InnovaSonic® 205i

General Purpose
Ultrasonic Liquid Flow Meter

Instruction Manual

Version IM-205i, Rev. O, April 2017

SIERRA®

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TRADEMARKS

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Important Customer Notice

Thank you for choosing the InnovaSonic® Model 205i Dedicated & Energy BTU 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.
- ✓ Go to **www.sierrainstruments.com/products/downloads.html** for a most current electronic version of this manual.
- ✓ We reserve the right to change the content of this manual without prior notification.
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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.**
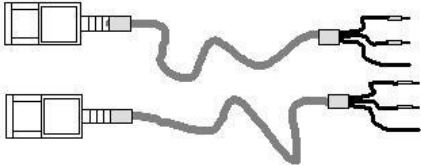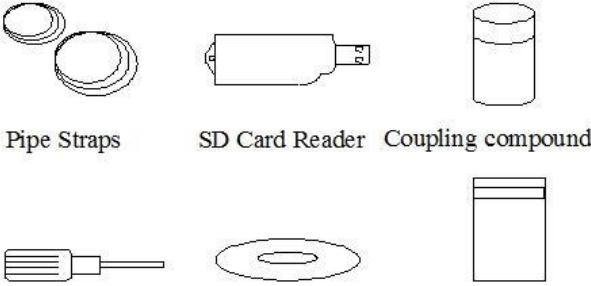
NOTE

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

Product Components

Inspection should be made before installing the InnovaSonic 205i. Check to see if the spare parts are in accordance with the packing list. Make sure that there is no damage to the enclosure due to a loose screw or loose wire, or other damage that may have occurred during transportation. Any questions, please contact your representative as soon as possible.

Transmitter	Transducers
Accessories	**Documents**
Pipe Straps SD Card Reader Coupling compound Screw Driver Software Screws and plastic bushings	1. Instruction Manual 2. Packing List 3. Certified 3-Point Factory Calibration 4. Position drawing 5. Application Worksheet

Content

1. Transmitter Installation and Connect

1.1. Inspection Prior to Transmitter Installation

You will find a "Position Drawing" in the packing. Please use it as a template in the place that you are going to install the flow meter. Then drill 4 installation holes at the screw positions shown on the drawing with a 5.5mm drill.
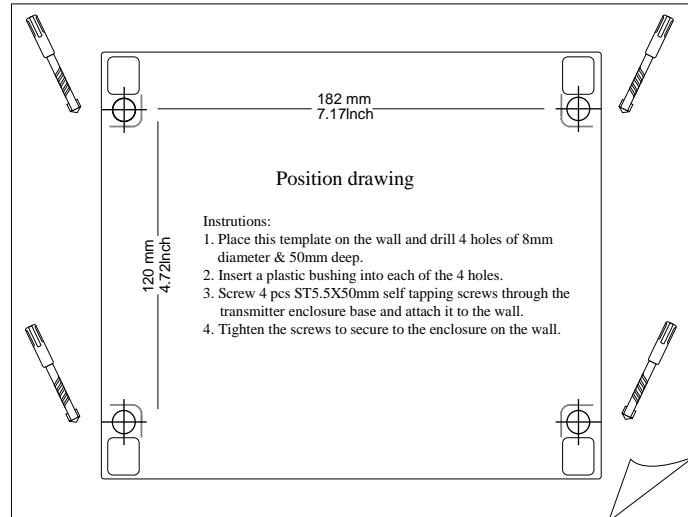
Take out the enclosed screws and plastic bushings. Insert the plastic bushings into the drill holes. Then open the two aluminum pieces on the two sides of the top cover. Put the flow meter into position and screw it in.
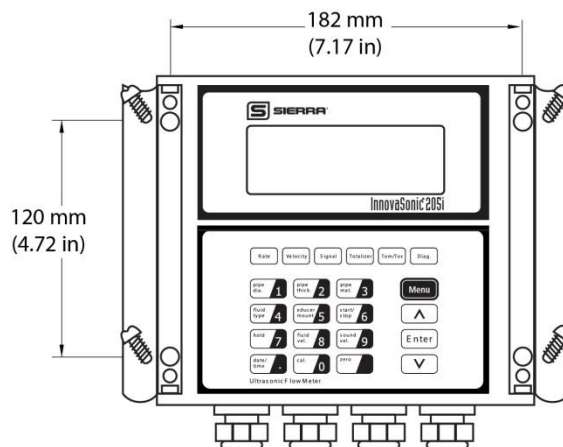
⚠️ **Attention**

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

1.2. Power Supply Connecting

1.2.1 Direct Mount Method

Customers should pay special attention to specify the desired power supply when placing an order. Factory standard power supply is 90~245 VAC, 15 Watts.

Observe the following precautions for installation procedures outlined in this chapter:

Ensure that power connections are made in accordance with the indications shown on the connection terminals.

Transmitters can be powered with 90~245VAC 15 watts or 10-36VDC @500mA.

1.2.2 Connecting the Wiring

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

Power board wiring ports, from left to right, are as follows:

Connect to AC power (90-245V), DC power (10-36V), Relay Output, OCT Output, Analog Input, Transducer wiring, 4-20mA Output, RS-232 Output, and RS-485 Output. (Be aware that "A" and "B" may be reversed by some interface manufactures; you may need to switch them)

For double-shielded transducer cable: "-" on the black wire, "+" on the red wire, and "shield" on the shield.
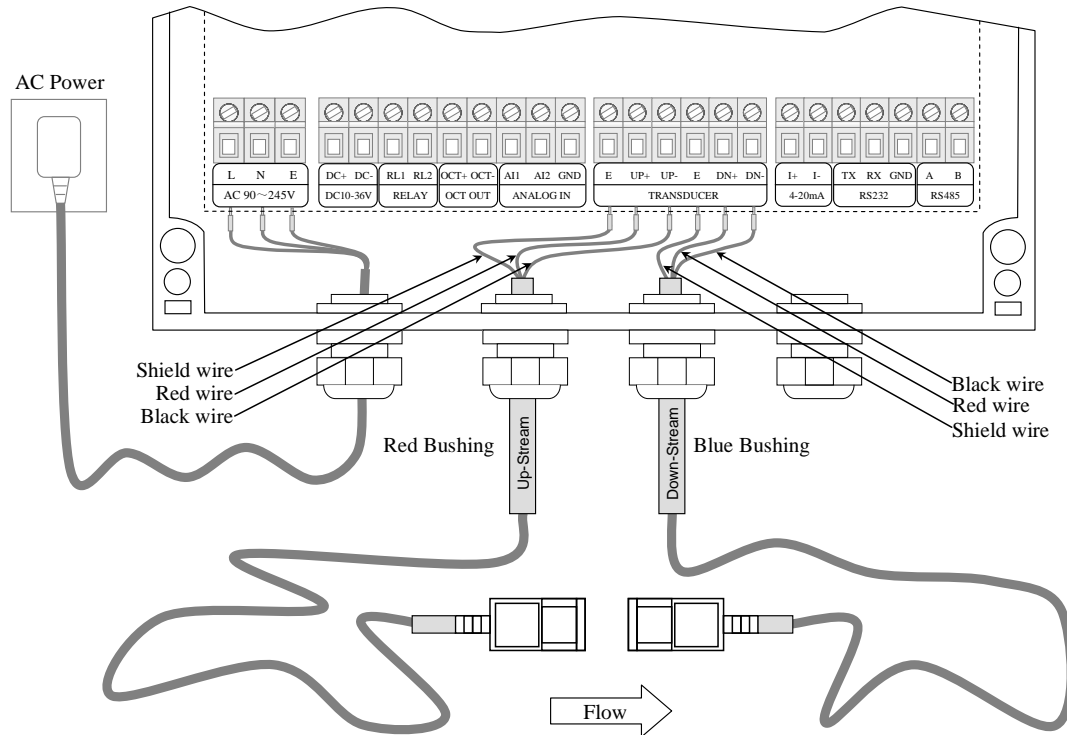
Figure 1. Wire Connection

⚠️ **Warning**

Wire with power off.

Use either AC or DC power supply. Do not connect them both at the same time.

1.3. Powering On

As soon as the 205i 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 Diagnoses). After that, the system will run automatically according to the last input parameters.

If the installation is accomplished when the system is switched on, gain adjustment can be monitored in Window M01. After S1, S2, S3, and S4 are displayed on the upper left corner of the screen, the system will activate the normal measurement condition automatically. It is indicated by code "*R" on the upper right corner of the screen.

The system will default to the last window settings and automatically display them at next power on.

1.4.   Keypad Functions

The InnovaSonic 205i keypad offers 12 dual-function keys for operation of the menu system plus six quick-setup keys. For quick setup of your InnovaSonic, simply press any of the keys across the top to get the desired menu instantly. See image of keypad below.

Follow these guidelines when using the InnovaSonic 205i menu system:

- Keys `cal. 0` to `sound vel. 9` are the menu codes to input information required for the flow measurement exercise.

- Use the `zero <` key to delete or move back to the previous menu.

- To toggle up and down in a menu, use the up `∧` or down `∨` arrow keys.

- After all data is selected, press the Enter key `Enter` to confirm your choices.

- The Menu key `Menu` is used to select a menu using two-digit numbers for each menu.   For example, to enter pipe outside diameter, press `Menu` `pipe dia. 1` `pipe dia. 1` to enter into the window ("MENU11" is the address code of the outer pipe diameter).

Figure 2. 205i Keypad

1.4.1   Quick Access Key Operation

Rate Key `Rate`
Press this key to display Flow Rate. The function is the same with Window M02.

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

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

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

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

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

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

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

Toms/Tos Key `Tom/Tos`
Press this key to display Transit Time Ratio. The function is the same with Window M91.

```
TOM/TOS* 100         [91
            0.0000%
```

Diag. Key

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

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

1.4.2 Dual-Function Keypad Operation

Pipe Diameter/1 Key

Press this key to enter Pipe Outer Diameter in Window M11.

```
Pipe Outer Diameter
              50  mm
```

Pipe Thickness/2 Key

Press this key to enter Pipe Wall Thickness in Window M12.

```
Pipe Wall Thickness
              4  mm
```

Pipe Material/3 Key

Press this key to enter Pipe Material in Window M14.

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

Fluid Type/4 Key

Press this key to enter Fluid Type in Window M20.

```
Fluid   Type       [20
   0.    Water
```

Transducer Mount/5 Key

Press this key to enter Transducer Mounting in Window M24.

```
Transducer  Mounting
   0.         V
```

Start/Stop/6 Key

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

```
        60 sec
ON     10.123      m3
```

Hold/7 Key

Press this key to display the Display / Hold Totalizer in turn.

```
Flow 0.1129    m3/h* R
POS             0 X1m3
```

Fluid Velocity/8 Key

Press this key to display Dynamic / Normal Flow Rate and Velocity in turn.

```
Flow 0.1129    m3/h  Dyn
Vel           1.0415   m/s
```

Sound Velocity/9 Key

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

```
Fluid  Sound  Velocity
           1443.4     m/s
```

Date/Time/. Key

Press this key to display Date and Time. The function
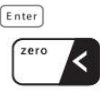
```
YY- MM- DD     HH:MM:SS
03- 04- 04     10:05:04
```

is the same with Window M60.

Calibrate/0 Key

Press [Enter] key to start Manual Totalizer, and then press [Enter] key to end Manual Totalizer.

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

Zero/< Key

Press this key to input code 1234 to set zero.

```
Set Zero
Please Enter PW
```

1.5. Keypad Operation

With all of the parameters entered, the instrument setup and measurement displays are subdivided or consolidated into more than 100 independent windows. The operator can input parameters, modify settings, or display measurement results by "visiting" a specific window. These windows are arranged by 2-digit serial numbers (including "+" sign) from 00~99, then to +0, +1, etc. Each window serial number, or so-called window ID code, has a defined meaning. For example, Window M11 indicates the parameter input for pipe outside diameter, while Window M25 indicates the mounting spacing between the transducers, etc. (Refer to Windows Display Explanations).

The keypad shortcut to visit a specific window is to press the [Menu] key at any time, then input the 2-digit window ID code. For example, to input or check the pipe outside diameter, just press [Menu][pipe dia. 1][pipe dia. 1] for window ID code 11.

Another method to visit a particular window is to press [∧] [∨] and [Enter] to scroll the screen. For example, if the current window ID code is 66, press the [∧] key to enter Window M65, press the [∧] key again to enter Window M64; then, press the [∨] key to go back to Window M65, and press the [∨] key again to enter Window M66.

Example 1: To enter a pipe outside diameter of 219.234, the procedure is as follows:

Press [Menu][pipe dia. 1][pipe dia. 1] to enter Window M11 (the numerical value displayed currently is a previous value). Now press the [Enter] key. The symbol ">" and the flashing cursor are displayed at the left end of the second line on the Screen. Then the new value can be entered…

[pipe thick. 2][pipe dia. 1][sound vel. 9][date/time .][pipe thick. 2][pipe mat. 3][field type 4][Enter]

```
Pipe Outer Diameter
>_
```

Example 2: If the pipe material is "Stainless Steel", press [Menu][pipe dia. 1][field type 4] to enter Window M14 first. Then press the [Enter] key to modify the options. Now, select the "1. Stainless Steel" option by pressing the [∧] and [∨] keys, and then press the [Enter] key to confirm the selection. It's possible to press the [pipe dia. 1] key to

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

change the selection and wait until "1. Stainless Steel"
is displayed on the second line of the screen. Then
press the key.

ATTENTION

Press the [Enter] key first if the operator wants to modify condition. If the modify is still not possible even after pressing the [Enter] key, it means that the system is locked by a password. To "Unlock" it, select "Unlock" in Window M47 and enter the original password. The keypad will not respond if the keypad is locked.

1.6. Flow Meter Window Descriptions

The InnovaSonic 205i has the unique feature of windows processing for all operations.

The windows are assigned as follows:

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

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

30~38   Flow Units Options: select the flow unit, totalizer unit, measurement unit, turn totalizer on/off, reset totalizer, etc.

40~49   Setup Options: scaling factor, network IDN (Window M46), system lock (Window M47), etc.

50~89   Input and Output Setup: relay output setup, 4-20mA outputs, flow batch controller, LCD backlit option, date and time, low/high output frequency, alarm output, date totalizer, etc.

90~95   Diagnosis: signal strength and signal quality (Window M90), TOM/TOS*100 (Window M91), flow sound velocity (Window M92), total time and delta time (Window M93), Reynolds number and factor (Window M94), data interval (Window M95), etc.

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

ATTENTION

The other windows are for hardware adjustment by the manufacturer.

2. Pipe Parameter Entry Shortcuts

For example, measuring the diameter of DN200 when the measuring medium is water, the material is carbon steel, and there's no liner, can be operated as follows:

Note: Set menu 30 to English for ANSI pipe sizes.

Step 1. Pipe outside diameter

Press [Menu] [pipe dia. 1] [pipe dia. 1] to enter Window M11 and enter the pipe outside diameter, and then press the [Enter] key.

```
Pipe Outer Diameter
          200  mm
```

Step 2. Pipe wall thickness

Press [V] [pipe dia. 1] [pipe thick. 2] to enter Window M12 and enter the pipe wall thickness, and then press the [Enter] key.

```
Pipe Wall Thickness
            6  mm
```

⚠ **WARNING**

The wall thickness needs to be at least 0.001mm for use with insertion sensors.

Step 3. Pipe material

Press [V] [pipe dia. 1] [fluid type 4] to enter Window M14, press the [Enter] key, press the [∧] or [V] keys to select pipe material, and press the [Enter] key.

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

Step 4. Liner material parameters

(Including thickness and sound velocity, if needed)

Press [V] [pipe dia. 1] [start/stop 6] to enter Window M16, press the [Enter] key, press the [∧] or [V] keys to select liner material, and then press the [Enter] key.

```
Liner  Material [16
0.None, No Liner
```

Step 5. Fluid type

Press [V] [pipe thick. 2] [cal. 0] to enter Window M20, press the [Enter] key, press the [∧] or [V] keys to select fluid type, and then press the [Enter] key.

```
Fluid  Type       [20
  0.   Water
```

Step 6. Transducer type

(The transmitter is available for various transducer types)

Press [V] [pipe thick. 2] [pipe mat. 3] to enter Window M23, press the [Enter] key, press the [∧] or [V] keys to select transducer type, and then press the [Enter] key.

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

⚠️ **NOTE**

The S, W, and WH type sensors are all standard type.

Step 7. Transducer mounting methods
  Press ⌄ ▢2 ▢4 to enter Window M24, press the Enter key, press the ⌃ or ⌄ keys to select transducer mounting method, and then press the Enter key.

```
Transducer Mounting
 0.           V
```

Step 8. Adjust transducer spacing
  Press ⌄ ▢2 ▢5 to enter Window M25 and accurately install the transducer according to the displayed transducer mounting spacing and the selected mounting method. (Refer to Installing the Transducers in this chapter)

```
Transducer Spacing
        159.86  mm
```

Step 9. Display measurement result
  Press Menu ▢0 ▢1 to enter Window M01 to display measurement result.

```
Flow 0.1129m3/h    * R
Vel     1.0415m/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 to guarantee a highly accurate measurement. 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.
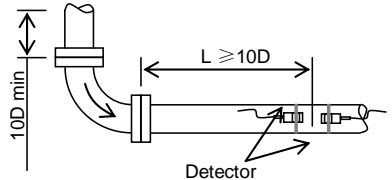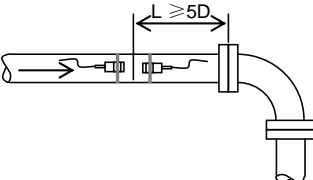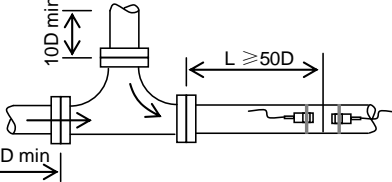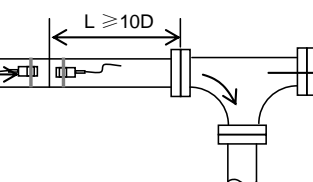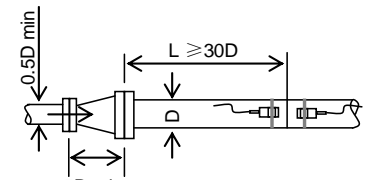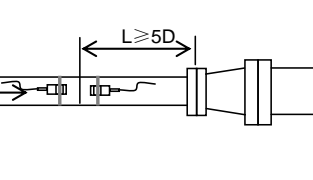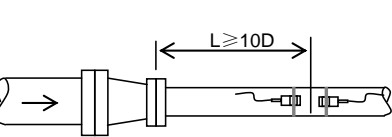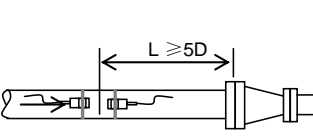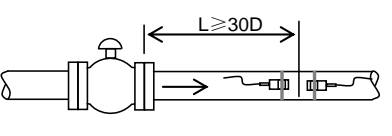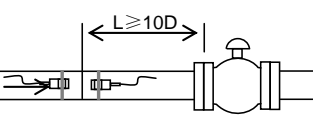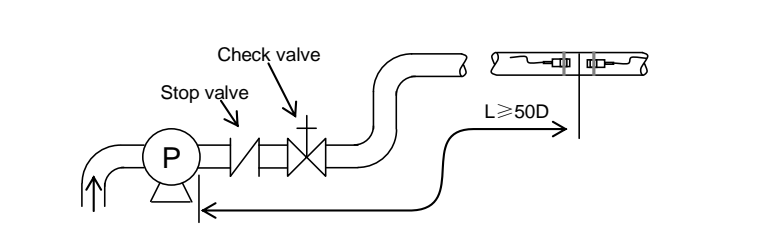
Name	Straight length of upstream piping	Straight length of downstream piping
90° bend		
Tee		
Diffuser		
Reduce		
Valve		
Pump		

Figure 3. 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, 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 guarantee 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 Window M25 and space the transducers accordingly.

4.1.2 Transducer Mounting Methods

Four 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 (DN100~400mm, 4"~16"). 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 25mm to 400mm (1~16") approximately. Also, it is convenient to use, but still requires proper installation of the transducer, contact on the pipe at the pipe's centerline and equal spacing on either side of the centerline.
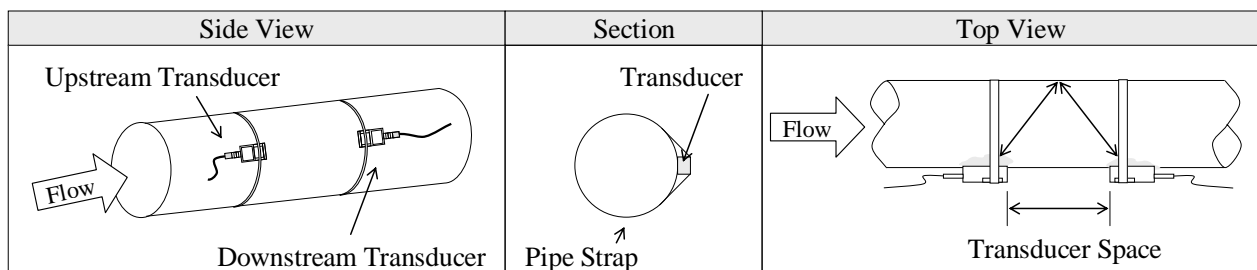
Figure 4. V Method Transducer Mounting

4.1.4   Z Method

The signal transmitted in a Z method installation has less attenuation than a signal transmitted with the V method. 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 approximately 100mm to 3000mm (4"~120"). We recommend the Z method for pipe diameters over 300mm (12").

Side View	Section	Top View
Upstream Transducer, Flow, Downstream Transducer	Transducer, Pipe Strap	Flow, Transducer Spacing
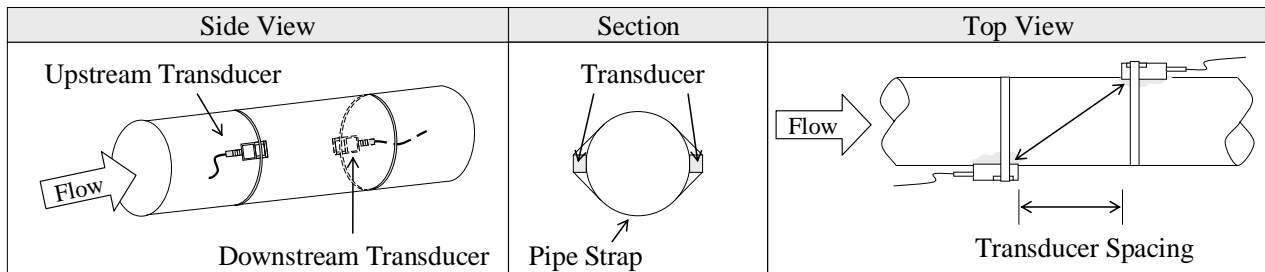
Figure 5. Z Method Transducer Mounting

4.1.5   N Method (not commonly used)

With the N method, the sound waves traverse the fluid three times and bounce twice times 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).

Side View	Section	Top View
Upstream Transducer, Flow, Downstream Transducer	Transducer, Pipe Strap	Flow, Transducer Spacing
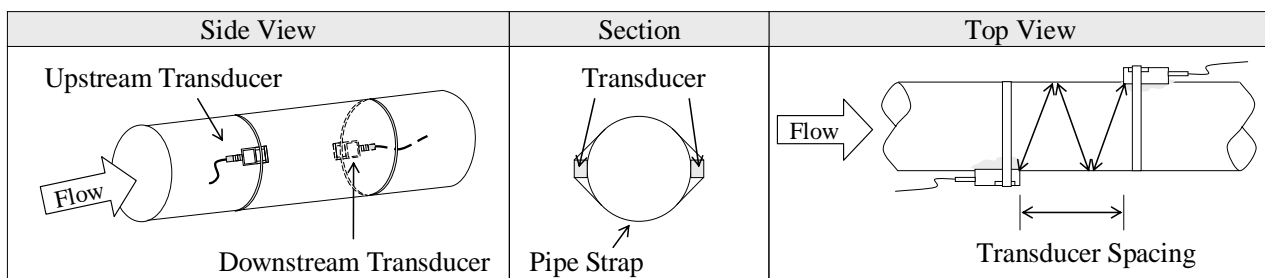
Figure 6. N Method Transducer Mounting

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. It can be confirmed by checking the detected signal strength, total transit time, delta time as well as transit time ratio.

The "mounting" condition directly influences the flow value accuracy and system long-time running reliability. In most instances, only apply a wide bead 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 Window 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 longer the operation of the instrument reliably, as well as the more stable the measurement value obtained.

Adjust the transducer to the best position and check to ensure that enough sonic coupling compound is applied adequately during installation in order to obtain the maximum signal strength.

System normally 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 to the Z method.

4.2.2 Signal Quality (Q value)

Q value is short for Signal Quality (displayed in Window 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 represents the maximum.

Normally, the transducer position should be adjusted repeatedly and coupling compound application should be checked frequently 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 Window 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. This means that the signal quality detected is too poor. It may be the result 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 if the transducer mounting spacing is accurate. The normal transit time ratio should be 100±3 if the installation is correct. Check it in Window 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 Window M25.

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

(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 transducer onto the pipe wall. While checking the signal strength and Q value, move the transducer slowly around the mounting site until the strongest signal and maximum Q value can be obtained. Make sure that the larger the pipe diameter, the more the transducer should be moved.

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

(4)   Pay special attention to those pipes that are formed by steel rolls (pipe with seams), since such pipe is always irregular. 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 very 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)   Make sure that the flow meter is able to run properly with high reliability. The stronger the signal strength displayed, the higher the Q value reached, the longer the flow meter runs accurately, the higher the reliability of the flow rates displayed. If there is interference from ambient electromagnetic waves or the signal detected is too poor, the flow value displayed is not reliable; consequently, the capability for reliable operation is reduced.

(6)   The transducer spacing in MENU 25 assumes perfect quality conditions.   The flow meter was calibrated on a "perfect condition" flow calibration loop.   It is necessary to check and perhaps adjust the transducer spacing in the real life application to ensure that the MENU 90 and MENU 91 diagnostic readings are within limits.   MENU 90 should indicate Signal Strength UP and DOWN > 60 and the Quality value "Q" > 50.   MENU 91, the Transit Time Ratio (TOM/TOS) must be 100 +/-3%.

5. Operating Instructions

5.1. System Normal Identification

Press [Menu] [cal. 0] [fluid vel. 8]. If the letter "*R" displays on the screen, it indicates system normal.
- If the letter "E" is displayed, it indicates that the current loop output is over ranged by 120%. This refers to the settings in Window M57. Enter a larger value in Window 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%, and this refers to the settings in Window M69. Increase the input value in Window 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 system be identified as abnormal.

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

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

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

5.2. Zero Set Calibration

Once zero flow occurs, a zero point may indicate on each measuring instrument, i.e. as the measurement value reaches zero flow, it is indicated as zero. It is necessary to establish the true zero flow condition and program that set point into the instrument.

If the zero set point is not at true zero flow, a measurement difference may occur. The smaller the physical measurement capacity is, the larger the measurement difference from the zero point will exist. Only when zero point reduced to a definite degree, as compared with the physical measurement capacity, can the measuring difference from zero point be ignored.

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

5.3. Scale Factor

Scale factor refers to the ratio between "actual value" and "reading value". For example, when the measurement 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 control operations. The difference is called "consistency". High quality products always require high consistency.

The scale factor default is "1.XX" for each instrument prior to shipment from the factory. This corresponds to the calibration factors for the transducers. The reason is that the scale factors in the flow meter are only limited by two parameters, i.e. the crystal oscillation frequency and the transducer. It has no relation to any circuit parameters.

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.

5.4. System Lock (Unlock)

System lock is intended to prevent operation error due to tampering by unauthorized personnel.
-   Press [Menu] [fluid type 4] [hold 7] [Enter], then press the [∧] or [∨] keys to select "Lock", press the [Enter] key, enter a 1~4 numerically long password, and then press the [Enter] key to confirm.
-   Unlock using the selected password only. Press [Menu] [fluid type 4] [hold 7] [Enter], then press the [∧] or [∨] keys to select "Unlock", enter the correct password, and then press the [Enter] key to confirm.
-   Keep the password in mind or recorded in a safe place or the instrument cannot be used.

5.5. 4~20mA Current Loop Verification

Possessing a current loop output exceeding an accuracy of 0.1%, the flow meter is programmable and configurable with multiple output modules such as 4 ~20mA or 0~20mA. Select in Window M55. For details, please refer to "Windows Display Explanations".

In Window M56, enter a 4mA flow value. Enter the 20mA flow value in Window M57. For example, if the flow range in a specific pipe is 0~1000m3/h, enter 0 in Window M56 and 1000 in Window M57. If the flow ranges from -1000~0~2000m3/h, configure the 20~4~20mA module by selecting Window M55 when flow direction is not an issue. Enter 1000 in Window M56 and 2000 in Window M57. When flow direction is an issue, module 0~4~20mA is available. When the flow direction displays as negative, the current output is in range of 0~4mA, whereas the 4~20mA is for the positive direction. The output module options are displayed in Window M55. Enter "-1000" in Window M56 and 2000 in Window M57.

Calibrating and testing the current loop is performed in Window M58. Complete the steps as follows:
Press [Menu] [xducer mount 5] [field vel. 8] [Enter], then press the [∧] or [∨] keys to display "0mA", "4mA", "8mA", "16mA", "20mA" readings, connect an ammeter to test the current loop output, and calculate the difference. Calibrate it if the difference is within tolerance.   Refer to Section 5.10 for Analog Output Calibration.

Check the present current loop output in Window 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, the relative frequency output required is 123~1000Hz, and the configuration is as follows:
In Window M68 (low limit frequency output flow value), input 0.
In Window M69 (high limit frequency output flow value), input 3000.
In Window M67 (low limit frequency), input 123.

There is no output circuit specially assigned to frequency output. It only can be transmitted through OCT, i.e. select Window M78 (item "13. FO").

Typical OCT output wiring diagram as below; pull-up resistor shown is external:
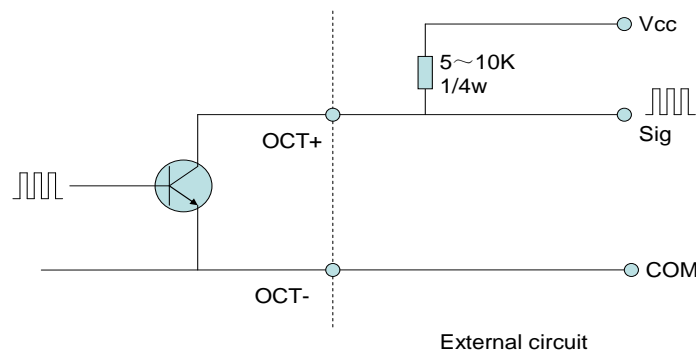
Figure 7. OCT Output Wiring Diagram

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. To configure the unit flow, please refer to Windows M32 and M33.

The totalizer pulse output can be transmitted through OCT or a relay. So, it is necessary to configure OCT and the relay accordingly. Refer to Window M78 and M79.

For example, if it is necessary to transmit the positive totalizer pulse through a relay, and each pulse represents a flow of 0.1m3, the configuration is as follows:
In Window M33, select the totalizer flow unit "Cubic Meters (m3)".
In Window M34, select the scale factor "x0.1".
In Window M79, select "9. Positive totalizer pulse output".

Attention

Make sure the totalizer pulse does not transmit more than 1 pulse per second. If the totalizer is set to transmit faster than 1 pulse per second, you may shorten the life of the output, as well as skip some pulses.

5.8. Alarm Programming

The flow meter has two programmable alarms: audible alarm and on/off output alarm. The audible alarm generates an internal beeper. Select the BEEPER trigger in Window M77. The on/off output alarm is generated through OCT or transmission to an external circuit by opening or closing a relay. The on/off output signal is activated under the following conditions:

(1) Signal not detected.
(2) Poor signal detected.
(3) The flow meter is not ready for normal measurement.
(4) The flow is in the reverse direction (back flow).
(5) The analog outputs exceed span by 120%.
(6) The frequency output exceeds span by 120%.
(7) The flow rate exceeds the ranges configured. (Configure the flow ranges using the software alarm system. There are two software alarms: Alarm#1 and Alarm #2. The lower limit value for Alarm#1 is configured in Window M73, and the upper limit value is configured in Window M74. As for Alarm#2, the lower limit value is in M75 and the upper one is in Window M76).

Example 1: To program the relay output alarm, activated when flow rate exceeds 300~1000m3/h:

    (1) In Window M73, input 300.

    (2) In Window M74, input 1000.

    (3) In Window M79, select item 6: "6. Alarm #1 limit exceed".

Example 2: To program the OCT output alarm signal, activated when flow rate exceeds 100~500m3/h; relay output alarm signal activated when flow rate exceeds 600~1000m3/h:

    (1) In Window M73, input 100.

    (2) In Window M74, input 500.

    (3) In Window M75, input 600.

    (4) In Window M76, input 1000.

    (5) In Window M78, select item 6: "6. Alarm #1".

    (6) In Window M79, select item 7: "7. Alarm #2".

5.9. Batch Controller

The batch controller is able to perform flow quantity control, or the batching of specific volumes to control events in product production or chemical dosing, etc. The internal batch controller in the flow meter is able to take the high or low end of analog input signals as an input, or through the keypad, to perform control functions. The output can be transmitted through OCT or a relay.

When taking analog inputs as control signals, input an analog output which is over 2mA through the analog input terminal to indicate the condition of "1"; current "0" indicates the condition of "0".

In Window M78 (OCT output), M79 (relay output), or M80 (Flow Batch CTRL), select Item 8 "Batch Controller" and the OCT or relay output will generate output signals.

Enter the batch value in Window M81. Start the batch controller after that. For details, please refer to "Windows Display Explanations".

5.10. Analog Output Calibration

Attention

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

The hardware adjustment menu must be activated prior to calibration of the analog output. The procedure is as follows:

Press [Menu] [V] [· 0] [Enter] to enter password "115800", then press the [Enter] key to activate the hardware adjustment menu. >4 mA. will be displayed.

Press the [V] key to calibrate the current loop 4mA output point. Use a milliamp meter to measure the current loop output current. Press the [∧] or [V] keys to adjust the milliamps displayed on the milliamp meter. Watch the milliamp meter until it reads 4.00. Stop at this point, the 4mA has been calibrated.

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

Press the [Enter] key when done and the results are saved in EEPROM and won't be lost when power is turned off.

5.11. Use of the Memory Card

5.11.1 Specifications

Memory: 1 or 2 GB Standard SD card. (SDHC card will not work)

Data collection update rate: User Selectable: 5 seconds to 13000 seconds (3.6 hours). .

Data content: date and time, flow, velocity, cumulated flow, positive totalizer, negative totalizer, heat quantity

File system format: **FAT16**

File type: plain text file (.txt)

File number: maximum 512 (this is a FAT 16 constraint, a larger capacity SD card will not change this)

Filename format: yymmdd (yy - year, mm - month, dd - day)

SD Data format:

        1= yy-mm-dd, hh:mm:ss

        2= +3.845778E+01m3/h

        3= +1.451074E+00m/s

        4= -0000010E+0m3

        5= +0000002E+0m3

        6= -0000012E+0m3

        7=+7.1429E-01KJ/s

        8=+3.9721E+03KJ

        9=+4.573242E+01

        10=+4.338866E+01

It can save 120bytes of data each time. When the capacity of the SD card is full, the new data will override the earliest files automatically. The CD supplied with your meter contains a CONVERTER.EXE file that will convert the text file above into an .XLS file

5.11.2   Installing or Removing the SD Card While the Meter is Powered On

If the operator desires to insert or remove the SD card with power on, the following operation is to be used:
As shown in the picture below, move the switch to the "OFF" position. This switch activates the Memory Logging ONLY; IT DOES NOT SHUT OFF POWER TO THE FLOW METER. It is then safe to remove or install the SD Card. Once reinstalled, move the switch to the "ON" position, now the SD card can continue to log data.

Digital Correlation Transit-Time Flowmeter

Insert The Memory Card Here

⚠ *Do not insert or remove the Memory card when the Memory light is on.*

OFF   ON
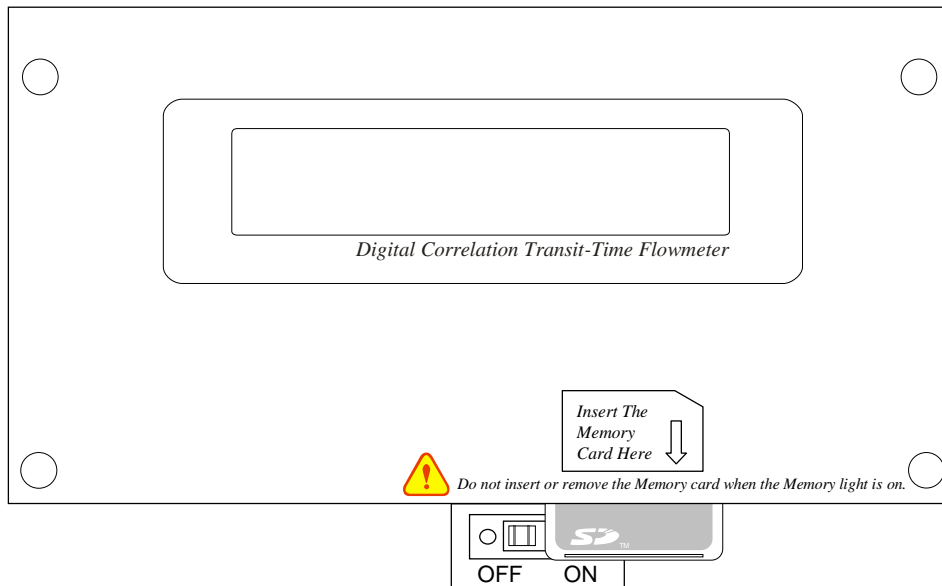
Figure 8. Installing & Removing SD Card

5.11.3   Reading the SD Data Externally

Remove the SD card from the flow meter. The operator may then use a PC carder reader to read the data in the card. On the PC the operator can save, edit and print the data in the SD card, and then recall and analyze the data. Care should be taken while working with the data on the SD card on a PC.

ATTENTION

⚠ Do not remove the SD card from the reader while actively working with the data. Data should be saved and stored in a separate location on the PC, and then processed form that file location. Processing the data directly from the SD card file location on the PC could result in lost or corrupt data if the SD card is removed while still being processed.

5.11.4   Reading the SD Data Internally with the Instrument Powered On

Open the cover of the meter and connect the flow meter to a PC via RS232. The operator can read and work with the data in the SD card with the "converter" software provided with the flow meter CD:
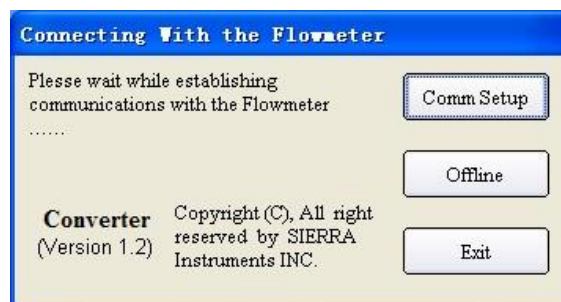
Click on "Comm Setup" to set up communications port (generally COM1) and baud rate:

After connecting to the flow meters RS232 you will see the screen shown below. If not connected to the flow meter, you can click the "Offline" button interface in the document conversion.
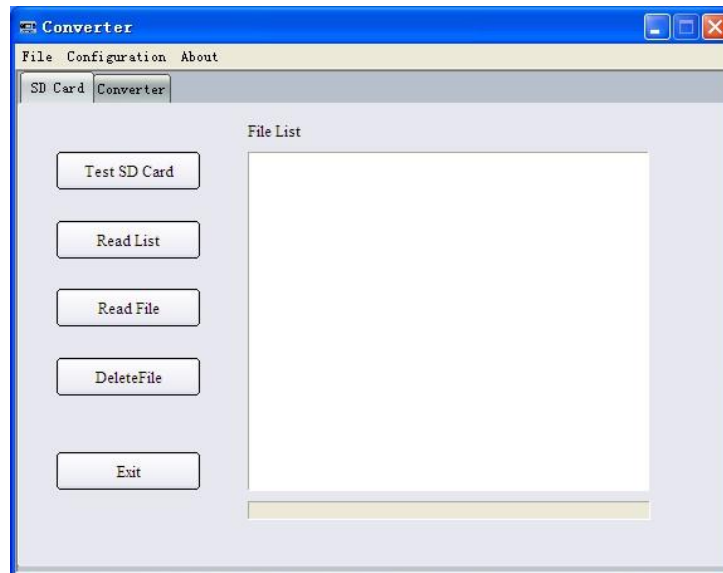
Due to the expanded memory (EMS) capacity of the flow meter being extremely small as compared with the SD memory card, the transfer speed is rather slow for some commands. We suggest you read the SD data externally by removing the card from the flow meter and inserting it into your PC.

(1) Choose "Test SD card". If the LED is lit there will be a message "The SD card is OK" displayed to show that the SD card is working.
(2) Click on "Read List" to return to the SD card catalog of all the documents.
(3) Click on "Read File" and there will be a reading of the progress of the document.
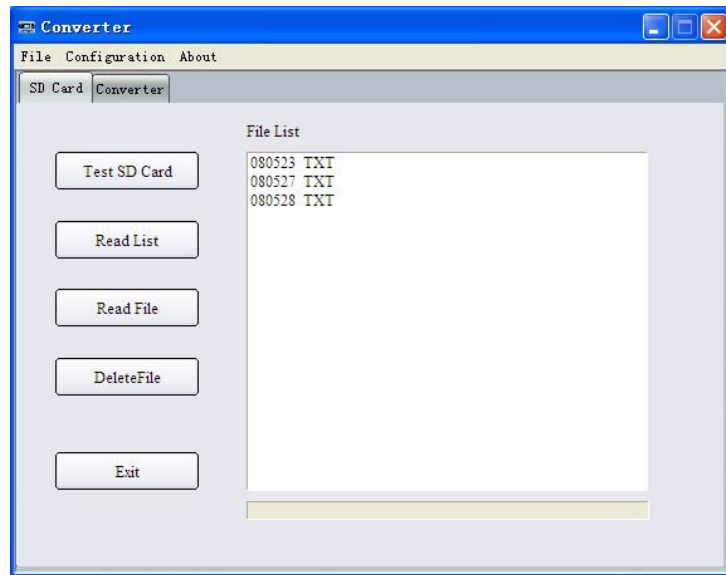
After the reading, a pop up display will show "The file has been read" and stored in the Converter.exe in the root directory.

You may then delete the file from the SD card if necessary.

5.11.5   File Converter Tool

The files saved in the SD card are in text format (.TXT). If the operator desires to convert it to Excel format (.XLS), the file-conversion tool (Converter.EXE) may be found in the CD shipped with the flow meter. This program must be run in the WINDOWS operating system. Click on "Offline" to use converter tool.
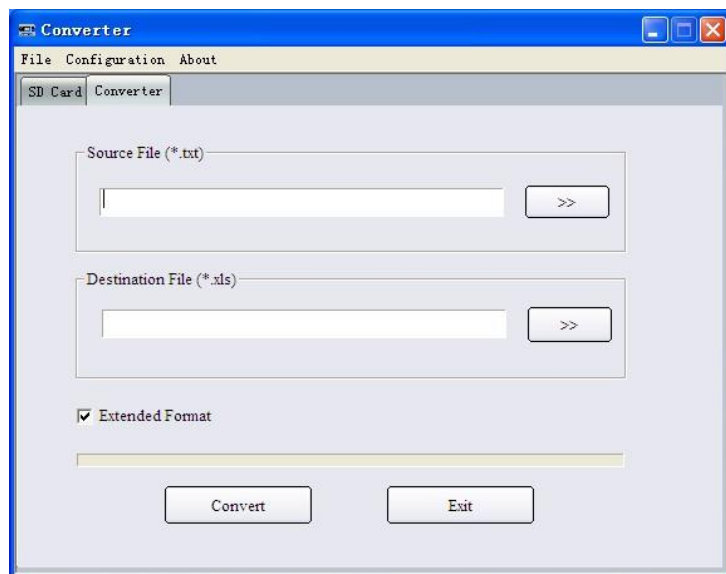
Select the file to be converted in "Source File" (*.txt), enter the directory path and the filename in "Destination File" (*.xls), then press "Convert". The conversion is completed.

5.12. Recover the Factory Default

If it is necessary to recover the factory default, Press MENU 37, then press and after the above mentioned characters are displayed on the screen. Generally, it is unnecessary to activate this function except during initial installation.

5.13. 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, instrument types, and versions are able to view in Window M61.

6. Windows Display Explanations

6.1. Windows 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
05	Reserved
06	Reserved
08	System Error Codes
09	Net Flow Today
Initial Parameter Setup	
10	Pipe Outer Perimeter
11	Pipe Outer Diameter
12	Pipe Wall Thickness
13	Pipe Inner Diameter
14	Pipe Material
15	Pipe Sound Velocity
16	Liner Material
17	Liner Sound Velocity
18	Liner Thickness
20	Fluid Type
21	Fluid Sound Velocity
22	Fluid Viscosity
23	Transducer Type
24	Transducer Mounting
25	Transducer Spacing
26	Parameter Setups
27	Cross-Sectional Area
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 Zero
43	Reset Zero
44	Manual Zero Point
45	Scale Factor
46	Network Identifying Address Code
47	System Lock
50	SD card data interval
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	Software Version and ESN
62	RS232 Setup
63	AI1 Value Range
64	AI2 Value Range
66	AI3 Value Range
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
78	OCT Output Setup
79	Relay Output Setup
80	Flow Batch CTRL
81	Flow Batch Controller
82	Date Totalizer
83	Automatic Correction
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
^5	Calculator

6.2. Display Explanation

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

Menu [cal. 0] [cal. 0]
Flow Rate / Net Totalizer
Display flow rate and net totalizer.

If the net totalizer has been turned off (refer to Window 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 [cal. 0] [pipe dia. 1]
Flow Rate / Velocity
Display flow rate and velocity.

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

Menu [cal. 0] [pipe thick 2]
Flow Rate / Positive Totalizer
Display flow rate and positive totalizer.

Select the positive totalizer units in Window 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 [cal. 0] [pipe mat 3]
Flow Rate / Negative Totalizer
Display flow rate and negative totalizer.

Select the negative totalizer value in Window 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 [cal. 0] [fluid type 4]
Date Time / Flow Rate
Display the current date time and flow rate.

The time setting method is found in Window M60.

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

Menu `cal. 0` `xducer mount 5`

Reserved

Menu `cal. 0` `start/stop 6`

Reserved

Menu `cal. 0` `fluid 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 Diagnosis".

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

Menu `cal. 0` `sound vel. 9`

Net Flow Today

Display net total flow today.

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

Menu `pipe dia. 1` `cal. 0`

Pipe Outer Perimeter

Enter the pipe outer perimeter. If the diameter of the pipe is known, enter it in Window M11.

```
Pipe Outer Perimeter
     157   mm
```

Menu `pipe dia. 1` `pipe dia. 1`

Pipe Outer Diameter

Enter the pipe outside diameter; the pipe outside diameter must range from 10mm to 6000mm.

```
Pipe Outer Diameter
     50  mm
```

Menu `pipe dia. 1` `pipe thick 2`

Pipe Wall Thickness

Enter the pipe wall thickness. If the pipe inside diameter is already known, skip this window and enter it in Window M13.

```
Pipe Wall Thickness
     4  mm
```

Menu `pipe dia. 1` `pipe mat. 3`

Pipe Inner Diameter

Enter the pipe inside diameter. If the pipe outside diameter and pipe wall thickness has been entered, press `v` to skip this window.

Note: Enter either pipe wall thickness or pipe inside diameter.

```
Pipe Inner Diameter
     52  mm
```

Menu [pipe dia.] 1 [fluid type] 4

Pipe Material

Enter pipe material. The following options are available by using the ∧, ∨, 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	9.	Other

Refer to item 9 "Other"; it is possible to enter other materials, which are not included in the previous eight items. Once item 9 is selected, the relevant pipe sound velocity must be entered in Window M15.

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

Menu [pipe dia.] 1 [sducer mount] 5

Pipe Sound Velocity

Enter pipe sound velocity. This function is only used when item 9 "Other" is selected in Window M14. Otherwise, this window cannot be viewed.

```
Pipe Sound Velocity
    2800 m/s
```

Menu [pipe dia.] 1 [start/ stop] 6

Select the Liner Material

The following options are available:

0.	None ,No Liner	1.	Tar Epoxy
2.	Rubber	3.	Mortar
4.	Polypropylene	5.	Polystryol
6.	Polystyrene	7.	Polyester
8.	Polyethylene	9.	Ebonite
10.	Teflon	11.	Other

Item 11 "Other" is available to enter other materials that are not included in the previous ten items. Once the "Other" is selected, the relevant liner sound velocity must be entered in Window M17.

```
Liner  Material [16
0.None, No Liner
```

Menu [pipe dia.] 1 [hold] 7

Liner Sound Velocity

Enter liner sound velocity. This function is only used when Item 11 "Other" is selected in Window M16.

```
Liner Sound Velocity
        2270  m/s
```

Menu [pipe dia.] 1 [fluid vel] 8

Liner Thickness

Enter liner thickness. It only can be visited when a definite liner is selected in Window M16.

```
Liner Thickness [18
         10 mm
```

Menu [pipe thick 2] [cal. 0]

Select Fluid Type

The following options are available:

0. Water	1. Sea Water
2. Kerosene	3. Gasoline
4. Fuel Oil	5. Crude Oil
6. Propane (-45℃)	7. Butane (0℃)
8. Other	9. Diesel Oil
10. Castor Oil	11. Peanut Oil
12. Gasoline #90	13. Gasoline #93
14. Alcohol	15. Water (125℃)

"Other" refers to any fluid. The relevant sound velocity must be entered in Window M21

```
Fluid  Type          [20
   0.   Water
```

Menu [pipe thick 2] [pipe dia. 1]

Fluid Sound Velocity

Enter the fluid sound velocity. It can only be used when item "Other" is selected in Window M20, i.e. it is unnecessary to enter all the fluids listed in Window M20.

```
Fluid Sound  Velocity
       1482.3   m/s
```

Menu [pipe thick 2] [pipe thick 2]

Fluid Viscosity

Enter fluid's kinematics viscosity. It only can be used when item "Other" is selected in Window M20, i.e. it is unnecessary to enter all the fluids that listed in Window M20.

```
Fluid   Viscosity [22
        1.0038    cST
```

Menu [pipe thick 2] [pipe mat. 3]

Transducer Type

Please select "0. Standard". For all Sierra Transducers

(The transmitter can be used for various transducer types)

Press [V] [pipe thick 2] [pipe mat. 3] to enter Window M23, press the [Enter] key, press the [∧] or [V] keys to select transducer type, and then press the [Enter] key.

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

⚠️ **NOTE**

The S, W, WH type sensors are all standard type.

Menu [pipe thick] 2 [fluid type] 4

Transducer Mounting

Four mounting methods are available:

V (2 passes; the most commonly used method)

Z (1 pass; commonly used on large pipes)

N (3 passes; used on small pipes)

```
Transducer  Mounting
   0.          V
```

Menu [pipe thick] 2 [xducer mount] 5

Transducer Spacing (this value is calculated by the flow meter)

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

```
Transducer  Spacing
     148.666  mm
```

Menu [pipe thick] 2 [start/stop] 6

Parameter Save and Load

Load or Save (recall) the parameters of 18 different sets of setup conditions for different applications.

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

Select "0. Entry to Save" and press Enter. An ID code and the original parameters are displayed in the window. Press the ∧ or ∨ keys to move the ID code, then press the Enter key again to save the current parameter under the current ID.

When selecting "1. Entry to Load" press Enter and the system will read and calculate the parameters automatically and display the transducer mounting

spacing in Window M25

```
Parameter    Setups
   Entry  to   SAVE
```

Menu [pipe thick] 2 [hold] 7

Cross-Sectional Area

Display the cross-sectional area inside the pipe.

```
Cross-sectional Area
     31415.9    mm2
```

Menu [pipe thick] 2 [fluid 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.

```
Holding with Poor Sig
        NO
```

Menu [pipe thick] 2 [sound vel] 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 window 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.

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

Menu [pipe mat. 3] [cal. 0]

Measurement Units Options

Select the measurement unit as follows:

    0.   Metric

    1.   English

Factory default is metric.

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

Menu [pipe mat. 3] [pipe dia. 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 [pipe mat. 3] [pipe thick. 2]

Totalizer Units Options

Select totalizer units. The available unit options are as same as those found in Window M31. The user can select units as their required. Factory default is cubic meters.

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

Menu [pipe mat. 3] [pipe mat. 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.

[Menu] [pipe mat. 3] [fluid type 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 Window M00 will not change. Factory default is "ON".

[Menu] [pipe mat. 3] [xducer mount 5]

ON/OFF POS Totalizer

On/Off positive totalizer. "ON" indicates the flow meter starts to totalize the value. When it is turned off, the positive totalizer displays in Window M02. Factory default is "ON".

[Menu] [pipe mat. 3] [start/ stop 6]

ON/OFF NEG Totalizer

On/Off negative totalizer. "ON" indicates the totalizer is turned on. When it is turned off, the negative totalizer displays in Window M03.
Factory default is "ON".

[Menu] [pipe mat. 3] [hold 7]

Totalizer Reset

Totalizer reset; all parameters are reset. Press [Enter]; press [∧] or [∨] keys to select "YES" or "NO". After "YES" is selected, the following options are available:

    None, All, NET, POS, NEG

If it is necessary to recover the factory default, press the [date/ time 8] [zero 9] keys after the above mentioned characters are displayed on the screen.

Generally, it is unnecessary to activate this function except during the initial installation.

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

```
Net   Totalizer      [34
              ON
```

```
POS   Totalizer      [35
              ON
```

```
NEG   Totalizer      [36
              ON
```

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

Menu | pipe mat. 3 | fluid vel. 8

Manual Totalizer

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

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

Menu | fluid type 4 | cal. 0

The damping function will stabilize the flow display. Essentially, it is a part of the signal filter. Enter a coefficient. Increasing the coefficient increases the stability. However, the measurement displayed may be slightly delayed due to over damping. Logging too long may result in no response to real-time fluctuation, especially when flow rate fluctuates wildly.

Therefore, damping should be kept at a minimum and increased just enough to reduce the fluctuation to an acceptable degree by 3 to 10 seconds.

The damping factor ranges from 0~999 seconds. 0 indicates no damping and 999 indicates the maximum damping. Usually a damping factor of 3 to 10 is recommended in applications.

```
Damping             [40
         10  sec
```

Menu | fluid type 4 | pipe dia. 1

Low Flow Cutoff Value

If the flow rate falls below the low flow cutoff value, the flow indication is driven to zero. This function can prevent the flow meter from reading flow after a pump is shut down but there is still liquid movement in the pipe, which will result in a totalizing error.

Generally, 0.03m/s is recommended to enter as the low flow cutoff point. The low flow cutoff value has no relation to the measurement results once the velocity increases over the low flow cutoff value.

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

Menu [fluid type] 4 [pipe thick] 2

Set 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 the [Enter] key and wait for the processing instructions at the bottom right corner 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 Window M43.

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

Menu [fluid type] 4 [pipe mat] 3

Reset Zero

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

```
Reset  Zero        [43
        NO
```

Menu [fluid type] 4 [fluid type] 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 [fluid type] 4 [xducer mount] 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 calibration results.

```
Scale Factor       [45
            1
```

Menu [fluid type] 4 [start/ stop] 6

Network IDN

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

```
Network  IDN      [46
                88
```

Menu [fluid type/4] [hold/7]

System Lock

Lock the instrument.

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

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

Menu [xe icon/5] [cal./0]

Data Interval

Input the data collection time interval in this menu. Time is in seconds. The interval can be selected in the range of 5~13000 seconds (3.6 hours). Press [Enter], the display shows ">" on the second line, input the required data collection interval, and then press [Enter]. The data collection interval is set. The factory default is 5 seconds.

```
DATA    interval     [50
 5                  S
```

Menu [xducer mount/5] [xducer mount/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	set up the output range from 4-20mA
1.	0-20mA	set up the output range from 0-20mA
2.	0-20mA via RS232	set up to be controlled by Serial Port
3.	4-20mA vs. Fluid	set up the CL output 4-20mA corresponding sound velocity
4.	20-4-20mA	set up the CL output range from 20-4-20mA
5.	0-4-20mA	set up the CL output range from 0-4-20mA
6.	20-0-20mA	set up the CL output range from 20-0-20mA
7.	4-20mA vs. Vel.	set up the CL output range from 4-20mA corresponding flow velocity
8.	4-20mA vs. Energy	set up the CL output range from 4-20mA corresponding heat flow

20-4-20mA mode output	20-0-20mA mode output	0-20mA mode output

4-20mA mode output	0-4-20mA mode output	Fluid velocity / 4-20mA mode output
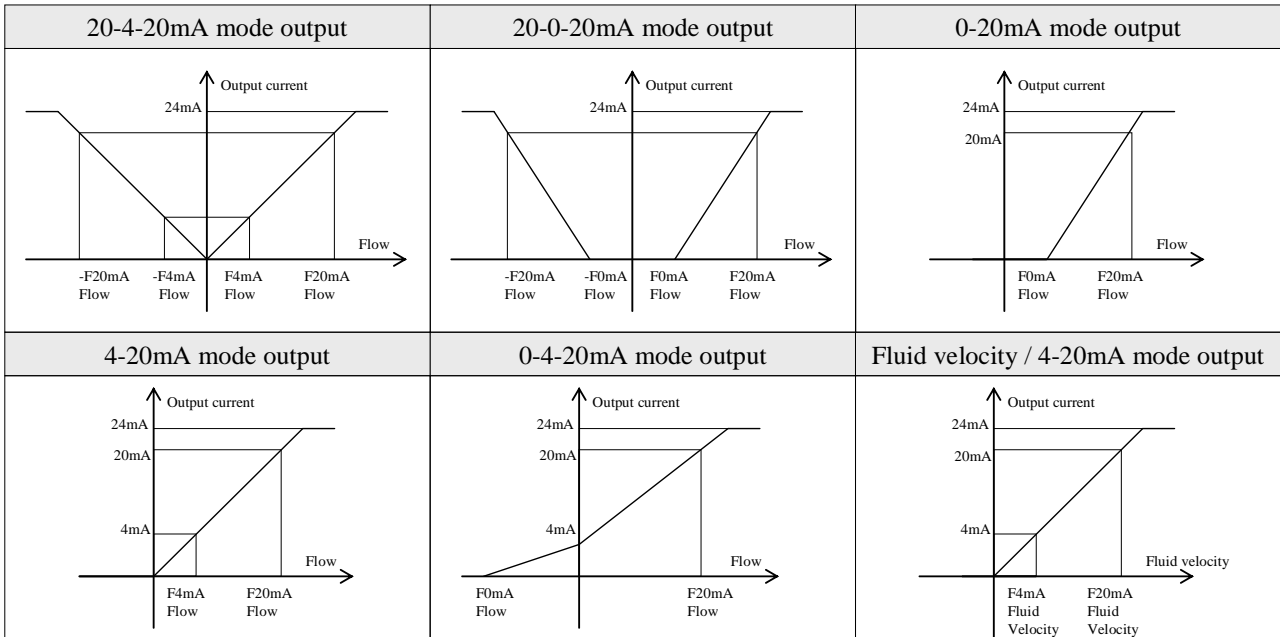
Figure 9. Output Current Value

The Serial Port controls the output according to the command and parameter entered in the RS232 to output a definite current value through the current loop. The command formats are narrated in the command explanations to Serial Port controls. For example, if it is necessary to output a 6mA current through the current loop, it can be realized by setting Window M56 to the mode "0-20mA Via RS232" and giving a command as "AO6 (CR)". This function is able to make the flow meter operate a control valve conveniently.

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

In the six graphs shown above, flow F_{0mA} or F_{4mA} indicates the value that the user entered in Window M57. Flow F_{20mA} indicates the value that the customer entered in Window M58. In the 4-20mA and 0-20mA modes, F_{0mA} (or 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. As for modes 20-4-20mA and 20-0-20mA, the flow meter ignores the positive and negative value of the actual flow. Therefore, both F_{0mA} (or F_{4mA}) and F_{20mA} must be selected as positive flow values.

In mode 0-4-20mA, F_{0mA} must be selected as a negative value and F_{20mA} as a positive value. Furthermore, in mode 4-20mA, the output current is indicated as velocity.

Menu [xducer mount 5] [start/ stop 6]

CL 4mA or 0mA Output Value
Set the CL output value according to the flow value at 4mA or 0MA. (4mA or 0mA are determined by the settings in Window M56). The flow unit's options are the same as those in Window M31. Once "velocity 4-20mA" is selected in Window M56, the unit should be set as m/s.

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

```
CL 4 mA Output Value
 0          Tonnes/s
```

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 Window M31.

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

```
CL 20mA Output Value
 0            Tonnes/s
```

CL Check Verification

Check if the current loop has been calibrated before leaving the factory. Press the [Enter] key and press [^] or [v] separately to display 0mA or 4mA till 24mA, and at the same time, check with an ammeter to verify that the CL output terminals M31 and 32 agree with the displayed values. It is necessary to re-calibrate the CL if it's over the permitted tolerance. For more information, refer to "Analog Outputs Calibration".

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

CL Current Output

Display CL current output. The display of 10.0000mA indicates that the CL current output value is 10.0000mA. If the difference between the displaying value and the CL output value is too large, the current loop then needs to be re-calibrated accordingly.

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

Date and Time Settings

Generally, it is unnecessary to modify date and time as the system is provided with a highly reliable perpetual calendar chip.

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

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

ESN

Display the 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 for management by the user.

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

[Menu] [start/stop 6] [pipe thick. 2]

COM Setup

The window used to set the serial port baud rate. Parity fixed at None, Data length fixed at 8 bits, 1 stop bit. The choices of baud rates are 9600, 19200, 38400, 56000, 57600, 115200

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

[Menu] [start/stop 6] [pipe mat. 3]

AI1 Value Range

In Window 63 enter the temperature value which 4mA and 20mA analog input represented. In this example window "10" represents 4mA corresponding temperature value, and "100" represents 20mA corresponding temperature value.

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

[Menu] [start/stop 6] [fluid type 4]

AI2 Value Range

In Window 64 enter the temperature value which 4mA and 20mA analog input represented. In this example window "10" represents 4mA corresponding value, and "100" represents 20mA corresponding value.

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

[Menu] [start/stop 6] [xducer mount 5]

AI3 Value Range

In window 65 enter the temperature value which 4mA and 20mA analog input represented. In this example window "10" represents 4mA corresponding value, and "100" represents 20mA corresponding value.

```
AI 3 Value Range  [65
  10  -  100
```

[Menu] [start/stop 6] [hold 7]

Set FO Frequency Range

Set up the low FO Frequency and high FO frequency range. The high FO must be higher than the low FO frequency. Ranges from 1-9999Hz. Factory default is 2000 Hz.

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

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

Menu start/stop 6 fluid vel. 8

Low FO Flow Rate

Set up the 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 (when the frequency output is 1000Hz, then the low flow at this moment measured by the flow meter is 100m3/h).

```
L ow FO Flow Rate  [ 6 8
        0  m3 / h
```

Menu start/stop 6 sound vel. 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.

```
Hi gh FO Flow Rate [ 6 9
     2 6 5 5 0  m3 / h
```

Menu hold 7 cal. 0

LCD Backlit Option

Select LCD backlit controls.

0. Always OFF, 1. Always ON, 2.Lighting For Select "Time=", then enter the desired backlighting time for "n" seconds; after pressing the button, the backlighting will keep on for "n" seconds then turn off automatically. This function saves energy.

```
L CD  B a c kl i t   Op t i o n
  0 .     Al wa y s  ON
```

Menu hold 7 pipe thick. 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 the Enter key, and select "YES".

```
Wo r k i n g   Ti me r     [ 7 2
     0 0 0 0 0 0 11 :16 :38
```

Menu hold 7 pipe mat. 3

Alarm #1 Low Value

Enter the low alarm value. Both relevant alarms are turned on in Windows 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.

```
Al a r m  # 1   L ow   Va l u e
           0  m3 / h
```

Menu hold 7 fluid type 4

Alarm #1 High Value

Enter the high alarm value. Both relevant alarms are turned on in Windows 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.

```
Al a r m  # 1   Hi gh   Va l u e
      14400    m3 / h
```

Menu hold 7 xducer mount 5

Alarm #2 Low Value

Enter the alarm low value. Both relevant alarms are turned on in Windows M78 and M79. Any 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 hold 7 start/stop 6

Alarm #2 High Value

Enter the alarm high value.

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

Menu hold 7 fluid vel. 8

OCT Output Setup

The OCT output in the flow meter is a kind of isolated collector open circuit output with programmable open and close qualifications. The user can program the open and close functions if the system alarm signals are being activated or the totalizer pulse is being transmitted.

The frequency output signal is also transmitted from the OCT. When it functions as the frequency output, other functions are unavailable.

The following signal options are available:

```
OCT Output Setup [78
  16.Fluid changed
```

0. No Signal	1. Poor Signal
2. Not Ready (No*R)	3. Reverse Flow
4. AO Over 100%	5. FO Over 120%
6. Alarm #1	7. Alarm #2
8. Batch Control	9. POS Int Pulse
10. NEG Int Pulse	11. NET Int Pulse
12. Energy Pulse	13. FO
14. FO via RS-232C	15. ON/OFF viaRS232
16. Fluid Changed	17. Not Using

Menu hold 7 sound vel. 9

Relay Output Setup

The relay output in the flow meter is programmable. The user can program the open and close functions if the system alarm signals are activated or the totalizer pulse is transmitting. The relay is single-pole and constant-on for external instrument controls.

The following options are available:

```
RELAY  Output   Setup
   8.  Batch  Control
```

0. No Signal	1. Poor Signal
2. Not Ready (No*R)	3. Reverse Flow
4. AO Over 100%	5. FO Over 120%
6. Alarm #1	7. Alarm #2
8. Batch Control	9. POS Int Pulse
10. NEG Int Pulse	11. NET Int Pulse
12. Energy Pulse	13. ON/OFF via RS232
14. Fluid Changed	15. Not Using

Menu [fluid vel.] 8 [cal. 0]

Flow Batch CTRL

Set the input trigger for the batch control function on the flow meter.

The following options are available:

0.Key Input	1.AI1 Up Edge
2.AI1 Down Edge	3.AI2 Up Edge
4.AI2 Down Edge	5.AI3 Up Edge
6.AI3 Down Edge	7.AI4 Up Edge

```
Flow Batch CTRL by
0.Key Input
```

Menu [fluid vel.] 8 [pipe dia. 1]

Flow Batch Controller

The internal batch controller in the flow meter is able to control the input signals through keypad or analog input Serial Port. Output signals can be transmitted through OCT or relay.

The flow batch value can be modified in this window. The screen will enter the batch control display as soon as the modification completed.

```
FlowBatch Controller
     1000   x1 m3
```

Menu [fluid vel.] 8 [pipe thick. 2]
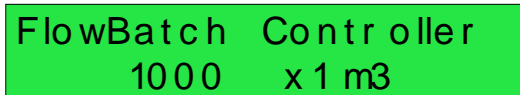
Date Totalizer

The following options are available:

    0.   Day

    1.   Month

    2.   Year

In this window, it is possible to review the historical flow data totalizer for any day for the last 64 days, any month for last 64 months and any year for last 5 years. Press Enter, use the ∧ or ∨ keys to review the totalizer in days, months, and years. Left upper corner: "00-63" indicates the serial numbers;

In the middle: "03-04-05" indicates the date; upper right corner: "G-H-I" indicates the working condition. If there is only "--------" displayed, it indicates the system was normal during that time period. If other characters are displayed, please refer to the "Error Code and Resolutions".

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.

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

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

```
00 03-04-05 ------
>4356.78 m3
```
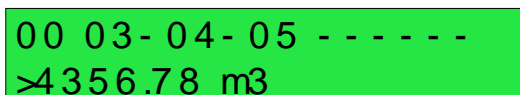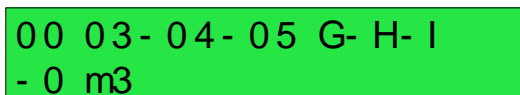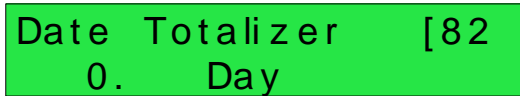
Menu [fluid vel. 8] [pipe mat. 3]

Automatic Flow Correction

With the automatic flow correction function, 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 "NO" to cancel this function.

```
Automatic Correction
        YES
```

Menu [sound vel. 9] [cal. 0]

Signal Strength and Signal Quality

They 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. Normally, signal quality Q value should be better than 50.

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

Menu [sound vel. 9] [pipe dis. 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 that 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       [91
        0.0000%
```

Menu [sound vel. 9] [pipe thick. 2]

Fluid Sound Velocity

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

```
Fluid Sound Velocity
     1443.4    m/s
```

Menu ⑨ ③

Total Time and Delta Time

Display the measured ultrasonic average time (unit: nS) 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 ⑨ ④
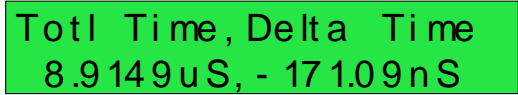
Reynolds Number and Factor

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.
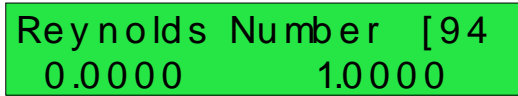
```
Reynolds Number  [94
 0.0000       1.0000
```

Menu ⑨ ⓪

Data Interval

Input the data collection time interval in this menu. Time is in seconds. The interval can be selected in the range of 5~13000 seconds (3.6 hours). Press Enter, the display shows ">" on the second line, input the required data collection interval, and then press Enter. The data collection interval is set. The factory default is 5 seconds.

```
DATA  interval  [95
 300       S
```

Menu ∧ ⓪
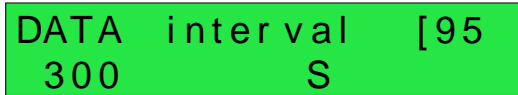
Power ON/OFF Time

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 window, press Enter 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 corner.

```
ON/OFF Time      [+0
Press ENT When Ready
```

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

Menu ∧ ①
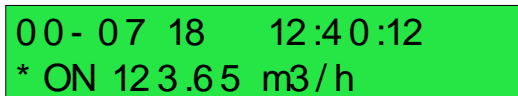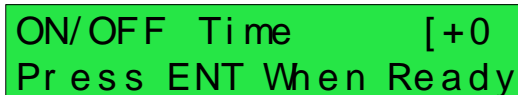
Total Working Hours
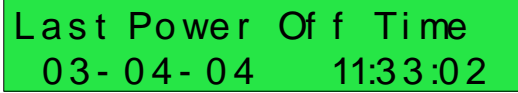
With this function, it is possible to view the total

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] [∧] [pipe thick 2]
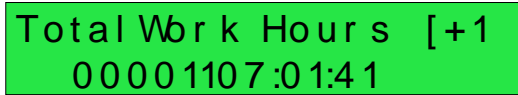
Last Power Off Time

Display the last power off time.

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

[Menu] [∧] [pipe mat 3]

Last Flow Rate

Displays the last flow rate.

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

[Menu] [∧] [fluid type 4]

Total ON/OFF Times

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

```
ON/OFF Times     [+4
            40
```
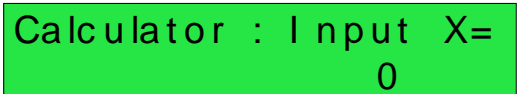
[Menu] [∧] [xducer mount 5]

Calculator

This window works as a calculator with an internal calculation function. To use the calculator, enter the first parameter X, select a calculating operator; if there is a second parameter, enter it as parameter Y, then combine the calculation results into parameter X. For example:

To calculate 1+2 it is necessary to press [Menu] [∧] [xducer mount 5] [pipe dia 1] [Enter], use [∧] or [∨] to select "+", press [Enter] [pipe thick 2] [Enter] to confirm.   This calculator is also provided with a register function.

Note: Using the calculator while the system is running will not influence the measurement.

```
Calculator : Input X=
            0
```

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 the 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 Window 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 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.
*E	Current Loop Over 20mA (No influence normally. Ignore it if no current output is being used)	4-20mA current loop over 120%. Improper settings to current loop output.	Check settings (refer to Window M56) and confirm if actual flow is too high.
*Q	Frequency Output Over Set Value (No influence normally. Ignore it if no frequency output is being used)	Frequency output over 120%. Improper settings to frequency output or actual flow are too high.	Check settings (refer to Window M66-M69) and confirm if the actual flow is too high.
*F	Refer to Table 1.	Error in self-diagnosis 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 Windows 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 Window M29	No fluid in pipe or settings incorrect.	Once fluid is detected in the pipe, set 0 in Window M29.

7.3. 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 a layer of scale between the transducers and pipe inside wall.

Question: Why is there no CL (current loop) output?

Answer: Check if the desired current output mode is set in Window M55. See if the CL is powered off by "CL Off" settings.

Question: Why is the CL output abnormal?

Answer: Check to see if the desired current output mode is set in Window M55.

Check to see if the maximum and minimum current values are set properly in Windows M56 and M57.

Re-calibrate CL and verify it in Window M49.

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 Window M42). If it is confirmed, recover the factory default in Window M43.

Question: With a poor measurement site environment in the plant and the voltage and power supplies fluctuating widely, is the instrument really able to keep running 24 hours a day repeatedly without stopping and last for several years under such conditions?

Answer: The InnovaSonic 205i is designed to work with high reliability under such conditions. It is provided with an intelligent signal conditioning circuit and internal correction circuitry. It will work under strong interference conditions and is able to adjust itself with strong or weak sound waves. It will work in a wide band of voltage: 90-245VAC or 10V~36VDC voltage.

8. Product Overview

8.1. Introduction

The InnovaSonic 205i is a state-of-the-art universal transit-time flow meter designed using SLSI technology and low voltage broadband pulse transmission. While principally designed for clean liquid applications, the instrument is tolerant of liquids with small amounts of air bubbles or suspended solids found in most industrial environments.

8.2. Features of InnovaSonic 205i

With distinctive features such as high precision, high reliability, high capability and low cost, the flow meter features other advantages:

- Low consumption power, high reliability, anti-jamming, and outstanding applicability.
- Clear, user-friendly menu selections make flow meter simple and convenient to use.
- U.S., British, and Metric measurement units are available. Meanwhile, almost all-universal measurement units worldwide may be selected to meet customer's requirements.
- Daily, monthly, and yearly totalized flow: Totalized flow for the last 64 days and months as well as for the last 5 years may be viewed.
- Power on/off function: allows the viewing of time and flow rate as power is switched on and off 64 times. Also, the flow meter has manual or automatic amendment during offline sessions.
- Self-contained signal output, including relay, open collector, frequency, and 4~20mA current loop analog outputs, etc.
- Parallel operation of positive, negative, and net flow totalizer with scale factor (span) and 7 digit display, while the output of totalize pulse and frequency output are transmitted via relay and open collector.
- Internally configured batch controller makes batch control convenient.

8.3. 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:

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

Remarks:

V	Medium Velocity
M	Ultrasonic frequency of reflection
D	Pipe Diameter
θ	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

$\Delta T = T_{up} - T_{down}$
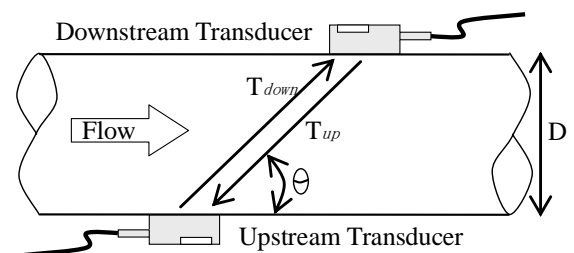
8.4. Applications

Water, sewage (with low particle content), and seawater

Water supply and drainage water

Power plants (nuclear power plant, thermal and hydropower plants), heat energy, boiler feed water, and energy management system

Metallurgy and mining applications (cooling water and acid recovery)

Petroleum and chemicals

Food, beverage, and pharmaceutical

Marine operation and maintenance

Energy economy supervision and water conservation management

Pulp and paper

Pipeline leak detection

Regular inspection, tracking, and collection

Energy measuring and balance

Network monitoring systems and energy/flow computer management

8.5. Specifications

PERFORMANCE SPECIFICATIONS

Accuracy
Accuracy +/-0.5% of reading from 1.6 to 40 t/s (0.49 to 12 m/s)

Repeatability
+/- 0.15% of reading

Pipe Size
2 to 236 inches (50 to 6000 mm)

OPERATING SPECIFICATIONS

Flow Range
0.16 to 40 ft/s (0.05 to 12 m/s)

Temperature
Ambient: -40°F to 140°F (-40°C to 60°C)
Operating: -40°F to 176°F (-40°C to 80°C)

Power Supply
90 to 250 VAC, 48 to 63 Hz and
10 to 36 VDC (both are available on each unit)

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, (1A @ 125 VAC or
            2A @ 30 VDC)
Digital output: Modbus RTU, RS-485, RS-232

Keypad
22 tactile keys with 12 dual-function and 6 quick setup keys

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

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

Data Logging
1 GB SD card high-memory data logger

PHYSICAL SPECIFICATIONS

Transmitter
NEMA 4X (IP65), die-cast aluminum

Transducer
Encapsulated design IP 67
Standard cable length: 30 ft (9 m)
Maximum cable length: 300 ft (90 m)

Weight
Transmitter: approximately 4.7 lb. (2.2 kg)
Transducer: approximately 2 lb. (0.9 kg)

DIMENSIONS

Front View 205i Transmitter Wall Mount
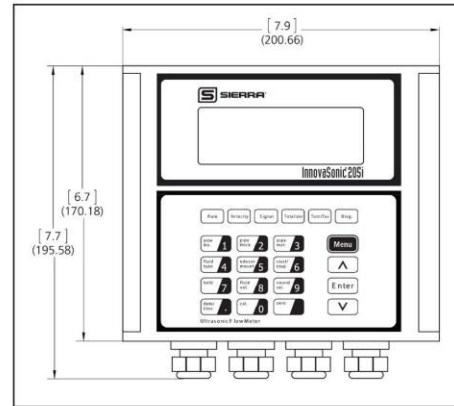
Side View 205i Transmitter Wall Mount
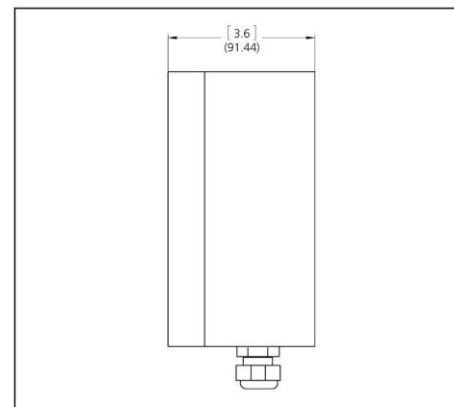
Side View 205i Clamp-on Transducers
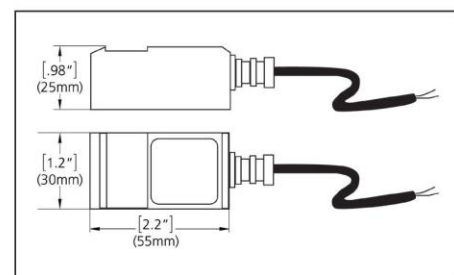
Note: Transducer Hazardous area classification: Ex d II BT4

OPTIMAL INSTALLATION LOCATIONS

Transducer Installation Examples

Installing the Transducers (*example*)
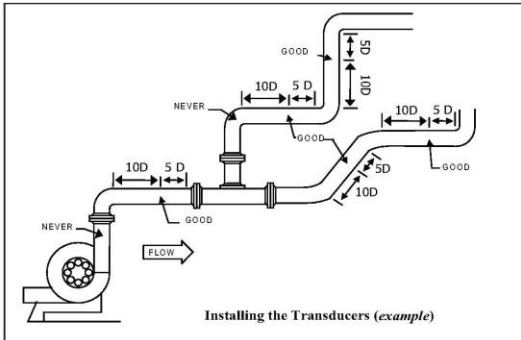
Transducer Installation For Pump Storage Tank
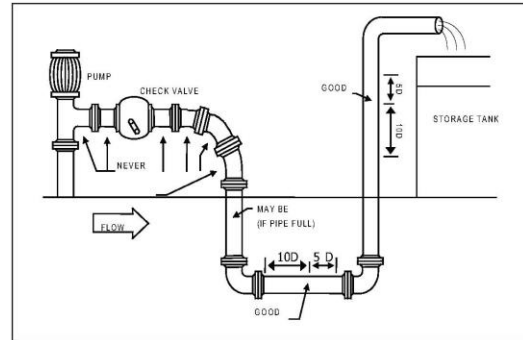
TRANSDUCER SPACING REQUIREMENTS

Z Method Transducer Spacing
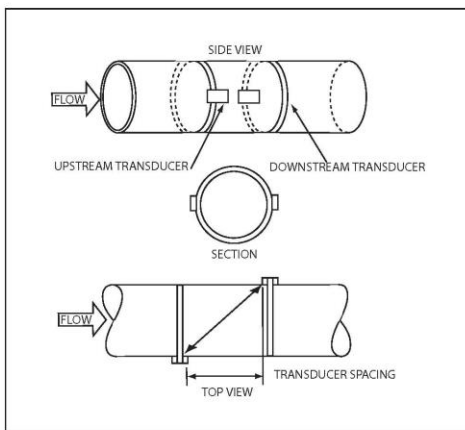
V Method Transducer Spacing
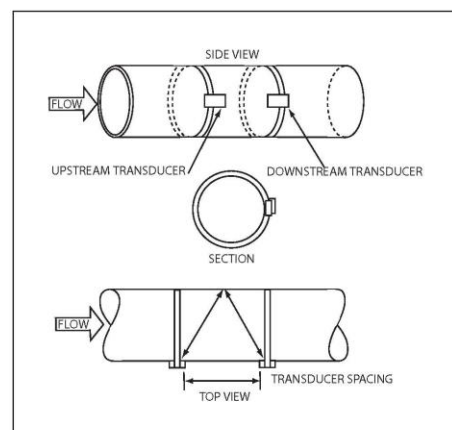
TYPICAL INSTALLATIONS

Front View Clamp-on Transducers

Transducer Installation Examples

Features — Option
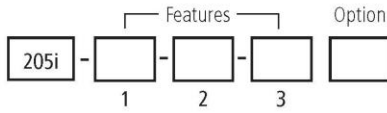
205i - [ ] - [ ] - [ ]   [ ]
       1   2   3

Instructions: To order the 205i, please fill in each number block by selecting the codes from the corresponding features below.

Parent Number	
205i	InnovaSonic® General Purpose Ultrasonic Transit-Time Liquid Flow Meter

Feature 1: Enclosure	
1	NEMA 4X (IP 65); Die-cast aluminum machined enclosure

Feature 2: Transducers	
S	Clamp-on transducer, operating temperature: -40°F to 176°F (-40°C to 80°C) IP 68

Note: Insertion transducers include ball valves (1.5 inch), carbon steel installation seat for ball valve (brass), mounting kit (includes 4 screws and four plastic bushings) and seal kits (consult factory for other materials)

Feature 3: Transducer Cable			Option: NIST Traceable Certificate	
30	30 ft. (9m) standard cable length		NIST	5-point calibration certification traceable to NIST. Add two weeks to standard delivery.
X (in feet)	Special length up to 300 ft. (90 m)			

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*Disclaimer: Dependent on availability of stock.

205i P.3 01/17

9. Appendix 1 - Flow Application Data

9.1. Sound Velocity and Viscosity for Fluids Commonly Used

Fluid	Sound Velocity (m/s)	Viscosity
Water 20°C	1482	1.0
Water 50°C	1543	0.55
Water 75°C	1554	0.39
Water 100°C	1543	0.29
Water125°C	1511	0.25
Water 150°C	1466	0.21
Water 175°C	1401	0.18
Water 200°C	1333	0.15
Water 225°C	1249	0.14
Water 250°C	1156	0.12
Acetone	1190	
Carbine	1121	
Ethanol	1168	
Alcohol	1440	1.5
Glycol	1620	
Glycerin	1923	1180
Gasoline	1250	0.80
Benzene	1330	
Toluene	1170	0.69
Kerosene	1420	2.3
Petroleum	1290	
Retinal	1280	
Aviation kerosene	1298	
Peanut oil	1472	
Castor oil	1502	

9.2. Sound Velocity for Various Materials Commonly Used

Pipe Material	Sound Velocity (m/s)
Steel	3206
ABS	2286
Aluminum	3048
Brass	2270
Cast iron	2460
Bronze	2270
Fiber glass-epoxy	3430
Glass	3276
Polyethylene	1950
PVC	2540
Titanium	3150
Cement	4190
Bitumen	2540
Porcelain enamel	2540
Glass	5970
Plastic	2280
Polyethylene	1600
PTFE	1450
Rubber	1600

9.3. Sound Velocity in Water (1 atm) at Different Temperatures

t (°C)	v (m/s)
0	1402.3
1	1407.3
2	1412.2
3	1416.9
4	1421.6
5	1426.1
6	1430.5
7	1434.8
8	1439.1
9	1443.2
10	1447.2
11	1451.1
12	1454.9
13	1458.7
14	1462.3
15	1465.8
16	1469.3
17	1472.7
18	1476.0
19	1479.1
20	1482.3
21	1485.3
22	1488.2
23	1491.1
24	1493.9
25	1496.6
26	1499.2
27	1501.8
28	1504.3
29	1506.7
30	1509.0
31	1511.3
32	1513.5
33	1515.7
34	1517.7
35	1519.7

36	1521.7
37	1523.5
38	1525.3
39	1527.1
40	1528.8
41	1530.4
42	1532.0
43	1533.5
44	1534.9
45	1536.3
46	1537.7
47	1538.9
48	1540.2
49	1541.3
50	1542.5
51	1543.5
52	1544.6
53	1545.5
54	1546.4
55	1547.3
56	1548.1
57	1548.9
58	1549.6
59	1550.3
60	1550.9
61	1551.5
62	1552.0
63	1552.5
64	1553.0
65	1553.4
66	1553.7
67	1554.0
68	1554.3
69	1554.5
70	1554.7
71	1554.9
72	1555.0

73	1555.0
74	1555.1
75	1555.1
76	1555.0
77	1554.9
78	1554.8
79	1554.6
80	1554.4
81	1554.2
82	1553.9
83	1553.6
84	1553.2
85	1552.8
86	1552.4
87	1552.0
88	1551.5
89	1551.0
90	1550.4
91	1549.8
92	1549.2
93	1548.5
94	1547.5
95	1547.1
96	1546.3
97	1545.6
98	1544.7
99	1543.9

If the sound velocity of other fluids and materials is needed, please contact the factory.

10. Appendix 2 - Wetted Transducer

10.1. Overview

Insertion transducers can be installed into metal pipelines via an isolation ball valve (installation into pipelines of plastic or other materials may require an optional coupling). The maximum pipe diameter in which insertion transducers can be installed is DN5000mm. Sensor cable length (9m standard) normally can be extended to as long as 305m. Follow the procedure below to install insertion transducers (If hot tapping is required, refer to the operating instructions of the manufacturer of hot tapping devices. Note that the pipe tap size should not be smaller than φ38mm).

Figure 1 shows a diagram of the Insertion Transducer (Ordering option – W). The insertion transducer is attached to its mounting base (which is welded to the pipe section at the measurement point) via a ball valve. When the transducer is removed, pipe fluids can be contained by shutting off the ball valve. Therefore, installation and extraction of the transducer can be performed without relieving pipeline pressure. An O-ring seal and joint nut guarantee user safety while installing or operating the transducer.

$$H = 323.5\text{-}h \text{ mm}$$

Pipe outside wall   Pipe inside wall
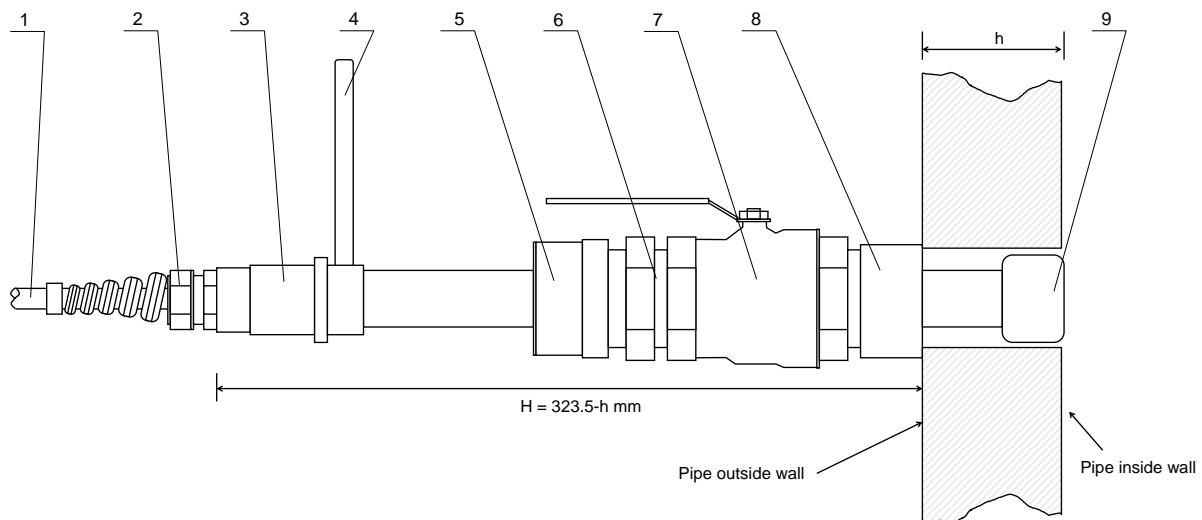
1. Cable
2. Flexed-resistance revolved piece
3. Connector
4. Orientation handle
5. Locating sleeve
6. Joint nut
7. Ball valve
8. Mounting base
9. Transducer housing

Figure.10 Construction Drawing of W type Transducer

10.2. Measurement Point Selection

To guarantee highly accurate measurement results, it is necessary to select an appropriate measurement point before installing the transducer. For examples of measuring point selection, see the related section in the manual.

10.3.   Determining Transducer Spacing & Transducer Installation

To obtain the strongest signal strength and the most accurate measurement results, it is critical to ensure correct transducer spacing. Select an appropriate measurement point to install the transducer

> **Important**
>
> When programming the instrument for use with Insertion Sensors, set the Pipe Wall Thickness in MENU 12 to 0.001.   Set the "transducer Type" in MENU 23 as "0.Standard".

Perform the following procedure to adjust the transducer spacing:

Calculate the center-to-center hole distance between the two transducers by using the formula below:

$S＝SP＋34$ (units in mm)

In this formula, SP is the spacing value calculated (by the flow meter) by entering the pipe parameters such as pipe inner diameter, pipe wall thickness, etc. (units in mm).

Drill holes 40mm in diameter at the determined measurement points on the pipe and weld the mounting base of the transducer vertically at that position on the pipe surface.

There are two transducer cables for the transducers: Upstream transducer cable with red terminal ends and downstream transducer cable with blue terminal ends. It should be noted that upstream transducer and downstream transducer must be installed at the appropriate measurement point in accordance with the flow direction. If the cable connection is reversed, opposite flow direction will be measured by the flow meter.

Tighten the ball valve securely onto the mounting base (shut off the ball valve).

Unscrew the locating sleeve and loosen the lock ring, retract the transducer into the joint nut, and then tighten the joint nut onto the ball valve.

Open the ball valve and insert the transducer into the pipe. At the same time, measure the dimension between the outside pipe and the A point (Refer to Figure 10) and make sure it complies with the following formula:

$H＝323.5 - h$

In this formula:

H is Mounting height (mm)

323.5 is Transducer length (mm)

h is Pipe wall thickness (mm)

Attach the lock ring to the joint nut by fitting its pinhole in the locating pin, then tighten the screw slightly and turn the orientation handle until it points at the middle position between the two transducers and its axes matches the axes of the pipeline. Finally, tighten the locking screw and screw the locating sleeve onto the joint nut.

Connect the transducer cables to the corresponding upstream/downstream (upstream = red, downstream = blue) terminal ends.

> **IMPORTANT**
>
> For horizontal pipelines, transducers must be fixed on the sides of the pipe (i.e. at the 3 and 9 o'clock position of the pipe) to prevent signal attenuation caused by sediment on the bottom of the pipe or air bubbles and air pockets in the top of the pipe.

10.4. Transducer Mounting Methods

Two transducer mounting methods are available, Z method and V method. Select one of them in the menu according to specific application conditions.

10.4.1 Z Mounting Method

Z method is the most commonly used mounting method for insertion-type ultrasonic flow meters, suitable for pipe diameters ranging from 50mm to 5000mm. Due to strong signal strength and high measurement accuracy, the Z method is preferable for pipe sections severely rusted or with too much scale formation on the inside wall. When installing the transducer using the Z method, be sure that the two transducers and the pipeline center axis are in the same plane, but never in the 6 or 12 o'clock positions. See example below:

Profile Chart	Top View	Section
	Flow Drill hole spacing T+34mm	Top Reference point At 9 o'clock → ← Reference point At 3 o'clock Bottom
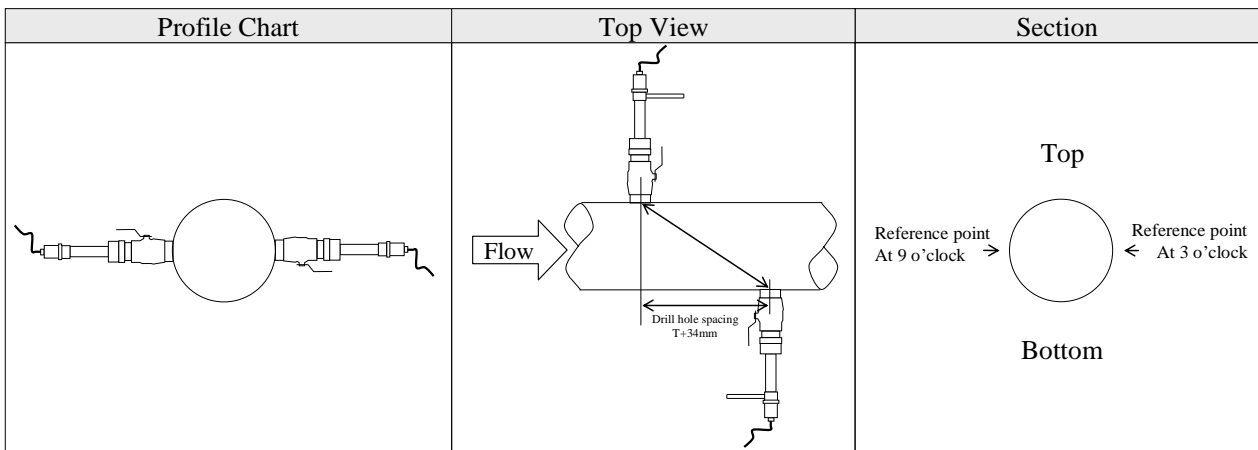
10.4.2 V Mounting Method

V method is suitable for pipe diameters ranging from 300mm to 1200mm. It is used when only one side of the pipe is available (example: the other side is against a wall) at the installation site. See example below:

Profile Chart	Top View	Section
	Flow Drill hole spacing T+34mm	Top Reference point At 9 o'clock → ← Reference point At 3 o'clock Bottom
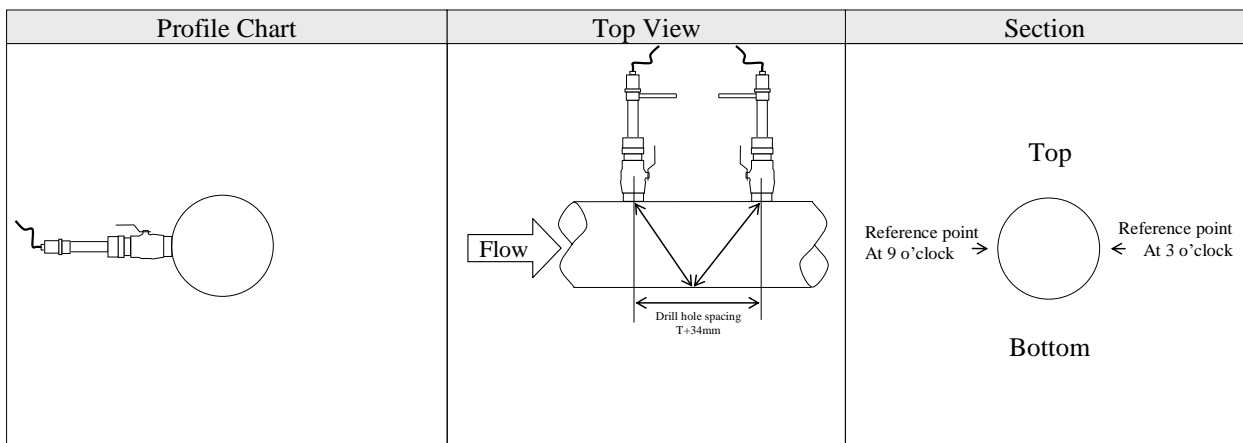
11. Appendix 3 - Serial Interface / Network Use

11.1. Overview

The flow meter comes standard with a RS-485 multi-drop and RS-232 point to point connection. RS-232 can be used for point to point (one master one slave 205i) communication 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 205i slaves on one wire pair. This could be up to 30, 205is on one RS-485 segment, and 127 on a whole RS-485 network.

Both RS485 and RS232 communication can be used with the Modus RTU protocol. The network address identifying code (IDN) is set in Menu 46. Although RS232 doesn't normally use an address, when using the Modbus protocol it does.

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.

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

11.2. RS-232 / RS-485 Pin Definitions

Flow Meter:	PC COM Port:
TXD receive	Pin 2 Rx
RXD send	Pin 3 Tx
GND	Pin 5 GND

Flow Meter:	RS485 2 Wire Network:
A	A (-)
B	B (+)
GND	GND

Note: A&B may need to be reversed

11.3. Connection of RS-232 or RS-485

See the above list of flow meter serial port definitions.
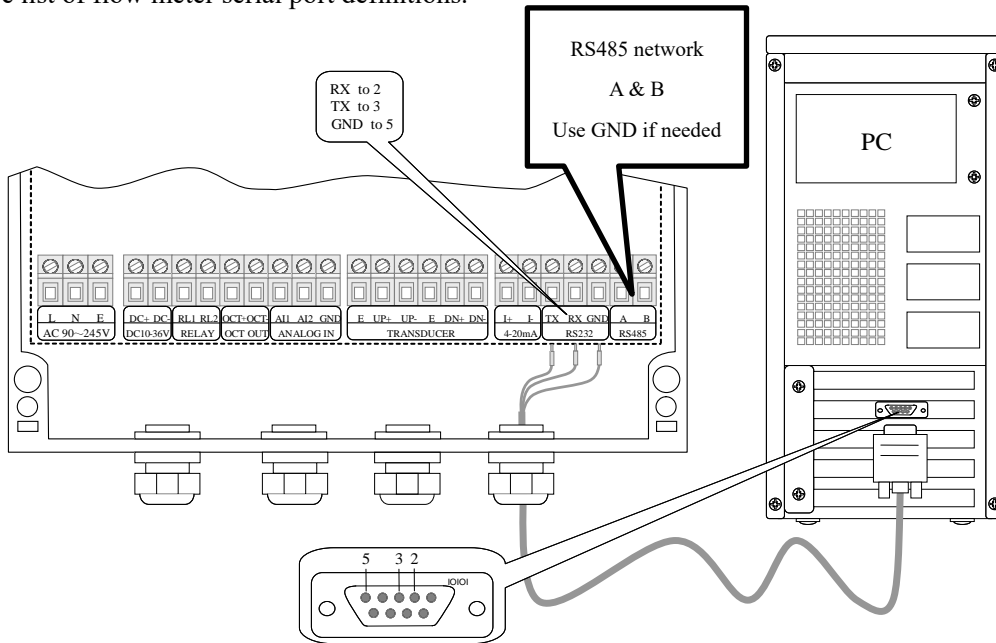
11.4. Setting Up the 205i to Use Modbus RTU

Menu 4 6

Press Enter, when the > cursor appears type in your entry. Press enter when done.

Input the Modbus address your 205i will be using on your network. These numbers can be selected from 0-65535; however Modbus only supports 1-255. The 205i has some reserved addresses you can't use; 13 (0DH ENTER), 10 (0AH Newline), 42 (2AH), and 38 (26H).

```
Network  IDN    [46
              88
```

Menu 6 2

Press Enter, when the > cursor appears use the ∧ and ∨ keys to make your selection. Press Enter when done.

This window is used to setup the Modbus serial port baud rates. Your choices are 9600, 19200, 38400, 56000, 57600, or 115200. This setting must match the master and other slaves on your Modbus network. The Parity is fixed at None, Data length fixed to eight, Stop bit fixed at 1.

Default factory serial port parameters are: "9600, 8, None, 1".

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

11.5. Modbus-RTU Protocol

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

Function Code	Performance Data
0x03	Read register
0x06	Write single register

1) 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

2) 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 are 1-247, 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	First Address Register	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
Flowmeter 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 flowmeter 44100 register as 0x02, the write command is as follows:

0x01	0x06	0x10 0x03	0x00 0x02	0xFC 0xCB
Flowmeter Address	Function Code	Register Address	Register Number	CRC Verify Code

Flowmeter returned data is:

0x01	0x06	0x10 0x03	0x00 0x02	0xFC 0xCB
Flowmeter Address	Function Code	Register Address	Register Number	CRC Verify Code

3) 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
Flowmeter Address	Function Code	Register Address	Register Number	CRC Verify Code

Flowmeter returned error code is:

0x01	0x83	0x02	0xC0 0xF1
Flowmeter Address	Error Code	Error Extended Code	CRC Verify Code

4) 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 205i 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.

PDU Address	Register	Read	Write	Type	No. Registers*
$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	Energy total – low word	32 bits int.	2	
$0012	40019	Energy total – high word			
$0013	40020	Energy total – exponent	16 bits int.	1	
$0014	40021	Energy flow – low word	32 bits real	2	
$0015	40022	Energy flow – 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			
$0041	40066	Reserved			
$0042	40067	Reserved			

$0043	40068	ID code – low word	32 bits int.	2	
$0044	40069	ID code – high word			
$0045	40070	Serial number – char 1,2	String	4	
$0046	40071	Serial number – char 3,4			
$0047	40072	Serial number – char 5,6			
$0048	40073	Serial number – char 7,8			
$0049	40074	Reserved			
$004a	40075	Reserved			
$004b	40076	Reserved			
$004c	40077	Reserved			

a)   Single Write Register Address List (use 0x06 performance code to write)

PDU Address	Register	Description	Read/Write	Type	No. Registers*
$1003	44100	Flowmeter address (1-247)	R/W	16 bits int.	1
$1004	44101	Communication Baud Rate 1 = 4800, 2 = 9600 3 = 19K2, 4 = 38K4 ,5 = 57K6	R/W	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

12. Appendix 4 - Warranty Policy

12.1 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.