DMS450 Series   Thermal Mass Flowmeter

User's Manual

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1 General

Every DMS450 thermal mass flowmeter will be carefully inspected before delivered to users.
Please carefully check if there is any damage on the package and product when you received them
Please check if the package contains all the accessories according to 1.2 or your purchase order.
Please make sure the person in charge of this device has carefully read this manual and understand its descriptions.

1.1 Model Number and General Specification

Please check if the model number and specifications on the name plate match your requirement on the purchase order.
Please kindly record the model number and instrument ID code, which will be required if you need and service or support from us.

1.2 Packing List

When you recived the package, please check if it contains the items as below:

DMS450 thermal mass flowmeter x1
User's manual x1

Calibration certificate x1
Quality certificate x1
Cable (For remote type only, length according to customer's requirement)
Counter flanges (For wafer type, or for flanged type when customer requied so)
Screws and bolt (For wafer type, or for flanged type when customer requied so)

1.3 Storage

If the product needs to be stored for a long period before use, please be awared of below:

(1) The product should be kept in the origin package and same as it was when received.

(2) Please store the product in a proper location according to the requirements below:

Not in a uncovered field.

Not in a location where could have great vibration.

Please keep the enclosure of the meter closed.

The ambient temperature, atmospheric pressure and humidity should be:

Temperature: -20~+60℃；RH：5%~99%；Pressure：86~106Kpa

1.4 Measuring principle

DMS450 Series Thermal Mass Flowmeter measures gas mass flow base on thermal diffusion theory and thermal principle of Newton , It have two RTD sensor (ref to picture 1.2) located in the flow. One RTD is heated to T1 by a heating power rate of P, the other is not heated but to measure the medium temperature T2. So there is a temperature difference T^D=T1-T2 . T^D reach max when mass flow is 0. When the mass flow Q increases, the heat on T1 is taken away so the T1 decline and the T^D become smaller. So there is a certain relationship between heating power rate P, difference of temperature T^D and mass flow Q as below:

$P/ T^D = K1 + K2 \, F(Q)^{K3}$
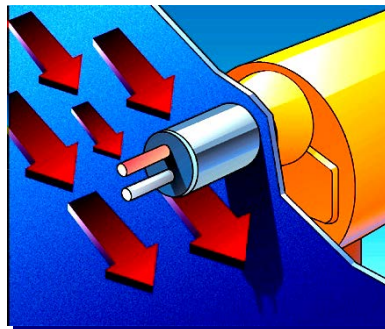
Picture 1.2 Principle

The K1,K2 and K3 in above equation is constant related to the character of medium . So the mass flow Q can be get through measuring the heating power rate P and difference of temperature T^D . In actual application, there are two different method, one is consistent current method (keep the P unchanged) and the other is consistent temperature method (keep T^D unchanged)

2 Install

2.1 Find Most Suitable Location

2.1.1 Ambient temperature

Please avoid installing the flowmeter at a location where temperature could dramaticly changes. If the meter is under heavy heat radiation, please implement effective heat insulation and venting method.

2.1.2 Atomosphere
Please do not install the meter at a locaition where the atomosphere contains a high level of corrosive substance. If can not install the meter at a better location, please make sure there is enough venting.
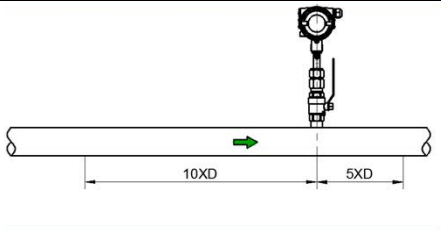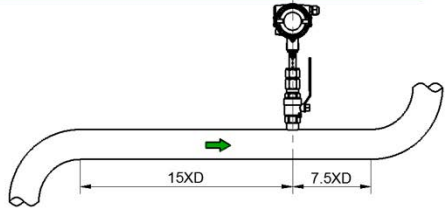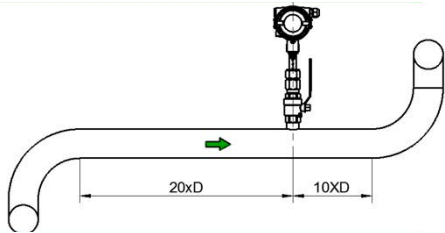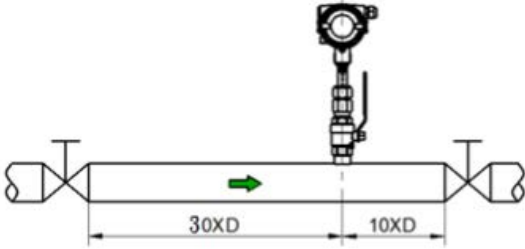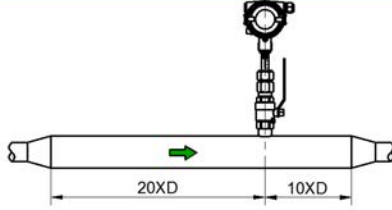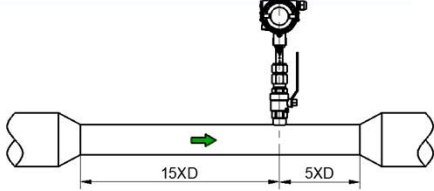
2.1.3 Vibration
The meter should not be installed at a location where could have strong vibration. If the mounting pipeline could have heavy vibration, the pipe line should be holden steady by some supporting racks.
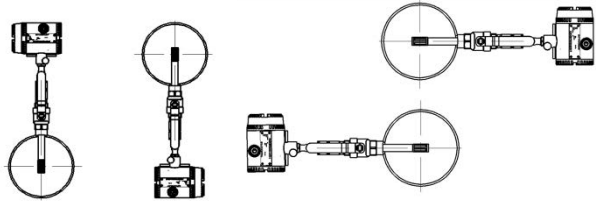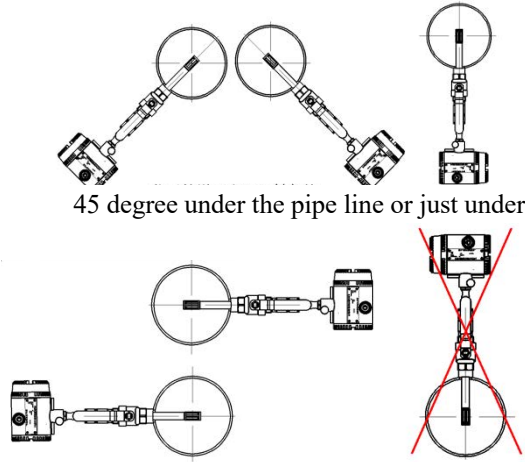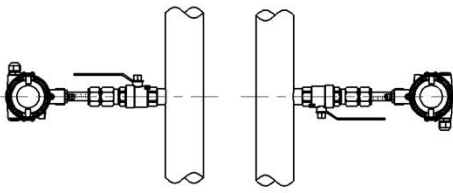
2.1.4 Caution
(a) All screws and bolts should be tighen.
(b) Make sure there is not leakage point on the connection.
(c) The process pressure should not be higher than the meter's rated pressure.
(d) Once the meter is under pressure, please do not screw the bolts and screws.
(e) When measuring harzad gas, do not breath the gas in
(f) If the meter is insertion mounted, please the outer of the connection part should be sealed with proper sealant.
(g) If the meter is insertion mounted,

2.2 Requirement on straight pipe line

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Curved pipe line in the upstream or downstream	
Curved pipe line that may creat turbulence in the upstream or downstream	
There are valves or pressure controller or any other device may cause turbulence in upstream or down stream of the flowmeter	
If the pipeline of the flowmeter is upsized	
If the pipeline of the flowmeter is downsized	

2.3 Requirement on insertion direction

On a horizontal pipe line, normal air or gas	Above or under the pipeline Side of the pipe line
On a horizontal pipe line, high humidity air or wet natural gas.	45 degree under the pipe line or just under the pipelien On the side of the pipe. Do not recommend to install the meter above the pipeline
On a vertical pipeline, when the density of the gas is higher than air	

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2.4 Procedure of installation

2.4.1 Nut sleeve insertion (No flow in pipeline)

1) Drill a hole on the position where the meter will be installed, Ø 13mm （± 0.5 mm）

2) Clean the burrs and sharps on where will be welded

3) Weld the MNPT 1/2" socket (Part No.1) on the open hole vertically. The socket and the open hole should be concentric, and vertical to the center line of the pipe line
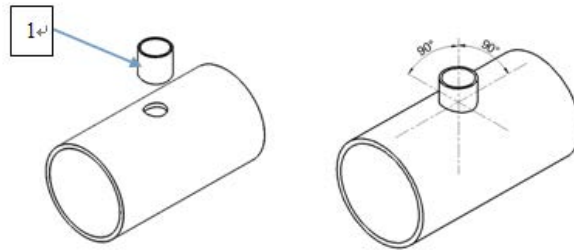
4) Connect the 1/2" ball valve (Part No.2) with FNPT threads on both ends to the socket. Seal the thread connection with thread sealant. Please note the lever on the ball valve should be point to up when the valve is open
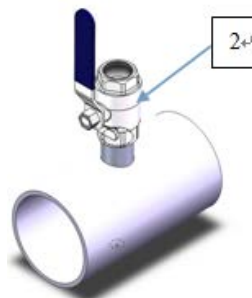
5) Insert the flowmeter into the ball valve and the socket, connect the sleeve (Part No.3) on the meter and the ball valve, seal the thread conection part with thread sealant. Tighten the nut (Part No.4) with hand.

6) Calculate the insertion depth. The sensor should be in the middle of the pipe area, insertion depth S=A/2+B+C. Please reference to the picture below

A: Inner diameter of the pipeline

B: Thickness of the pipe line

C: The distance between the top of the pipeline and the upper end of the nut when the nut is fixed
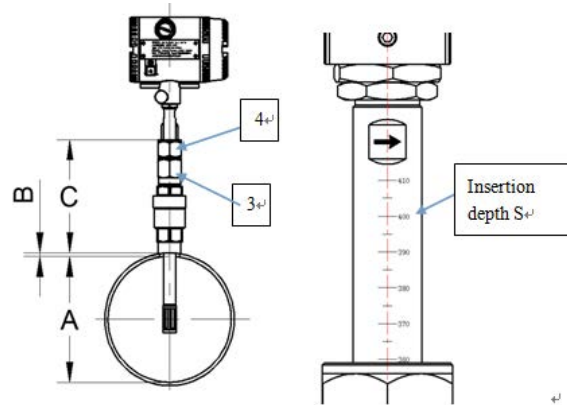
7) Adjust the direction of the flowmeter: Make sure the derection mark on the probe (Part No.5) is pointing to the direction as the flow goes. Please reference to the picture below.

8) Insert the flowmeter to the depth S as calculated previous, now hold the sleeve (Part No.3) with a wrench and tighen the nut (Part No.4) with another wrench. Make sure the nut sleeve is holding the meter tightenly.
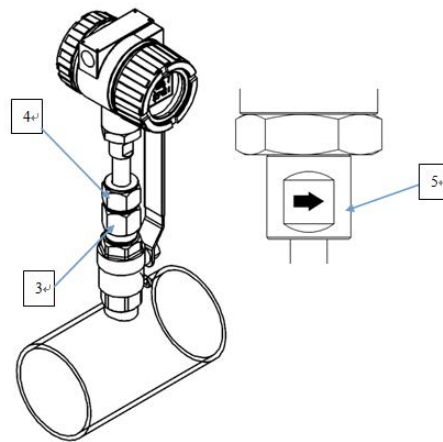
Remark: If flow rate higher than 90Nm/s or pipe size larger than DN400, will require 19mm diameter probe, mounted in 1" ball valve and 1" socket and 22mm hole

2.4.2 Nut sleeve insertion (flow and pressure in pipeline)

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1) Weld the MNPT 1/2" socket (Part No.1) on the pipeline vertically. The socket should be vertical to the center line of the pipe line
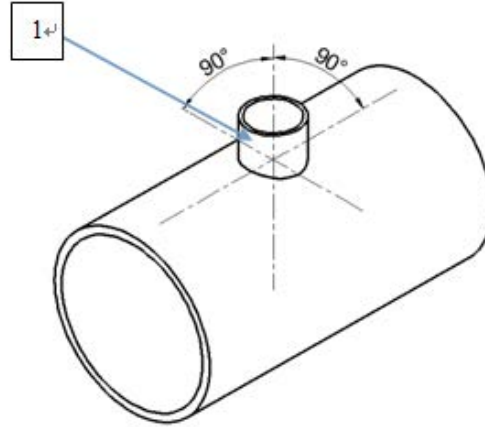
2) Connect the 1/2" ball valve (Part No.2) with FNPT threads on both ends to the socket. Seal the thread connection with thread sealant. Please note the lever on the ball valve should be point to up when the valve is open.
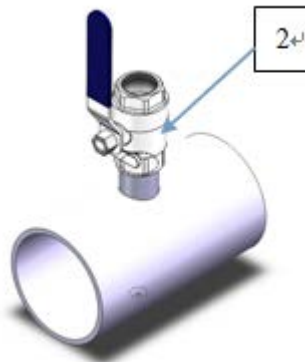
3) Drill a hole with the hot tap hole opener, Ø 13mm   (± 0.5 mm). (Please reference to the manual of hot tap mounting for details)

4) Make sure the senor of the meter is with in the sleeve on the flowmeter, so the sleeve can protect the sensor.
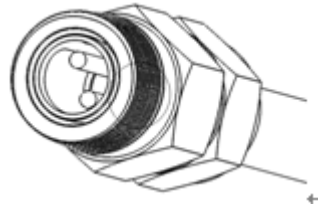
5) Connect the sleeve with the ball valve with the thread, please seal the 1/2" NPT thread connection with thread sealant, (the ball valve should be closed)

6) Calculate the insertion depth. The sensor should be in the middle of the pipe area, insertion depth S=A/2+B+C. Please reference to the picture below

A: Inner diameter of the pipeline

B: Thickness of the pipe line

C: The distance between the top of the pipeline and the upper end of the nut when the nut is fixed

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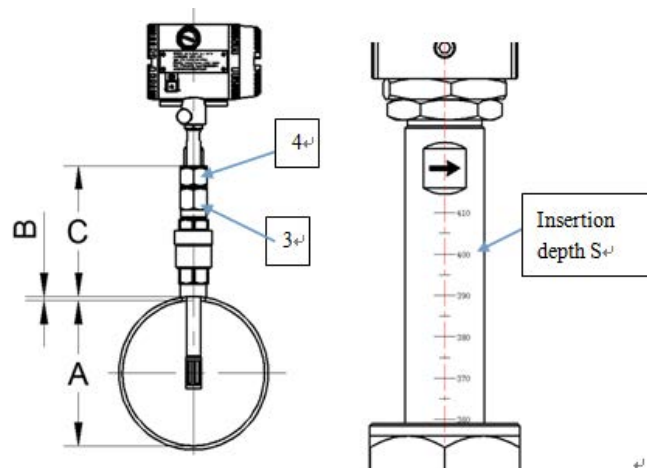
7) Adjust the direction of the flowmeter: Make sure the derection mark on the probe (Part No.5) is pointing to the direction as the flow goes. Please reference to the picture below.

8) Open the ball valve, please make sure that procedure 1~7 is operated properly before opening the ball valve. The sleeve should be connected to the ball valve tightenly that the meter can not be ejected out.

9) Insert the meter to the depth S as calculated with the hot tap mounting tool. (Please reference to the manual of hot tap mounting for details). Now hold the sleeve (Part No.3) with a wrench and tighen the nut (Part No.4) with another wrench. Make sure the nut sleeve is holding the meter tightenly.

Remark: If flow rate higher than 90Nm/s or pipe size larger than DN400, will require 19mm diameter probe, mounted in 1" ball valve and 1" socket and 22mm hole

3 Wiring

The terminal board of DMS450 is as picture 3.1 below

I+ I- A B P+ P- ⎍ V- V+
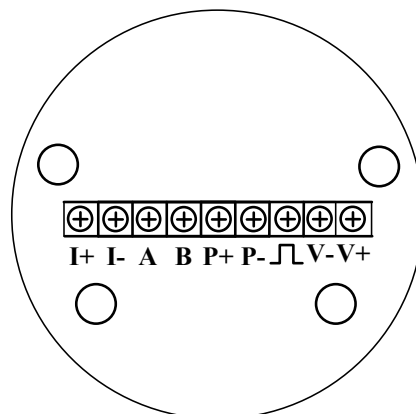
Picture 3.1 DMS450 terminal board

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On above board, V+ and V- are for power, the DC power should be within 15VDC~32VDC. ⎍ is pulse output terminal. A, B are "+" and "-" for RS485Modbus communication, I+ and I- are + and – for 3-wire or 4-wire 4~20 mA. P+,P- are for pressure transmitter .

3.1 Wiring for terminal board

3.1.1 Wiringfor 3-wire pulse output

DMS450 use a current pulse output with 50% duty ratio. If the pulse reciving instrument require voltate pulse, please add a resistor between " ⎍ " and "V-", the resistance should be within 500ohms~1000ohms, and power consumption should be no less than 0.5W.
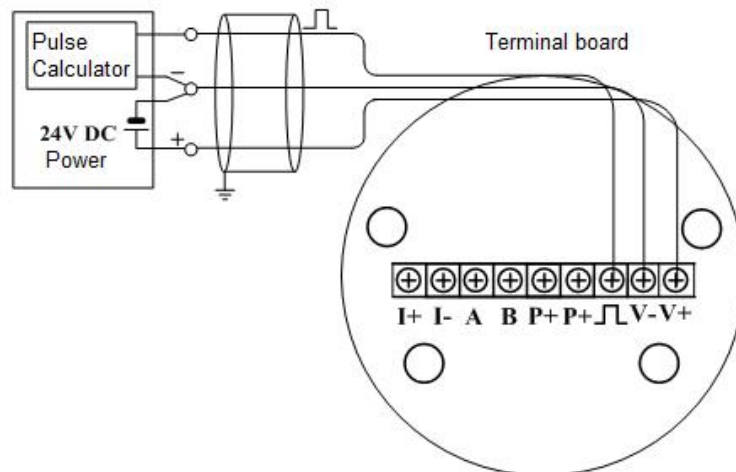
Picture 3.2 Wiring of DMS450 3-wire pulse output

3.1.2 Wiringfor 3-wire HART@4~20mA

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DMS450 terminal board
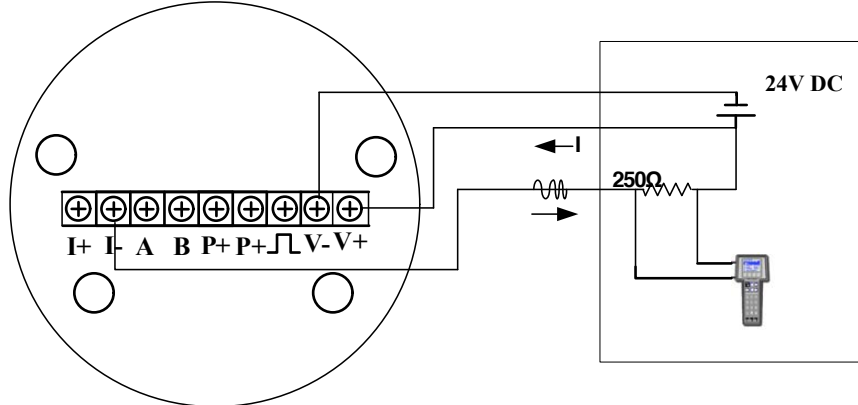
Picture 3.3 Wiring of DMS450 3-wire HART@4~20mA

3.1.3 Wiringfor 4-wire HART@4~20mA
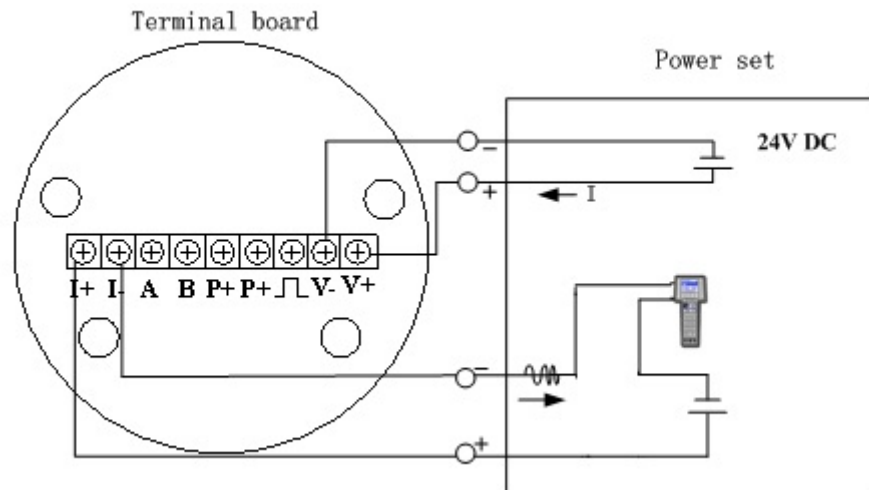
Picture 3.4 Wiring of DMS450 4-wire HART@4~20mA

3.1.4 Wiring for RS485
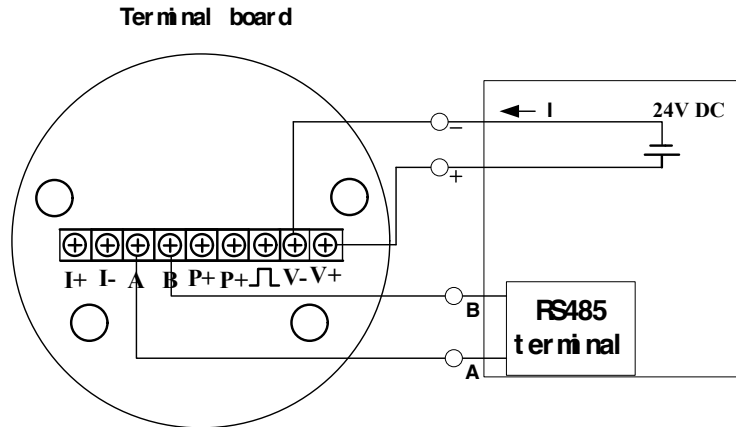
Picture 3.5 Wiring of DMS450 RS485

3.2 Shell grounding and elimination of interference

In DMS450 thermal mass flowmeter the power supply of signal processing circuit is transferred from outside power supply by a isolation type DC-DC transmitter with advanced grounding technology . The field frequency interference can be isolated well.
When using this product , the "V-" of power supplier should not be connected with the ground .When this product is used in a environment with strong interference , the shell should be clean connected with earth through cable , so the interference can be eliminated .

3.4 Requirement on wiring

1) Please do not conduct wiring when the power is on in a explosive environment.
2) Please open the rear cover first, then inert the cable into back zone of housing thourgh the water-proof cable gland.
3) Conduct wiring according to 3.2.
4) If possible, please conduct the wiring according to picture 3.6 to avoid the water get into the housing through the cable.
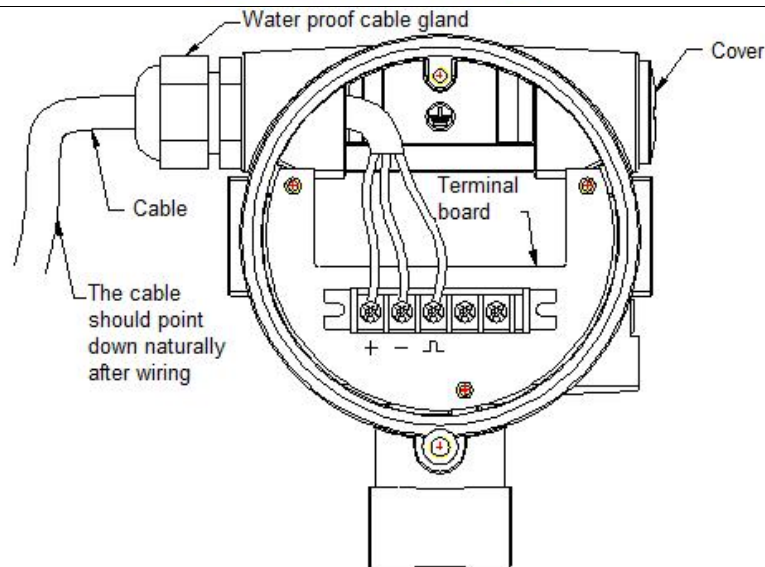
Picture 3.6 Wiring instruction

4 Display

DMS450 thermal mass flow meter provide with local display and setting. Users can display several variables on the local multi-funcational LCD display. The transmitter also has 3 buttons so users can do setting on it.

4.1 Intruction of multi-functional LCD display

DMS450 thermal mass flow meter has a display to indicate "Temperature" "Flow rate" "Total flow" and more parameters. Please reference to picture 4.1 below.

Pitcure 4.1 DMS450 display

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The LCD display has 2 areas to display the content, the upper row, the lower row.   The upper row displays the flow rate/mass flow/standard flow rate. Below the upper row shows the unit of the variable displayed in upper row.

The lower row display indicates other variables, such as temperature/ pressure/ total flow/ density. And below the lower row shows the unit of the variable displayed in lower row.

Please reference to picture 4.2 for display

Picture 4.2 Flow rate and total flow display

DMS450 multi-varibale version can also display temperature. Users can switch the parameter displayed by using the buttons and the parameter will be displayed for 30 seconds. Please reference to picture 4.3 for mass flow and temperature displaying. Users can also fix the lower row to display a parameter consistently.

Picture 4.3 Mass flow and temperature display

You can also set the lower row to display several variables in circular turn.

4.2 Unit of the variable displayed

The variables that can be displayed in lower row and their units that can be displayed are as the chart 4.4 below.

Subject	Variable	Unit	Circular display code
TOTAL	Total flow	Nm^3, m^3,L,kg or t	01

TEMP	Temperature	°C	02
PRES	Pressure	MPa or kPa	03
FREQ	Frequency	Hz	04
DENS	Density	kg/m^3	05

Chart 4.4 The displayed units

Remark: Clients can select the unit, pressure need separate pressure sensor

4.3 Three button setting

DMS450 series thermal mass flowmeter has three buttons on the top of the displayer, which are: $\longleftrightarrow$ (will be mentioned as "L-R button" below), $\updownarrow$ (will be mentioned as "U-D button" below), (will be mentioned as "Enter button" below). Please reference to below picture
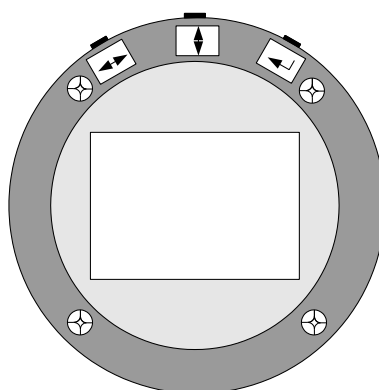
Picture 4.5 buttons

When under working, use "U-D button" to switch the displaying content, use "L-R button" can switch to the left and right digits of total flow. "Enter button" is to dispay the entire digits of total flow directly.

When the flowmeter is under setting mold, the "L-R button" means move to left and right to select the digit, the "U-D button" means to set the digit to a number, the "Enter button" means "confirm". All the "Digital setting" and "Code setting" of VFM series vortex flowmeter is made through these 3 buttons. Please reference to related article for details.

4.4 Total flow displaying

DMS450 can display the total flow with 9 digits left to decimal point and 3 digits right to it.When there is more than six digits, the total flow reading will be displayed in two times. One time displays the right digits and the other displays the left digits. You can use the "L-R button" to switch between the right digits and left digits. The left digits will be displayed with a mark of "x1000". Please reference to picture 4.6

Picture 4.6 Displaying the left digits, a "x1000" mark is displayed

If you want to check the right digits now, please pressure the "L-R button", the display will be as picture 4.7 below.

Picture 4.7 Displaying the right digits

According to picture 4.6 and 4.7, the total flow is 569864.581 kg.

4.5 Status

DMS450 series thermal mass flowmeter have three different statuses as below

■ **Working status**
■ **Setting status**
■ **Calibration status**

When under working status,please follow the instruction in 4.1 to switch the parameter displayed.

When under setting status, you can set the flowmeter, while the flowmeter is still processing, so setting will not have effect on the measuring. In next chapter, there will be instruction of how to do setting.

The calibration of the flowmeter have been finished in manufacture's lab before delivery, including temperature and pressure calibration if required and the setting of high-limit and low-limit of 4~20mA stimulation output.   Thus customers do not to set any more.

5 Setting

Note: Every DMS450 thermal mass flowmeters has been set according to requirement before delivery, please do not change setting unless it is necessary and under correct instruction!

DMS450 thermal mass flowmeter have digital setting and code setting. Use code setting to set parameters such as damping and output signal. Use digital setting to set parameters related to a number, such as pipe size, flow range, factor.

5.1 How to set

5.1.1 Code setting

Under working status, to enter code setting, please hold "Enter button" then press "U-D button" at the same time. Please reference to picture 5.1.
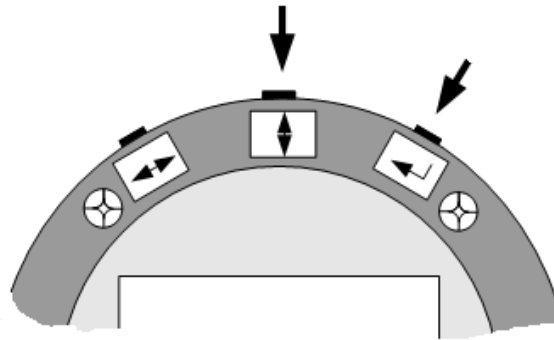
Picture 5.1 enter and quit code setting

When in code setting, the first row will display the reference number of the code setting, and the lower row will display the contents of this parameter. The digit that is flashing is the digit under setting. Please reference to picture 5.2, which means C01=02, that is set the pre-heating time to 2 seconds.

Picture 5.2 code setting

When under code setting, Now ,user can use "L-R button" to choose which digit on the displayer are to be set , and use "R-D button" to switch the digit to 0~9   . The first time of pressing "Enter button" means to set the lower row, when under this situation, users can still use "L-R button" or "U-D button" to set. Press "Enter button" again to check if the setting is available. If setting is available, the display will not flash, when user can still press "L-R button" or "U-D button" to set again. When display is not flashing, pressure "Enter button" to save and go to next setting.

If want to quit code setting, same as entering, please hold "Enter button" then press "U-D button" at the same time.

5.1.2 Digital setting

Under working status, to enter code setting, please hold "Enter button" then press "L-R button" at the same time. Please reference to picture 5.3.
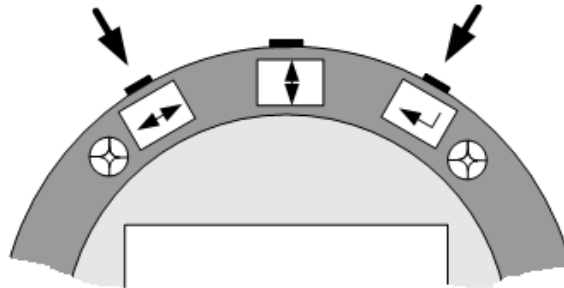
Picture 5.3 Picture Enter or quit digital setting

When in digital setting, the first row will display the reference number of the digital setting, and the lower row will display the contents of this parameter. The digit that is flashing is the digit under setting. Please reference to picture 5.4., which means D001=1.60000, Max flow is 1.6 (unit according to other setting.)

Picture 5.4 digital setting

When under digital setting,, user can use "L-R button" to choose which digit on the displayer are to be set , and use "R-D button" to switch the digit to 0~9. The first time of pressing "Enter button" means to set the lower row, when under this situation, users can still use "L-R button" or "U-D button" to set. Press "Enter button" again to check if the setting is available. If setting is available, the display will not flash, when user can still press "L-R button" or "U-D button" to set again. When display is not flashing, pressure "Enter button" to save and go to next setting.

If want to quit code setting, same as entering, please hold "Enter button" then press "U-D button" at the same time.

5.2 Setting list

Please check chart 5.1 and 5.2 for code and digital setting address list.

Chart 5.1 Code setting address

Code setting address	Item	Code	Description of code
C01	Start up time	01~99	Set the start up time within 1~99 seconds
C02	Density type	00	Display standard volume flow rate
		01	Density preset, display mass flow
		02	Display actual flow rate
C03	Pulse output type	00	pulse output off
		01	Frequency output
		02	Pulse equivalent output
C06	Pulse output parameter	00	Flow rate
		01	Temperature
		02	Pressure
		03	Total flow
C07	Damping	01~16	1~16 seconds
C08	Instrument number	00~99	For Modbus

Code setting address	Item	Code	Description of code
		00~15	For HART communication
C09	Baud rate	1	1200 no parity 1 stop bit
		2	1200 even parity 1 stop bit
		3	2400 no parity 1 stop bit
		4	2400 even parity 1 stop bit
		5	4800 no parity 1 stop bit
		6	4800 even parity 1 stop bit
		7	9600 no parity 1 stop bit
		8	9600 even parity 1 stop bit
		9	19200 no parity 1 stop bit
		10	19200 even parity 1 stop bit
		11	1200 odd parity 1 stop bit
		12	2400 odd parity 1 stop bit
		13	4800 odd parity 1 stop bit
		14	9600 odd parity 1 stop bit
		15	19200 odd parity 1 stop bit
		16	38400 no parity 1 stop bit
		17	38400 even parity 1 stop bit
		18	38400 odd parity 1 stop bit
		19	57600 no parity 1 stop bit
		20	57600 even parity 1 stop bit
		21	57600 odd parity 1 stop bit
		22	115200 no parity 1 stop bit
		23	115200 even parity 1 stop bit
		24	115200 odd parity 1 stop bit

Code setting address	Item	Code	Description of code
C10	Time unit for flow rate	00	/s
		01	/min
		02	/h
C11	Mass unit	00	kg
		01	ton
		02	lb
C12	Volume unit for flow rate	00	Standard cubic meter
		01	Cubic meter
		02	Standard litre
		03	Litre
		04	Standard Cubic feet
		05	Gallon

Code setting address	Item	Code	Description of code		
		06	Imperial gallon		
C13	Pressure unit	00	Kpa (Absolute pressure)		
		01	Kpa (Gauge pressure,minus sign for negative pressure)		
		02	Kpa (Gauge pressure)		
		03	Mpa (Absolute pressure)		
		04	Mpa (Gauge pressure,minus sign for negative pressure)		
		05	Mpa (Gauge pressure)		
		06	PSI (Absolute pressure)		
		07	PSI (Gauge pressure,minus sign for negative pressure)		
		08	PSI (Gauge pressure)		
		09	Bar (Absolute pressure)		
		10	Bar (Gauge pressure,minus sign for negative pressure)		
		11	Bar (Gauge pressure)		
C14	Temperature unit	00	°C		
		01	°F		
		02	K		
C15	Right digits number for total flow	00~05	00：No right digits for total flow		
			01~05：1~5 right digits for total flow		
C25	Password for setting	00	Password protection off		
		01	Password protection on		
C26	Fixed max flow	00	Fixed max flow off		
		011	Fixed max flow on. (If the flow rate measured is over the setting of D039, the display will show the reading as D039)		
C31	Time space for circle display	00~30	00：circle display off		
			1~30：1~30 seconds between the display of different parameter		
C32	First paratmeter displayed in circle display	00~05	00：circle display off		
			01~05：see chart 4.1		
C33	Second paratmeter displayed in circle display	00~05	00：circle display off		
			01~05：see chart 4.1		

Code setting address	Item	Code	Description of code
C36	Last paratmeter displayed in circle display	00~05	Same as above
C40	The date sequence of IEEE formate float of Modbus	01	Lower 16bits address in front, the lower 8bits in the 16bits address in front
		02	Higher 16bits address in front, the Higher 8bits in the 16bits address in front
		03	Lower 16bits address in front, the higher 8bits in the 16bits address in front

		04	Higher 16bits address in front, the lower 8bits in the 16bits address in front
C41	Shape of pipeline	00	Round pipeline(D:D010)
		01	Rectangel pipeline(L:D018 W:D019)
C47	Set password	00	Keep the password
		01	Change the pass word
C49	Status	00	Working status
		01	4~20mA output calibration statues
		02	Flow rate calibration statues
		03	Temperature calibration statues
		04	Pressure calibration statues
C50	Total flow reset	00	Reset total flow to 0
		01	Default
C60	Restore to backup date	06	Restore to backup date
C61	Save setting backup	16	Save current setting for backup
C80	Version No. of hardware		Read Only
C81	Version No. of software		Read Only
C82	Calibration date		Read Only
C83	Number of errors		Read Only
C84	Version No. of HART		Read Only
C86	Communication interface	00	Modbus Read Only
		01	Hart Read Only
C87	Pressure sensor type	00	No pressure sensor Read Only
		01	Piezo Read Only
		02	Piezo Read Only
		03	4~20mA Read Only
		04	0~10mA Read Only
C88	Product ID No.		Read Only

Note:

1) If the unit of flow rate is changed or measurement changed from flow rate to mass flow, users can reset the total flow to 0 or record the current total flow, as the number of total flow will not change according to unit.

2) Total flow can only be output by pulse, temperature and pressure can only be output by frequency

Chart 5.2 Digits settingaddress

Code setting address	Item	Code	Description of code
D001	Max flow rate	[-99999，999999]	Unit is same as flow rate,Max/min flow rate of 4~20mA and 200~1000Hz output
D002	Min flow rate	[-99999，999999]	
D003	Max frequency output	0.5~10000	The frequency output of max flow, unit is Hz
D004	Min frequency output	0.5~10000	The frequency output of min flow, unit is Hz
D005	Cut off small signal	[-99999，999999]	Unit is same as flow rate
D008	K factor	0~999999	
D009	Density	0~999999	Unit is Kg/m³
D010	Pipe size	0~9999999	Unit is mm
D011	Max temperature (Unit as set in C14）	-99999~999999	The max frequency when temperature is output by frequency, 1000Hz for instance. The max current when temperature is output by current, 20mA for instance.
D012	Min temperature (Unit as set in C14）	-99999~999999	The min frequency when temperature is output by frequency, 200Hz for instance. The min current when temperature is output by current, 4mA for instance.
D013	Max pressure (Unit as set in C13）	-99999~999999	The max frequency when temperature is output by frequency, 1000Hz for instance. The max current when temperature is output by current, 20mA for instance.
D014	Min pressure (Unit as set in C13）	-99999~999999	The min frequency when temperature is output by frequency, 200Hz for instance. The min current when temperature is output by current, 4mA for instance.
D015	Ambiant pressure	0~999999	Unit according to setting
D017	Equivalent of pulse output	0~999999	Set the equivalent that one pulse output stands for.Unit as C06
D018	Length of rectangle pipeline	0~999999	Unit is mm
D019	Width of rectangle pipeline	0~999999	Unit is mm
D030	Temperature of standard condition	0~20	Default temperature of standard condition is 20 degree C
D033	Reference flow rate	0~999999	When measured flow rate is over calibrated max flow, will display/output the reference flow rate

Note:

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1) When setting the max or min of pressure, please take consideration of gauge pressure or absolute pressure, if the pressure sensor is outputting gauge pressure, please set D015 the ambient pressure to get correct pressure reading.

5.3 Example of setting

Sample: For insertiong connecting, measure air in DN150 pipe, density preset, unit displayed in kg/hr, flow range of 0~4000kg/hr, 200~1000Hz output

	Address	Code	Description
Code setting	C02	01	Density preset
	C03	01	Frequency output
	C06	00	Output parameter is flow rate
Digital setting	D009	1.2930	Density=1.293 ,air
	D008	1.000	Factor =1
	D001	5000	The flow rate for 1000Hz output
	D002	0	The flow rate for 200Hz output
	D010	150	Pipe size=150mm
	D003	1000	Max output frequency
	D004	200	Min output frequency

5.4 Password setting instruction

There is no password set in default in a new DMS450 thermal mass flowmeter ,users can set a password following instruction below.

Enter code setting, set C47=01, confirm and quit then enter the password setting ineterface as picture 5.5

```
SPC

0000
```
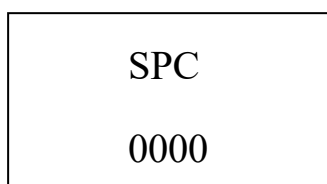
Picture 5.5 Password setting interface

To set a new password, users have to input the correct password twice, the password will become effective only if the both inputs are the same; or users have to input again. If the power is off during a password setting process, the password will be 0000 as default. When a password becomes effective, users have to input the correct password before he can set the flowmeter, please reference to picture 5.6. If users input incorrect password 3 times consistently, the display will come back to normal display

```
┌─────────────────────┐
│                     │
│        SPI          │
│                     │
│       0000          │
│                     │
└─────────────────────┘
```

Picture 5.6 Password input

If a password has been set to a DMS450 thermal mass flowmeter, users can enter code setting C47=01 to set a new password.

6 Instruction of RS485 Modbus Communication

6.1 Interface regulation

The communication interface should be RS485, the range of Baud rate should be 1200~115200.

The wiring terminal is "A" and "B".

The communication should comply with MODBUS-RTU statute.

The combination of a communication signal: Address code - function code – date segment – CRC calibration code. The distance between two characters should not be longer than one character, or it will be considered as the beginning of a new message or the end of a old message. The message is combined with hexadecimal arrays.

Defination of the dates: Please reference to the chart 6.1 below.

Chart 6.1 Address of the displayed date

Register address	Usage	Nature	Date type
0~1	Flow rate	Read only	Float
2~3	Frequency	Read only	Float
4~5	Pressure	Read only	Float
6~7	Total Flow	Read only	Float

The displayable dates including flow rate, pressure, temperature and total flow, if the meter is not multi-variable version, then the reading of pressure and temperature will both be 0. The date of the parameters in above chart can be read by using function code 03 according to the address above and shifting.

The addresses of code setting are as below.

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Chart 6.2 Address of code setting

Register	Usage	Range	Nature	Date type
1000	Pre-heating time (warm up) C01	1~99	Read only	Short
1001	Density compensation C02	0~2	Read/Write	Short
1002	Method of pulse output	0~2	Read/Write	Short
1004	Output C05	0~2	Read/Write	Short
1005	Pulse output parameter	0~3	Read/Write	Short
1006	Damping C07	1~16	Read/Write	Short
1007	Instrument number C08	Hart(0~15) MB(1~99)	Read	Short
1008	Baud rate C09	1~24	Read	Short
1009	Unit of time C10	0~2	Read/Write	Short
1010	Mass unit C11	0~2	Read/Write	Short
1011	Volume unit C12	0~6	Read/Write	Short
1012	Pressure unit C13	0~11	Read/Write	Short
1013	Temperature unit C14	0~2	Read/Write	Short
1014	Right digits number for total flow C15	0~5	Read/Write	Short
1030	Time of circle display C31	0~30	Read/Write	Short
1031	First paratmeter displayed in circle display C32	1~5	Read/Write	Short
1032	Second paratmeter displayed in circle display C33	0~5	Read/Write	Short
1033	Third paratmeter displayed in circle display C34	0~5	Read/Write	Short
1034	Fourth paratmeter displayed in circle display C35	0~5	Read/Write	Short

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1035	fifth paratmeter displayed in circle display C36	0~5	Read/Write	Short
1039	Sequence of float C40	1~4	Read/Write	Short
1040	Shape of pipeline C41	0~1	Read/Write	Short
1042	The array length of moist control C43	5~50	Read/Write	Short
1048	Status C49	0~10	Read/Write	Short
1049	Total flow reset to 0 C50	0~1	Read/Write	Short

Users can use function code 04 and 06 to access to the address for code setting above.

Digital setting address is as below.

Chart 6.3 Address of digital setting

Register	Usage	Restriction of modification	Nature	Date type
2000~2001	D001 Max flow	-1e5~1e6	Read/Write	Float
2002~2003	D002 Min flow	-1e5~1e6	Read/Write	Float
2004~2005	D003 Max frequency output	0~1e6	Read/Write	Float
2006~2007	D004 Min frequency output	-1e5~1e6	Read/Write	Float
2008~2009	D005 Small signal cut off	0~1e6	Read/Write	Float
2014~2015	D008 K factor	0~1e6	Read/Write	Float
2016~2017	D009 Density setting	0~1e6	Read/Write	Float
2018~2019	D010 Pipe inner diameter	0~1e6	Read/Write	Float
2020~2021	D011 Max temperature	-1e5~1e6	Read/Write	Float
2022~2023	D012 Min temperature	-1e5~1e6	Read/Write	Float
2024~2025	D013 Max pressure	-1e5~1e6	Read/Write	Float
2026~2027	D014 Min pressure	-1e5~1e6	Read/Write	Float

2028~2029	D015 Ambient pressure	0~1e6	Read/Write	Float
2030~2031	D016 Temperature for standard condition	-1e5~1e6	Read/Write	Float
2032~2033	D017 Equivalent of pulse output	0~1e6	Read/Write	Float
2034~2035	D018 Length of rectangle pipeline	0~1e6	Read/Write	Float
2036~2037	D019 Width of rectangle pipeline	0~1e6	Read/Write	Float
2058~2059	D030 Temperature for standard condition	0~20	Read/Write	Float
2064~2065	D033 Reference flow rate	0~1e6	Read/Write	Float

The chart above indicates the register address, usage of the register, restriction of modification, read/write nature and date type.   The register above are all holding register, the supporting function code is 03,04,06,16 function code.

6.2 Commends

Function code 03 and 04 are the codes supported for reading the registers. Function code 06 is for writing one register. Function code 16 is for wrting multi registers. Function code 06 is only supported for writing short date. Function code 16 is supported for writing both short date and float date.

Function code 03 – Read register

Request	Response
01 : Address	01: Address
03 : Function code	03 : Function code
00 : Register address higher	04 : Quantity of bit
00 : Register address lower (display the address)	80 : Date 1
00 : Register number higher	04 : Date 2
02 : Register number lower	80 : Date 3
CRCL : CRC Parity code lower	80 : Date 4
CRCH ：CRC parity code higher	CRCL : CRC Parity code lower
	CRCH ：CRC parity code higher

Note: To read a float date, the quantity of the register addresses and their values have to be even,

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or reponse will be error.

Function code 04 – Same as function code 03

Function code 06 – write one register

Request	Response
01 : Address	01: Address
06 : Function code	06 : Function code
00 : Register address higher	00 : Register address higher
01 : Register address lower (code setting address)	01 : Register address lower
00 : Value higher	00 : Value higher
04 : Value lower	04 : Value lower
CRCH ： CRC parity code higher	CRCH ： CRC parity code higher
CRCL : CRC Parity code lower	CRCL : CRC Parity code lower

Note: Function code is only supported for writing short dater.

Function code 16- write multi registers.

Request	Response
01 : Address	01: Address
10H : Function code	10H : Function code
00 : Register address higher	00 : Register address higher
01 : Register address lower (digital setting address)	01 : Register address lower
00 : Quantity of register higher	00 : Quantity of register higher
02 : Quantity of register lower	02 : Quantity of register lower
04 : Quantity of values	CRCH ： CRC parity code higher
86h : Value 1	CRCL : CRC Parity code lower
00 : Value 2	
00 : Value 3	
48H: Value 4	
CRCH ： CRC parity code higher	
CRCL : CRC Parity code lower	

Note: Function code 16 is supported to write float date. But for float date, the first register address and the quantity of the registers must be even, or writing is not allowed.

6.3 Calculation of CRC parity code.

Request	Response
01 : Address	N1 CRC=0FFFFH is initial value

10 : Function code	N2 XOR operation the CRCL and N1
00 : Register address higher	N3 CRC move 1 bit right , if move out is 1 bit
01 : Register address lower	N4 CRC=CRC XOR A001H
00 : Register quantity higher	N5 if move out is 0 , CRC=CRC
04 : Register quantity lower	N6 Move right for 8 times to finish the N1 calculation
04 : Date quantity	N7 …
80 : Date 1	N8 XOR operation the CRCL and N11
04 : Date 2	N9 CRC move 1 bit right , if move out is 1 bit
80 : Date 3	N10 CRC=CRC XOR A001H
80 : Date 4	N11 if move out is 0 , CRC=CRC
CRCL : CRC Parity code lower	Move right for 8 times to finish the N11 calculation
CRCH ：CRC Parity code higher	Get the CRC calibration value

6.4 The float date format of the instrument

The storage sequence of 4 bits float formate is as below:

Address: 0   1   2   3
Content: MMMMMMMM   MMMMMMMM   EMMMMMMM   SEEEEEEE

Use IEEE standard method, do not store 1 on top digit, if top digit is 1, means negative; if top digit is 0, means positive. So the 23 mantissas and a 1 on top digit, which is concealed, constitute a 24 bits fixed point true form decimal, which is a decimal have mantissas less than 1 and more than or equal to 0.5. The lowest 8 bits are exponent-marker using shift code method. The exponent marker equals to the actual value minus 127. For example: 7=86H-7FH, -10=75H-7FH

e.g.:   100=0x00,0x00,0x42,0xc8

-100=0x00,0x00, 0xc2,0xc8

0=0x00.0x00.0x00.0x00 (exponent-marker is 0, the number is 0)

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6.5 The sequence of the float date bytes of instrument

Code setting C40 is used for setting the sequence of the float date bytes of instrument.

  1: LL_LH_HL_HH the lower 16 bytes registers come first, the lower 8 bytes within the 16 bytes registers come first.
  eg: 100=0x00,0x00, 0xc8, 0x42
   -100=0x00, 0x00, 0xc8, 0xc2
  2: HH_HL_LH_LL the higher 16 bytes registers come first, the higher 8 bytes within the 16 bytes registers come first.
  eg: 100=0x42,0xc8,0x00,0x00
   -100=0xc2,0xc8 ,0x00,0x00
  3: LH_LL_HH_HL the lower 16 bytes registers come first, the higher 8 bytes within the 16 bytes registers come first.
  eg: 100=0x00,0x00,0x42,0xc8
   -100=0x00,0x00,0xc2,0xc8
  4: HL_HH_LL_LH the higher 16 bytes registers come first, the lower 8 bytes within the 16 bytes registers come first.
  eg: 100=0xc8,0x42,0x00,0x00
   -100=0xc8,0xc2,0x00,0x00

6.6 Modbus error reponse

When the host sends a command and asks for a correct reponse, one of below four is going to happen:

1) If the command from the host is correct and processable, the flow meter will give a correct reponse.

2) If the flowmeter failed to receive the command due to a communication failure, the flowmeter will not response. . The host will process an overtime commend.

3) If the flowmeter received a command, but detected parity, the error of LRC and CRC will cause no reponse. The host will process an overtime commend.

4) If the flowmeter recived a correct command, but can not process it (read or write a none-existing register etc.), the flowmeter will send a error reponse

A error reponse has two byte sections to show its difference from a correct reponse.

Function code section: In a correct reponse, the flowmeter will copy the origin function code sent from the host, and the highest bytes of them are all 0(all function codes are smaller than 0x80). In a error reponse, the flowmeter will set the highest bytes to 1. The host can detect the error code and know the content of the error when it detect that the highest bytes of function codes are 1.

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Value section: In a error reponse, the flowmeter will reply a byte as the error code to definite the content of the error. Pleaes reference to the chart below for the error codes and its definition:

Code	Name	Meaning
01	Illegal function code	Flowmeter can not process the function code in a command. Maybe this function code can only be used on a new device, or it can also indicate that the flowmeter is under error statues.
02	Illegal address	The flowmeter can not process with the address in the command. The initiate address plus address diversion are higher than the highest address.
03	Illegal contents of value	The content of the value in the command is not acceptable for the flowmeter.
04	Flow meter function failed	An unrecoverable failure happened when the flowmeter is trying to reponse.
05	Reponse	The flow meter will take a long while to process the command. So reponse this error code to prevent the host from processing a overtime command.
06	Flowmeter is busy	To advise the host that the flowmeter is processing a command which will takes a long time. So the host should resend the command when the flowmeter is free.

6.7 Examples of communication

The flowmeter's instrument Modbus address is 01, baud rate=4800 (C08=01, C09=05, C40=02).

Example 1: Read flow rate F,F=916.49 (4 bytes float)
   Host command：   01 03 00 00 00 02 C4 0B
   Flowmeter reponse：   01 03 04 **44 65 1F CE** 77 78

Example 2: Read total flow
   Host command：   01 03 00 06 00 02 24 0A
   Flowmeter reponse： 01 03 04 **44 9D 1E 3F** 36 9D

Example 3: Read all the value displayed on the flowmeter, including flow rate, temperature, pressure, total flow ….. all together 4 value (16 bytes)
   Host command：   01 03 00 00 00 08 44 0C
   Flowmeter reponse：01 03 10
                 44 65 1F CE（flow rate＝916.49）
                  00 00 00 00（temperature＝0）
                 00 00 00 00（pressure＝0）
                 44 9D 1E 3F（total flow in float＝1256.94）
                 B7   (CRCL)

7 Introduction of HART communication protocol

7.1 HART commands

7.1.1 Command 0:Read transmitter unique identifier

Command formate

Return to the expension device type code, version number and identification number

Request: None

Response:

Byte 0:	254
Byte 1:	Manufacture's ID
Byte 2:	Manufacture's device type
Byte 3:	Number of request preambles
Byte 4:	Revision level of universal command
Byte 5:	Revision level of transmitter document
Byte 6:	Software revision level
Byte 7:	Hardware revision level
Byte 8:	Flags, none defined at this time
Byte 9-11:	Device Indentification Number

Test of command

Send 0 command:FF FF FF FF FF 02 80 00 00 82; to request information of the instrument

Receive 0 command:FF FF FF FF FF 06 80 00 0E 00 00 FE 1A 1A 05 05 00 00 00 00 AD 18 8C 4F

7.1.2 Command 1: Read primary variable value (PV)

Command formate:

Return to primary variable value in float.

Request:None

Response:

Byte 0:	Primary variable unit code
Byte 1-4:	Primary variable

Remark: Set primary command to flow rate.

Test of command:

Send command 1: FF FF FF FF FF 82 9A 1A AD 18 8C 01 00 3A   ;to read the IEEE754 float value of primary variable.

Receive command 1:FF FF FF FF FF 86 9A 1A AD 18 8C 01 07 00 00 13 00 00 00 00 2A

7.1.3 Command 2:Read primary variable's current and percentage value

Command formate:

Read the current and percent of the primary variable, the current of primary variable always match the AO current output of the instrument. Percent is not restricted within 0~100%, if it is beyond the limit of primary variable, it will find the limit of the transmitter.

Request: None
Reponse:

Byte 0-3:	Analog output current mA,
Byte 4-7:	Percent of range

Test of command:

Send command 2: FF FF FF FF FF 82 9A 1A AD 18 8C 02 00 39; to read the current and primary variable percent of range.

Receive command 2: FF FF FF FF FF 86 9A 1A AD 18 8C 02 0A 00 00 40 80 00 00 00 00 00 00 F7

7.1.4 Command 3: Read primary variable current and dynamic variables

Command formate:

Read the current of primary variable and 4 preset dynamic variables at maximum. The current of primary variable always match the AO output current of the instrument. Every type of device has a definition on a relative dynamic variable, for example the secondary variable is temperature sensor.

Request: None

Response:

Byte 0-3:	Analog output current mA, IEEE 754
Byte 4:	Primary variable unit code
Byte 5-8:	Primary variable, IEEE 754
Byte 9:	Secondary variable unit code
Byte 10-13:	Secondary variable, IEEE 754
Byte 14:	Tertiary variable unit code
Byte 15-18:	Tertiary variable, IEEE 754
Byte 19:	Quaternary variable unit code
Byte 20-23:	Quaternary variable, IEEE 754

Remark: Primary variable is flow rate. The unit code is 75:kg/hour, 19:m3/hour;

Secondary variable is total flow. The unit code is 61:kg, 43:m3;

Tertiary variable is temperature. The unit is 32: ℃;

Quaternary variable is pressure. The unit is 12: Mpa;

Test of command:

Send command 3: FF FF FF FF FF 82 9A 1A AD 18 8C 03 00 38; to read dynamic variables

Receive command 3: FF FF FF FF FF 86 9A 1A AD 18 8C 03 1A 00 00 40 80 00 00 13 00 00 00 00 2B 48 33 5A 4B 26 00 00 00 00 20 00 00 00 00 B2

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7.1.5 Command 6: Write polling address

Command formate:

It is a date link manangment command. This command writes a polling address to the device. This address is used to control the AO of primary variable and providing of device ID.

Only when the polling address of the instrument is 0, that the AO output of primary variable is available. If the address is 1~15, AO will be not activated and will not reponse, AO will be minimum value; transmission status will be the 3rd statue------primary variable AO fixed; max and min alarm not implemented. If polling address is write back to 0, AO will be activated again and will reponse.

    Request:
        Byte 0:   Device polling address
    Response:
        Byte 0:   Device polling address

Test of command:

Send command 6: FF FF FF FF FF 82 9A 1A AD 18 8C 06 01 00 3C: to write POLLING ADDRESS

Receive command 6: FF FF FF FF FF 86 9A 1A AD 18 8C 06 03 00 00 00 3A

7.1.6 Command 11: Read unique identifier associated with tag

Command formate:

It is a date link manangment command. This command will return the device type, revision level and divice indentification number of the device which matches to the tag. Process the command upon receipt of the expension address or broadcast address. The expension addresses in command and reponse are the same.

    Request:
        Byte 0-5:   Tag,Packed ASCI
    Response:
        Byte 0:   Device type code for expansion
        Byte 1:   Manufacture Indentification code
        Byte 2:   Manufacture device type
        Byte 3:   Number of request preambles
        Byte 4:   Revision level of universal command
        Byte 5:   Revision level of transmitter document
        Byte 6:   Software revision level
        Byte 7:   Hardware revision level
        Byte 8:   Flags, none defined at this time.
        Byte 9-11:   Device identification number

Test of command:

Send command 11: FF FF FF FF FF 82 9A 1A AD 18 8C 0B 00 30; Read relevant info of the device such as unique identifier associated with tag

Receive command 11: FF FF FF FF FF 86 9A 1A AD 18 8C 0B 0E 00 00 FE 1A 1A 05 05 00 00 00

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00 AD 18 8C FD

7.1.7 Command 12:Read message

Command formate:

To read message

Request: None

Response:

Byte 0-23:   Message

Test of command:

Send command 12:FF FF FF FF FF 82 9A 1A AD 18 8C 0C 00 37 ; read message

Receive command 12:FF FF FF FF FF 86 9A 1A AD 18 8C 0C 1A 00 00 59 00 74 D6 05 8F 49 41 58 80 42 47 25 40 4C 81 04 8F 0C 54 D3 3D 28 20 10

7.1.8 Command 13: Read tag, descriptor, date

Command formate:

Read device tag,description and date.

Request: None

Response:

Byte 0-5:   Tag,ASCII

Byte 6-17:   Descriptor,ASCII

Byte 18-20: Date: day,month,year

Test of command:

Send command 13:FF FF FF FF FF 82 9A 1A AD 18 8C 0D 00 36 ;read device tag, descriptor and date

Receive command 13:FF FF FF FF FF 86 9A 1A AD 18 8C 0D 17 00 00 50 11 E0 82 08 20 58 F4 94 15 88 06 30 F5 CD 15 41 52 0F 01 6F E2

7.1.9 Command 14: Read primary variable sensor information: device serial number and limits

Command formate:

Read device information

Request: None

Response:

Byte 0-2:   Sensor serial number MSB, 24-BIT unsigned integer

Byte 3:   Flow rate unit

Byte 4-7:   Upper sensor limit of flow rate

Byte 8-11:   Lower sensor limit of flow rate

Byte 12-15: Minimum span of flow rate

Test of command:

Send command 14: FF FF FF FF FF 82 9A 1A AD 18 8C 0E 00 35; to read primary sensor serial

number and limits.

Receive command 14: FF FF FF FF FF 86 9A 1A AD 18 8C 0E 12 00 00 00 00 00 13 43 96 00 00 00 00 00 00 38 D1 B7 17 AC

7.1.10 Command 15: Read primary variable output information

Command formate:

Read Primary variable alarm select code, primary variable transfer code,primary variable range values units code, primary variable upper and lower range value, primary variable damping value, write protect code and private label distributor code VIII

Request: None
Response:
　　　Byte0:　　　　Alarm select code
　　　Byte1:　　　　Primary variable transfer function code
　　　Byte2:　　　　Primary variable range values unit code
　　　Byte3-6:　　　Primary variable upper range value, IEEE754
　　　Byte7-10:　　　Primary variable lower range value, IEEE754
　　　Byte11-14:　　Primary variable damping value, IEEE754,units of seconds
　　　Byte15:　　　　Write protect code
　　　Byte16:　　　　Private Label Distributor Code

Test of command:

Send command 15:FF FF FF FF FF 82 9A 1A AD 18 8C 0F 00 34; Read primary variable output information

Receive command 15:FF FF FF FF FF 86 9A 1A AD 18 8C 0F 13 00 00 00 00 13 43 96 00 00 00 00 00 00 42 20 00 00 FB 12 6E

7.1.11 Command 16: Read final assembly number

Command formate:

Read final assembly number.
Request: None
Response:
　　　　Byte 0-2:   Final assembly number

Test of command:

Send command 16:FF FF FF FF FF 82 9A 1A AD 18 8C 10 00 2B; Read final assembly number
Receive command 16: FF FF FF FF FF 86 9A 1A AD 18 8C 10 05 00 00 A8 36 81 35

7.1.12 Command 17: Write message

Command formate:

Write message
Request:
> Byte 0-23: Message

Responee:
> Byte 0-23: Message

Test of command:
> Send command 17:FF FF FF FF FF 82 9A 1A AD 18 8C 11 18 00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F 10 11 12 13 14 15 16 17 32 ;message
> Receive command 17:FF FF FF FF FF 86 9A 1A AD 18 8C 11 1A 00 00 00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F 10 11 12 13 14 15 16 17 34

7.1.13 Command 18: Write tag, descriptor, date

Command formate:
> Write tag, descriptor, date.
> Request:
>> Byte 0-5:   Tag,ASCII
>> Byte 6-17:   Descriptor,ASCII
>> Byte 18-20: Date: day, month, year
> Response:
>> Byte 0-5:   Tag,ASCII
>> Byte 6-17:   Descriptor,ASCII
>> Byte 18-20: Date: day, month, year

Test of command:
> Send command 18: FF FF FF FF FF 82 9A 1A AD 18 8C 12 15 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 3C
> Receive command 18:FF FF FF FF FF FF 86 9A 1A AD 18 8C 12 17 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 3A

7.1.14 Command 19: Write final assembly number

Command formate:
> Write final assembly number
> Request:
>> Byte 0-2:   Final assembly number
> Response:
>> Byte 0-2:   Final assembly number

Test of command:
> Send command 19: FF FF FF FF FF 82 9A 1A AD 18 8C 13 03 01 02 03 2B ;
> Receive command 19: FF FF FF FF FF 86 9A 1A AD 18 8C 13 05 00 00 01 02 03 29

7.1.15 Command 34: Write primary variable damping value

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Command formate:

Write primary variable damping value. If the value is not acceptable, will revert with alarm

Request:

Byte 0-3:   Damping value, IEEE754

Response:

Byte 0-3:   Actual damping value, IEEE754

Test of command:

Send command 34: FF FF FF FF FF 82 9A 1A AD 18 8C 22 04 40 00 00 00 5D; Write primary variable damping value

Receive command 34: FF FF FF FF FF 86 9A 1A AD 18 8C 22 06 00 00 40 00 00 00 5B

7.1.16 Command 35: Write primary variable range values

Command formate:

The upper and lower limits of primary variable are independent. The primary variable range unit value that this command received has no effect on the primary variable unit value. The primary value range value will be returned in the unit received.

Most device allows that the measurement range upper limit lower than lower limit ,to support the device to reverse output.

Request:

Byte 0:   Primary variable upper and lower range value unit code

Byte 1-4:   Primary variable upper range limit, IEEE 754

Byte 5-8:   Primary variable lower range limit, IEEE 754

Response:

Byte 0:   Primary variable upper and lower range value unit code

Byte 1-4:   Primary variable upper range limit, IEEE 754

Byte 5-8:   Primary variable lower range limit, IEEE 754

Test of command:

Send command 35: FF FF FF FF FF 82 9A 1A AD 18 8C 23 09 13 40 00 00 00 40 00 00 00 02; Write primary variable range values

Receive command 35: FF FF FF FF FF 86 9A 1A AD 18 8C 23 0B 00 00 13 00 00 00 00 00 00 00 00 04

7.1.17 Command 36: Write primary variable upper limit value

Command formate:

Write the primary variable upper limit to current primary variable value. The change of primary variable upper limit value has no effect on the primary variable lower limit.

Request:

NONE

Response:

NONE

Test of command:

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Send command 36: FF FF FF FF FF 82 9A 1A AD 18 8C 24 00 1F; Write the primary variable upper limit to current primary variable value.

Receive command 36: FF FF FF FF FF 86 9A 1A AD 18 8C 24 02 00 00 19

7.1.18 Command 37: Write primary variable lower limit value

Command formate:

Write the primary variable lower limit to current primary variable value. The change of primary variable lower limit value has no effect on the primary variable higher limit.

Request:
NONE
Response:
NONE

Test of command:

Send command 37: FF FF FF FF FF 82 9A 1A AD 18 8C 25 00 1E; Write the primary variable lower limit to current primary variable value.

Receive command 37: FF FF FF FF FF 86 9A 1A AD 18 8C 25 02 00 00 18

7.1.19 Command 40: Enter/Exit primary variable current mode

Command formate:

Device is set to fixed primary variable current, when primary variable is 0, means to exit primary variable current mode.

Request:
Byte 0-3:   Fixed primary variable current level IEEE 754, mA
Response:
Byte 0-3:   Actual fixed primary variable current level IEEE 754, mA

Test of command:

Send command 40: FF FF FF FF FF 82 9A 1A AD 18 8C 28 04 40 80 00 00 D7

Receive command 40: FF FF FF FF FF 86 9A 1A AD 18 8C 28 06 00 00 40 80 00 00 D1

7.1.20 Command 45: Trim primary variable current DAC zero

Command formate:

Trim the primary variable current AO zero, so the current current value is accurate set to its min value.

Before implementing this command, use command 40 to set current to accurate primary variable

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AO min value. If device is not under fixed primary variable current mode or current has not been set to accurate min value, need to return response code 9---not under correct current mode.

Request:

Byte 0-3: Externally measured primary variable current level IEEE754, units of mA

Response:

Byte 0-3: Actual measured primary variable current level IEE 754

Test of command:

Send command 45: FF FF FF FF FF 82 9A 1A AD 18 8C 2　D 04 40 80 00 00 D2

Receive command 45: FF FF FF FF FF 86 9A 1A AD 18 8C 2D 06 09 00 40 80 00 00 DD : response code is 09, device is not under correct current mode.

7.1.21 Command 46: Trim primary variable current DAC gain

Command formate:

Trim primary variable AO gain,so the current current value is accurate set to its max value.

Before implementing this command, use command 40 to set current to accurate primary variable AO max value. If device is not under fixed primary variable current mode or current has not been set to accurate max value, need to return response code 9---not under correct current mode.

Request:

Byte 0-3: Externally measured primary variable current level IEEE754, units of mA

Response:

Byte 0-3: Actual measured primary variable current level IEE 754

Test of command:

Send command 46: FF FF FF FF FF 82 9A 1A AD 18 8C 2　E 04 40 80 00 00 D1

Receive command 46: FF FF FF FF FF 86 9A 1A AD 18 8C 2E 06 09 00 40 80 00 00 DE : response code is 09, device is not under correct current mode.

8 Maintaining

8.1 How to change the transmitter's direction

1) The transmitter can be reversed to any direction.

2) Before reverse the transmitter, please loose the nut (Part No.1) under the transmitter.

3) Reverse the transmitter to the direction required, then screw and tighten the fixing nut.

Please reference to picture 8.1
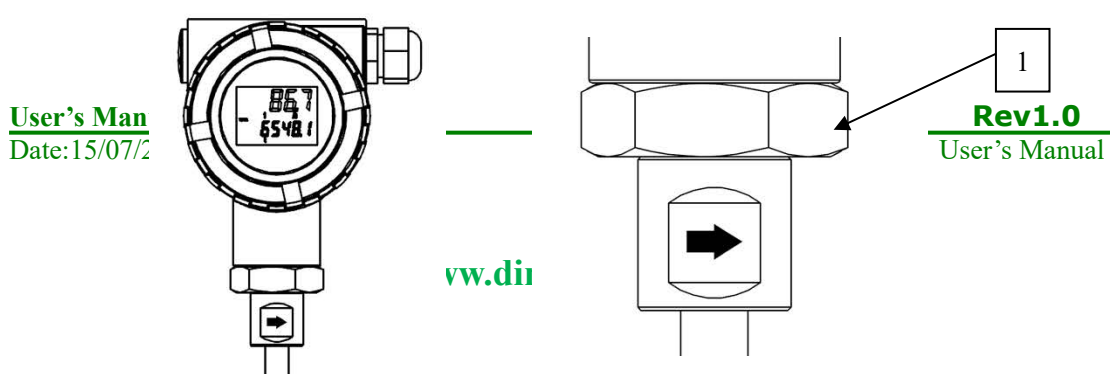
Picture 8.1 Change the transmitter's direction

8.2 Replace a transmitter circuit boards

1) Please make sure the power is off before replacing the transmitter.
2) Remove the front cover.
3) Loose the 4 screws on the circuit boards, than can take the boards out a little.
4) Remove all the plugs on the circuit board.then remove the circuit board away
5) Put the new circuit board in and put the plug on
6) Tighten the 4 screws on the board, tighten the front cover
Please reference to picture 8.2

Long screws
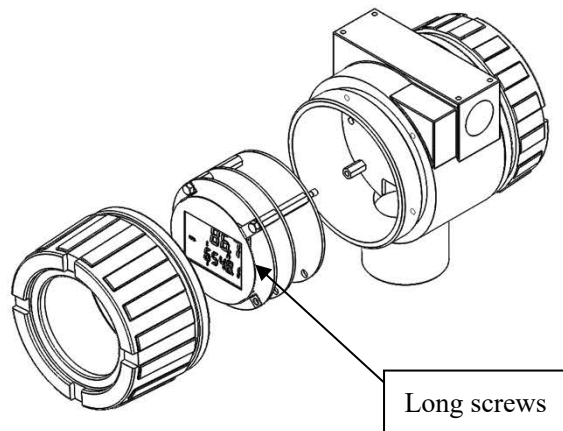
Picture 8.2 Replace the transmitter

8.3 Remove the flow meter

1) Please make if the meter is under pressure from pipeline, if it is, please hold it before loosing the nut sleeve to prevent it from ejecting out
2) Loose the nut (Part No.1) with a wrench (loose it for 2 or 3 circle will be enough)
3) Pull out the meter as you can, relock the nut (Part No.1), please note the sleeve is still connected to the ball valve so far
4) Close the ball valve (Part No.3) to hold the pressure inside the pipeline
5) Loose the sleeve (Part No.2) and take out the flow meter
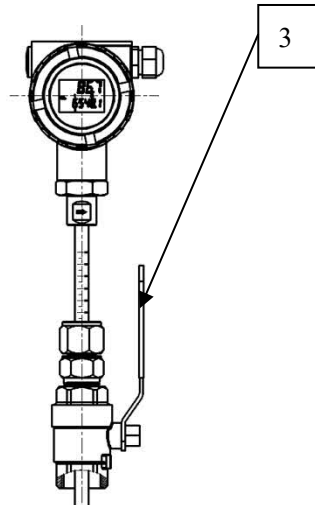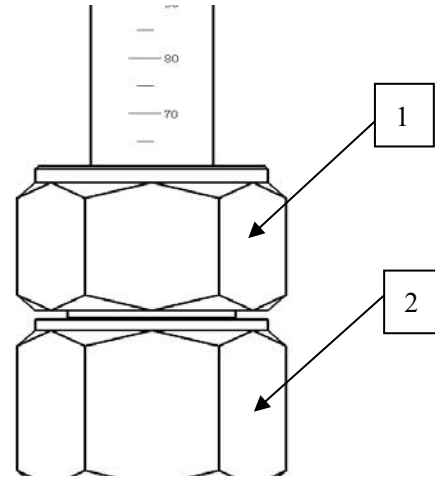
<div align="center">Picture 8.3   Picture 8.4</div>

8.4 How to clean the sensors

The sensor itself can be dirt caused by the oil, dust, impurity and dirt in the fluid, which may cause effect on the measurement result. When it is necessary to clean the sensor, please remove the meter according to 8.3. Then dip the sensor into alcohol or acetone (according to the contents of the dirty) for 10~30 minutes, then wipe the sensors with clean cloth or paper. Please make sure the sensor is well protected during the whole process, do not hit or scratch it.
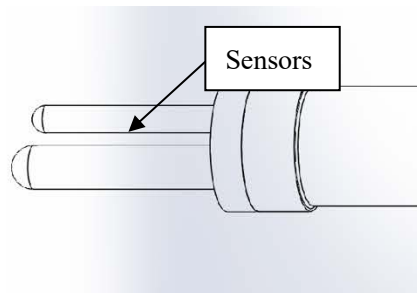
<div align="center">Picture 8.5</div>

9 Troubleshooting and repair

9.1 Safty introduction

Please do not open the cover on the flame proof enclosure if in an explosive environment.

When trying to wire to HART or RS485 device, please make sure that the process of wiring the device into the loop complys with the intrinsic safty requirement. Or please process the wiring in a none-explosive environment.

Please make sure the environment the flowmeter in can meet the requirement of the certificate.

When power is wired, please make sure the front and rear cover is closed properly.

9.2 Troubleshooting and repair

Please check out below issues before the troubleshooting
1) Please make sure the power source and its wiring is correct
2) Please process all wiring according to Chapter 3
3) Please make sure the straight pipeline length apply to the requirement in Chapter 2
4) Please make sure the meter's flow direction mark is point at the direction where the flow goes

After checking out above issues, please process trouble shooting according to following description.

Problem	Possible Cause	Solution
Velocity measurement is erractic or fluctuating	Very erractic or non-uniform flwo	Follow installation requirements shown in Chapter 2
	Flow meter installed with less than required minimum pip diameters upstream and dlown stream of the sensor	Follow installation requirements shown in Chapter 2
	Insertiong sensor probe not mounted securely	Sensor probe must be mounted securely without vibration
	Earthing circuit loop	Wire the meter according to the introduction in Chapter 3
	Liquid contains in fluid	Install a water filter in upstream of the meter
	Sensor failure	Return to factory for evaluation
	Transmitter failure	Return to factory for evaluation
The measuring flow is too high or too low	Sensor is not inserted to the middle of the pipe line	Please fix the sensor in the middle of the pipeline

	The flowmeter is not vertical to the center line of the pipe line	Re-install the meter and make the probe vertical to the center line of the pipe line
No flow measured	The limit of small signal cut off is set too high	Set the small signal cut off limit to a lower and proper value
	The flow rate in pipeline is smaller than the lower limit of the meter	Contact the supplier
	The flow rate in pipeline is larger than the higher limit of the meter	Contact the supplier
	Flow profile distortion	Try to find another location for the meter
	Sensor failure	Return to factory for evaluation
	Transmitter failure	Return to factory for evaluation
	Extremely turbulent flow	Do not place the emter near a ventilator static mixer or valve

9.3 Self-diagnose function

DMS450 thermal mass flowmeter display can also indicate the self-diagnose code as below：

Error code	Problem	Repair
Err-003	Temperature sensor disconnected	Check Temperature sensor
Err-004	Pressure sensor disconnected	Check pressure sensor
Err-005	About to over total flow	This is a reminding message
Err-006	Display value over limit	The value is over the physical limit of the display
Err-013	Button is pressed and hold for too long time	Check the button circuit

Err-014	Reset code setting failed	Check EEPROM
Err-015	Reset digital setting failed	Check EEPROM
Err-016	Read total flow error	Check EEPROM
Err-017	Temperature calibration setting is wrong	Check the record of temperature calibration
Err-018	Pressure calibration setting is wrong	Check the record of pressure calibration
Err-020	Flow rate limit setting is incorrect	Check the flow rate limit setting
Err-023	Communication connection error	Check the communication link
Err-026	Pulse equivalent is set too high	Reset D017
Err-027	Pulse equivalent is set too low	Reset D017

Appendix

Specification

	Insertion type	In-line type
Media Compatibility	Air, Nitrogen	
Pipe diameter	DN25~900mm	DN15~300mm
Flow velocity range	0.6~60Nm/s or 0.9~90Nm/s or 1.2~120Nm/s or 1.5~150Nm/s	
Accuracy	1.5% RD+ ±0.5% FS	

| Temperature of medium	$-40\sim+150°c$	
Pressure of medium	1.6MPa	4.0Mpa
Power supply	AC85～265V or DC13.5～42V	
Response time	1 second	
Output	Frequency and RS485	
Communication	RS~485 as standard , 4~20mA@HART as optional	
Date displayed	Mass flow, Volume flow in normal condition Total flow , Temperature of medium. Velocity	
Ingress protection grade	IP65 (GB China)	

Remark:

The insertion probe of meter has 2 diameters, which are 11mm with 1/2" NPT and 19mm with 1" NPT.

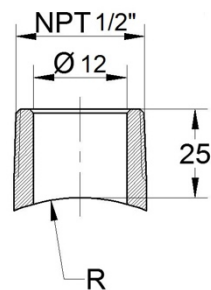When pipe line is over DN400 or flow velocity is higher than 90Nm/s, will use 19mm probe.

Size and dimension

Nut sleeve insertion with ball valve

DN25~DN400 (Please contact us if need to customized probe length)
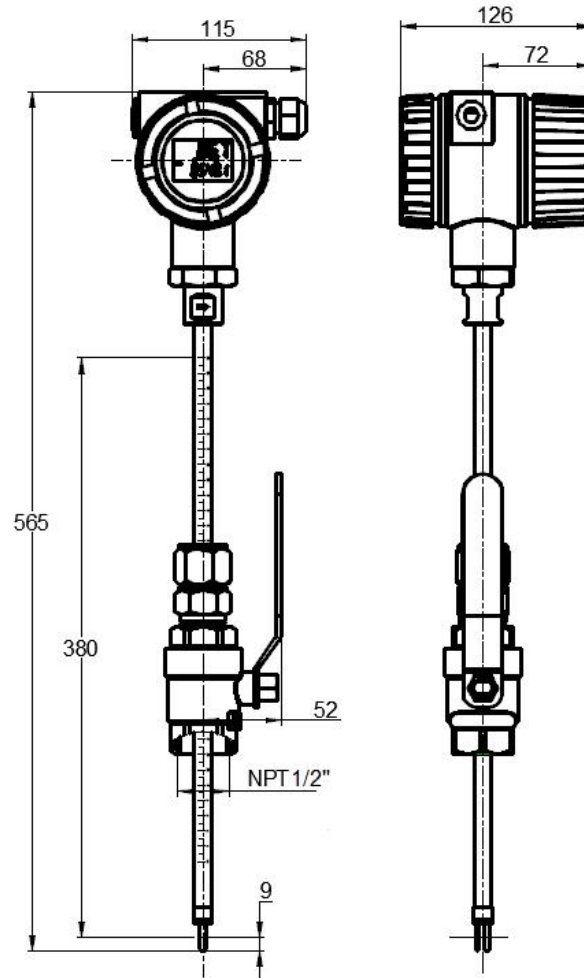
1/2 " NPT socket base for nut sleeve insertion

Remark: R is the outer shape of the pipeline. The material can be same as the pipeling if required so. If customer's chosen model require 1" NPT, than will need 1" socket base

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