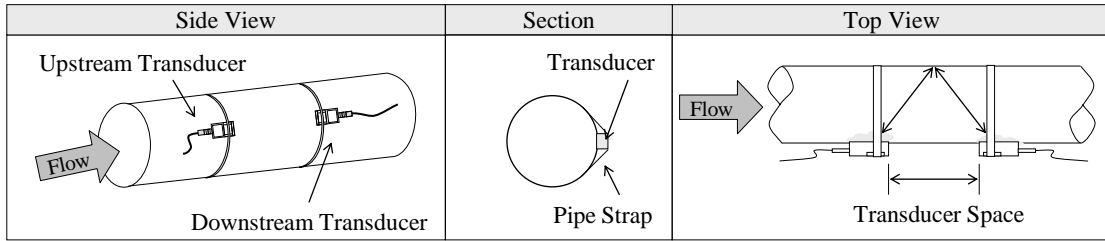
Figure 5. V Method Transducer Mounting Method

### 4.1.4 Z Method

The signal transmitted in a Z method installation has less attenuation than a signal transmitted with the V method

Use for big pipes, if there are some suspended solid in the fluid, or the scaling and liner are too thick. This is because the Z method utilizes a directly transmitted (rather than reflected) signal which transverses the liquid only once.

The Z method is able to measure on pipe diameters ranging from 100mm to 800mm (4″ ~32″) approximately. Therefore, we recommend the Z method for pipe diameters over 300mm (12″).
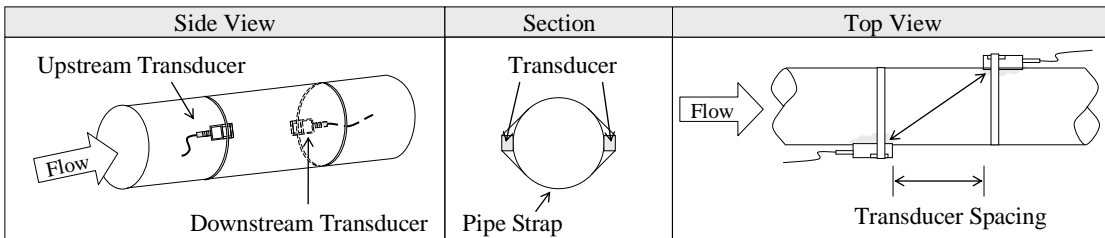


Figure 6. Z Method Transducer Mounting Method

### 4.1.5 N Method (not commonly used)

With the N method, the sound waves traverse the fluid three times and bounce twice off the pipe walls. It is suitable for small pipe diameter measurement.

The measurement accuracy can be improved by extending the transit distance with the N method (uncommonly used).
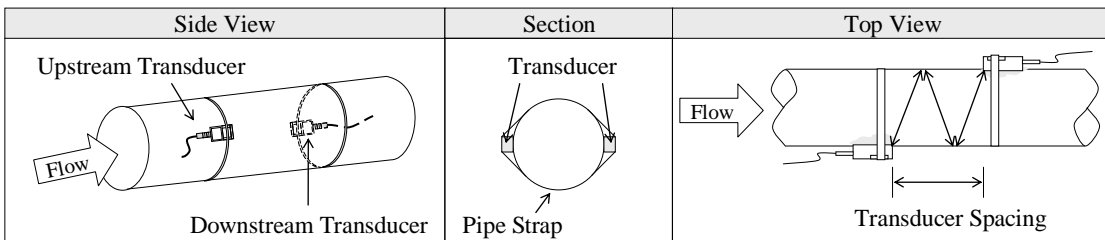


Figure 7. N Method Transducer Mounting Method

## 4.2 Transducer Mounting Inspection

Check to see if the transducer is installed properly and if there is an accurate and strong enough ultrasonic signal to ensure proper operation and high reliability of the transducer. This can be confirmed by checking the detected signal strength, total transit time, delta time and transit time ratio.

The "mounting" condition directly influences the flow value accuracy and system reliability. In most instances, you need only apply a wide band of sonic coupling compound lengthwise on the face of the transducer and stick it

to the outside pipe wall to get good measurement results. However, the following inspections still need to be carried out in order to ensure the high reliability of the measurement and long-term operation of the instrument.

## 4.2.1  Signal Strength

Signal strength (displayed in menu M90) indicates a detected strength of the signal both from upstream and downstream directions. The relevant signal strength is indicated by numbers from 00.0~99.9. 00.0 represents no signal detected while 99.9 represents maximum signal strength.

Normally, the stronger the signal strength detected, the more stable the measurement value obtained.

Fine tune the sensor placement by adjusting the transducers to obtain the maximum signal strength.

System normal (*R) requires signal strength over 60.0, which is detected from both upstream and downstream directions. If the signal strength detected is too low, the transducer installation position and the transducer mounting spacing should be re-adjusted and the pipe should be re-inspected. If necessary, change the mounting method to be Z method.

## 4.2.2  Signal Quality (Q value)

Q value is short for Signal Quality (displayed in menu M90). It indicates the level of the signal detected. Q value is indicated by numbers from 00~99. 00 represents the minimum signal detected while 99 represent the maximum.

The transducer position should be adjusted until the signal quality detected is as strong as possible.

## 4.2.3  Total Time and Delta Time

"Total Time and Delta Time", which displays in menu M93, indicates the condition of the installation. The measurement calculations in the flow meter are based upon these two parameters. Therefore, when "Delta Time" fluctuates widely, the flow and velocities fluctuate accordingly, and the signal quality detected is too poor. It may be the resulted of poor pipe installation conditions, inadequate transducer installation or incorrect parameter input.

Generally, "Delta Time" fluctuation should be less than ±20%. Only when the pipe diameter is too small or velocity is too low can the fluctuation be wider.

## 4.2.4  Transit Time Ratio

Transit Time Ratio indicates the transducer mounting spacing is accurate. The normal transit time ratio should be 100+/-3. Check it in menu M91.

---

**ATTENTION**

If the transit time ratio is over 100±3, it is necessary to check:

(1)    If the parameters (pipe outside diameter, wall thickness, pipe material, liner, etc.) have been entered correctly.

(2)    If the transducer mounting spacing is accordance with the display in menu M25.

(3)    If the transducer is mounted at the pipe's centerline on the same diameter.

(4)    If the scale is too thick or the pipe mounting is distorted in shape, etc.

---

**WARNINGS**

(1)    Pipe parameters entered must be accurate; otherwise the flow meter will not work properly.

(2)    During the installation, apply enough coupling compounds in order to stick the transducers onto the pipe wall. While checking the signal strength and Q value, move the transducers slowly around the mounting site until the strongest signal and maximum Q value can be obtained. Note that the larger the pipe diameter, the more the transducers may have to be

moved

(3)    Check to be sure the mounting spacing is accordance with the display in menu M25 and the transducer is mounted at the pipe's centerline on the same diameter.

(4)    Pay special attention to those pipes with seams, since such pipe is always irregular.

(5)    If the signal strength is always displayed as 0.00, that means there is no signal detected. Thus, it is necessary to check that the parameters (including all the pipe parameters) have been entered accurately. Check to be sure the transducer mounting method has been selected properly, the pipe is not worn-out, and the liner is not too thick. Make sure there is indeed fluid in the pipe or the transducer is not too close to a valve or elbow, and there are not too many air bubbles in the fluid, etc. With the exception of these reasons, if there is still no signal detected, the measurement site has to be changed.

# 5 Operating Instructions

## 5.1    System Normal Identification

Press the [Menu] [zero 0] [sound vel. 8] keys. If the letter "*R" is displayed, it indicates system normal.

- If the letter "E" is displayed, it indicates that the current loop output is over ranged by 100%. This refers to the settings in menu M57. Enter a larger value in Menu M57, and the letter "E" will disappear. It can be ignored if no current loop output is used.
- If the letter "Q" is displayed, it indicates that the frequency output is over ranged by 120%. This refers to the settings in Menu M69. Increase the input value in Menu M69, and the letter "Q" will disappear. It can be ignored if no frequency output is used.
- If the letter "H" is displayed, it indicates that the ultrasonic signal detected is poor. For more information, please refer to "Error Diagnosis".
- If the letter "G" is displayed, it indicates that system is adjusting the signal gain prior to the measurement. Also, it means system normal. Only when the adjustment takes too long without stopping, can the system be identified as abnormal. You will normally see this at start up.

Letter "I" indicates no signal is being detected. Check that the transducer wiring connections are correct, the transducers are installed firmly, etc.

Letter "J" indicates a hardware defect exists. Normally, such a defect is temporary; it can be eliminated by system reboot (power off and restart).

Letter "F" indicates hardware defect.

For further information, please refer to "Error Diagnosis".

## 5.2    Zero Set Calibration

With no movement of liquid in the pipe, the meter should read zero.

For an ultrasonic flow meter, the measurement difference from zero point cannot be ignored at low flow. It is necessary to perform a static zero set calibration to improve low flow measurement accuracy.

Press Menu M42 to set the Zero, press [Enter] first, and then wait the readings displayed at the lower right corner reducing to be "0". If this is carried out with flow, the flow will be displayed as "0", M43 can help to restore factory settings. You should note that, even with no flow, there could still be movement of fluid in the pipe due to temperature or pressure differentials.

## 5.3    Scale Factor

Scale factor refers to the ratio between "actual value" and "reading value". For example, when the measured value is 2.00, and it is indicated as 1.98 on the instrument, the scale factor reading is 2/1.98. This means that the best scale factor constant is 1.

However, it is difficult to keep the scale factor as "1" on the instrument especially in batch productions. The difference is called "consistency".

During operation, there still exists possible difference in pipe parameters, etc. The "scale factor" may be necessary when used on different pipes. Thus, scale factor calibration is specially designed for calibrating the differences that result from application on different pipes. The scale factor entered must be one that results from actual calibration. The scale factor can be input in Menu M45.

## 5.4    System Lock (Unlock)

System lock is readable but un-editable to prevent operation error due to unauthorized tampering.

Press the [Menu] [cool cap. 4] [flow vel. 7] [Enter] keys, if displays "Unlock" on the screen, then press the [Enter] key, enter a 1~4 numerically long password, and then press the [Enter] key to confirm.

Unlock it by using the selected password only. Press [Menu] [cool cap. 4] [flow vel. 7] [Enter] , if displays "lock" on the screen press the [Enter] key and enter the correct password, then press [Enter] to confirm.   Keep the password in mind or recorded in a safe place, otherwise the instrument cannot be used.

## 5.5    4~20mA Current Loop Verification

With a current loop output exceeding an accuracy of 0.1%, the flow meter is programmable and configurable with multiple output modes such as flow rate or fluid velocity. Select in Menu M55. For details, please refer to "Menus Display Explanations".

In Menu M56, enter a 4mA flow rate or fluid velocity value. Enter the 20mA flow rate or fluid velocity value in Menu M57. For example, if the flow range in a specific pipe is 0~1000m3/h, enter 0 in Menu M56 and 1000 in Menu M57.

Calibrating and testing the current loop is performed in Menu M58. Complete the steps as follows:

Press [Menu] [heat cap. 5] [sound vel. 8] [Enter], move [^/+] or [v\-] to display "0mA", "4mA", "8mA", "12mA","16mA", "20mA" readings, connect an ammeter to test the current loop output and calculate the difference. Calibrate it if the difference is within tolerance. If the difference is without tolerance, refer to the "Analog Output Calibration" to calibrate the current loop.

Check the present current loop output in Menu M59 as it changes along with change in flow.

## 5.6    Frequency Output

The flow meter is provided with a frequency output transmitter function. The high or low frequency output displayed indicates the high or low flow rate reading. The user can reset the frequency output as well as flow rate per his requirements.

For example: if a pipe flow range is 0~3000m3/h and the relative frequency output required is 123~1000Hz, the configuration is as follows:
In Menu M68 (low limit frequency output flow value), input 0;
In Menu M69 (high limit frequency output flow value), input 3000;
In Menu M67 (low limit frequency range) input 123 ;( high limit frequency range) input 1000.
There is no output circuit specially assigned to frequency output. It only can be transmitted through OCT, i.e. select the fifth item in Menu M78 (item "5. FO").

Typical OCT (Open Collector Transistor) Output wiring diagram as below:
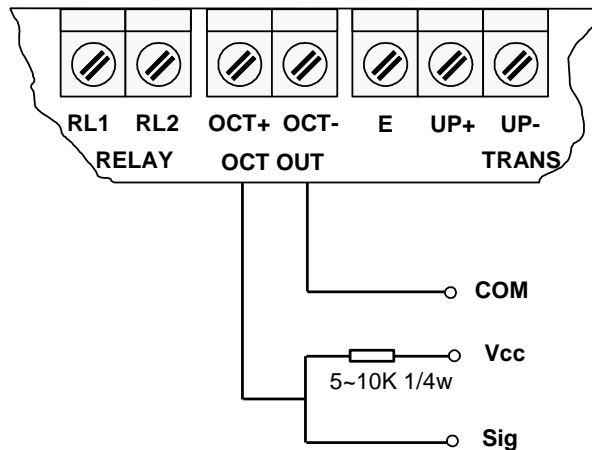


Figure 8. OCT Output Wiring Diagram

## 5.7    Totalizer Pulse Output

Each time the flow meter reaches a unit flow, it may generate a totalizer pulse output to a remote counter.

The totalizer pulse output can be transmitted through OCT or Relay output. So it is necessary to configure OCT or Relay accordingly. (Please refer to Menu M78, M79) For example, if it is necessary to transmit the positive totalize pulse through a Relay, and each pulse represents a flow of 0.1m3; the configuration is as follows:

1.  In Menu M33, select totalizer the flow unit "Cubic Meter (m3)" ;
2.  In Menu M34, select the scale factor "x0.1";
3.  In Menu M79, select "3. Net totalizer pulse output".

## 5.8    Alarm Programming

The on/off output alarm is generated through OCT or Relay output. The on/off output signal is activated under the following conditions:

1.  The transmitter can't receive the ultrasonic signals.
2.  Alarm #1 is out of limit.
3.  Alarm #2 is out of limit.

## 5.9  Recover the Factory Default

Press [Menu] [start/stop 3] [flow vel. 7] to Menu M37, press [cal. .] [diag. <] keys to recover the factory default.

## 5.10  4~20mA Analog Output Calibration

**NOTE**

**Each flow meter has been calibrated before leaving factory. It is unnecessary to carry out this step except when the current value (detected while calibrating the current loop) displayed in Menu M58 is not identical with the actual output current value.**

The hardware detect menu must be activated prior to calibration the Analog Output. The procedure is as follows:

Press [Menu] [v\-] [zero 0] [Enter] enter password "115800", then press [Enter] to activate the detect menu. With no effect to next power on, this menu will close automatically as soon as the power is turned off.

Press [v\-] to calibrate the current loop 4mA output. Use a milliamp meter to measure the current loop output current. At the same time, press [^/+] or [v\-] to adjust the displayed numbers. Watch the ammeter until it reads 4.00. Stop at this point, the 4mA has been calibrated.

Then, press [Enter] to calibrate the current loop 20mA output. The method is the same as 4mA calibration.

The results are automatically saved in EEPROM and won't lose when power off.

## 5.11  ESN

We provide the flow meter with a unique electronic serial number to identify each flow meter for the convenience of the manufacturer and customers. The ESN is able to be viewed in Menu M61.

**ATTENTION**

Other Operation refers to "6.2 Menus Display Explanations".

# 6. Menus Display Explanations

## 6.1. Menus Display Codes

| Flow Totalizer Display | |
|---|---|
| 00 | Flow Rate/Net Totalizer |
| 01 | Flow Rate/Velocity |
| 02 | Flow Rate/POS Totalizer |
| 03 | Flow Rate/NEG Totalizer |
| 04 | Date Time/Flow Rate |
| 08 | System Error Codes |
| 09 | Net Flow Today |
| **Initial Parameter Setup** | |
| 11 | Pipe Outer Diameter |
| 12 | Pipe Wall Thickness |
| 14 | Pipe Material |
| 23 | Transducer Type |
| 24 | Transducer Mounting Method |
| 25 | Transducer Spacing |
| 26 | Parameters Setups |
| 28 | Holding with Poor Sig |
| 29 | Empty Pipe Setup |
| **Flow Units Options** | |
| 30 | Measurement Units |
| 31 | Flow Rate Units |
| 32 | Totalizer Units |
| 33 | Totalizer Multiplier |
| 34 | Net Totalizer |
| 35 | Pos Totalizer |
| 36 | NEG Totalizer |
| 37 | Totalizer Reset |
| 38 | Manual Totalizer |
| **Setup Options** | |
| 40 | Damping |
| 41 | Low Flow Cutoff Value |
| 42 | Set Static Zero |
| 43 | Reset Zero |
| 44 | Manual Zero Point |
| 45 | Scale Factor |
| 46 | Network Identifying Address Code |
| 47 | System Lock |
| **Input and Output Setup** | |
| 55 | CL Mode Select |
| 56 | CL 4mA Output Value |
| 57 | CL 20mA Output Value |

| | |
|---|---|
| 58 | CL Check |
| 59 | CL Current Output |
| 60 | Date and Time |
| 61 | ESN |
| 62 | Serial Port Parameter |
| 63 | Reserved |
| 64 | Reserved |
| 67 | FO Frequency Range |
| 68 | Low FO Flow Rate |
| 69 | High FO Flow Rate |
| 70 | LCD Backlit Option |
| 72 | Working Timer |
| 73 | Alarm #1 Low Value |
| 74 | Alarm #1 High Value |
| 75 | Alarm #2 Low Value |
| 76 | Alarm #2 High Value |
| 77 | Beeper Setup |
| 78 | OCT Output Setup |
| 79 | Relay Output Setup |
| 82 | Date Totalizer |
| 83 | Automatic Correction |
| **Calorimetry** | |
| 84 | Reserved |
| 85 | Reserved |
| 86 | Reserved |
| 87 | Reserved |
| 88 | Reserved |
| 89 | Reserved |
| **Diagnosis** | |
| 90 | Signal Strength and Quality |
| 91 | TOM/TOS*100 |
| 92 | Fluid Sound Velocity |
| 93 | Total Time and Delta |
| 94 | Reynolds Number and Factor |
| **Appendix** | |
| +0 | Power ON/OFF Time |
| +1 | Total Working Hours |
| +2 | Last Power Off Time |
| +3 | Last Flow Rate |
| +4 | ON/OFF Times |
| -0 | Hardware Adjusting Entry |

**NOTE**：**The other menu features are retained by manufacturers and the menus in gray background are optional functions.**

## 6.2. Display Explanation

While reading this section, please compare it with the instrument in order to improve your understanding.

`Menu` `zero 0` `zero 0`

Flow Rate ／ Net Totalizer

Display flow rate and net totalizer.

If the net totalizer has been turned off (refer to M34), the net totalizer value displayed is the total prior to its turn off.

```
Flow  0.1154 m3/h     * R
NET    0 x 1m3
```

`Menu` `zero 0` `rate 1`

Flow Rate ／ Velocity

Display flow rate and velocity.

```
Flow  0.1129 m3/h     * R
Vel     1.0415 m/s
```

`Menu` `zero 0` `total 2`

Flow Rate  ／ Positive Totalizer

Display flow rate and positive totalizer.

Select the positive totalizer units in Menu M31.

If the positive totalizer has been turned off, the positive totalizer value displayed is the total prior to its turn off.

```
Flow   0.1129 m3/h    * R
POS          0 x 1m3
```

`Menu` `zero 0` `start/stop 3`

Flow Rate ／ Negative Totalizer

Display flow rate and negative totalizer.

Select the negative totalizer value in Menu M31.

If the negative totalizer has been turned off (refer to M36), the value displayed is the total prior to turn off.

```
Flow    0.1120 m3/h   * R
NEG          0 x 1m3
```

`Menu` `zero 0` `cool cap. 4`

Date Time ／ Flow Rate

Display the current date time and flow rate.

The time setting method can be found in Menu M60.

```
03-04-03  15:49:40 * R
Flow    0.1116  m3/h
```

`Menu` `zero 0` `sound vel. 8`

System Error Codes

Display the working condition and the system error codes. More than one error code can occur at the same time.

The explanations of error codes and detailed resolution methods can be found in "Error Diagnoses".

```
*R - - - - - - - - - - - - -
System  Normal
```

`Menu` `zero 0` `signal 9`

Net Flow Today

Display net total flow today.

```
Net Flow Today    M09
       0.458748     m3
```

Menu rate 1 rate 1

Pipe Outer Diameter

Enter the pipe outside diameter or enter the pipe circumference in Menu M10. The pipe outside diameter must range from 51mm to 6000mm.

Note: Enter either pipe outside diameter or pipe circumference.

```
Pipe Outer Diameter
        50  mm
```

Menu rate 1 total 2

Pipe Wall Thickness

Enter the pipe wall thickness.

```
Pipe Wall Thickness
         4  mm
```

Menu rate 1 cool cap. 4

Pipe Material

Enter pipe material. The following options are available by ^/+ and v\- buttons or numerical keys:

| | | | |
|---|---|---|---|
| 0. | Carbon Steel | 1. | Stainless Steel |
| 2. | Cast Iron | 3. | Ductile Iron |
| 4. | Copper | 5. | PVC |
| 6. | Aluminum | 7. | Asbestos |
| 8. | Fiber Glass-Epoxy | | |

```
Pipe Material     [14
  0. Carbon Steel
```

Menu total 2 start/ stop 3

Transducer Type
  0. Standard
  1. Ty-45B
"Standard" is clamp-on type transducer，"Ty-45B" is WS inserted type transducer(optional).

```
Transducer Type [23
  0. Standard
```

Menu total 2 cool cap. 4

Transducer Mounting

Four mounting methods are available:

  0. V
  1. Z use
  2. N (for small pipe)

```
Transducer Mounting
  0.         V
```

Menu total 2 heat cap. 5

Transducer Spacing

The operator must mount the transducer according to the transducer spacing displayed (be sure that the transducer spacing must be measured precisely during installation). The system will display the data automatically after the pipe parameter had been entered.

```
Transducer Spacing
     148.666  mm
```

28

Menu total 2 temp 6

Initial Parameter Setups and Save

Load and save the parameters. 18 different sets of setup conditions/groups are available to load and save by three methods (i.e.-you can load and save 18 different applications):

0.  Entry to Save
1.  Entry to Load
2.  To Browse

Select "Entry to Save", press Enter. An ID code and the original parameters are displayed in the menu. Press ^/+ or ∨\- to move the ID code, then press the Enter key again to save the current parameter in the current ID room.

When selecting "Entry to Load", press Enter, and the system will read and calculate the parameters automatically and display the transducer mounting spacing in Menu M25.

Menu total 2 sound vel. 8

Holding with Poor Sig

Select "Yes" to hold last good flow signal displayed if the Flow meter experiences a poor signal condition. This function will allow continued data calculation without interruption.

Menu total 2 signal 9

Empty Pipe Setup

This parameter is used to overcome the possible problems that usually show up when the pipe being measured is empty. Since signals can be transmitted through the pipe wall, the flow meter may still read a flow while measuring an empty pipe. To prevent this from happening, you can specify a value. When the signal quality falls below this value, the measurement stops automatically. If the flow meter is already able to stop measuring when the pipe is empty, a value in the range of 30 to 40 should also be entered in this menu to ensure no measurement when the pipe is empty.

* It should be understood that the instrument is NOT designed to function correctly on an empty pipe.

Menu start/ stop 3 zero 0

Measurement Units Options

Select the measurement unit as follows:

0.  Metric
1.  English

```
Parameter   Setups
   Entry  to  SAVE
```

```
Holding with Poor Sig
          NO
```

```
Empty Pipe Setup [29
          0
```

Factory default is metric.

```
Measurement Units In
   0.   Metric
```

Menu start/stop 3 rate 1

**Flow Rate Units Options**

The following flow rate units are available:

    0. Cubic Meters      (m3)
    1. Liters            (1)
    2. USA   Gallons     (GAL)
    3. Imperial Gallons  (Imp gal)
    4. Million Gallons   (mg)
    5. Cubic Feet        (cf)
    6. USA Barrels       (US bbl)
    7. Imperial Barrels  (Imp bbl)
    8. Oil Barrels       (Oil bbl)

The following time units are available:

    /Day              /Hour

    /Min              /Sec

Factory default is Cubic Meters/hour

```
Flow Rate Units    [31
           m3/h
```

Menu start/stop 3 total 2

**Totalizer Units Options**

Select totalizer units. The available unit options are as same as those found in Menu M31. The user can select units as their requirement. Factory default is Cubic Meters.

```
Totalizer   Units  [32
     Cubic  Meter (m3)
```

Menu start/stop 3 start/stop 3

**Totalizer Multiplier Options**

The totalizer multiplier acts as the function to increase the totalizer indicating range. Meanwhile, the totalizer multiplier can be applied to the positive totalizer, negative totalizer and net totalizer at the same time. The following options are available:

    0. X0.001(1E-3)
    1. X0.01
    2. X0.1
    3. X1
    4. X10
    5. X100
    6. X1000
    7. X10000(1E+4)

Factory default factor is x1.

```
Totalizer   Multiplier
    0.   x0.001(1E-3)
```

Menu start/stop 3 cool cap. 4

**ON/OFF Net Totalizer**

On/off Net Totalizer. "ON" indicates the totalizer is turned on, while "OFF" indicates it is turned off. When it is turned off, the net totalizer displays in Menu M00 will not change. Factory default is "ON".

```
Net   Totalizer    [34
           ON
```

Menu start/stop 3 heat cap. 5

ON/OFF POS Totalizer

On/off POS Totalizer. "ON" indicates the Flow meter starts to totalize the value. When it is turned off, the positive totalizer displays in Menu M02 will not change. Factory default is "ON".

```
POS  Totalizer     [35
          ON
```

Menu start/stop 3 temp 6

ON/OFF NGE Totalizer

On /off NGE Totalizer. "On" indicates the totalizer is turned on. When it is turned off, the negative totalizer displays in Menu M03 will not change.

Factory default is "ON".

```
NEG  Totalizer     [36
          ON
```

Menu start/stop 3 flow vel. 7

Totalizer Reset

Totalizer reset; all parameters are reset. Press Enter; press ^/+ or v\- arrow to select "YES" or "NO". After "YES" is selected, the following options are available:

```
Totalizer Reset? [37
       Selection
```

None: No reset

All: Reset all totalizers

NET Totalizer Reset

POS Totalizer Reset

NEG Totalizer Reset

Press cal. . diag. < to reset all parameter back to simplified defaults.

---

⚠ **Attention**

This operation will delete the entire user's data and reset as the factory default. Please consider carefully before taking this operation.

---

Menu start/stop 3 sound vel. 8

Manual Totalizer

The manual totalizer is a separate totalizer. Press Enter to start, and press Enter to stop it. It is used for flow measurement and calculation.

```
Manual Totalizer    [38
Press ENT When Ready
```

Menu | cool cap. 4 | zero 0

Damping Factor

The damping factor ranges from $0\sim999$ seconds. 0 indicates no damping; 999 indicates the maximum damping.

The damping function will stabilize the flow display.

Its principle is the same as that in a single-section RC filter. The damping factor value corresponds to the circuit time constant.

Usually a damping factor of 3 to 10 is recommended in applications.

```
Damping          [40
       10  sec
```

Menu | cool cap. 4 | rate 1

Low Flow Cutoff Value

Low Flow Cutoff is used to make the system display as "0" value at lower and smaller flows to avoid any invalid totalizing. For example, if the cutoff value is set as 0.03, system will take all the measured flow values below ±0.03 as "0". Usually 0.03 is recommended in most applications.

```
Low Flow Cutoff  Val.
      0.01 m/s
```

Menu | cool cap. 4 | total 2

Set Static State Zero

When fluid is in the static state, the displayed value is called "Zero Point". When "Zero Point' is not at zero in the Flow meter, the difference is going to be added into the actual flow values and measurement differences will occur in the Flow meter.

Set zero must be carried out after the transducers are installed and the flow inside the pipe is in the absolute static state (no liquid movement in the pipe). Thus, the "Zero Point" resulting from different pipe mounting locations and parameters can be eliminated. The measuring accuracy at low flow is enhanced by doing this and flow offset is eliminated. Press Enter, wait for the processing instructions at the right corner bottom to reach 0.

Performing Set zero with existing flow may cause the flow to be displayed as "0". If so, it can be recovered via Menu M43.

```
Set Zero          [42
     Press ENT to go
```

Menu | cool cap. 4 | start/ stop 3

Reset Zero

Select "YES"; reset "Zero Point" which was set by the user.

```
Reset  Zero        [43
           NO
```

Menu [cool cap. 4] [cool cap. 4]

Manual Zero Point

This method is not commonly used. It is only suitable for experienced operators to set zero under conditions when it is not preferable to use other methods. Enter the value manually to add to the measured value to obtain the actual value. For example:

Actual measured value　　＝250 m3/H
Value Deviation　　　＝-10 m3/H

Flow meter Display　＝　　　240　　　m3/H

Normally, set the value as "0".

```
Manual Zero Point [44
          0 m3/h
```

Menu [cool cap. 4] [heat cap. 5]

Scale Factor

The scale factor is used to modify the measurement results. The user can enter a numerical value other than "1" according to the actual calibration results.

```
Scale Factor      [45
          1
```

Menu [cool cap. 4] [temp. 6]

Network IDN

Input system identifying code, these numbers can be selected from 0～65535 except that 13 (0DH ENTER), 10 (0AH Newline), 42 (2AH＊) and 38 (26H&) are reserved. System IDN is used to identify the flow meter to a network

```
Network  IDN     [46
          88
```

Menu [cool cap. 4] [flow vel. 7]

System Lock

Lock the instrument.

Once the system is locked, any modification to th e system is prohibited, but the parameter is reada ble. "Unlock" using your designated password.
The password is composed of 1 to 4 numbers.

```
System Lock      [47
**** Unlocked ****
```

Menu [heat cap. 5] [heat cap. 5]

Current Loop Mode Select

```
CL Mode Select [55
  0.  4 -  20 mA
```

Select the current loop mode. The following options are available:

　0.　4-20mA Output Mode　　　　　set up the 4-20mA output to be flow rate mode
　1.　4-20mA vs. Vel.　　　　　set up the 4-20mA output to be flow velocity mode
　2.　4-20mA vs. Energy　　　　　set up the 4-20mA output to be energy mode

Other different current output characteristics are displayed in below figures. The user can select one of them according to his actual requirements.

| 4-20mA mode output | Fluid velocity / 4-20mA mode output |
|---|---|
|  |  |
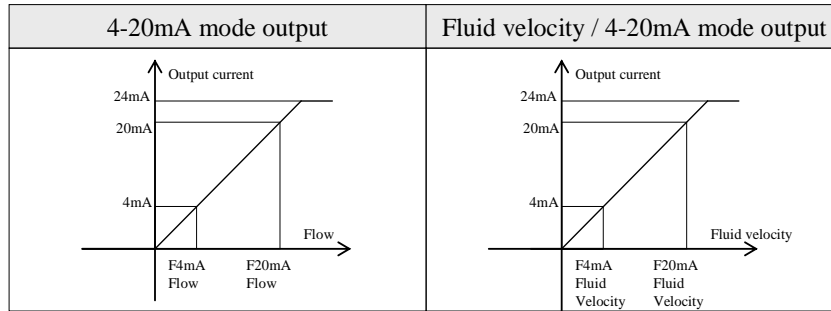
In two graphs shown above, flow $F_{4mA}$ indicates the value that the user entered in Menu M57; and flow $F_{20mA}$ indicates the value that the user entered in Menu M58. In the 4-20mA modes, $F_{4mA}$ and $F_{20mA}$ can be selected as a positive or negative flow value as long as the two values are not the same.

In 4-20mA flow rate mode, the output current is indicated as velocity. In 4-20mA energy mode, the output is indicated as energy.

[Menu] [heat cap. 5] [temp 6]

**CL 4mA Output Value**

Set the CL output value according to the flow value at 4mA. The flow unit's options are the same as those in Menu M31. Once "4-20mA vs. Vel." is selected in Menu M56, the unit should be set as m/s.

```
CL 4 mA Output Value
             0 m3/h
```

[Menu] [heat cap. 5] [flow vel. 7]
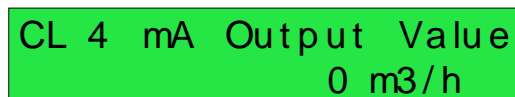
**20mA Output Value**

Set the CL output value according to the flow value at 20mA. the flow unit is the same as that found in Menu M31. Once "4-20mA vs. Vel." is selected in Menu M57, the unit should be set as m/s.

```
CL 20mA Output Value
         14400 m3/h
```

[Menu] [heat cap. 5] [sound vel. 8]
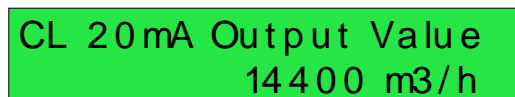
**CL Check Verification**

Check if the current loop has been calibrated before leaving the factory. Press [Enter] to start, press [∧/+] to display 0mA, 4mA, 8mA, 12mA, 16mA, 20mA, and at the same time, check with an ammeter to measure the current loop output current and calculate the differences to see if it is under the permitted tolerance. If not, refer to the "Analog Output Calibration" to calibrate.

```
CL Checkup        [58
Press ENT WhenReady
```

[Menu] [heat cap. 5] [sound vel. 8]

**CL Current Output**

Display CL current output. The display of 10.0000mA indicates that CL current output value is 10.0000mA.

If the difference between displaying value and CL output value is too large, the current loop then needs to be re-calibrated accordingly.

```
CL Current Output [59
           15.661 mA
```

[Menu] [temp 6] [zero 0]
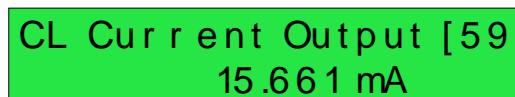
Date and Time Settings

Date and time modifications are made in this menu. The format for setting time setting is 24 hours. Press [Enter], wait until ">" appears, the modification can be made.

```
YY- MM- DD    HH:MM:SS
03- 04- 04    10:05:04
```

[Menu] [temp 6] [rate 1]

ESN

Display electronic serial number (ESN) of the instrument. This ESN is the only one assigned to each flow meter ready to leave the factory. The factory uses it for files setup and the user uses it for management.

```
Ultrasonic  Flowmeter
  S/N= 05071188
```

[Menu] [temp 6] [total 2]

Serial Port Settings

This menu is used for serial port setting. Serial port is used to communicate with other instruments.

The serial port parameters setting of the instrument that applies the serial port connection must be consistence. The first selected data indicates baud rate, 9600, 19200, 38400, 56000, 57600, 115200 are available.

The second option indicates parity bit, None (No verification).
Data length fixed to 8;
The factory default serial port parameter is "9600, None"
Stop bit length for a fixed length.

```
RS- 232  Setup    [62
  9600,        None
```

[Menu] [temp 6] [start/stop 3]

AI1 Analog Input Value Range

This menu is for entering Analog Input 4mA and 20mA for temperature or pressure value.

```
AI 1 Value Range  [63
  10  -  100
```

[Menu] [temp 6] [cool cap. 4]

AI2 Analog Input Value Range

This menu is for entering Analog Input 4mA and 20mA for temperature or pressure value.

```
AI 2 Value Range  [64
  10  -  100
```

[Menu] [temp 6] [flow vel. 7]

Set FO Frequency Range

Set up high FO frequency range. It must be higher than the low FO frequency. Ranges from 1-9999Hz. Factory default is 1~1001 Hz.

Note: The frequency output is transmitted through OCT Serial Port; therefore the OCT must be set to the frequency output mode.

```
FO Frequency  Range
  1  -  5000
```

Menu temp 6 sound vel. 8

Low FO Flow Rate

Set up low FO flow rate, i.e. the corresponding flow value when output signal frequency is at the lowest FO frequency. For example, when the low FO frequency is 1000Hz, low FO flow rate is 100m3/h then when the frequency output is 1000Hz, the low flow at this moment measured by the Flow meter is 100m3/h.

```
Low FO Flow Rate [68
        0  m3/h
```

Menu temp 6 signal 9

High FO Flow Rate

Enter the high FO flow rate, i.e. the corresponding flow value when frequency output signal is at highest FO frequency. For example, when the low FO frequency is 3000Hz, low FO flow rate is 1000m3/h then when the frequency output is 3000Hz, the low flow at this moment measured by the Flow meter is 1000 m3/h

.

```
High FO Flow Rate [69
     26550 m3/h
```

Menu flow vel. 7 zero 0

LCD Backlit Option

Select LCD backlit controls.

   0.   Always OFF,

   1.   Always ON,

   2.   Lighting for nn sec

Keeping the backlight off can save about 30mA of power.

```
LCD  Backlit  Option
 0.    Always ON
```

Menu flow vel. 7 total 2

Working Timer

Display the totalized working hours of the Flow meter since last reset. It is displayed by HH:MM:SS. If it is necessary to reset it, press Enter, and select "YES".

```
Working Timer   [72
  000000 11:16:38
```

Menu flow vel. 7 start/ stop 3

Alarm #1 Low Value

Enter the low alarm value. Relevant alarm is turned on in Menus M78 and M79; any of the measured flow, which is lower than the low value, will activate the alarm in the OCT hardware or Relay output signal.

```
Alarm #1  Low  Value
        0  m3/h
```

36

Menu | flow vel. 7 | cool cap. 4

Alarm #1 High Value

Enter the high alarm value. Relevant alarm is turned on in Menus M78 and M79; any of the measured flow, which is higher than the high value, will activate the alarm in the OCT hardware or Relay output signal.

```
Alarm #1 High Value
          14400   m3/h
```

Menu | flow vel. 7 | heat cap. 5

Alarm #2 Low Value

Enter the low alarm value. Relevant alarm is turned on in Menus M78 and M79; any of the measured flow, which is lower than the low value, will activate the alarm in the OCT hardware or Relay output signal.

```
Alarm #2 Low Value
              0   m3/h
```

Menu | flow vel. 7 | temp 6

Alarm #2 High Value

Enter the high alarm value. Relevant alarm is turned on in Menus M78 and M79; any of the measured

flow, which is higher than the high value, will activate the alarm in the OCT hardware or Relay output signal.

```
Alarm #2 High Value
          14400   m3/h
```

Menu | flow vel. 7 | flow vel. 7

Beeper Setup

Set up the beeper on-off state.
   0.   ON                  Beeper ON
   1.   OFF                 Beeper OFF

```
BEEPER Setup    [77
0.         ON
```

Menu | flow vel. 7 | sound vel. 8

OCT Output Setup

Set up the output trigger event sources of the OCT hardware output components.

The following signal options are available:

```
OCT Output Setup [78
  0.Not Ready(NO* R)
```

| 1.   Not Ready(NO*R) | 2.   Alarm   #1 |
|---|---|
| 3.   Alarm   #2 | 4.   NET Int Pulse |
| 5.   Energy Pulse | 6.   FO |

Menu | flow vel. 7 | signal 9

Relay Output Setup

Set up the output trigger event sources of the OCT hardware output components. RELAY is single-tool for controlling the external device.

The following signal options are available:

```
RELAY  Output   Setup
  0.Not Ready(NO * R)
```

| 0.   Not Ready(NO*R) | 1.   Alarm   #1 |
|---|---|
| 2.   Alarm   #2 | 3.   NET Int Pulse |

37

Menu `sound vel. 8` `total 2`

Date Totalizer

In this menu, it is possible to review the historical flow data totalizer for any day of the last 64 days, any month of the last 64 months and any year of the last 5 years.Press `Enter`, use the `^/+` or `v\-` to review totalizer in days, months and years; "0" for day, "1" for month, and "2" for year. Use the `^/+` or `v\-` to review the totalizer in some day, some month, some year.

For example, to display the flow total for July 18, 2000, the display "-----------" at the upper right corner of the screen indicates that it was working properly the whole day. On the contrary, if "G" is displayed, it indicates that the instrument gain was adjusted at least once. Probably it was offline once on that day. If "H" is displayed, it indicates that poor signal was detected at least once. Also, it indicates that the operation was interrupted or problems occurred in the installation.

For info please refer to "Error Code and Resolutions".

Menu `sound vel. 8` `start/ stop 3`

Automatic Flow Correction

With the function of automatic flow correction, the flow lost in an offline session can be estimated and automatically adjusted. The estimate is based on the average value, which is obtained from flow rate before going offline and flow measured after going online the next time, multiplied times the time period that the meter was offline. Select "ON" to use this function

and "OFF" to cancel this function Normally, signal quality Q value should be better than 50.

Menu `signal 9` `zero 0`

Signal Strength and Signal Quality

Display the measured signal strength and signal quality Q value upstream and downstream.

Signal strength is indicated from 00.0 ～ 99.9. A reading of 00.0 indicates no signal detected, while

99.9 indicates maximum signal strength. Normally the signal strength should be ≥60.0. Signal quality Q is indicated by 00 ～ 99. Therefore, 00 indicates the poorest signal while 99 indicates the best signal.

During the installation, pay attention to the signal strength and signal quality, the higher, the better. The strong signal strength and high quality value can ensure the long-term stability and the high accuracy of the measurement results.

```
Date  Totalizer    [82
  0.    Day
```

```
00 03-04-05 G-H-I
- 0 m3
```

```
00 03-04-05 ------
>4356.78 m3
```

```
Automatic Correction
      YES
```

```
Strength+Quality [90
UP:00.0 DN:00.0   Q=00
```

[Menu] [signal 9] [rate 1]

TOM/TOS*100

Display the ratio between the actual measured transmit time and the calculated transmit time according to customer's requirement. Normally the ratio should be 100±3％. If the difference is too large, the user should check whether the parameters are entered correctly, especially the sound velocity of the fluid and the installation of the transducers. This data is of no use before the system is ready.

TOM/TOS* 100          [ 9 1
          0.0000%

[Menu] [signal 9] [total 2]

Fluid Sound Velocity

Display the measured fluid sound velocity. Normally this value should be approximately equal to the entered value in Menu M21. If the difference is too large, it probably results from an incorrect value entered in Menu M21 or improper installation of the transducers.

Fluid  Sound  Velocity
       1443.4     m/s

[Menu] [signal 9] [start/stop 3]

Total Time and Delta Time

Display the measured ultrasonic average time (unit:

uS) and delta time of the upstream and downstream (unit: nS) time. The velocity calculation in the Flow meter is based on the two readings.   The delta time is the best indication that the instrument is running steadily. Normally the fluctuation in the ratio of the delta time should be lower than 20%. If it is not, it is necessary to check if the transducers are installed properly or if the parameters have been entered correctly.

Totl Time,Delta Time
8.9149uS,-171.09nS

[Menu] [signal 9] [cool cap. 4]

Reynolds Number and Factor

Display the Reynolds number that is calculated by the Flow meter and the factor that is set currently by the Flow meter. Normally this scaling factor is the average of the line and surface velocity factor inside the pipe.

Reynolds Number  [94
 0.0000        1.0000

[Menu] [∧/+] [zero 0]

corner.

Power ON/OFF Time

To view the power on/off time and flow rate for the last 64 update times to obtain the offline time period and the corresponding flow rate. Enter the menu, press [Enter] and [∧/+] to display the last update before the last 64 times of on/off time and flow rate values. "ON" on right hand indicates that time power is on; "00" on the upper left corner indicates "00-07-18 12:40:12" the date time; flow rate is displayed in the lower right

ON/OFF Time       [+0
Press ENT When Ready

00-07 18   12:40:12
* ON 123.65 m3/h

[Menu] [∧/+] [rate 1]

Total Working Hours

With this function, it is possible to view the total working hours since the flow meter left the factory. The figure on the right indicates that the total working

hours since the flow meter left the factory is 1107 hours 1 minute 41 seconds.

```
Total Work Hours  [+1
  00001107:01:41
```

[Menu] [∧/+] [total 2]

Last Power Off Time

Display the last power off time.

```
Last Power Off Time
  03-04-04    11:33:02
```

[Menu] [∧/+] [start/stop 3]

Last Flow Rate

Display the last flow rate.

```
Last Flow Rate     [+3
  100.43    m3/h
```

[Menu] [∧/+] [cool cap. 4]

Total ON/OFF Times

Display total on/off times since the flow meter left the factory.

```
ON/OFF Times     [+4
                 40
```

[Menu] [∨\-] [zero 0]

Analog Output Verification

Please refer to the 5.5 "4~20mA Analog Output Verification (optional)"

```
Hardware Adjusting
    Entry
```

# 7. Error Diagnosis

The ultrasonic flow meter has advanced self-diagnostics functions and displays any errors in the upper right corner of the LCD via definite codes in a date/time order. Hardware error diagnostics are usually performed upon each power on. Some errors can be detected during normal operation. Undetectable errors caused by incorrect settings and unsuitable measurement conditions can be displayed accordingly. This function helps to detect the errors and determine causes quickly; thus, problems can be solved in a timely manner according to the solutions listed in the following tables.

Errors displayed in the flow meter are divided into two categories:

Table 1 is for errors displayed during self-diagnostics upon power on. "* F" may be displayed on the upper left corner of the screen after entering the measuring mode. When this occurs, it is necessary to power on for self-diagnostics once again to detect and solve possible errors using the table below. If a problem still exists, please contact the factory or the factory's local representative for assistance.

Table 2 applies when errors caused by incorrect settings and signals are detected and are announced by error codes displayed in Menu M08.

## 7.1 Table 1. Self-diagnosis and Error Solutions (upon power on)

| LCD Display | Cause | Solution |
|---|---|---|
| Rom Parity Error | System ROM illegal or error | Contact the factory |
| Stored Data Error | System stored data block error | Power on again or contact the factory |
| SCPU Fatal Error | SCPU circuit fatal error | Power on again or contact the factory |
| Timer Slow Error<br>Timer Fast Error | System clock error | Contact the factory |
| CPU or IRQ Error | CPU or IRQ problem | Power on again |
| System RAM Error | System RAM questionable | Power on again or contact the factory |
| Time or Bat Error | System date time chip error | Power on again or contact the factory |
| No Display, Erratic or Abnormal Operation | Bad wiring connection | Check wiring connections |
| Stroke Key - No Response | Keypad locked or bad plug connection | Enter the unlock password if the keypad is locked |

## 7.2 Table 2. Error Codes and Solutions (during operation)

| Code | M08 Display | Cause | Solution |
|------|-------------|-------|----------|
| *R | System Normal | System normal | No errors |
| *J | SCPU Fatal Error | Hardware defect | Contact the factory |
| *I | Signal Not Detected | Signal not detected. | Attach transducer to the pipe and tighten it securely. Apply a plenty of coupling compound on transducer and pipe wall. |
| | | Spacing is not correct between the transducers or not enough coupling compound applied to face of transducers. | Remove any rust, scale, or loose paint from the pipe surface. Clean it with a file. |
| | | Transducers installed improperly. | Check the initial parameter settings. |
| | | Scale is too thick. | Remove the scale or change the scaled pipe section. Normally, it is possible to change a measurement location. The instrument may run properly at a new site with less scale. |
| | | New pipe liner. | Wait until liners solidified and saturated. |
| *H | Low Signal Strength | Low signal strength. Cause refers to above-mentioned reasons. | Solution refers to above-mentioned solutions. |
| *H | Poor Signal Quality | Poor signal quality All reasons are included in the above-mentioned causes. | Solution refers to above-mentioned solutions. |
| *F | Refer to Table 1. | Error in self-diagnoses during power on. | Power on again; resolve it by the method listed in Table 1. If it is still a problem, contact the factory. |
| | | Permanent hardware error. | Contact the factory. |
| *G | Adjusting Gain>S1 Adjusting Gain>S2 Adjusting Gain>S3 Adjusting Gain>S4 (Display in Menus M00,M01,M02,M03) | Adjusting gain for normal measurement. Stop in S1 or S2 and only switch between S1 and S2 indicates a poor waveform or low signal strength. All reasons may be included in above-mentioned items. | |
| *K | Pipe Empty. Set in Menu M29 | No fluid in pipe or settings incorrect. | Once fluid is detected in the pipe, set 0 in Menu M29. |

## 7.2 Frequently Asked Questions and Answers

Question: New pipe, high quality material, and all installation requirements met: why still no signal detected?

Answer: Check pipe parameter settings, installation method and wiring connections. Confirm if the coupling compound is applied adequately, the pipe is full of liquid, transducer spacing agrees with the screen readings and the transducers are installed in the right direction.

Question: Old pipe with heavy scale inside, no signal or poor signal detected: how can it be resolved?

Answer: Check if the pipe is full of fluid. Try the Z method for transducer installation (If the pipe is too close to a wall, or it is necessary to install the transducers on a vertical or inclined pipe with flow upwards instead of on a horizontal pipe).

Carefully select a good pipe section and fully clean it, apply a wide band of coupling compound on each transducer face (bottom) and install the transducer properly.

Slowly and slightly move each transducer with respect to each other around the installation point until the maximum signal is detected. Be careful that the new installation location is free of scale inside the pipe and that the pipe is concentric (not distorted) so that the sound waves do not bounce outside of the proposed area.

For pipe with thick scale inside or outside, try to clean the scale off, if it is accessible from the inside. (Note: Sometimes this method might not work and sound wave transmission is not possible because of the layer of scale between the transducers and pipe inside wall).

Question: Why is the flow rate still displayed as zero while there is fluid obviously inside the pipe and a symbol of "R" displayed on the screen?

Answer: Check to see if "Set Zero" was carried out with fluid flowing inside the pipe (Refer to Menu M42). If it is confirmed, recover the factory default in Menu M43.

# 8. Product Overview

## 8.1    Theory of Operation

When the ultrasonic signal is transmitted through the flowing liquid, there will be a difference between the upstream and downstream transit time (travel time or time of flight), which is proportional to flow velocity, according to the formula below.

$$V = \frac{MD}{\sin 2\theta} \times \frac{\Delta T}{T_{up} \bullet T_{down}}$$

$\Delta T = T_{up} - T_{down}$

Remarks:

| | |
|---|---|
| $V$ | Medium Velocity |
| $M$ | Ultrasonic frequency of reflection |
| $D$ | Pipe Diameter |
| $\theta$ | The angle between the ultrasonic signal and the flow |
| $T_{up}$ | Transit time in the forward direction |
| $T_{down}$ | Transit time in the reverse direction |
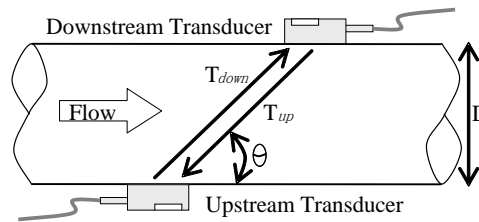
# 8.2   Specifications

## PERFORMANCE SPECIFICATIONS

**Accuracy**
+/- 1.0% of reading from 1.6 to 40 ft/s (0.49 to 12 m/s)

**Repeatability**
+/- 0.3% of reading

**Pipe Size**
2 to 48 inches (50.8 to 1200 mm)

## OPERATION SPECIFICATIONS

**Flow Range**
1.6 to 40 ft/s (0.49 to 12 m/s)

**Temperature**
Ambient: 14°F to 122°F (-10°C to 50°C)
Operating:  32°F to 140°F (0°C to 60°C)

**Power Supply**
10 to 36 VDC at 1A

**Output**
Analog:          4 to 20 mA current loop (max load 750 Ω)
Pulse output:   0 to 9999 Hz, OCT, (min. and max.
                frequency is adjustable)
Relay output:   SPST, max 1 Hz, (0.3 A@ 125VAC or 1A @
                30VDC)
Digital output:  Modbus RTU, RS-485

**Keypad**
16 tactile keys with 12 dual-function keys for easy setup

**Display**
40 character, 2 line (20×2) lattice alphanumeric, backlit LCD

**Humidity**
Up to 99% RH (non-condensing)

## PHYSICAL SPECIFICATIONS

**Transmitter**
NEMA 4X, IP 65 (PC/ABS)

**Transducer**
Encapsulated design IP 68
Standard cable length: 30 ft (9 m)
Maximum cable length: 100 ft (30 m)

**Weight**
Transmitter: approximately 1.5 lb. (.7 kg)
Transducer: approximately 0.9 lb. (0.4 kg)

## DIMENSIONS

**Front View 203 Transmitter**
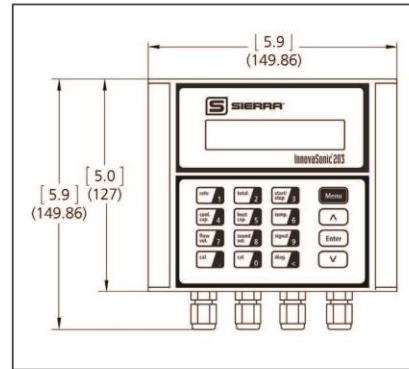
**Side View 203 Transmitter**
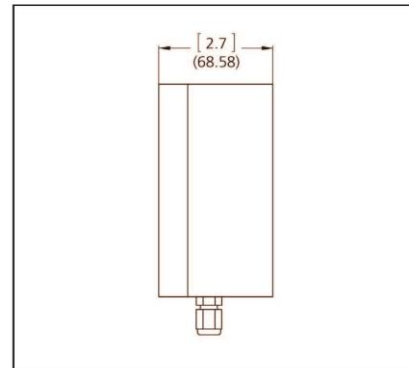
**Front View Clamp-on Transducers**

3

## OPTIMAL INSTALLATION LOCATIONS

### Transducer Installation Examples



Installing the Transducers (example)
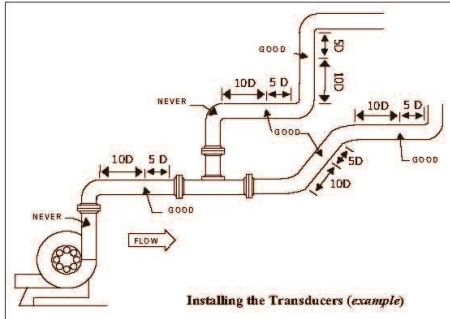


## TRANSDUCER SPACING REQUIREMENTS

### Z Method Transducer Spacing



### V Method Transducer Spacing

```
          ┌ Features ┐    Option
          ┌──────┐ ┌──────┐ ┌──────┐
   203  - │      │-│      │-│      │
          └──────┘ └──────┘ └──────┘
             1        2
```
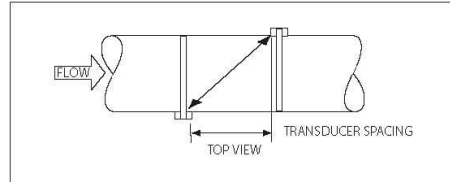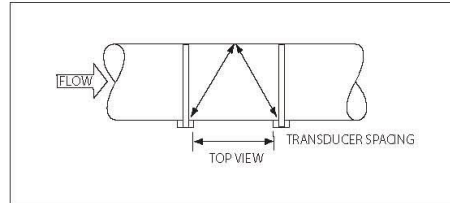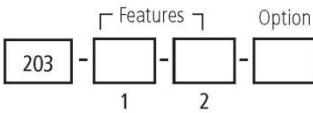
Instructions: To order the 203, please fill in each number block by selecting the codes from the corresponding features below.

| Parent Number | |
| --- | --- |
| 203 | InnovaSonic 203® Economical ultrasonic transit time liquid flow meter; clamp-on transducers (CP) included in base price. |

| Feature 1: Outputs | |
| --- | --- |
| 4 | OCT, Relay, RS-485, 4 to 20 mA current loop (max load 750 Ω), Modbus RTU |

| Feature 2: Transducers | |
| --- | --- |
| CP | Clamp-on transducers. Operating temperature 32°F to 140°F (0°C to 60°C). Standard 30 ft. (9 m). Included in base price. |
| CP (X) | Special length up to 100 ft. (30 m) |

Note: Transducers included in base price.

| Option: NIST Traceable Certificate | |
| --- | --- |
| NIST | 5-point calibration certification traceable to NIST. Add two weeks to standard delivery. |

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# 9. Appendix1-Serial Interface Network Use and Communications Protocol

## 9.1 Overview

The flow meter comes standard with a RS-485 multi-drop communication port. An option RS-232 communication connection is available as a special. RS-232 can be used for point to point (one master one slave 203) communication only with wire runs of 50 feet or less. The RS-485 can be used to communicate over 1,000 meters baud rate dependent with several 203 slaves on one wire pair. This could be up to 30, 203s on one RS-485 segment, and 127 on a whole RS-485 network.

When the RS-485 communication method is used to implement a monitoring system network, the address identification code (in menu M46) of the flow meter is used to set the Network ID in the 203 slave.

When using digital commutations the analog current loop and OCT output of flow meter can be free to be used to control the opening of a control valve. The relay output can be used to power-on/off other equipment. The analog input of the system can be used to input signals such as pressure and temperature. These analog values can be read using the Modbus RTU protocol to be used by customer software.

RS-232 (<50 ft.) or RS-485 (up to 4,000 ft.) can be directly used for data transmission link for a short distance. Current loop, radio transmission and modems can be used in medium or very long distance transmission.

When the flow meter is used in a network environment, various operations can be performed at the host device, except for programming of the address identification code, which needs to be done at the flow meter keyboard. The command answer mode is used in data transmission, i.e. the host device issues commands and the flow meter answers correspondingly (polling communications).

> ⚠️ **ATTENTION**
> RS-232 and RS-485 serial communications cannot be used at the same time.

## 9.2 Serial Port Pin Definitions

Flow meter RS-232:
    TXD receive
    RXD send
    GND
PC 9 pin Com Port:
    PIN 1 empty
    PIN 2 RXD receive
    PIN 3 TXD send
    PIN 4 ground

PIN 5 ground

Optional RS-485:
Tx=A- (note, A & B may be reversed on some equipment)
Rx=B+
GND=RS-485 common

## 9.3    Connection to RS-232/RS-485 Host Device

See the below figure flow meter serial port wiring.
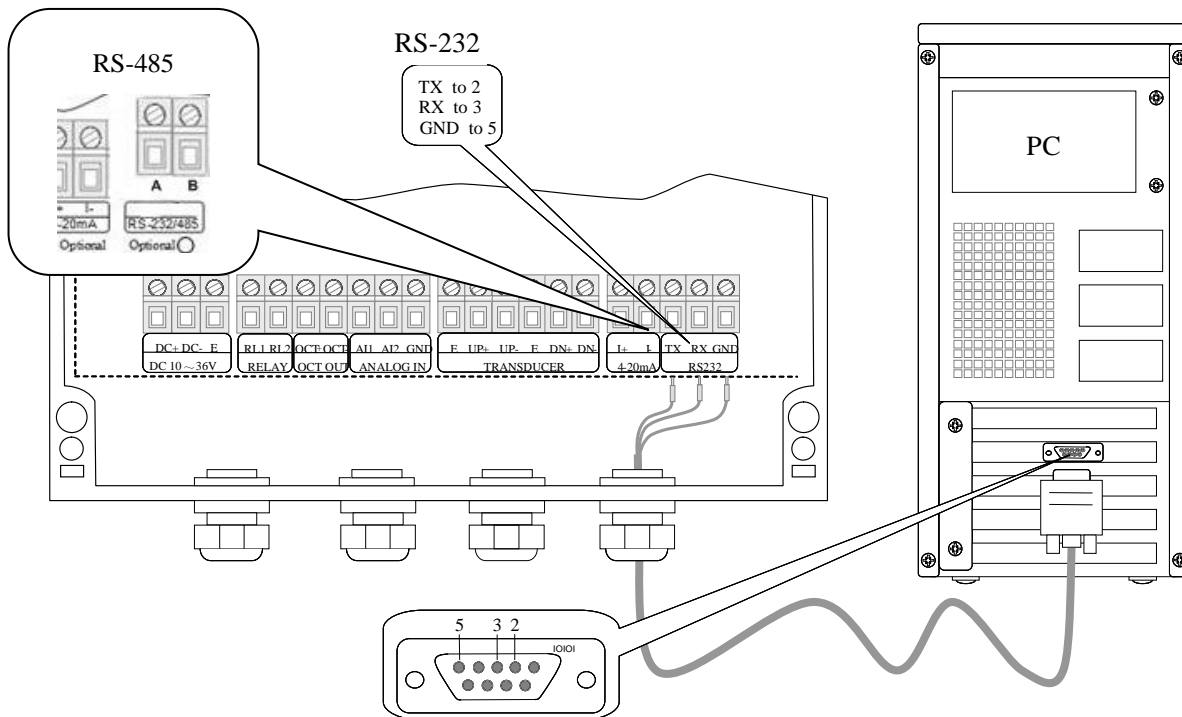


Figure 9. Connecting RS-232/RS-242 Direct to Host Device

[Menu] [temp 6] [total 2]

The serial port baud rate settings of the 203 must be consistent with the host device and are set in Menu 62. The first selected data indicates baud rate, 9600, 19200, 38400, 56000, 57600, 115200 are available.
Parity fixed at None
Data length fixed at 8
Stop Bits fixed at 1
The factory default serial port parameter is "9600, None

[Menu] [cool cap. 4] [temp 6]

Network IDN
This is the 203 salve address. Normally this is not used on RS-232, however when using Modbus host soft ware you will still need to set this address. The range of flow meter addresses 1 to 247 (Hex 1～0xF7), an

d can be set in Menu 46. Numbers 13, 10, 42, and 38 are reserved and cannot be used.

## 9.4 Modbus-RTU Communication Protocol

This Modbus-I Protocol uses RTU transmission mode. The Verification Code uses CRC-16-IBM (polynomial is $X^{16}+X^{15}+X^2+1$, shield character is $0xA001$) which is gained by the cyclic redundancy algorithm method.
Modbus RTU mode uses hexadecimals to transmit data.

1) Modbus-I Protocol Function Code and Format

The flow meter protocol supports the following two-function codes of the Modbus:

| Function Code | Performance data |
|---|---|
| 0x03 | Read register |
| 0x06 | Write single register |

2) Modbus Protocol function code 0x03 usage

The host sends out the read register information frame format:

| Slave Address | Operation Function Code | First Address Register | Register Number | Verify Code |
|---|---|---|---|---|
| 1 byte | 1 byte | 2 bytes | 2 bytes | 2 bytes |
| 0x01~0xF7 | 0x03 | 0x0000~0xFFFF | 0x0000~0x7D | CRC(Verify) |

The slave returns the data frame format:

| Slave Address | Read Operation Function Code | Number of Data Bytes | Data Bytes | Verify Code |
|---|---|---|---|---|
| 1 byte | 1 byte | 1 byte | N*x2 byte | 2 byte |
| 0x01~0xF7 | 0x03 | 2xN* | N*x2 | CRC(Verify) |

N*＝data register number

3) Modbus Protocol function code 0x06 usage

The host sends a command to write a single register information frame format (performance code 0x06):

| Slave Address | Operation Function Code | Register Address | Register Data | Verify Code |
|---|---|---|---|---|
| 1 byte | 1 byte | 2 bytes | 2 bytes | 2 bytes |
| 0x01~0xF7 | 0x06 | 0x0000~0xFFFF | 0x0000~0xFFFF | CRC(Verify) |

The slave returns the data frame format (performance code 0x06):

| Slave Address | Operation Function Code | Register Address | Register Data | Verify Code |
|---|---|---|---|---|
| 1 byte | 1 byte | 2 bytes | 2 bytes | 2 bytes |

| 0x01~0xF7 | 0x06 | 0x0000~0xFFFF | 0x0000~0xFFFF | CRC(Verify) |

The range of flow meter addresses 1 to 247 (Hexadecimal: 0x01~0xF7), and can be checked in the Menu 46. For example, decimal number "11" displayed on Menu 46 means the address of the flow meter in the Modbus protocol is 0x0B.

The CRC Verify Code adopts CRC-16-IBM (polynomial is $X^{16}+X^{15}+X^2+1$, shield character is $0xA001$) which is gained by the cyclic redundancy algorithm method. Low byte of the verify code is at the beginning while the high byte is at the end.

For example, to read the address 1 (0x01) in the RTU mode, if the instantaneous flow rate uses hour as a unit（m3/h）, namely reads 40005 and 40006 registers data, the read command is as follows:

| 0x01 | 0x03 | 0x00 0x04 | 0x00 0x02 | 0x85 0xCA |
|------|------|-----------|-----------|-----------|
| Flow meter Address | Function Code | Register Address | Register Numbers | CRC Verify Code |

Flow meter returned data is (assuming the current flow = 1.234567m3/h)

| 0x01 | 0x03 | 0x04 | 0x06 0x51 0x3F 0x9E | 0x3B 0x32 |
|------|------|------|---------------------|-----------|
| Flow meter Address | Function Code | Data Bytes | Data（1.2345678） | CRC Verify Code |

The four bytes 3F 9E 06 51 is in the IEEE754 format single precision floating point form of 1.2345678.

Pay attention to the data storage order of the above example. Using C language to explain the data, pointers can be used directly to input the required data in the corresponding variable address, the low byte will be put at the beginning, such as the above example 1.2345678 m/s, 3F 9E 06 51 data stored in order as 51 06 9E 3F.

For example, it converts the address 1 (0x01) to 2（0x02）under the RTU mode, so to write the data of flow meter 44100 register as 0x02, the write command is as follows:

| 0x01 | 0x06 | 0x10 0x03 | 0x00 0x02 | 0xFC 0xCB |
|------|------|-----------|-----------|-----------|
| Flow meter Address | Function Code | Register Address | Register Numbers | CRC Verify Code |

Flowmeter returned data is:

| 0x01 | 0x06 | 0x10 0x03 | 0x00 0x02 | 0xFC 0xCB |
|------|------|-----------|-----------|-----------|
| Flow meter Address | Function Code | Register Address | Register Numbers | CRC Verify Code |

4) Error Check

The flow meter only returns one error code 0x02 which means data first address in error.

For example, to read address 1 (0x01) of the flow meter 40002 register data in the RTU mode, the flow meter considers it to be invalid data, and sends the following command:

| 0x01 | 0x03 | 0x00 0x01 | 0x00 0x01 | 0xD5 0xCA |
|------|------|-----------|-----------|-----------|
| Flow meter Address | Function Code | Register Address | Register Numbers | CRC Verify Code |

Flow meter returned error code is:

| 0x01 | 0x83 | 0x02 | 0xC0 0xF1 |

| Flow meter Address | Error Code | Error Extended Code | CRC Verify Code |

## 5) Modbus Register Address List

Most commercially available Modbus host software uses a register format. See Modbus.org for more details. This format is much easier to use. By using the 40000 registers, function code Ox 03 is automatically used for reads and function code Ox 06 is automatically used for single register writes. The CRC checksum is also automatically calculated and added to the data frame, as well as verified on the returned data frame. Error codes are received and decoded.

Modbus host software also allows for easy decoding of the data. The 203 uses the following data types:

32 bits real: Float or IEE754 (LSB-MSB byte order)
32 bits int.: 32 bit un-signed integer. Allows for a number from 0 to 4,294,967,295 (LSB-MSB byte order)
16 bits int: 16 bit signed integer. This allow for a number between -65,535 and +65,534
String: 8 bit ASCII characters, 2 per 16 bit register.

**Modbus Register Table**

| PDU Address | Register | Read | Data Type | No. Registers | Notes |
|---|---|---|---|---|---|
| $0000 | 40001 | Flow/s - low word | 32 bits real | 2 | |
| $0001 | 40002 | Flow/s - high word | | | |
| $0002 | 40003 | Flow/m - low word | 32 bits real | 2 | |
| $0003 | 40004 | Flow/m- high word | | | |
| $0004 | 40005 | Flow/h - low word | 32 bits real | 2 | |
| $0005 | 40006 | Flow/h - high word | | | |
| $0006 | 40007 | Velocity – low word | 32 bits real | 2 | |
| $0007 | 40008 | Velocity – high word | | | |
| $0008 | 40009 | Positive total – low word | 32 bits int. | 2 | |
| $0009 | 40010 | Positive total – high word | | | |
| $000A | 40011 | Positive total – exponent | 16 bits int. | 1 | |
| $000B | 40012 | Negative total – low word | 32 bits int. | 2 | |
| $000C | 40013 | Negative total – high word | | | |
| $000D | 40014 | Negative total – exponent | 16 bits int. | 1 | |
| $000E | 40015 | Net total – low word | 32 bits int. | 2 | |
| $000F | 40016 | Net total – high word | | | |
| $0010 | 40017 | Net total – exponent | 16 bits int. | 1 | |
| $0011 | 40018 | Reserved – low word | 32 bits int. | 2 | |
| $0012 | 40019 | Reserved – high word | | | |
| $0013 | 40020 | Reserved – exponent | 16 bits int. | 1 | |
| $0014 | 40021 | Reserved – low word | 32 bits real | 2 | |
| $0015 | 40022 | Reserved – high word | | | |
| $0016 | 40023 | Up signal int – low word | 32 bits real | 2 | 0~99.9 |
| $0017 | 40024 | Up signal int – high word | | | |
| $0018 | 40025 | Down signal int – low word | 32 bits real | 2 | 0~99.9 |
| $0019 | 40026 | Down signal int – high word | | | |

| $001A | 40027 | Quality | 16 bits int. | 1 | 0〜99 |
|---|---|---|---|---|---|
| $001B | 40028 | Analog output – low word | 32 bits real | 2 | Unit: mA |
| $001C | 40029 | Analog output – high word | | | |
| $001D | 40030 | Error code – char 1,2 | String | 3 | Refer to "Error Analysis" for detailed codes meanings. |
| $001E | 40031 | Error code – char 3,4 | | | |
| $001F | 40032 | Error code – char 5,6 | | | |
| $003B | 40060 | Velocity unit – char 1,2 | String | 2 | Currently supports m/s only |
| $003C | 40061 | Velocity unit – char 3,4 | | | |
| $003D | 40062 | Flow unit – char 1,2 | String | 2 | Note 1 |
| $003E | 40063 | Flow unit – char 3,4 | | | |
| $003F | 40064 | Total unit – char 1,2 | String | 1 | |
| $0040 | 40065 | Reserved – char 1,2 | String | 2 | Note 2- the setup is same as M84 and M85 |
| $0041 | 40066 | Reserved – char 3,4 | | | |
| $0042 | 40067 | Reserved – char 1,2 | String | 1 | |
| $0049 | 40074 | Analog Input AI1 Value- low word | 32 bits real | 2 | Returned temperature value with RTD option |
| $004a | 40075 | Analog Input AI1 Value- high word | | | |
| $004b | 40076 | Analog Input AI2 Value- low word | 32 bits real | 2 | Returned temperature value with RTD option |
| $004c | 40077 | Analog Input AI2 Value- high word | | | |
| $004d | 40078 | Reserved - low word | 32 bits int. | 2 | |
| $004e | 40079 | Reserved - high word | | | |
| $004f | 40080 | Reserved - exponent | 16 bits int. | 1 | |
| $0050 | 40081 | Reserved - low word | 32 bits int. | 2 | |
| $0051 | 40082 | Reserved - high word | | | |
| $0052 | 40083 | Reserved - exponent | 16 bits int. | 1 | |

Notes:

1. The following flow rate units are available:
   0. "m3" －Cubic Meter
   1. "1" －Liters
   2. "ga" －Gallons
   3. "ig" －Imperial Gallons
   4. "mg" －Million Gallons
   5. "cf" －Cubic Feet
   6. "ba" －US Barrels
   7. "ib" －Imperial Barrels
   8. "ob" －Oil Barrels
2. When the flow meter address or communication baud rate is changed, the meter will work under the new settings after the flow meter responds to the new address and baud rate.

# 10. Appendix2-Warranty Policy

## 10.1 Limited Warranty Policy- Register Online

All Sierra products are warranted to be free from defects in material and workmanship and will be repaired or replaced at no charge to Buyer, provided return or rejection of product is made within a reasonable period but no longer than one (1) year for calibration and non-calibration defects, from date of delivery. To assure warranty service, customers must register their products online on Sierra's website. Online registration of all of your Sierra products is required for our warranty process. Register now at www.sierrainstruments.com/register. Learn more about Sierra's warranty policy at www.sierrainstruments.com/warranty.