Ultrasonic Flowmeter and Analyzer Manual

Model: PUF8300

Update Record	Revision	3.0.2
	Date	05 . 2021

Notice

Thank you for choosing the PUF8300 Ultrasonic Flowmeter and Analyzer with ARM chip and low-voltage wide-pulse sending technology.

This instruction manual contains important information. Please read it carefully before operation the flowmeter thus avoiding damage to the flowmeter from improper use.

This instruction manual will advise how to use the flowmeter step-by-step manner, including product component description, installation, wiring and quick setup etc. to make it easier to operate.

A working knowledge of the menu settings will assist you in understanding the flowmeters' powerful and output function.

Warning

May cause injury.

Attention

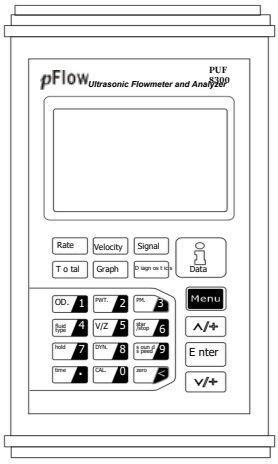
May damage the flow meter.

Some of theinstructions may be different from the flowmeter and analyzer you have purchased. That depends on the configuration requirements. It also may be due to changes in product design, modification and upgrade .You will find the flowmeter display interface intuitive and easy to understand and it shall prevail when there is no indication of the instructions. Please refer to the version number and the appendix for more information.

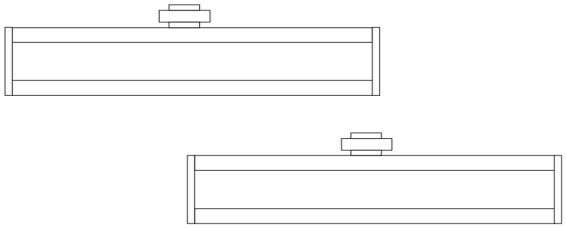
Product Components

Inspection should be made before installing the flowmeter. 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 loose screw or wires or other damage that may have occurred during transportation. Any questions, please contact your representative as soon as possible.

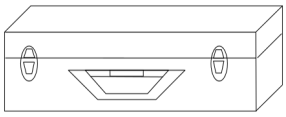
Transmitter



Transsducer

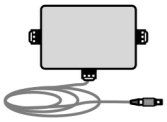


Accessories

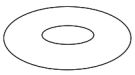


Carrying Case

Cable

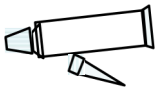


Signal Cable

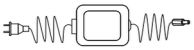


Software

Pipe Straps



Coupling Compound



Charger

Documents

1. Instruction
2.Packing List
3.Certified Factory Calibration

Content

Update Information:

1 Transmitter Installation and Connection

1.1 Power Supply Connections

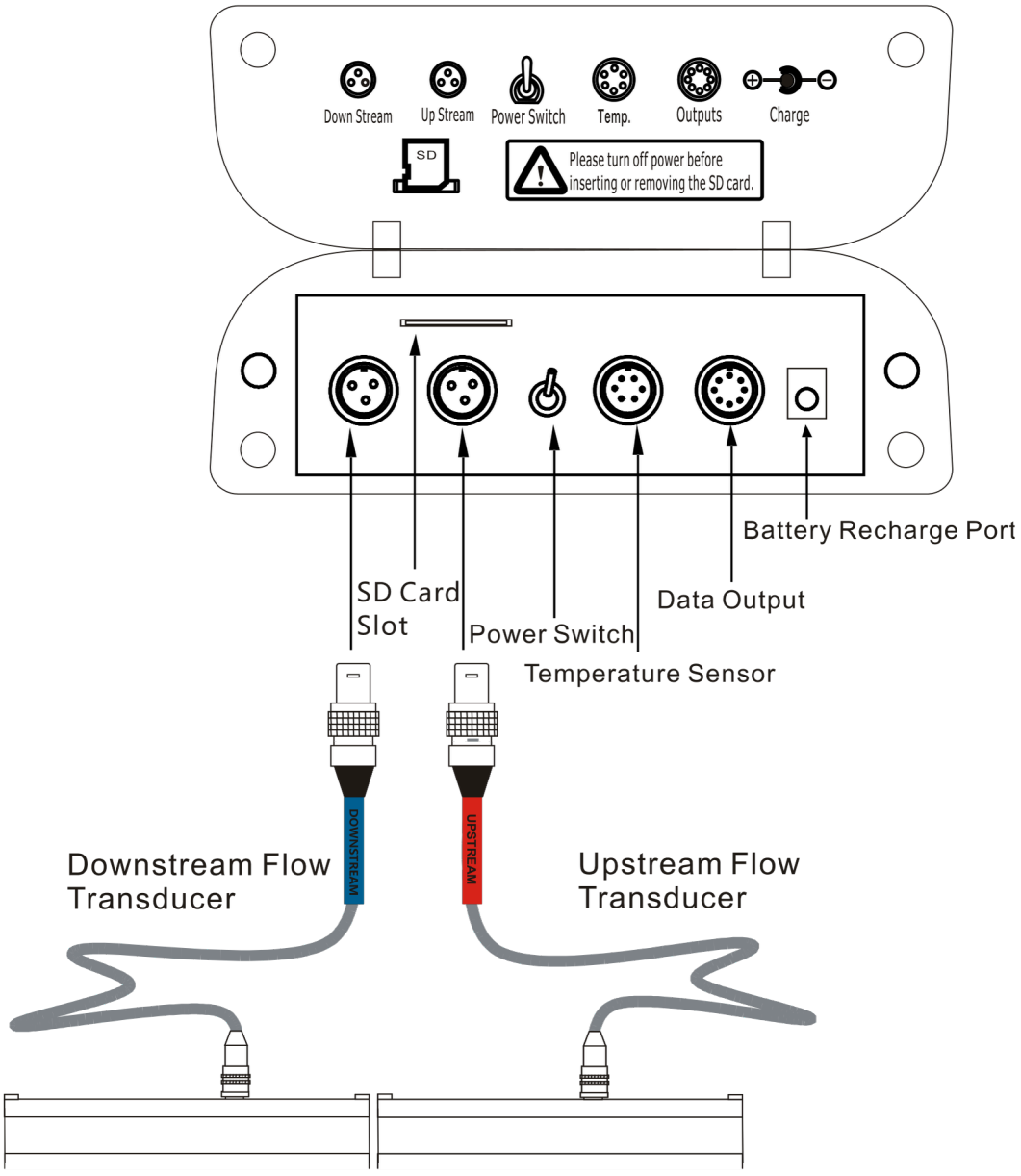
1.1.1 Type of Power Supply

The factory offers one rechargeable 11.1V Lithium battery and matching battery charger.

1.1.2 Wiring

Open the hinged top cover of the electronics. The wiring ports of the PUF8300, from left to right, are as follows:

Downstream transducer connector, upstream transducer connector, SD card slot, power switch, temperature sensor connector, and battery recharge port.

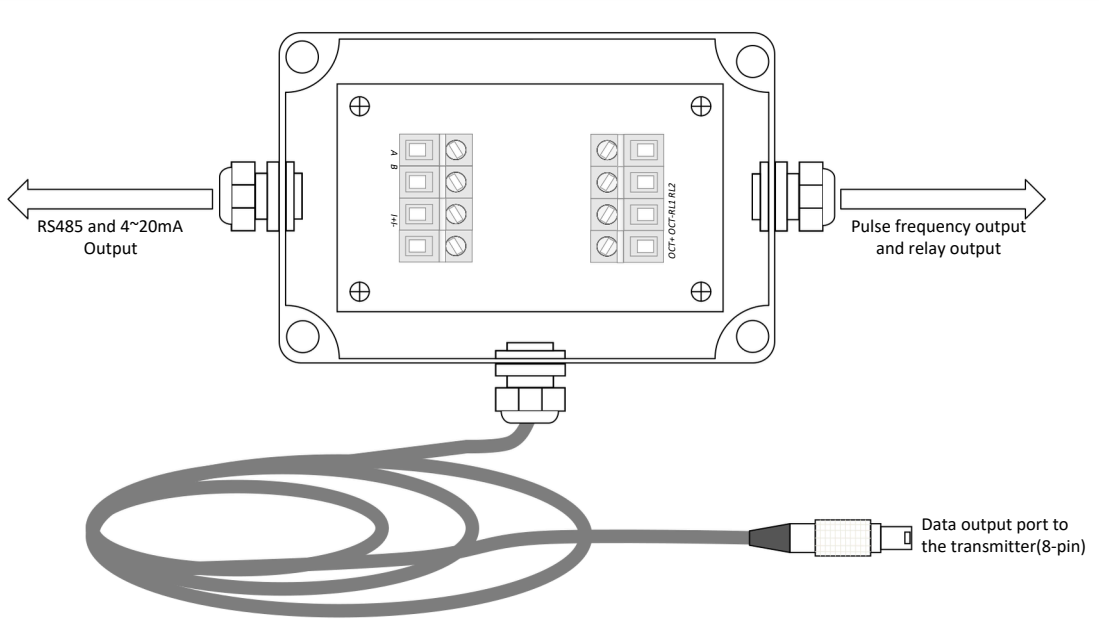


Warning

Wiring connections should be made when power is off.

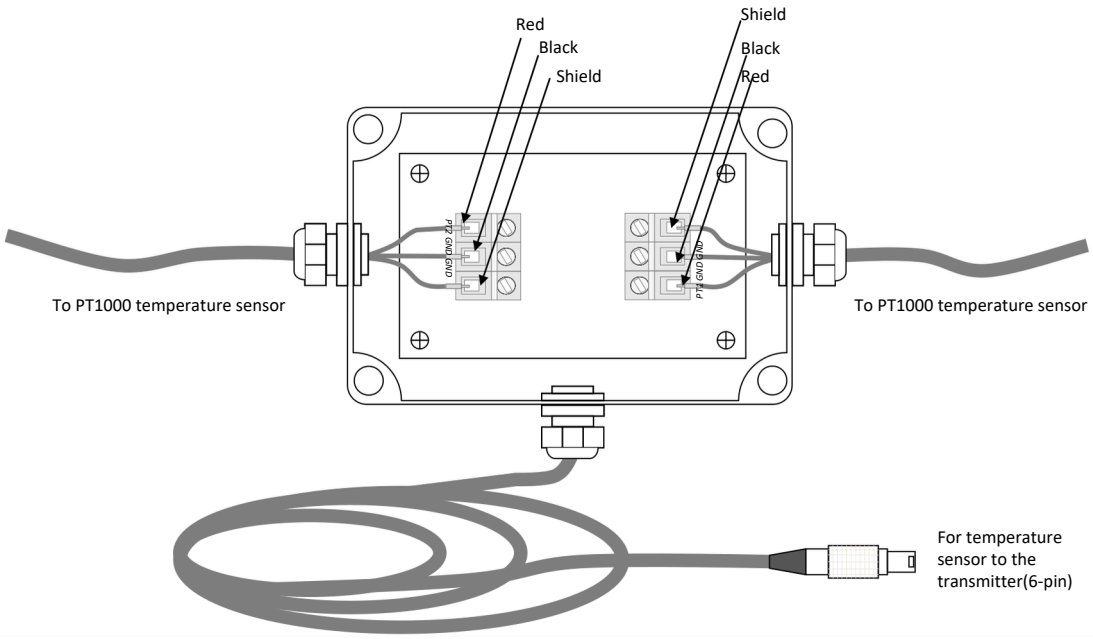
1.1.3 Data Output Wiring

Data output wiring as shown below: First connect the 8-pin plug with the data output port; then connect the OCT with the pulse frequency output, then connect the RL with the relay output, after these connect the AB with the RS485 Communication, finally get the I with the 4 ~ 20mA current output.



1.1.4 Temperature Sensor Wiring (Optional)

Temperature sensor wiring as shown below: connect the 6-pin plug with the temperature sensor port of the transmitter; then PT1&GND&GND and PT2&GND&GND separately connect with the return water temperature sensor.



1.2 Powering On

When the meter is powered on, it will start with the following screen, the Version Number Ver:1.01 and the Serial number S/N:50004002 will be shown at the bottom right corner.

If it is the first time of use or an installation on a new site, the customer needs to input the new installation site parameters. Any parameters which are set by the user will be saved permanently until they are changed by the user.

When the user modifies the parameters or removes the transducers, the meter will recalculate automatically, and operate normally with the newly set parameters.

1.3 Keypad Functions

Follow these guidelines when using the flowmeter keypad:

 ~  and  : Input numbers.

 : Backspace or delete characters to the left.

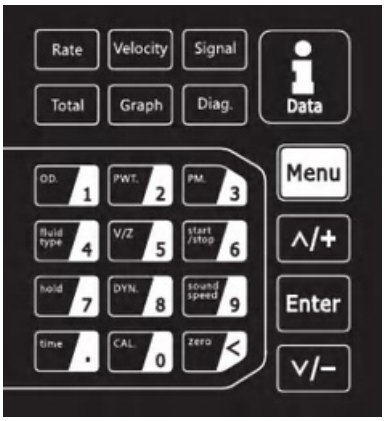
 and  : Return to the last Menu or open the next Menu. Acts as "+" and "-" are used to enter numbers.

 : Select a Menu. Press this key first, input a two-digit Menu number and the selected Menu data will be displayed. For example, in order to input a pipe outside diameter, press    where "11" is the window ID to display the pipe outside diameter.

 : Enter / Confirm.

 : Enter / Exit SD card storage interface.

 are shortcuts to the windows for Flow Rate, Velocity, Signal Quality, POS Totalizer, waveform, and Diagnosis.



1.4 Keypad Operation

The instrument setup and measurement displays are subdivided into more than 100 independent Menus. The operator can input parameters, modify settings or display measurement results by "visiting" a specific Menu. These Menus are arranged by 2-digit serial numbers from 00~99, then using +0, +1, etc. Each Menu ID code has a defined meaning. For example, Menu 11 indicates the pipe outside diameter, while Menu 25 indicates the mounting spacing between the transducers. Each Menu will be discussed later in this manual.

1.To visit a specific Menu, press the key at any time except the SD Card Storage Interface, then input the 2-digit Menu ID code and that Menu will be displayed. For example, to input or check the pipe outside diameter, press the keys for window ID code 11.

Another method to visit a particular Menu is to press the , and keys to scroll through the Menus. For example, if the current Menu is 30, press key to enter Menu 31, press the button again to enter Menu 30.

The Menus are divided into three types: 1) Data Type, such as M11, M12; 2) Selection Type, such as M14; 3) Display Type, such as M00, M01.

Visit Data Type Menus to check specific parameters. If parameter change is needed, just press first, then input the values and press to confirm.

Example 1: To enter a pipe outer diameter of 200mm, the procedure is as follows:

Press to enter Menu11 (the numerical value displayed currently is the previous pipe outer diameter). Now press the key. The symbol ">" and a flashing cursor is displayed on the screen.The new value can now be entered.

Visit Selection Type Menus to check the related options. If need to modify it, press first to enter the revised selection when the symbol ">" is displayed on the screen; or input numbers directly to select the option when the symbol ">" and a flashing cursor are displayed.

Example 2: If the pipe material is "Carbon Steel", press to enter Menu 14, then press to modify the option. Then, select"0. Carbon Steel" from the drop-down Menu (you may cycle through the choices by pressing the and keys) and then press to confirm the selection.

1.5 Flowmeter Menu Descriptions

These windows are assigned as follows:

00~09 Display Menus: Used to display flow rate, positive total, negative total, net total, velocity, date & time etc.

10~29 Setup Menus: Used to enter pipe outer diameter, pipe wall thickness, fluid type, transducer type, transducer mounting and spacing, etc.

30~38 Flow units selection and totalizer operating Menus: Used to select units of measurement. Other Menus set / reset the various totalizer modes.

40~45 Setup Menus: Zero Set Calibration menu, Scale Factor menu, etc.

46~81 Input and output setup Menus: current loop mode select, 4mA or 20mA output value, etc.

90~96 Diagnostics: signal strength quality (Menu 90), TOM/TOS*100 (Menu 91), sound velocity (Menu 92), total time and delta time of the measured signal (Menu 93), Reynolds number and K factor (Menu 94).

-0 4~20mA correction Menu.

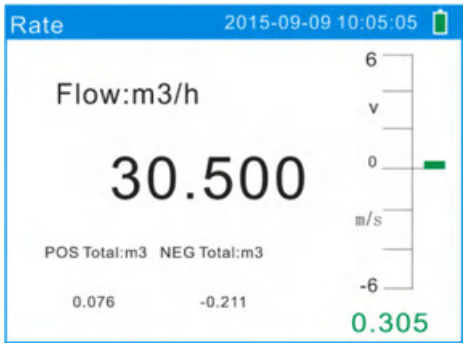
Attention

"Hidden" Menus are for hardware adjustment (retained by the manufacturer).

2 The Quick Setup Description

2.1DoubleFunctionKeysMenuDescription

Press  to display Flow Rate with large font.



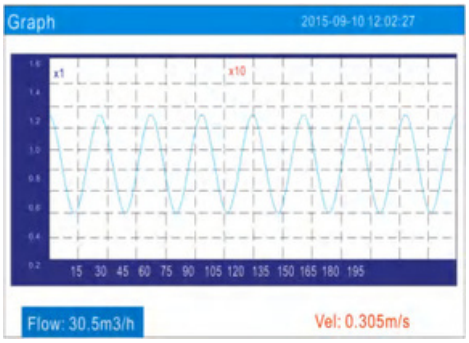
Press  to display Velocity with large font.

Press  to display Signal Quality with large font.

Press  to display POS Total with large font.

Press the Graph button to enter normal curve interface (Graph) model.

Press the 0 button loop switch (Graph) and dynamic (Dyn Mode) model; Press ∧/+ or ∨/- key switch instantaneous flow/velocity curve; Press Enter to pause/continue to view the waveform curve.



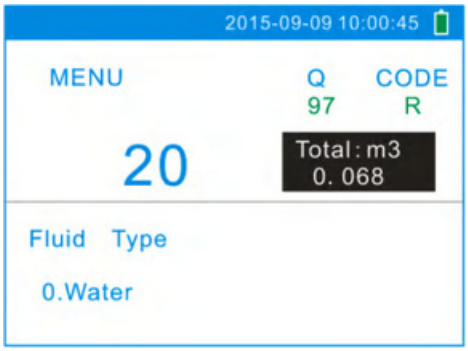
P ress Diag to display the Current State of the System.

Press 1 to display Pipe Outside Diameter. The function is the same with Menu 1 1.

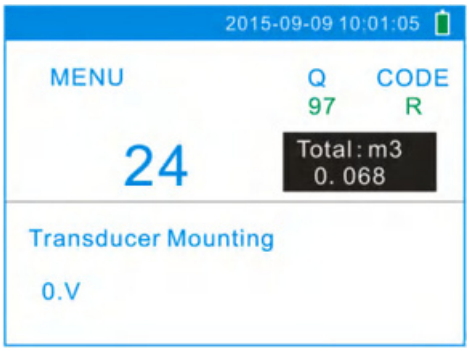
Press 2 to display Pipe Wall Thickness. The function is the same with Menu 1 2.

Press  to display Pipe Material. The function is the same with  .

Press  to display Fluid Type. The function is the same with  .



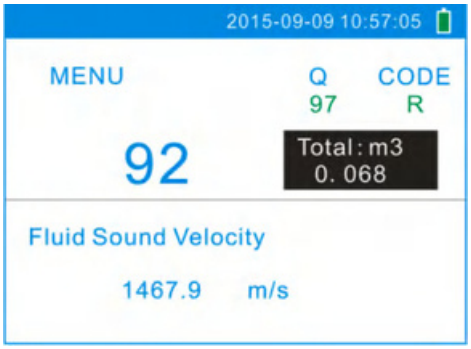
Press  to display Transducer Mounting Methods. The function is the same with  .



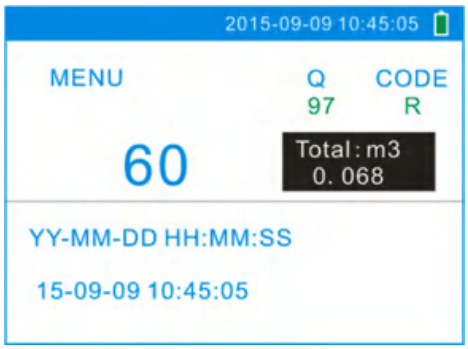
Press  to Start / Stop Manual Accumulation Total in turn.

Press  to Display / Hold Total in turn.

Press  to display Fluid Sound Velocity. The function is the same with  .

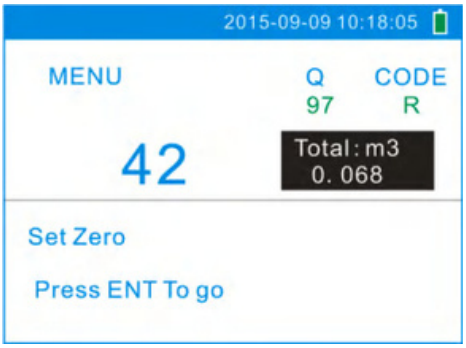


Press  to display Date and Time. The function is the same with  .



Press  to enter Manual Calibrate.After the flow velocity becomes steady, input standard totalizer to get theK factor. Then press  to complete the calibration.

Press  to input the password 1234 to reset zero.



2.2 For example

For Example: Let us assume you have a DN150 (6") pipe, measuring medium is water, Material is carbon steel with no liner. These parameters should be operated as follows:

Step 1. Pipe Outer Diameter

Press  keys to enter Menu 11, enter the Pipe Outside Diameter, then press the  key.

Step 2. Pipe Wall Thickness

Press the  key to enter Menu 12 the Pipe Wall Thickness, then press the  key.

Step 3. Pipe Material

Press the  key to enter Menu 14, press the  key, use the  or  key to select the pipe material from the drop-down Menu, then press the  key.

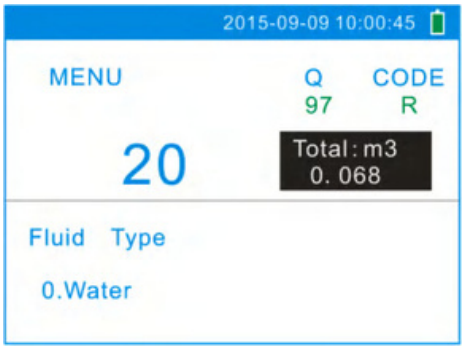
Step 4. Liner Material Parameters

(including thickness and sound velocity, if needed):

Press the Menu 1 6 key to enter Menu 16, press the Enter key, use the ∧/+ or ∨/− key to select liner material from the drop-down Menu, and then press the Enter key.

Step 5. Fluid Type

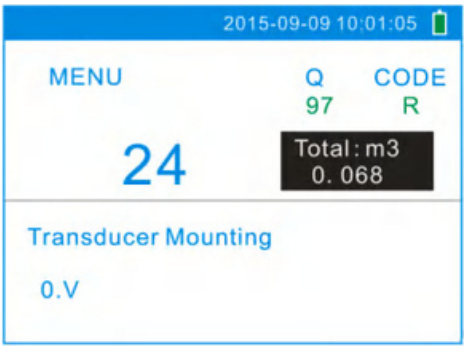
Press the Menu 2 0 key to enter Menu 20, press the Enter key, use the ∧/+ or ∨/− key to select fluid type from the drop-down Menu, then press the Enter key.



Step 6. Transducer Mounting

Press the Menu 2 4 key to enter Menu 24, press the Enter key, use the ∧/+ or ∨/− key to select transducer-mounting from the drop-down Menu, then press the Enter key.

(Details on Chapter 3.1.1).



Step 7. Transducer Spacing

Press the Menu 2 5 key to enter Menu 25, accurately install the transducer according to the displayed transducer mounting spacing and the selected mounting method.

(Details on Chapter 2.3).

Step 8. Display Measurement Results

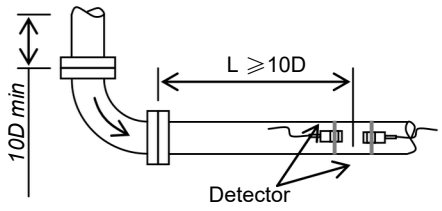
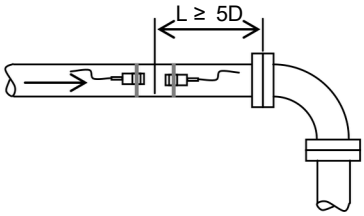
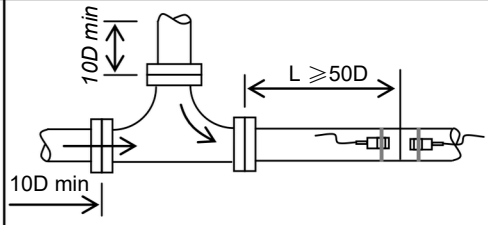
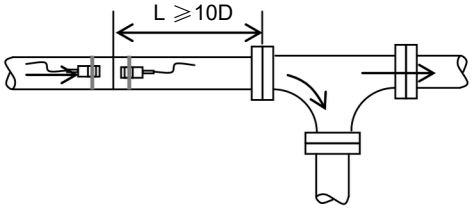
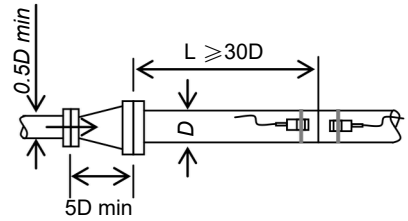
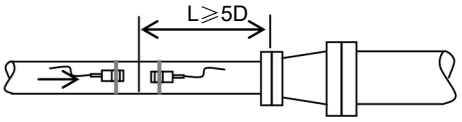
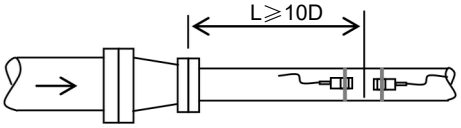
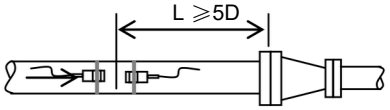
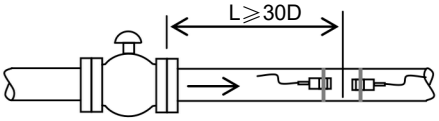
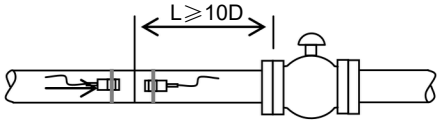
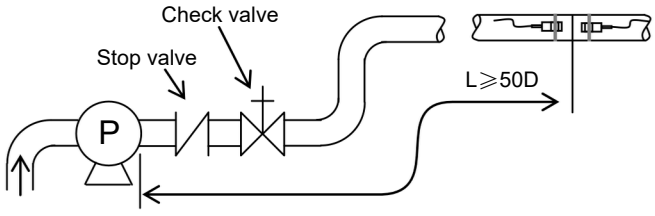
Press  to enter Menu 01 to display flow rate. (Subject to the real measurement.)

2.3 Measurement Site Selection

Compared with other kinds of flowmeters, Ultrasonic Flowmeter is the simplest one to install. Choose a proper measurement site, enter the pipe's parameters into the flowmeter. Install and fix the transducers on the pipe as instructed by the meter and start the measurement.

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.
- On the horizontal pipe, the transducer should be mounted on the 3 o'clock and 9 o'clock position of the pipe section, avoid the 6 o'clock and 12 o'clock position, in order to avoid the signal attenuation caused by the sediment at the bottom, or air bubbles or cavitation.
- 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.
- Choose a section of sound conducting pipe.

Name	Straight length of upstream piping	Straight length of downstream piping
90° bend		
Tee		
Diffuser		
Reduc e		
Valve	 Flow controlled upstream	 Flow controlled downstream
Pump		

3 Transducer Installation

3.1 Installing the Transducer

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

Note:

1. 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.
2. 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.
3. Refer to 2.15 for the Transducer Mounting Spacing.
4. If the transducers cannot be mounted horizontally symmetrically due to limitation of the local installation conditions, it may be necessary to mount the transducers at a location where there is a guaranteed full pipe condition (the pipe is always full of liquid).

3.1.1 Transducer Mounting Methods

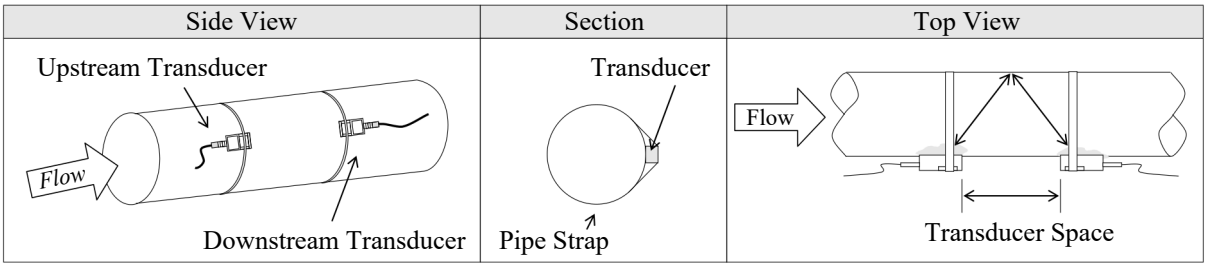
Three transducer mounting methods are available. They are respectively: V method, Z method and N method.

The V method is primarily used on small diameter pipes (DN100~300mm, 4"~12"). The Z method is used in applications where the V method cannot work due to poor signal or no signal detected. In addition, the Z method generally works better on larger diameter pipes (over DN300mm, 12") or cast iron pipes.

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

3.1.2 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 transducers, contact on the pipe at the pipe's centerline and equal spacing on either side of the centerline.

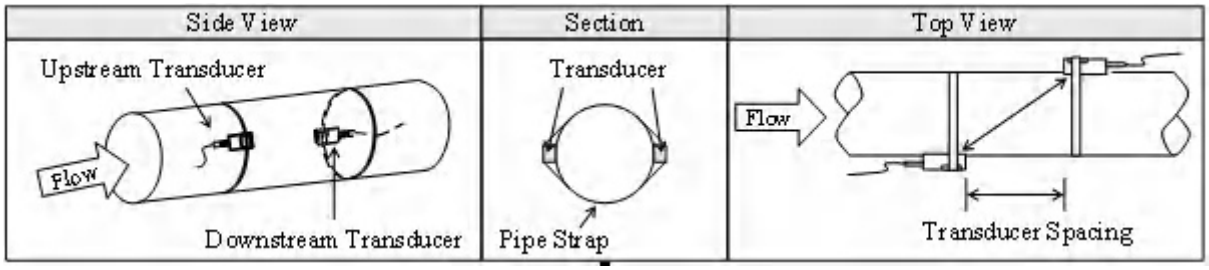


3.1.3 Z Method

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

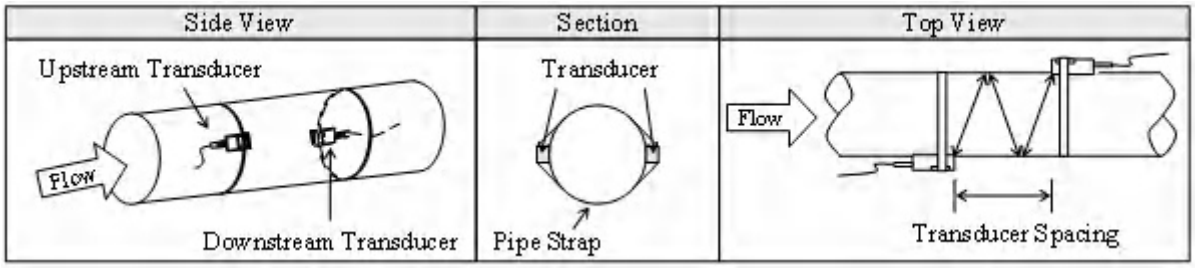
when the pipes are too large, there are some suspended solid in the fluid, or the scaling and liner are too thick.

This is because the Z method utilizes a directly transmitted (rather than reflected) signal which transverses the liquid only once. The Z method is able to measure on pipe diameters ranging from 100mm to 5000mm (4" to 200") approximately. Therefore, we recommend the Z method for pipe diameters over 300mm (12").



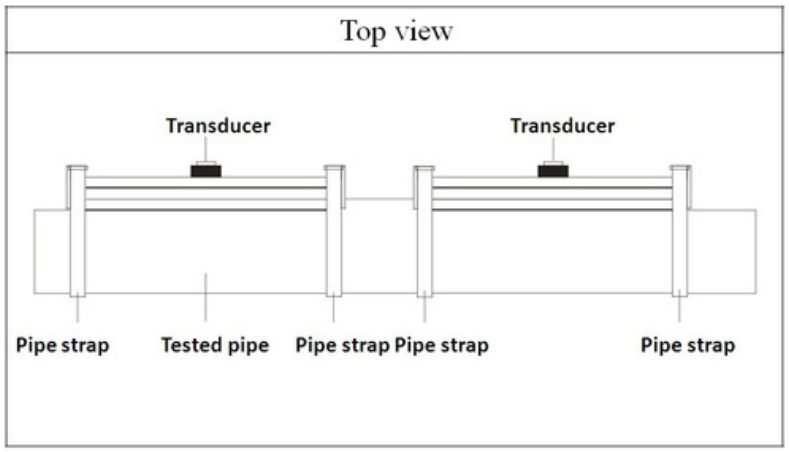
3.1.4 N Method (not commonly used)

With the N method, the sound waves traverse the fluid three times and bounce twice off the pipe walls. It is suitable for small pipe diameter measurement. The measurement accuracy can be improved by extending the transit distance with the N method (uncommonly used).



3.2 Transducer Installation and Fixing

Transducers can be installed onto the pipe with its magnetic racks. If you need to fasten them, then you can use the chains to make it firm. Show as below:



3.3 Transducer Mounting Inspection

Confirm the transducer is installed properly by checking the detected signal strength, total transit time, delta time as well as transit time ratio Key 9.

The "mounting" condition directly influences the flow value accuracy and system long-term operation reliability.

In most instances it is only necessary apply a wide band of sonic coupling compound lengthwise on the face of the transducer and stick it to the outside pipe wall to get good measurement results. However, the following checks still need to be carried out in order to ensure a high reliability of the measurement and long-term operation of the instrument.

3.3.1 Signal Strength

Signal strength (displayed in Signal) 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 better the instrument reliably will be. It will also result in a more stable the measurement value.

Ensure enough sonic coupling compound has been applied .Adjust the transducer position during the installation to obtain the maximum signal strength.

Normal system operation requires signal strength over 65.0 from both upstream and downstream directions. If the signal strength detected is too low, the transducer installation position and the transducer mounting spacing should be re-adjusted and the pipe should be re-inspected. If necessary, change the mounting method to be Z method.

3.3.2 Signal Quality (Q value)

Q value is short for Signal Quality (displayed in Signal). It indicates the level of the signal detected. Q value is indicated by numbers from 00 ~ 99. 00 represents the minimum signal detected while 99 represent the maximum. Normally, the transducer position should be adjusted repeatedly and coupling compound application should be checked frequently to ensure the signal quality can be detected as strong as possible.

3.3.3 Total Time and Delta Time

"Total Time and Delta Time", which displays in Window M6.04, indicates the condition of the installation. The measurement calculations in the flowmeter are based upon these two parameters. Therefore, when "Delta Time" fluctuates widely, so does the velocity and flow .This means that the signal quality detected is poor. It may be the resulted of poor pipe-installation conditions, inadequate transducer installation or incorrect parameter input.

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

3.3.4 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 proper. Check it in Window M91.

Attention

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

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

If the transducer mounting spacing is in accordance with the display in Window M25,

If the transducer is mounted at the pipe's centerline on the same diameter,

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

3.3.5 Warnings

1. Pipe parameters entered must be accurate; otherwise the flowmeter will not work properly.
2. During the installation, apply enough coupling compounds to the transducer to ensure adequate contact with the pipe wall. While checking the signal strength and Q value, move the transducers slowly around the mounting site until the strongest signal and maximum Q value can be obtained. .
3. Check to be sure the mounting spacing is accordance with the display in Window M2.15 and the transducer is mounted at the pipe's centerline on the same diameter.
4. If the signal strength is always displayed as 0.00 there is no signal detected. Thus, it is necessary to check that the parameters (including all the pipe parameters) have been entered accurately. Check to be sure the transducer mounting method has been selected properly, the pipe is not worn-out, and the liner is not too thick. Make sure there is indeed fluid in the pipe or the transducer is not too close to a valve or elbow. Ascertain there is not too much air or solids 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. Keep the flowmeter away from the electromagnetic interference area to ensure its proper operation.
6. After completing the installation, power on the instrument and check the parameters and the result accordingly.

4 Operating Instructions

4.1 SystemNormalIdentification

Press the    keys. 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 Menu 57. Enter a larger value in Menu 57, and the letter "E" will disappear. It can be ignored if no current loop output is used.

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 in such a condition for a long time, can the instrument be proved to be abnormal.

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

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

4.2 Low Flow Cutoff Value

The data in M41 is Low Flow Cutoff Value. If the flow rate falls below the low flow cutoff value, the flow indication is deemed to be ZERO. This can prevent the flow meter accumulate the flow when the actual flow is"0"after a pump was shut down. 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 is higher than the low flow cutoff value.

4.3 Zero Settings

When zero flow occurs an instrument may have a zero point which shows a measured value is not equal to “0”.This value indicates "Zero Offset". For any measuring instrument, the smaller the "Zero Offset" is, the better the accuracy will be. If the zero set point is not at true zero flow, a measurement error will occur. The smaller the measurement flow is, the larger the measurement error caused by the zero Offset will be. Only when zero point reduced to an acceptable degree can the measuring error caused by the zero point can be ignored.

For an ultrasonic flowmeter, the measurement error caused by the zero point cannot be ignored under low flow conditions. It is necessary to perform a static zero set calibration to improve the low flow measurement accuracy.

Set Zero in Menu42, press  , and then wait for the processing indication or displayed Complete..If setting Zero in flowing conditions, it may cause the flow to be displayed as "0". If so, it can be recovered via Menu 43.

4.4 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 productions. The difference is called "consistency".

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

4.5 4 ~ 20mA Current Loop Output

With a current loop output exceeding an accuracy of 0.1%, the flowmeter is programmable and configurable with outputs such as 4 ~ 20mA selected in Menu 55. Please refer to Menu 55 in "Window Display Explanations" for more information.

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 ~ 1000m^3/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 output by selecting in Window M55 when flow direction is not an issue. 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 5 0 Enter, move ^/+ or v/- to display "4mA" "20mA", connect an ammeter to test the current loop output and calculate the difference and check whether the difference is within tolerance or not. Refer to Section 4.6 for Current Loop Verification.

Check the present current loop output in Window M59, the value will change along with the change of the flow.

4.6 4-20mA Analog Output Calibration

Attention

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

Calibrate the analog input required to expand the hardware debugging Menu as below procedures:

Press Menu v/- 0 Enter to enter the password "115800" then press Enter. This action will be inoperative after powering off.

Then press Enter to enter the Current Loop Verification Mode, press Enter to enter the 4mA verification status, use an accurate ammeter to measure the output current of the current loop, and move ^/+ or v/- to adjust the displayed values, wait for the ammeter current value to reach "4.00mA", then the 4mA verification is finished.

Press Enter to do the 20mA verification using the same procedure as for the 4mA verification.

The verification results will be automatically saved in the EEPROM and will not be affected when the instrument is powered off.

4.7 SD Card Operation

4.7.1 Specifications

Memory: 8 GB (To prevail in kind).

Note: The SD card is a consumable item and its models updates quickly. Thus the configuration is on the basis of the physical matter received.

Data collection interval: any interval settings from 1 to 60 seconds are OK according to the requirement.If the rate is set longer than 60 seconds the default will be 60 seconds; when it is set to be less than 1 second, it will default to 1 second.

Data collection time: user selectable from 1~9999 mins. If it is set longer than 9999 mins, it will default to 9999 mins.

The data storage content and data storage format are shown in the following table:

No.	Data storage format	Data storage content	Description
1	07-04-10，14:16:33	date and time	MENU 52 Energy record switch "OFF", SD card stores 1~6 items of flow data
2	+3.845778E+01m3/h	flow rate	
3	+1.451074E+00m/s	flow velocity	
4	-0000010E+0m3	total flow	
5	+0000002E+0m3	positive totalizer	
6	-0000012E+0m3	negative totalizer	
7	+7.1429E-01KJ/s	energy	MENU 52 Energy record switch "ON", SD card stores 7~10 items of flow data
8	+3.9721E+03KJ	cumulative energy	
9	+4.573242E+01	inlet temperature	
10	+4.338866E+01	outlet temperature	

File system format: FAT32

File type: plain text file(.TXT)

File capacity: maximum 512 pcs

File name format: mmddhhmm (yy - year, mm - month, dd - date)

Turn to Chapter 4.7.3 for details if want to change a file name.

When the capacity of the SD card is insufficient, the data storage will be automatically stopped, and remind that the SD card is full.

Attention

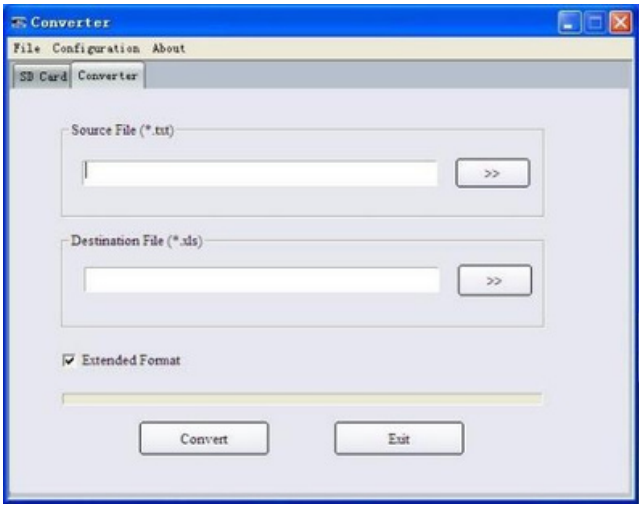
Plug the SD memory card need to be done in the case of power cuts.

4.7.2 Reading the SD Data Offline

Remove the SD card from the flowmeter and insert into the SD card reader. Copy the data to the PC. Use "Converter.exe" software to convert the format when needed.

1. File converter (Click the "Offline" button and enter the Document Conversion Interface).

Press "Converter" button, convert the T card data format from ".TXT "to ".XLS", the interface is as follows:



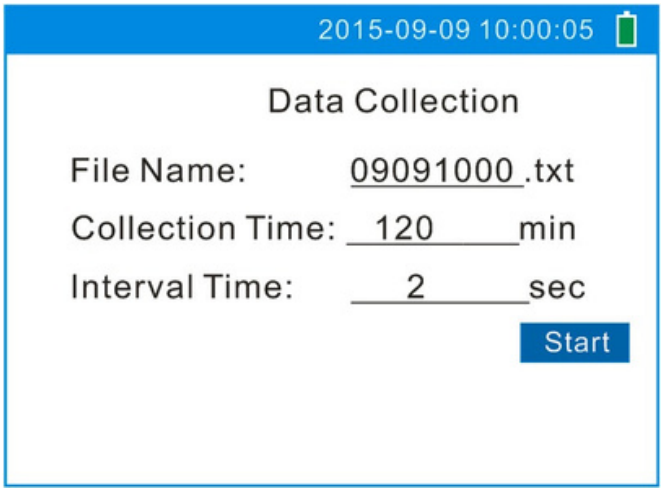
Select the file to be converted in "Source File (*.txt), enter the directory path and the file name in "Destination File (*.xls), then press "Convert". If "OK!" is displayed, the conversion is completed.

Attention

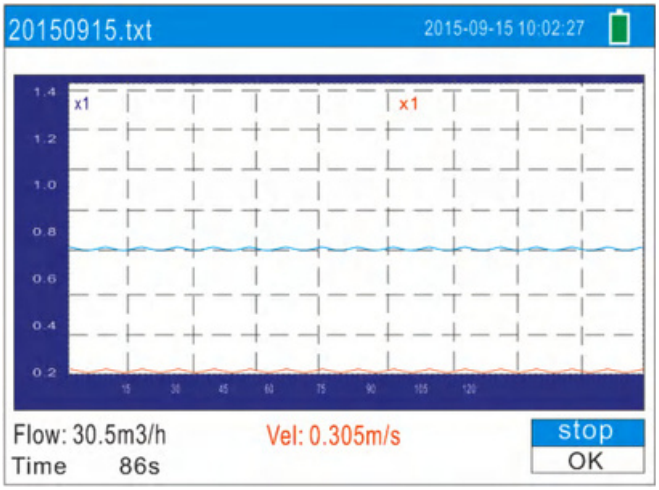
Put theconversion tool "Converter.exe" software and the TXT format data file stored in the SD card intothesame new folder. Open this software "Converter.exe"(as shown above picture), and click the“ 》 ” button of the right side of the "Source File (*.txt)" in the conversion interface, it will automatically enter the new folder. Select the TXT format data file to be converted, and then clickthe"Convert" button to generate an Excel file with the same name in the newly created folder.

4.7.3 SD Card Storage Operation Guide

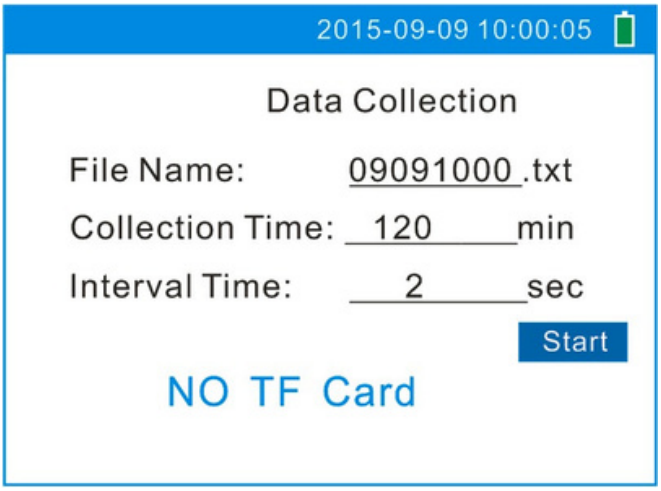
1. Insert the SD card, then press  button to enter the SD card storage setting interface.



2. If you need to modify the file name, acquisition time or acquisition interval, enter the number to modify it directly, press A/+ or Y/- key choice, press Enter to modify, press Enter to the completed modification.



3. After modification or to use the default value, press Enter to store the data. Theabove picture shows the normal operation interface. (If it does not work normally, will be shown as the picture below.)



4. If need to stop store the data, choose "Stop", "Start"and press Enter to stop or start data storage. Then choose "OK"and press Enter to exit the SD Card storage.

4.8 ESN

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

Attention

Other Operating Refer to "5.2 Window Display Explanations".

5 Window Display Explanations

5.1 WindowDisplayCodes

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	Instantaneous Heat/Cumulative Heat
06	Instantaneous Cold/Cumulative Cold
07	Temperature/Temperature Inlet / Outlet Water Difference
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
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 35
POS Totalizer	
36	NEG Totalizer
37	Totalizer Reset
38	Manual Totalizer
Setup Options	
40	Damping
41	Low Flow Cutoff Velocity
42	Set Zero
43	Reset Zero
44	Manual Zero Point
45	Scale Factor
Input and output setup	
46	Network IDN
47	System Lock
48	Segmented Correction
49	Segment Facter
52	Energy Record ON/OFF
55	CL Mode Select
56	CL 4mA Output Value
57	CL 20mA Output Value
58	CL Checkup
59	CL Current Output
60	Date and Time
61	ESN
62	RS485 Setup
67	FO Frequency Range
68	Low FO Flow Rate

69	High FO Flow Rate
72	Working Timer
73	Alarm #1 Low Value
74	Alarm #1 High Value
77	Beeper Setup
78	OCT Output Setup
79	Relay Output Setup
Energy	
84	Energy Unit Select
85	Energy Time Unit Select
86	Set the Temperature Sensitivity
87	Energy Accumulation Switch
88	Energy Accumulation Multiplication Factor
89	Energy Accumulator Reset
Diagnoses	
90	Signal Strength and Quality
91	TOM/TOS*100
92	Fluid Sound Velocity
93	Total Time and Delta
94	Reynolds Number and Factor
96	Time Fixed Delay
97	Language Select
Appendix	
-0	Hardware Parameter Modification
-1	Temperature Calibration

NOTE: The factory maintains the final explanation for other menu features.

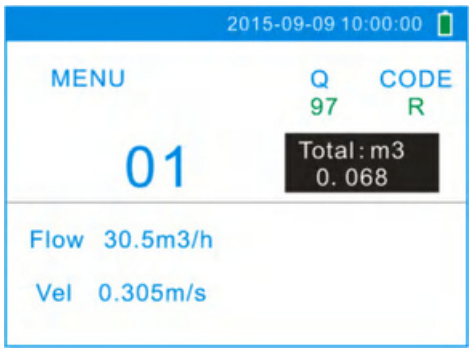
5.2 Display Explanation

Flow Rate／NetTotalizer

Display flow rateand net totalizer.

Flow Rate／Velocity

Display flow rate and velocity.



Flow Rate／PositiveTotalizer

Display flow rateandpositive totalizer.

Select the Flow Rateunits in Window M31.

Select the positiveTotalizer units in Window M32.

If the positive totalizerhas been turned off, the positive totalizervaluedisplayed is the total the total that existed priortoturning it off.

Flow Rate／NegativeTotalizer

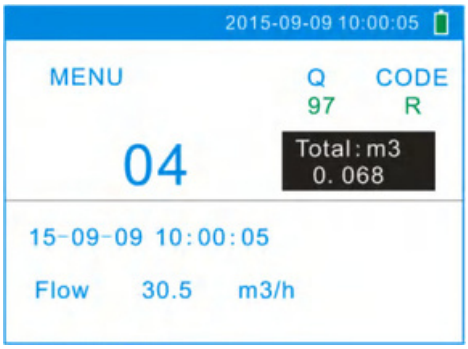
Display flow rate andnegative totalizer.

Select the negative totalizer value in Window M32.

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

CurrentTime／FlowRate

Displaythe current timeand flow rate.
The timesetting methodis found in window M60.

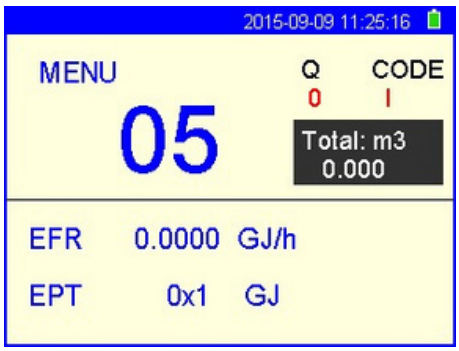


DisplayInstantaneousHeat/Cumulative Heat

Net Cumulative Heat: EPT

Instantaneous Heat: EFR

Note: in a Energy Meter: Heat-“P”, Cold-“N”.

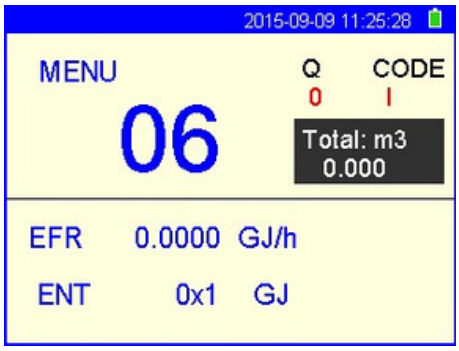


DisplayInstantaneousCold/Cumulative Cold

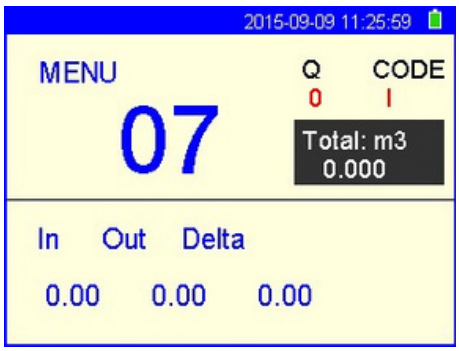
Net Cumulative Cold: ENT

Instantaneous Cold: EFR

Note:in a Energy Meter: Heat-“P”, Cold-“N”.



Display Inlet Water Temperature/Outlet WaterTemperature/Temperature Difference



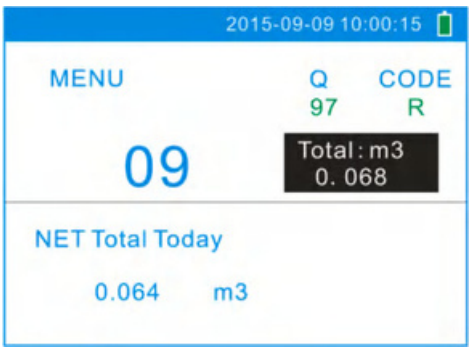
SystemErrorCodes

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

Theexplanations of error codes and detailed resolution methods can be found in "Error Diagnosis".

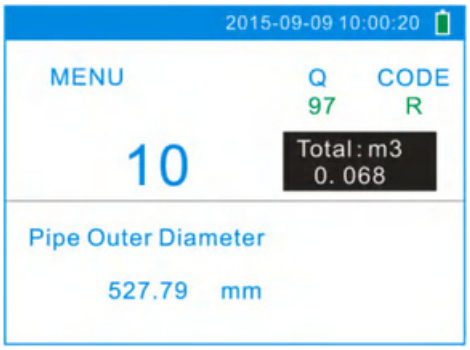
Net Flow Today

Display net totalflow today.



Pipe Outer Perimeter

Enter the pipe outer perimeter (circumference). If the pipe outer diameter isknown, enter it in window M11.



Pipe Outside Diameter

Enterthepipeoutside diameter; the pipe outside diametermustrange from15mm to 6000mm.

Note:

Entereitherthe pipe outside diameter or pipe outer perimeter.

Pipe WallThickness

Enter thepipewall thickness. If the pipe inside diameterisalready known,skip this window and enter it in windowM13.

Pipe InnerDiameter

Enter the pipeinsidediameter. If the pipe outside diameter andpipewallthickness has been entered, press  toskipthis window.

Note:

Entereither pipe wall thickness or pipe inside diameter.

Pipe Material

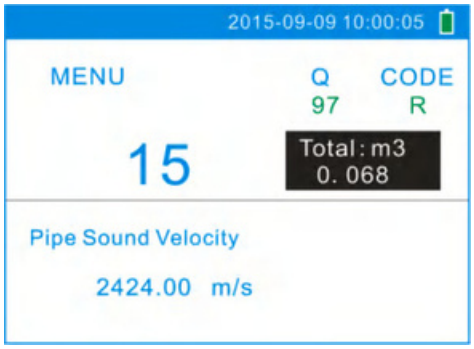
Enter pipe material. The following options are available (by  、  buttons or numerical keys):

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

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

Pipe Sound Velocity

Enterpipesoundvelocity. This function is only used whenitem9"Other"isselected in Window M14. At thesametime,this window cannot be visited. It will becalculatedautomatically according to the existing parameters.



Selectthe LinerMaterial

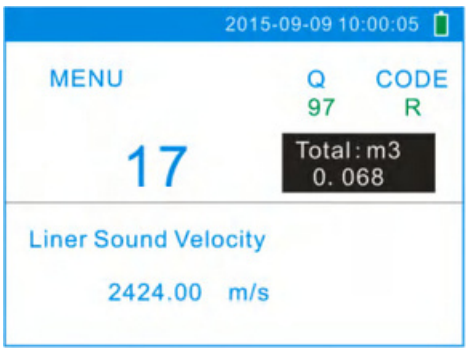
The followingoptions areavailable:

0. None,No Liner
1. TarEpoxy
2. Rubber
3. Mortar
4. Polypropylene
5. Polystyrol
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 previous ten items. Once the "Other" is selected, the relevant liner sound velocity must be entered in Window M17.

LinerSound Velocity

Enterliner sound velocity.It only can be visited when item"Other" in WindowM16 is selected.



LinerThickness

Enterliner thickness. It only can be visited when a definiteliner is selected in Window M16.

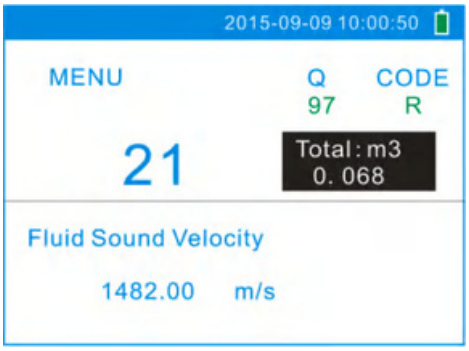
SelectFluid Type

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℃)

Fluid Sound Velocity

Enterthe fluidsoundvelocity. It only can be used whenitem "Other" isselected in window M20, i.e. it is unnecessarytoenterall the fluids listed in Window M20.



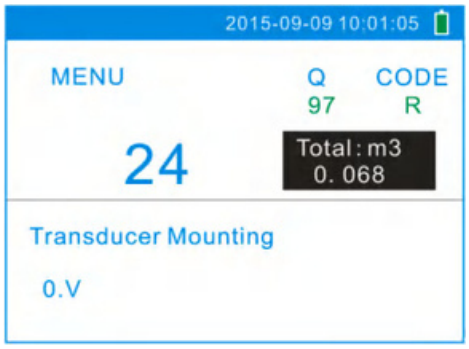
Fluid Viscosity

Enterfluid's kinematics viscosity. It only can be used whenitem "Other" is selected in Window M20, i.e. it is unnecessary to enter all the fluids that listed in WindowM20.

Transducer Mounting

Three mounting methodsare available:

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



Transducer Spacing

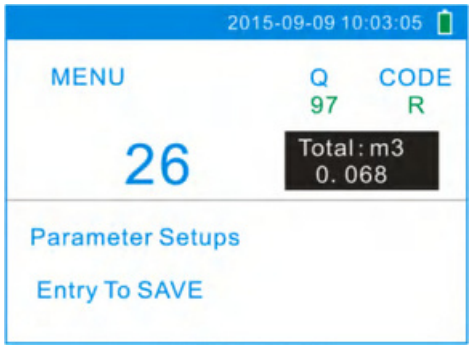
The operatormustmountthe transducer according to the transducerspacingdisplayed (be sure that the transducer spacingismeasured precisely during installation).Thesystemwill display the data automaticallyafterthepipe parameter has been entered.

InitialParameter Setups and Save

Loadandsavethe parameters. 18 different sets of setupconditions/groups are available to load and save by threemethods:

0.EntrytoSave
1.EntrytoLoad
2.ToBrowse

Select"EntrytoSave", press  . An ID code and the originalparameters are displayed in the window. PressUPorDOWN ARROW to move the ID code, thenpressthe  key again to save the current parameterinthecurrent ID file.



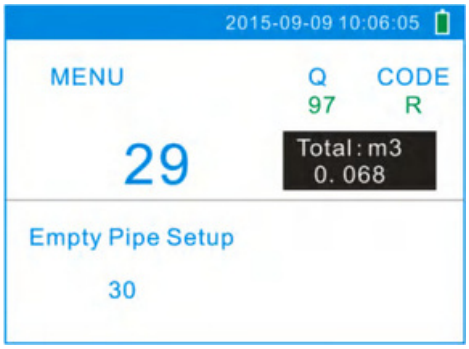
Cross-Sectional Area

Display the cross-sectional area inside the pipe.

HoldingWithPoor Sig

Select "Yes"tohold lastgood flow signal displayed if the flowmeterexperiences a poor temporary signal condition. Thisfunctionwill allow continued data calculation without interruption.

Empty Pipe Setup Thisparameterisusedtoovercomethe possible problemsthatusuallyshowupwhenthe pipe being measuredisempty.Sincesignalscanbe transmitted throughthepipewall,theflowmetermay still read a flowwhilemeasuringanemptypipe.To prevent this fromhappening,youcanspecifyavalue. When the signalqualityfallsbelowthisvalue,the measurement stopsautomatically.Iftheflowmeteris already able to stopmeasuringwhenthepipeisempty, a value in the rangeof30to40shouldalsobeentered in this windowtoensurenomeasurementwhen the pipe is empty.

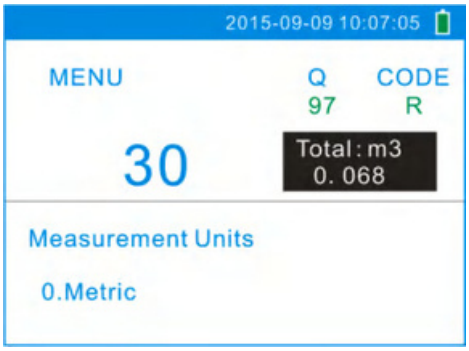


MeasurementUnits

Select the measurement unit as follows:

0. Metric
1. English

Factory default is metric.



Flow Rate Units Options

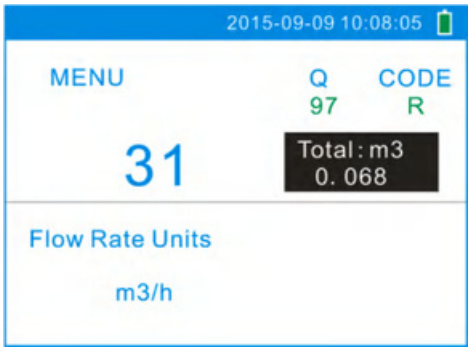
The following flow rate units are available:

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

The following time units are available:

/Day /Hour /Min /Sec

Factory default is Cubic Meters/hour.



Totalizer UnitsOptions

Select Totalizerunits.Theavailable unit options are as same as thosefoundinWindow M31. The user can select units astheirrequired.

Factory defaultisCubicMeters.

Totalizer MultiplierOptions

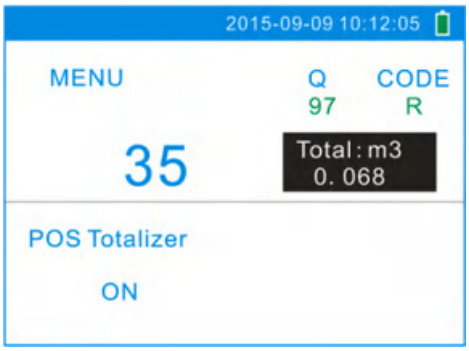
The totalizer multiplieractsasthe function to increase the totalizer indicatingrange.Meanwhile, the totalizer multiplier can be appliedtothepositive totalizer, negative totalizer andnettotalizer at the same time. The following optionsareavailable:

0. x 0.001 (1E-3)
1. x 0.01
2. x 0.1
3. x 1
4. x 10
5. x 100
6. x 1000
7. x 10000(1E+4)

Factory default factor is x1

ON/OFF POSTotalizer

On/OFF POSTotalizer."ON" indicates the totalizer is turned on, while"OFF"indicates it is turned off. When it is turnedoff,thenet totalizer displays in Window M02willnotchange. Factory default is "ON".



ON/OFF NEGTotalizer

ON/OFF NEGtotalizer. "ON" indicates the totalizer is turned on. Whenitisturned off, the negative totalizer displays in WindowM03.

Factory defaultis"ON".

Totalizer Reset

Totalizerreset;allparametersarereset. Press  ; move  or  arrowtoselect "YES" or "NO". After"YES"isselected,thefollowing options are available:

None

All

NET Totalizer

POS Totalizer

NEG Totalizer

Reset

If the userwantstodeleteallthealready set parametersandsetbacktothefactory default, select resetinthiswindowandthen the flowmeterwillresettobethefactory default automatically.

Attention

This operation will cancel all the data and revert back to factory default. Be careful with this operation.

ManualTotalizer

The manual totalizer is a separate totalizer. Press 

to start, and press 

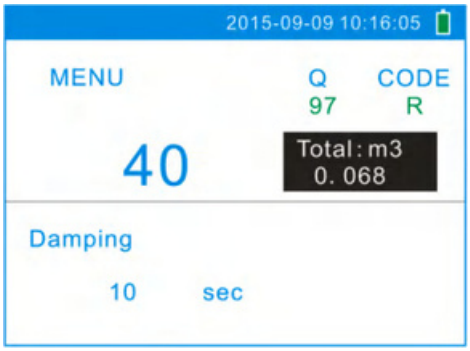
to stop it. It is used for flow measurement and calculation.

Damping

The damping factor ranges from 0~999 seconds.

0 indicates no damping; 999 indicate the maximum damping.

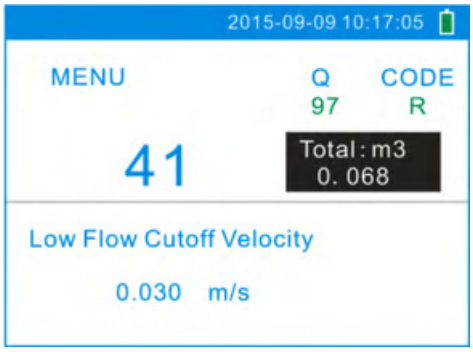
The damping function will stabilize the flow display. Usually a damping factor of 3 to 10 is recommended in most applications.

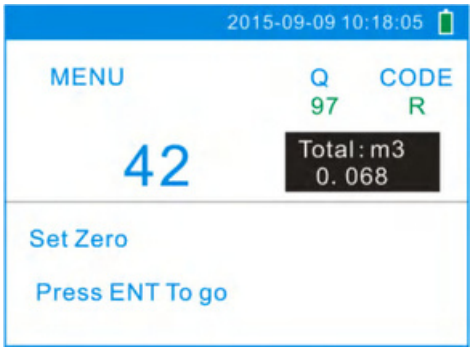


Low Flow CutoffValue

If the flow ratefallsbelowthe low flow cutoff value, the flow indicationisdrivento zero. This function can prevent the flowmeterfromreading flow after pump shut down but thereisstillliquid movement in the pipe, which willresultinaccumulative error.

Generally, 0.03m/sisrecommended to enter as the low flow cutoffpoint.Thelow flow cutoff value has no relation to themeasurement results once the velocity increasesoverthelow flow cutoff value.





Set Zero

When fluidisinthestaticstate(nomovement),the displayed value is called "Zero Point". When "Zero Point" isnotattruezerointheflowmeter,the difference is going to be added into the actual flow values andmeasurementdifferenceswilloccurinthe flowmeter.

Set zeromustbecarriedoutafterthetransducersare installed and the flow inside the pipe is in the absolute static state(noliquidmovementinthepipe).Thus, the"Zero Point" resulting from different pipe mounting location and parameters can be eliminated. The measuringaccuracyatlowflowisenhancedby doing thisfunctionandflowoffsetiseliminated.

Press Enter,waitfortheprocessinginstructionsat the

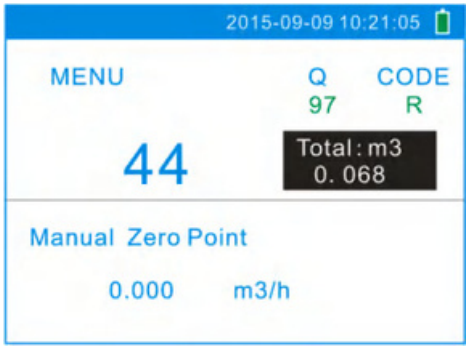
bottom right cornerofthedisplaytoreach0.

Performing Setzerowithexistingflowmaycausethe

flow to be displayedas"0".Ifso,itcanberecovered via window M43.

ResetZero

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



ManualZeroPoint

This methodisnot commonly used. It is only suitable for experiencedoperators to set zero under conditions when it is notpreferable to use other methods.

Enter the valuemanually to add to the measured value to obtain theactual value. For example:

Actualmeasured value＝250 m3/H;

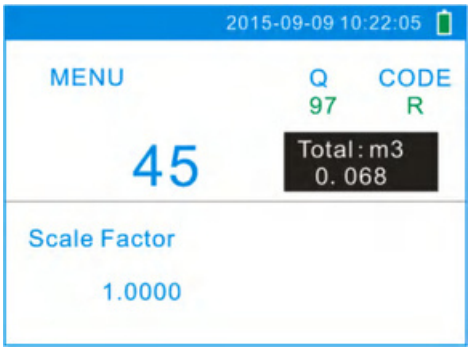
ValueDeviation＝10 m3/H;

Flowmeter Display＝240 m3/H.

Normally, set the value as "0".

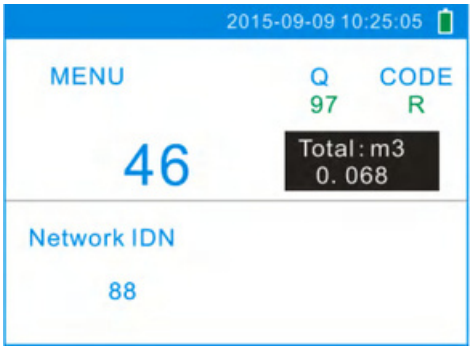
Scale Factor

Thescalefactor is used to modify the measurement results.Theuser can enter a numerical value other than"1"according to calibration results.



Network IDN

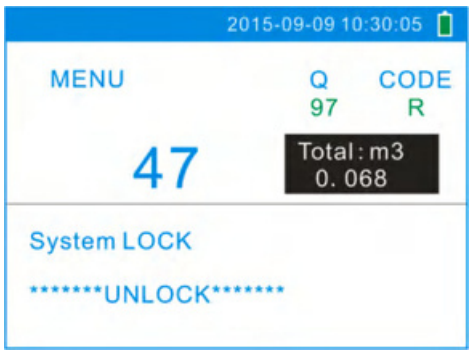
Input systemidentifying code, these numbers can be selectedfrom1~247 except that 13 (0DH ENTER),10(0AH Newline), 42 (2AH *) and 38 (26H&)arereserved. System IDN is used to identify the flowmetertoa network.



SystemLock

Locktheinstrument.

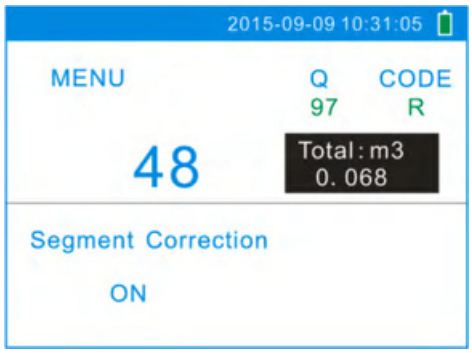
Oncethesystem is locked, any modification to the systemisprohibited, but the parameter is readable. "Unlock"using your designated password. The passwordis composed of 6 numbers.



Segmented Correction

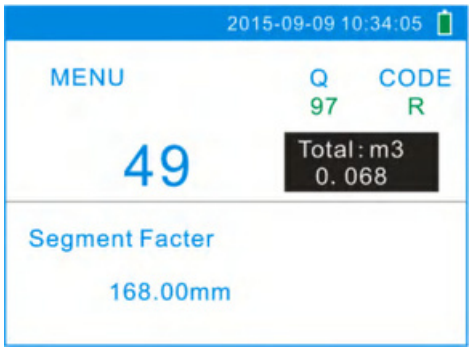
ON: Turn on the Sectional Correction Function;OFF: Turn off the Sectional Correction Function（optional）

Only when it is "ON", the settings of the Sectional Correction Value in M49 will be workable.



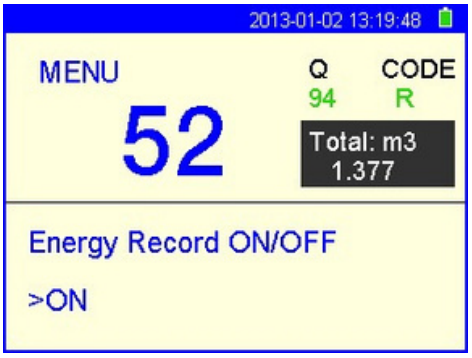
Segment Facter

You needtoinputthe password "115800", then press  keytoexpand. Expand only in the current period,automatically shut down when the power is cut off. Youcanset16groups correction coefficient for sectionallycorrecting measurement results. The user can inputtheactualscale factor, referring to the calibration results.



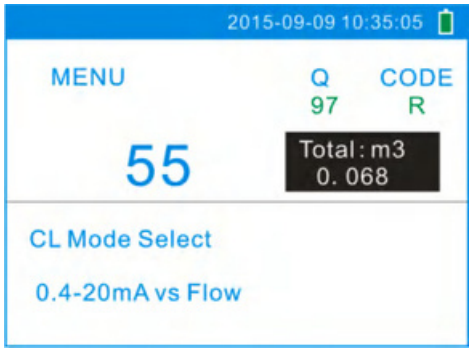
EnergyRecordON/OFF

Whenthe energyrecordis set as "ON", SD card can recordheat data,whenitis set as "OFF", SD card can not record the heatdata.The factory default setting is "OFF"。.



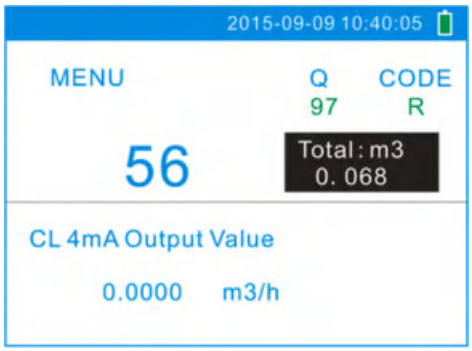
CurrentLoopMode Select

0. 4-20mA flow;
1. 4-20mA Velocity.



CL 4mA Output Value

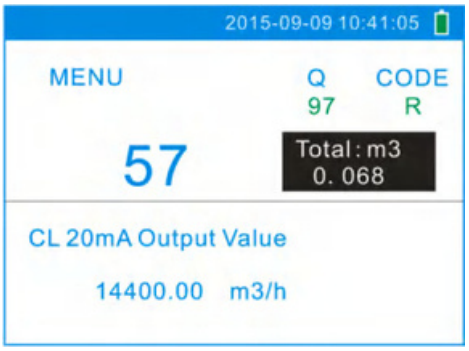
Set the CL output valueaccording to the flow value at 4mA. The flow unit'soptions are as same as those in Window M31. Once"velocity 4-20mA"is selected in Window M55, the unitshould be set as m/s if it is the velocity unit selected.



Menu 5 7

20mA Output Value

Set theCL outputvalueaccording to the flow value at 20mA.The flowunitisthe as same as that found in WindowM31.Once"velocity 4-20mA"is selected in WindowM55,theunitshould be set as m/s, if m/s is the velocity selection.

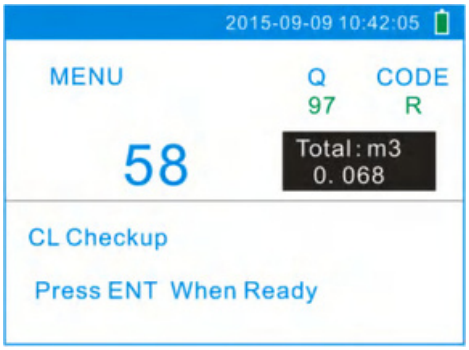


Menu 5 8

CL Check Verification

Check if the currentloophas been calibrated before leaving the factory.Press Enter move ∧/+ or ∨/− separatelytodisplay 4mA, 20mA, and at the same time, checkwithanammeter to verify that CL output terminalsM31and32 agree with the displayed values. It is necessarytore-calibrate the CL if it is over the permittedtolerance. For more information,

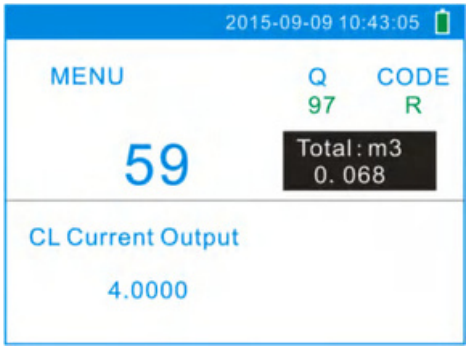
refer to "AnalogOutputCalibration".



Menu 5 9

CL CurrentOutput

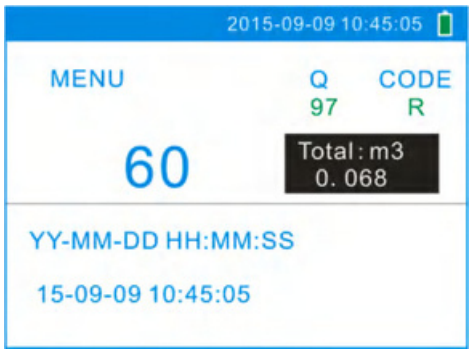
Display CLcurrentoutput. The display of 10.0000mA indicates thatCLcurrent output value is 10.0000mA. If the differencebetween displaying value and CL output valueistoolarge, the current loop then needs to be re-calibratedaccordingly.



Menu 6 0

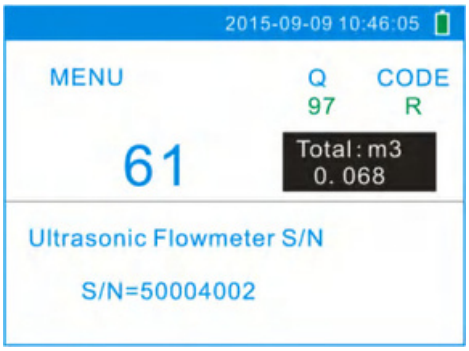
Date and TimeSettings

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



ESN

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



Serial Port Settings

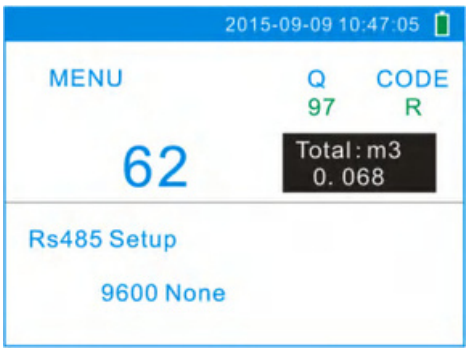
Thiswindowisusedforserial port setting. Serial port is usedtocommunicatewith other instruments.The serialportparameterssetting of the instrument that appliestheserialportconnection must be consistence. Thefirstselecteddataindicates baud rate, 9600, 19200,38400,56000,57600, 115200 are available.

Thesecondoptionindicates parity bit, None (No verification).

Data length fixed to 8;

Stopbitlengthforafixedlength.

Thefactorydefaultserialport parameter is "9600, None".

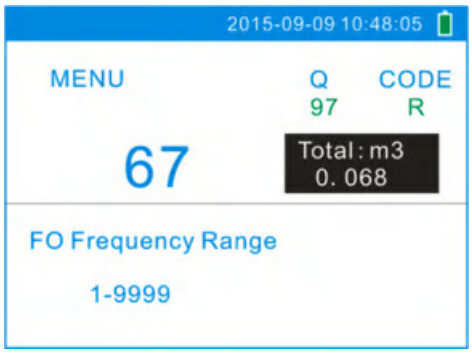


Set FOFrequency Range

Set uphigh FO frequency range. It must be higher than thelow FO frequency. Ranges from 1-9999Hz.

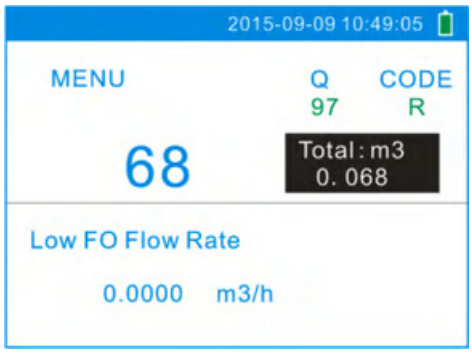
Factorydefault is 1~1001 Hz.

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



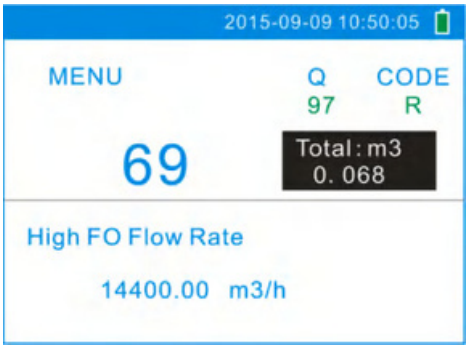
LowFO FlowRate

Setuplow FOflow rate, i.e. the corresponding flow valuewhen output signal frequency is at the lowest FO frequency. For example, when the low FO frequency is 1000Hz, low FO flow rate is 100m3/h then when the frequency output is 1000Hz, the low flow at this moment measured by the Flowmeter is100m3/h.



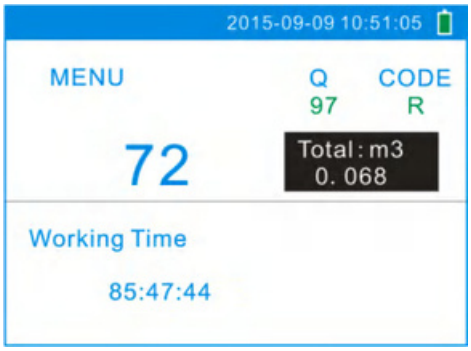
HighFO FlowRate

Enterthe highFOflow rate, i.e. the corresponding flowvalue whenfrequency output signal is at highest FOfrequency.Forexample, when the low FO frequency is 3000Hz,low FO flow rate is 1000m3/h thenwhen thefrequency output is 3000Hz, the low flowatthis momentmeasured by the Flowmeter is 1000m3/h.



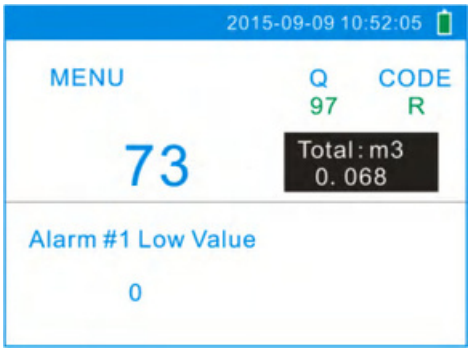
Working Timer

Display the totalworking hours of the Flowmeter since last reset.Itis displayed by HH:MM:SS. If it is necessary to resetit, press Enter, and select "YES".



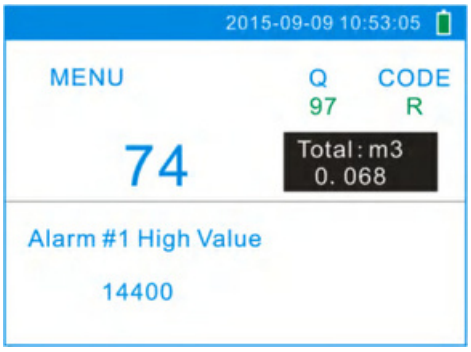
Alarm #1 Low Value

Enterthelowalarm value. Relevant alarm is turned on in WindowsM78 andM79; any of the measured flow, whichislowerthan thelow value, will activate the alarmintheOCT hardware or Relay output signal.



Alarm#1 HighValue

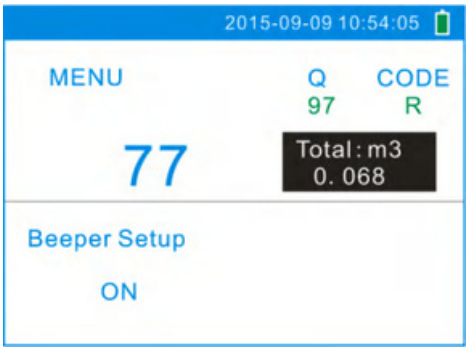
Enterthe highalarmvalue.Relevant alarm is turned on inWindowsM78andM79; any of the measured flow,which ishigherthanthe high value, will activate the alarm in theOCThardware or Relay output signal.



Beeper Setup

Set upthe beeper on-off state.

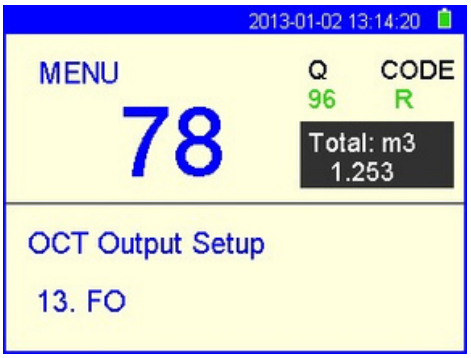
0. ON Beeper ON
1. OFF Beeper OFF



OCT OutputSetup

The followingsignal options are available:

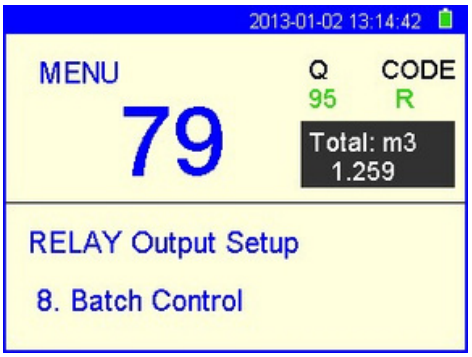
0. No Signal	1. Poor Signal
2. Not Ready (No*R)	3. Reverse Flow
4. AO Over 100%	5. FO Over 120%
6. Alarm #1	7. Alarm #2
8. Batch Control	9. POS Int Pulse
10. NEG Int Pulse	11. NET Int Pulse
12. ON/OFF viaRS232	13. FO
14. Not Using	



RelayOutputSetup

The relay is single-pole and constant-on for external instrument controls. The following options are available:

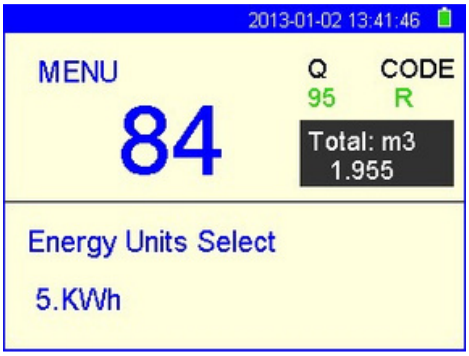
0. No Signal	1. Poor Signal
2. Not Ready (No*R)	3. Reverse Flow
4. AO Over 100%	5. FO Over 120%
6. Alarm #1	7. Alarm #2
8. Batch Control	9. POS Int Pulse
10. NEG Int Pulse	11. NET Int Pulse
12. ON/OFF viaRS232	13. Not Using



EnergyUnitSelect

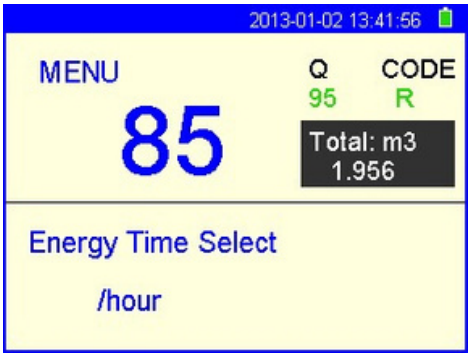
DefaultunitisGJ. The following units to choose from:

0. Giga Joule (GJ)
1. Kilocalorie (Kc)
2. MBtu
3. KJ
4. Btu
5. KWh
6. MWh



EnergyTimeUnit Select

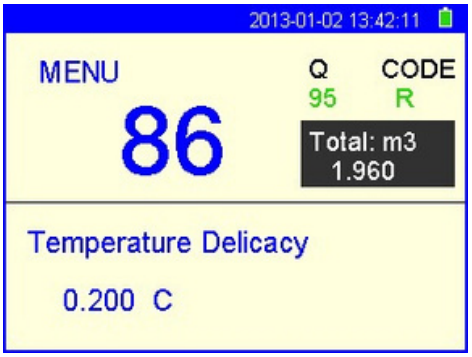
CanbeselectedTime unit:day/hour/min/sec, default select is: /hour.



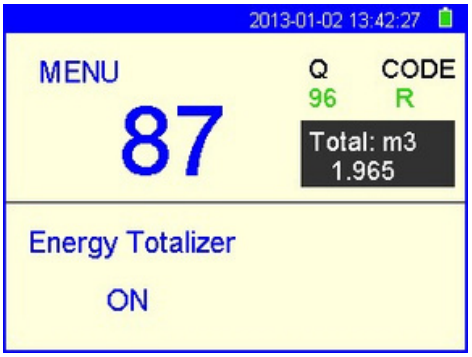
Set theTemperatureSensitivity

Whenthe temperaturedifference is less than the set sensitivity, no energywould be accumulated, and the adjustable range of thesetting is 0 to 10 degrees.

The default setting is0.2degrees.

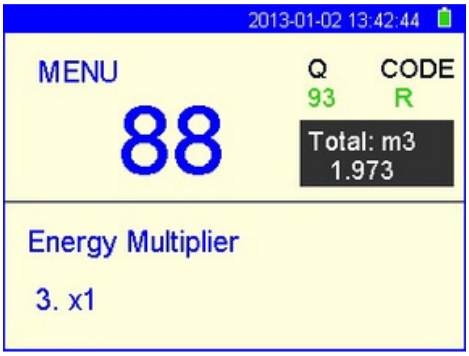


EnergyAccumulationSwitch



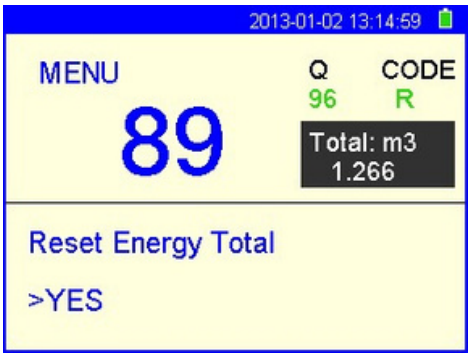
EnergyAccumulationMultiplication Factor

Alternative rang: ex0.001~ x10000（1E-3~1E+4）



Reset Energy Totalizer

Select"YES"toreset Energy Totalizer value.



SignalStrengthandSignal Quality

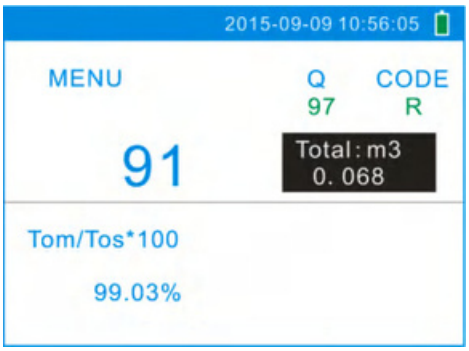
Displaythemeasuredsignal strength and signal qualityQvalueupstream and downstream.

Signalstrengthisindicated from 00.0~99.9. A reading of 00.0indicatesnosignal detected, while 99.9 indicatesmaximumsignal strength. Normally the signalstrengthshouldbe ≥60.0.

SignalqualityQisindicated by 00~99. Therefore, 00 indicatesthepoorestsignal while 99 indicates the best signal.Normally,signal quality Q value should be better than 50.

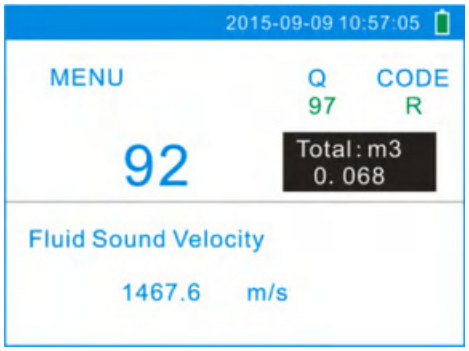
TOM/TOS*100

Displaytheratiobetween the actual measured transmittimeandthecalculated transmit time accordingtocustomer's requirement. Normally the ratio shouldbe100±3%. If the difference is too large, the usershouldcheckthat the parameters are entered correctly,especiallythe sound velocity of the fluid and theinstallationofthe transducers. This data is of no usebeforethesystem is ready.



FluidSound Velocity

Displaythe measuredfluid sound velocity. Normally this value should be approximately equal to the enteredvalue in WindowM21. If the difference is too large,itprobably resultsfrom an incorrect value enteredin Window M21or improper installation of the transducers.

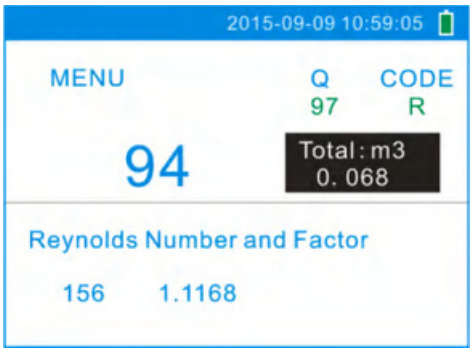


Total Time and Delta Time

Displaythemeasuredultrasonicaverage time (unit: nS)anddeltatimeoftheupstreamand downstream (unit:nS)time.Thevelocitycalculation in the flowmeterisbasedonthetworeadings. The delta timeisthebestindicationthattheinstrument is runningsteadily.Normallythefluctuation in the ratio ofthedeltatimeshouldbelowerthan 20%. If it is not, itisnecessarytocheckifthetransducers are installed properlyoriftheparametershavebeen entered correctly.

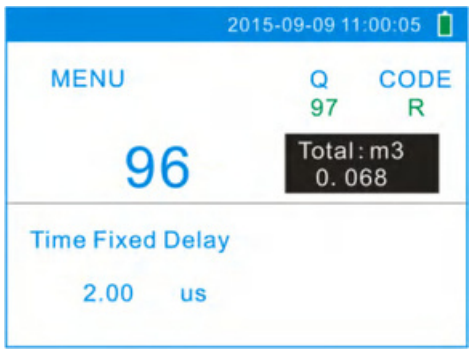
Reynolds Number andFactor

Display the reynolds number that is calculated by the flowmeter and the factorthat is set currently by the flowmeter. Normally thisscaling factor is the average of the line and surface velocity factor inside the pipe.



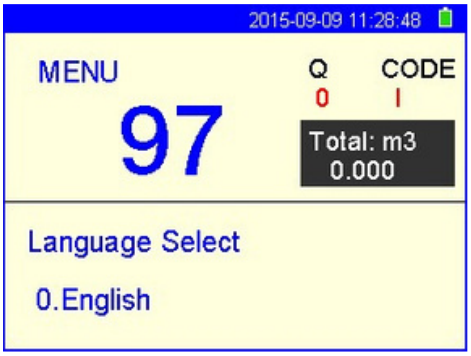
TimeFixed Delay

Displaythe time fixed delay.



Language Select

0. English
1. Chinese

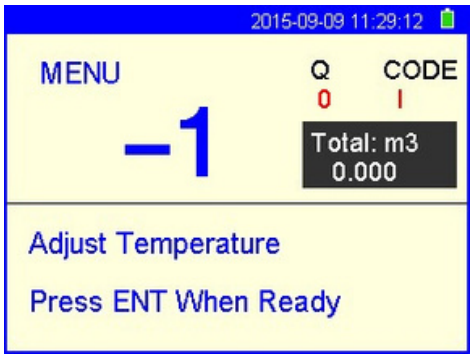


AnalogOutputVerification

Pleaserefer to the Menu 58 "4~20mA Analog Output Verification".

TemperatureCalibration

Seedetails to9.4Temperature calibration method



6 Error Diagnoses

The ultrasonic flowmeter 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. Some errors can be detected during normal operation.

Undetectable errors caused by unskilled operation, incorrect settings and unsuitable measurement conditions can be displayed accordingly during work. This function helps the user detect the errors and find causes quickly; thus, problems can be solved in a timely manner according to the solutions listed in the following tables.

The error codes caused by incorrect settings and the detected signal can be displayed in Window M08.

6.1 Table 1. Error Codes and Solutions (during operation)

Codes	***M08 Display***	***Causes***	***Solutions***
*R	System Normal.	* System normal.	
*I	Signal Not Detected.	* Signal not detected. * Spacing is not correct between the transducers or not enough coupling compound applied to face of transducers. *Transducers installed improperly. *Scale is too thick. *New pipe liner.	* Attach transducer to the pipe and tighten it securely. Apply a plenty of coupling compound on transducer and pipe wall. * Remove any rust, scale, or loose paint from the pipe surface. Clean it with a file. * Check the initial parameter settings. * 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. * Wait until liners solidified and saturated
*G	Adjusting Gain (Display in Windows M01).	* Adjusting gain for normal measurement.	

6.2 Frequently Asked Questions and Answers

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

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

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

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

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

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

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

Question: Why is the 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.

7 Product Overview

7.1 Introduction

The Model PUF8300 Ultrasonic Flowmeter is a state-of-the-art universal transit-time flowmeter designed using ARM technology and low-voltage broadband pulse transmission. While principally designed for clean liquid applications, the instrument is tolerant of liquids with the small amounts of air bubbles or suspended solids found in most industrial environments.

7.2 Features of Flowmeter

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

1. With ARM COMA chip, low power consumption, high reliability, anti-jamming and outstanding benefits.
2. Clear, user-friendly Menu selections make flowmeter 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.
3. With the SD Card, 512 files can be stored; the time interval can be within 1 second.
4. Parallel operation of positive, negative and net flow totalizer with scale factor and 7 digit display.

The flow meter ensures the higher resolution and wider measuring range by the 0.04nS high resolution, high linearity and high stability time measuring circuit and 32 bits digits processing program.

7.3 Theory of Operation

This Ultrasonic Flowmeter and Analyzer adopts the time-difference measurement principle. The ultrasonic waves emitted by the sensor in a fluid, the flowing in the propagation direction of acoustic wave propagation velocity downstream increases, decreases the upstream direction, have different propagation distance in the same transmission time, measure the flow rate according to the difference of the transmission time and the fluid flow velocity.

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.

$$V \quad \frac{MD}{\sin 2\theta} \cdot \frac{\Delta T}{T_{up} \cdot T_{down}}$$

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

Remarks:

V Medium Velocity

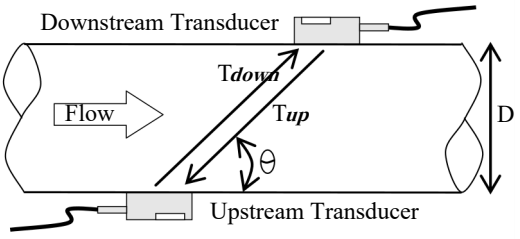
M Ultrasonic frequency of reflection

D Pipe Diameter

θ The angle between the ultrasonic signal and the flow

Tup Transit time in the forward direction

Tdown Transit time in the reverse direction



7.4 Applications

Water, sewage (with low particle content) and seawater; Acid alkali liquor, edible oil, diesel oil, crude oil, alcohol, beer, etc.

Water plant and sewage treatment plants;

Plant irrigation;

Metallurgy and mining applications (cooling water and acid recovery, for example)

Petroleum and chemicals; Food and medicine;

Energy-saving monitoring, water-saving management and flow inspection,flow tracking and collection, computerized management and monitoring network system.

7.5 Specifications

Performance Specifications	
Flow range	± (0.03 ~ 40) ft/s ± (0.01 ~ 12) m/s
Accuracy	± 0.5% of measured value. 1.5 ft/s～40 ft/s or -1.5 ft/s～-40 ft/s （0.5 m/s～12 m/s or -0.5 m/s～-12 m/s）
Repeatability	0.15%.
Pipe Size	0.6" ~ 240" (DN15 ~ DN6000)
Function Specifications	
Output	Analog output: 0/4 ~ 20 mA, (max load 750 Ω); Pulse output: 0 ~ 9999 Hz, OCT (min. and max. frequency is adjustable); Relay output: max. frequency 1Hz (1A@125VAC or 2A@30VDC).
SD card	Storage: 8GB (To prevail in kind); Max: 512 files; Interval: 1 ~ 60 seconds.
Power Supply	rechargeable Lithium Battery Power (continuous operation of main battery 10 hours).
Keypad	Tactile Keys.
Display	3.5 inch TFT color screen(320 × 240), backlit LCD.
Temperature	Transmitter: 14°F to 122°F (-10℃～50℃) Transducer: -40°F to 176°F (-40℃～80℃,standard）
Humidity	0 ~ 99% RH, non-condensing.
Physical Specifications	
Transmitter	NEMA13 (IP54).
Transducer	Encapsulated design, IP68; Standard cable length: 5m.
Weight	Transmitter: 1kg.

8 Appendix 1 - Flow Application Data

8.1 SoundVelocityandViscosityforFluidsCommonly Used

Fluid	*Sound Velocity (m/s)*	*Viscosity*
water 20℃	1482	1.0
water 50℃	1543	0.55
water 75℃	1554	0.39
water 100℃	1543	0.29
water 125℃	1511	0.25
water 150℃	1466	0.21
water 175℃	1401	0.18
water 200℃	1333	0.15
water 225℃	1249	0.14
water 250℃	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	

8.2 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

Liner Material	*Sound Velocity (m/s)*
PTFE	1225
Titanium	3150
Cement	4190
Bitumen	2540
Porcelain enamel	2540
Glass	5970
Plastic	2280
Polyethylene	1600
PTFE	1450
Rubber	1600

8.3 Sound Velocity In Water (1 atm) At Different Temperatures

T (℃)	*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

Please contact the factory for other sound of the velocity of fluids and materials.

9 Appendix2 – Serial Interface Network Use and Communications Protocol

9.1 Overview

The flowmeter has perfect communication protocol. It can also be connected to a RS-485 bus .

Two basic schemes can be chosen for networking, i.e. the analog current output method only using the flowmeter or the RS232 communication method via serial port directly from the flowmeter. This method is suitable to replace dated instruments in old monitoring networks. The later method is used in new monitoring network systems. It has advantages include low hardware investment and reliable system operation.

When the serial port communications method is directly used to implement a monitoring network system, the address identification code (in window M46) of the flowmeter is used as a network address code. Expanded command set with [W] is used as communication protocol. Thus the analog current loop and OCT output of flowmeter can be used to control the opening/closing 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. The system provides an RTU function for flow measurement.

RS-232 (cable length 0 ~ 15m) or RS-485 (cable length 0 ~ 1000m) can be directly used for data transmission links for a short distance. Current loop can be used in medium or long distance transmission.

When the flowmeter is used in a network environment, various operations can be performed by a host device, except for programming of the address identification code, which needs to be done via the flowmeter keyboard.

The command answer mode is used in data transmission, i.e. the host device issues commands and the flowmeter answers correspondingly.

Common/special flow / thermal data monitoring system developed by our company can be used for flow data collection. Based on characteristics of the flowmeter, the system makes full use of software and hardware designs with flowmeter features. The system is simple, clear, economical, and reliable in operation.

Attention

In the communication protocol used functions, RS232 and RS485 serial communications can not be used at the same time.

9.2 Serial Port Definitions

Flowmeter - RS232:

TXD send

RXD receive

GND ground

PC:

PIN 1 empty

PIN 2 RXD send

PIN 3 TXD send

PIN 4 ground

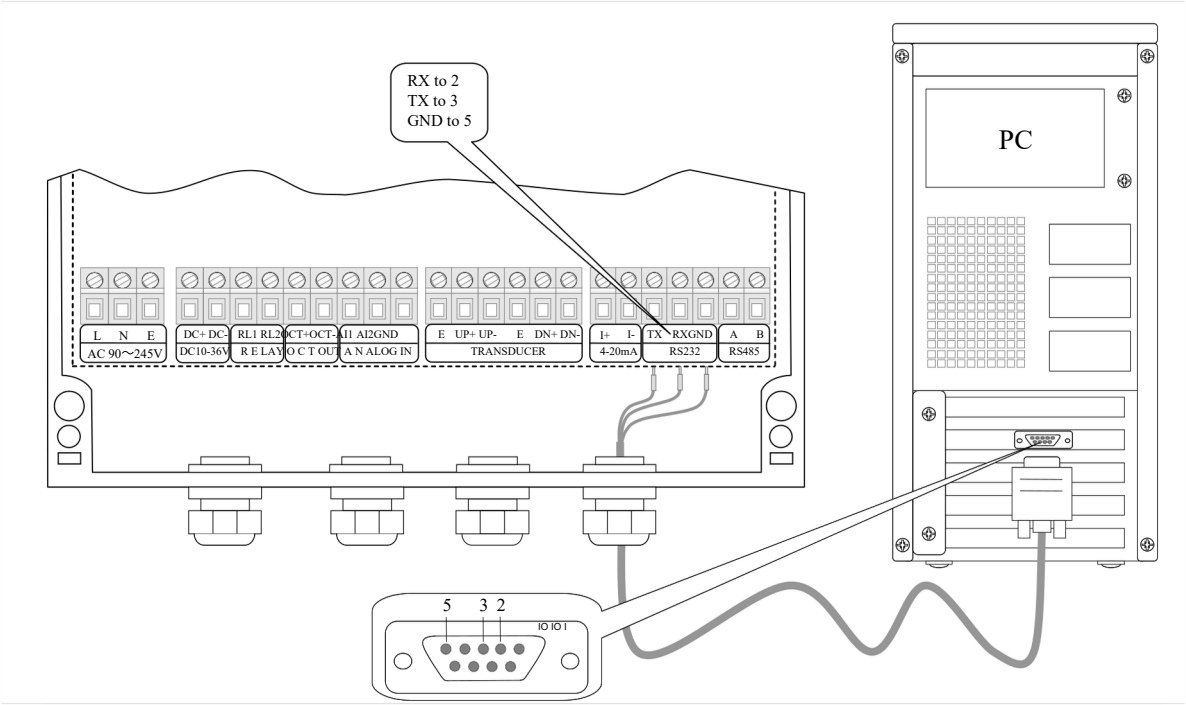
PIN 5 ground

PIN 6 empty PIN 7 empty PIN 8 empty

PIN9empty

9.3 Direct connection via RS232 to the host device

See the below list of flowmeter serial port definitions.



9.4 Communications Protocol and the Use

The flowmeter meter supports these three communication protocols: FUJI Protocol, MODBUS-C Protocol, MODBUS Protocol.

9.4.1 FUJI Protocol

Choose "0.FUJI" in Menu 96 for FUJI Protocol.

The communication protocol format used by the ultrasonic flowmeter is an expanded set of the Fuji FLV series flowmeter protocol. The host device requests the flowmeter to answer by sending a "command". The baud rate of asynchronous communication (Primary station: computer system; Secondary station: ultrasonic flowmeter) is generally 9600BPS. A single byte data format (10 bits): one start bit, one stop bit and 8 data bits. Check bit: none.

A data character string is used to express basic commands and a carriage return (ENTER) is used to express the end of a command. The characteristic is that the string of data is flexible. The order applies to both RS232 and RS485. Frequently used commands are as follows:

Communications commands

Command	***Description***	***Data format***
DQD(cr)(lf)注0	Return daily instantaneous flow	±d.dddddE±dd(cr)*1
DQH(cr)(lf)	Return hourly instantaneous flow	±d.dddddE±dd(cr)
DQM(cr) (lf)	Return instantaneous flow per minute	±d.dddddE±dd(cr)
DQS(cr) (lf)	Return instantaneous flow per second	±d.dddddE±dd(cr)
DV(cr) (lf)	Return instantaneous velocity	±d.dddddE±dd(cr)
DI+(cr) (lf)	Return positive accumulative flow	±ddddddE±d(cr)82
DI-(cr) (lf)	Return negative accumulative flow	±ddddddE±d(cr)
DIN(cr) (lf)	Return net accumulative flow	±ddddddE±d(cr)

DIE(cr) (lf)	Return totalized energy value	±ddddddE±d(cr)
E(cr) (lf)	Return instantaneous energy value	±ddddddE±d(cr)
AI1(cr) (lf)	Return analog input value of AI1 (Temperature, Pressure, etc.)	±ddddddE±d(cr)
AI2(cr) (lf)	Return analog input value of AI2 (Temperature, Pressure, etc.)	±ddddddE±d(cr)
AI3(cr) (lf)	Return analog input value of AI3 (Temperature, Pressure, etc.)	±ddddddE±d(cr)
DID(cr) (lf)	Return identification code of instrument (address code)	ddddd(cr) 5 bits in length
DL(cr) (lf)	Return signal intensity	UP:dd.d，DN:dd.d，Q=dd(cr)
DS(cr) (lf)	Return percentage of analogous output (AO)	±d.dddddE±dd(cr)
DC(cr) (lf)	Return current error code	*3
DA(cr) (lf)	Alarm signal of OCT or RELAY	TR:s，RL:s(cr)*4
DT(cr) (lf)	Current date and time	yy-mm-dd，hh:mm:ss(cr)
M@(cr) (lf)	Analogous key value @ sent to flowmeter	M@(cr)*5
LCD(cr) (lf)	Return currently displayed content on LCD display	
C1(cr) (lf)	OCT actuated	
C0(cr) (lf)	OCT not actuated	
R1(cr) (lf)	RELAY actuated	
R0(cr) (lf)	RELAY not actuated	
FOdddd(cr) (lf)	Frequency output value n	Fdddd(cr)(lf)
Aoa(cr) (lf)	Current output value a of current loop	AOa(cr)(lf)*6
ESN(cr) (lf)	Return electronic serial number	ddddddd t(cr)(lf)*7
W	Networking command prefix of numeric string address	*8
P	Prefix of return command with check	
&	Function sign of command "add"	
RING(cr)(lf)	Modem request handshake command	ATA(cr)(lf)
OK(cr) (lf)	Modem answer signal	No output
TEST(cr) (lf)	Test if there is a SD cardornot.	There is a card ,then return "OK!",NO SD Card , then return "NOCARD".
DELETyymmdd(cr) (lf)	Delete the file"yymmdd",(yy: year, mm: month, dd: day.)	Successfully delete it, then return "OK!"; if not ,return "NOCARD".
READyymmdd(cr) (lf)	Read the file"yymmdd", (yy: year, mm: month, dd: day.)	Successfully delete it, then return the file contents; if not, return "NOCARD".
STOP(cr) (lf)	Stop the data storage	Successfully delete it, then return "OK!"; if not ,return "NOCARD".
START(cr) (lf)	Start the data storage	Successfully delete it, then return "OK!"; if not ,return "NOCARD".

Note:

0. (cr)expresses carriage return. Its ASCII value is 0DH. (lf) expresses line feed. Its ASCII value is 0AH.
1. "d" expresses 0-9 number. 0 value is expressed as +0.000000E+00.
2. "d" expresses 0-9 numbers. There is no decimal point in integral part before "E".
3. The status of the machine is expressed by 1-6 letters. See the error code section for the meaning of the characters. For example, "R" and "IH".
4. "s" expresses ON or OFF or UD. For example, "TR:ON, RL:ON" expresses that the OCT and relay are in an actuated status; "TR:UD，RL:UD" expresses that the OCT and relay are not actuated.
5. "@" expresses the key value. For example, 30H expresses "0" key; Command "M4" is equivalent to pressing the key "4".
6. "a" expresses the current value. The value range is 0-20. For example, AO2.34567 and AO0.2.
7. Eight "ddddddddd" expresses the electronic serial number of the machine. "t" expresses the type of machine.
8. If there are multiple flowmeters in a data network then the basic commands cannot be used alone. The prefix W must be added. Otherwise, multiple flowmeters will answer simultaneously, which will cause chaos in the system.

1. Function prefix and function sign

1) Prefix P

The character P can be added before every basic command. It means that the transferred data has CRC verification. The method of counting the verified sum is achieved by binary system addition.

For example: Command DI+(CR) (the relative binary system data is 44H, 49H, 2BH, 0DH) transferred data is + 1234567E+0m3. (CR) (the relative binary system data is 2BH, 31H, 32H, 33H, 34H, 35H, 36H, 37H, 45H, 2BH, 30H, 6DH, 33H, 20H, 0DH, 0AH). And command PDI + (CR) transferred data is +1234567E+0m3! F7 (CR), "!" means the character before it is the sum character, and the verified sum of the two bytes after it is (2BH+31H+32H+33H+34H+35H+ 36H+37H+45H+2BH+30H+6DH+33H+20H = (2) F7H).

Note: There can be no data before " ! ", and also may be a blank character.

2) Prefix W

Usage of prefix W: W+ numeric string address code +basic command. Value range of the numeric string is 0 ~ 65535, except 13 (0DH carriage return), 10 (0AH line feed), 42 (2AH *) and 38 (26H &). If the instantaneous velocity of No. 12345 flowmeter is to be accessed, the command W12345DV(CR) can be issued. Corresponding binary code is 57H, 31H, 32H, 33H, 34H, 3 5H, 44H, 56H and 0DH.

3) Function sign &

Function sign & can add up to 5 basic commands (Prefix P is allowed) together to form a compound command sent to the flowmeter together. The flowmeter will answer simultaneously. For example, if No. 4321 flowmeter is requested to simultaneously return: 1] instantaneous flow, 2] instantaneous flow velocity, 3] positive total flow, 4] energy total, 5] AI1 analogous input current value, the following command is issued:

W4321PDQD & PDV&PDI + &PDIE&PBA1 (CR)

Simultaneously returned data are likely as follows:

+0.000000E+00m3/d!AC(CR)

+0.000000E+00m/s!88(CR)

+1234567E+0m3 !F7(CR)

+0.000000E+0GJ!DA(CR)

+7.838879E+00mA!59(CR)

2. Key Code

In a network environment, a key code is used to simulate the use of keys at the host device.

For example, the instruction "M1" is input through the serial port, which is equivalent to pressing Key 1 on the keyboardof the ultrasonic flowmeter. Codes:

Key	***Key Code (Hexadecimal system)***	***Key Code (Decimal system)***	***ASCII***
	30H	48	0
	31H	49	1
	32H	50	2
	33H	51	3
	34H	52	4
	35H	53	5
	36H	54	6
	37H	55	7
	38H	56	8
	39H	57	9
	3AH	58	:
	3BH (0BH)	59	;
	3CH (0CH)	60	<
	3DH (0DH)	61	=
	3EH	62	>
	3FH	63	?

9.4.2 MODBUS Communication Protocol

This MODBUS Protocol uses RTU transmission mode. The Verification Code uses CRC-16-IBM (polynomial is X16+X15+X2+1, shield character is 0xA001) which is gained by the cyclic redundancy algorithm method.

MODBUS RTU mode uses hexadecimals to transmit data.

1. MODBUS Protocol Function Code and Format

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

Function Code	***Performance data***
0x03	Read register
0x06	Write single register

2.MODBUS Protocol function code 0x03 usage

The host sends out the read register information frame format:

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

The slave returns the data frame format:

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

N* = Data register number

3.MODBUS Protocol function code 0x06 usage

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

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

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

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

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

0x01 0x03 0x00 0x04 0x00 0x02 0x85 0xCA

Flowmeter Address Function Code First Address Register Register Numbers CRC Verify Code

Flowmeter returned data is (assuming the current flow=1.234567m^3/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 06 51 3F 9E.

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:

0x060x01 0x10 0x03 0x00 0x02 0xFC 0xCB

Flowmeter Address Function Code Register Address Register Number CRC Verify Code

4.Error Check

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

For example, to read address 1 (0x01) of the flowmeter 40002 register data in the RTU mode, the flowmeter 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

5.MODBUS Register Address List

The flowmeter MODBUS Register has a read register and a write single register.

a. Read Register Address List (use 0x03 function code to read)

PDU Address	***Register***	***Data description***	***Type***	***No. registers****	***Remark***
$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 bitsreal	2	
$0007	40008	Velocity – high word			
$0008	40009	Positive total – low word	32 bitsint.	2	
$0009	40010	Positive total – high word			
$000A	40011	Positive total – exponent	16 bitsint.	1	
$000B	40012	Negative total – low word	32 bitsint.	2	
$000C	40013	Negative total – high word			
$000D	40014	Negative total – exponent	16 bitsint.	1	
$000E	40015	Net total – low word	32 bitsint.	2	
$000F	40016	Net total – high word			
$0010	40017	Net total – exponent	16 bitsint.	1	
$0011	40018	Energy total – low word	32 bitsint.	2	
$0012	40019	Energy total – high word			
$0013	40020	Energy total – exponent	16 bitsint.	1	
$0014	40021	Energy flow – low word	32 bitsreal	2	
$0015	40022	Energy flow – high word			
$0016	40023	Up signal int – low word	32 bitsreal	2	0 ~99.9
$0017	40024	Up signal int – high word			
$0018	40025	Down signal int – low word	32 bitsreal	2	0 ~ 99.9
$0019	40026	Down signal int – high word			
$001A	40027	Quality	16 bitsint.	1	0 ~ 99
$001B	40028	Analog output – low word	32 bitsreal	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 Flow			
$003D	40062	unit – char 1,2	String	2	Note1
$003E	40063	Flow unit – char 3,4			
$003F	40064	Total unit – char 1,2	String	1	
$0040	40065	Energy unit char 1,2	String	2	Note 2- the setup is same as M84.
$0041	40066	Energy unit – char 3,4			
$0042	40067	Energy total unit – char 1,2	String	1	

$0043	40068	ID code – low word	32 bitsint.	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 Analog			
$0049	40074	Input AI1 Value- low word	32 bitsreal	2	Returned temperature value with RTD option
$004a	40075	Analog Input AI1 Value- high word			
$004b	40076	Analog Input AI2 Value- low word	32 bits real	2	Returned temperature value with RTD option
$004c	40077	Analog Input AI2 Value- high word			

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

PDU Address	***Register***	***Data description***	***Read/ Write***	***Type***	***No. registers****
$1003	44100	Flowmeter address (1 - 247)	R/W	16 bitsint.	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. "l" －Liters
   2. "ga" －Gallons
   3. "ig" －Imperial Gallons
   4. "mg" －Million Gallons
   5. "cf" －Cubic Feet
   6. "ba" －US Barrels
   7. "ib" －Imperial Barrels
   8. "ob" －Oil Barrels
2. The following energy units are available：
   0. "GJ" －Giga Joule
   1. "Kc" －Kilocalorie
   2. "MB" －MBtu
   3. "KJ" －Kilojoule
   4. "Bt" －Btu
   5. "Ts" －US Tonnes
   6. "Tn" －US Tons
   7. "kw" －Kwh
3. When the flowmeter address or communication baud rate change, the meter will work under the new address or communication baud rate after the communication baud rate responded with returned primary address and communication baud rate.
4. 16 bits int—short integer, 32 bits int – long integer, 32 bits real—floating point number, String—alphabetic string.

10 Appendix 3 -RTD Module Connected to PT1000 (Optional)

10.1 RTD module thermal measurement function

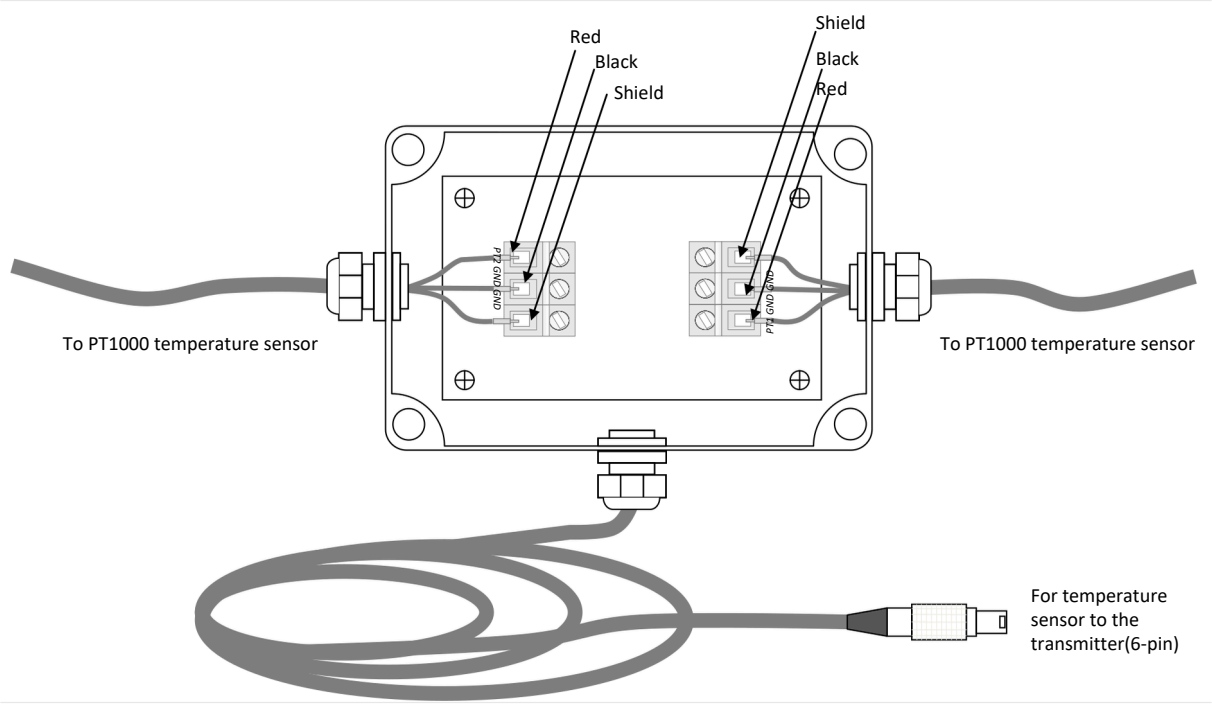
This function is suitable for the following models and measuring temperature range:

DCT1288i: 0 ~ 100 ℃, equipped with PT1000 temperature sensor;

The main function of the RTD is to input the temperature value for the heat metering which can automatically calculate the calorie content of the water at different temperatures and obtain the instantaneous calorific value and the cumulative calorific value.

10.2 Wiring (PT1000)

RTD module and PT1000 use three-wire connection, connect PT1000 and RTD module (in the main unit) according to the following figure (Note: PT1, PT2 connect red line, GND connect black line and shield line).



Two temperature sensors of PT1000 are installed onto the inlet and return pipes respectively and they can transmit the temperature signal to the transmitter.

10.3 Measurement type

Flow meter heat calculation method:

The thermal energy value can be expressed as follows according to the thermodynamic formula:

$$Q = m\ (h_1 - h_2)$$

Where: ***Q*** ——the calorific value

m ——the mass of the medium

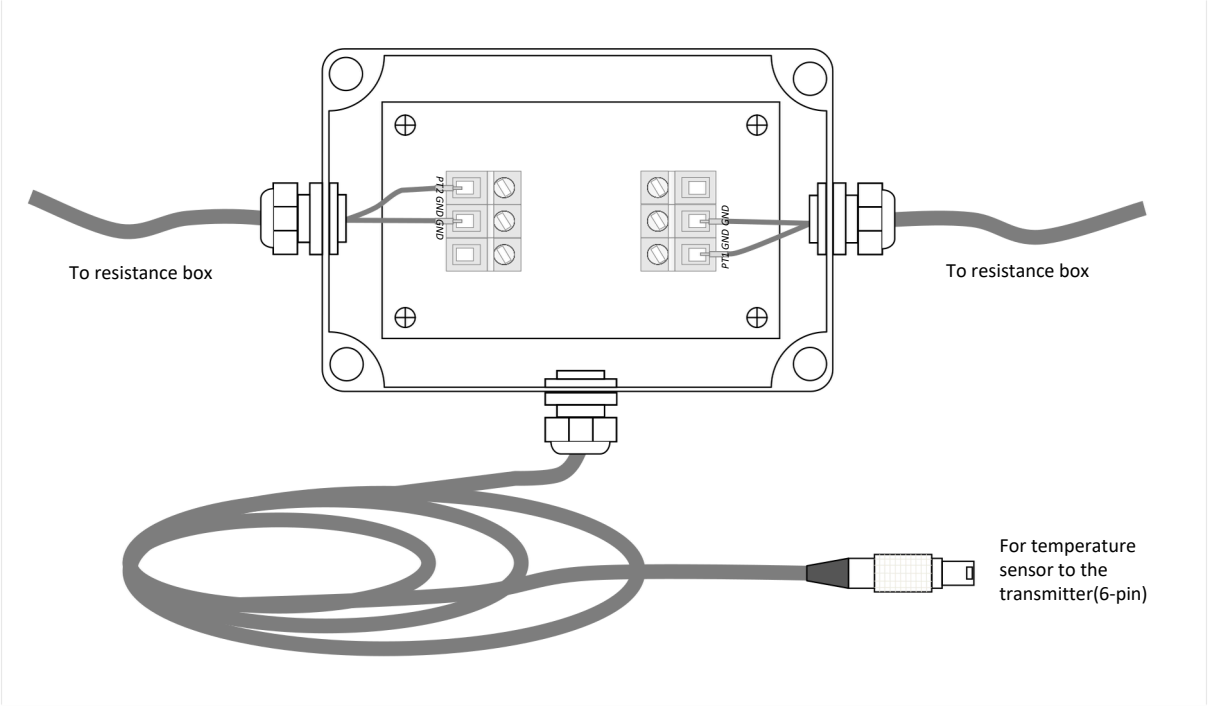
h1 ——the enthalpy of the inlet water

h2 ——the enthalpy of the return water

By the temperature sensor and the transmitter can measure the temperature of the inlet and return water, and then according to the water enthalpy table, respectively access the enthalpy of the inlet and return water. With measured medium flow rate, according to the above formula and the factory calibration of thermal correction coefficient can get the calorific value.

10.4 Temperature calibration method

Resistance box calibration method



Use tools: a DC resistance box, two twin core wires (length of each wire is less than 40mm) and a screwdriver.

1. Plug the six-pin connector into the temperature sensor interface.
2. Connect TP1 to one end of DC resistor terminal in the junction box and GND to the other end of the DC resistor terminal. Connect TP2 to one terminal of the other DC resistor terminal and GND to the other end of the other DC resistor terminal.
3. Set two DC resistances as 1000.00Ω。
4. Press Menu √- 1Enter, input “115800” then press Enter to spread out。Only validwhile power on.
5. Press Enter to enter and select “Adjust 0” to enter the outlet water temperature 0 degree calibration, press the up and down keys to adjust the displayed temperature to 0.00, press Enter to enter the inlet water temperature 0 degrees calibration, press the up and down keys to adjust the displayed temperature to 0.00. And press Enter to finish 0 degree calibration.
6. Set two DC resistances as 1385.06Ω。
7. Press Menu √- 1Enter to enter and select “Adjust 100” to enter the outlet water temperature 100 degree calibration，press the up and down keys to adjust the displayed temperature to 100.00, press Enter to enter the inlet water temperature 100 degrees calibration，press the up and down keys to adjust the displayed temperature to 100.00.And press Enter to finish 100 degree calibration.
8. Repeated 5 ~ 7 steps to calibrate 0 degrees and 100 degrees for several times, enter the menu M07 to check and contrast the follows, when matched, the commissioning is completed.

   0 degrees: Inlet and Outlet water temperature 0.00±0.05, temperature difference 0.00±0.05

   100 degrees: Inlet and Outlet water temperature 0.00±0.05, temperature difference 0.00±0.05