



FMT-25W Ultrasonic Flow Meter

User's Guide

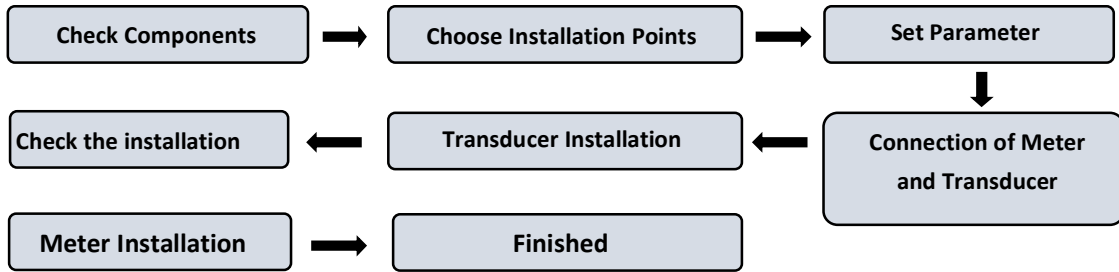
V1.1

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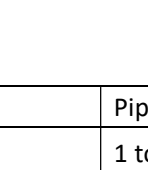
The FMT-25W is a new generation ultrasonic flow meter manufactured using patented technology which employs the transit-time principle to measure the velocity of relatively clean liquids in full pipes.

The purpose of this guide is to provide installation procedures and basic operating instructions for the FMT-25W. General Installation Procedure


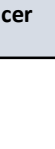




1 Product Models





1.1 FMT-25 Meter Versions

Model No.	FMT-25W-AB	FMT-25W-AE
Picture		
Description	Wall Mount Flow Meter in ABS Enclosure	Wall Mount Flow Meter in Cast Aluminum Enclosure

1.2 Available Flow Transducers

Flow transducer	Picture	Model	Pipe Size*	Temperature
Clamp on		TS-2 (small)	1 to 4 inches	-30 ~ 90°C
		TM-1 (medium)	2 to 28 inches	
		TL-1 (large)	12 to 240 inches	
High temp. Clamp on		TS-2-HT (small)	1 to 4 inches	-30 ~ 160°C
		TM-1-HT (medium)	2 to 28 inches	
		TL-1-HT (large)	12 to 240 inches	

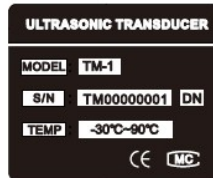
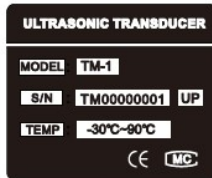
Insertion		TC-1 (standard)	2 to 235 inches	-30 ~ 160°C
		TC-2 (extended)		
		TP-1 (parallel)	3 to 235 inches	
Inline		Standard	0.5 to 40 inches	-30 ~160°C

Temperature transducer	Picture	Model	Pipe Size	Temperature	Cutoff water
Clamp on		CT-1	2 to 235 inches	-40 ~ 160°C	No need
Insertion		TCT-1	2 to 235 inches	-40 ~ 160°C	Need
Insertion under pressure		PCT-1	2 to 235 inches	-40 ~ 160°C	No need
Insertion small sizes		SCT-1	< 2 inches+	-40 ~ 160°C	Need

*Pipe size given in DNx-y notation where DN is Diameter Nominal and x-y is the diameter range in mm(eg. DN25-100 is used with pipe sizes with nominal diameter from 25 to 100 mm)

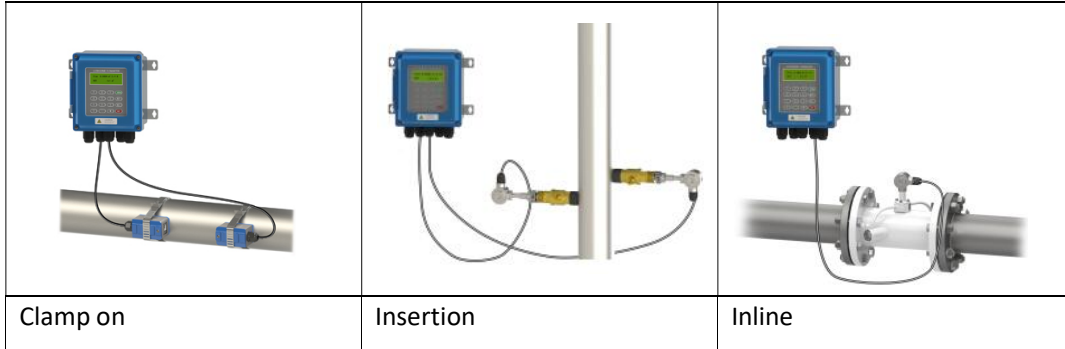
2 Check Components

1. Please check you have all the components in the order.
2. All codes on transducers should be matched as they are used in sets.



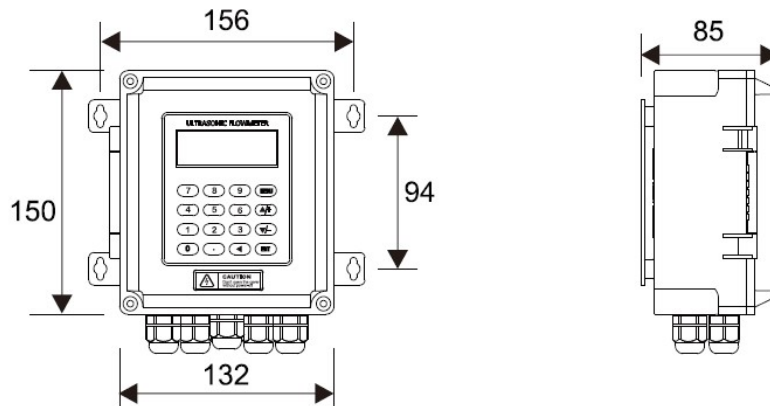
3 Transducer Mounting Diagrams

3.1 Mounting



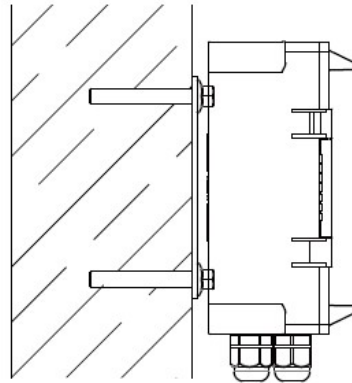
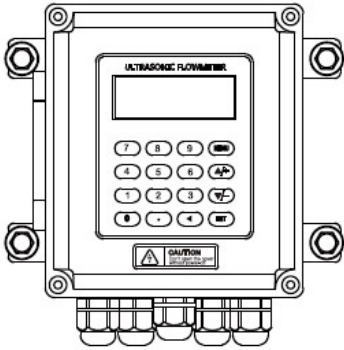
4 Meter Installation and Wiring Diagram

4.1 FMT-25W-AB Installation Instruction

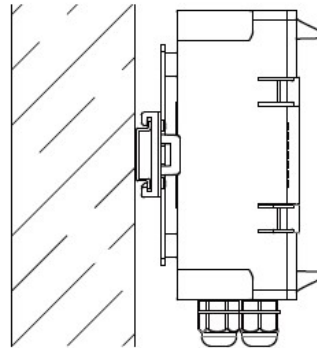
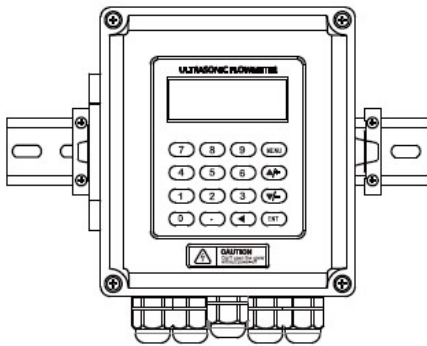


(Dimensions in mm)

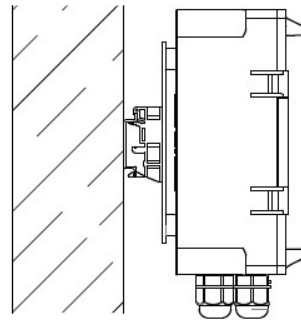
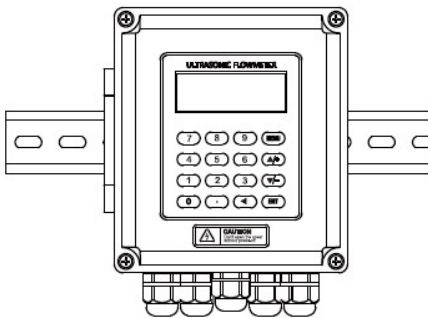
Wall mounting: Fix the converter with 4 Φ 6mm expansion bolts or normal bolts.



DIN-rail mounting by using rail fixing clamps.

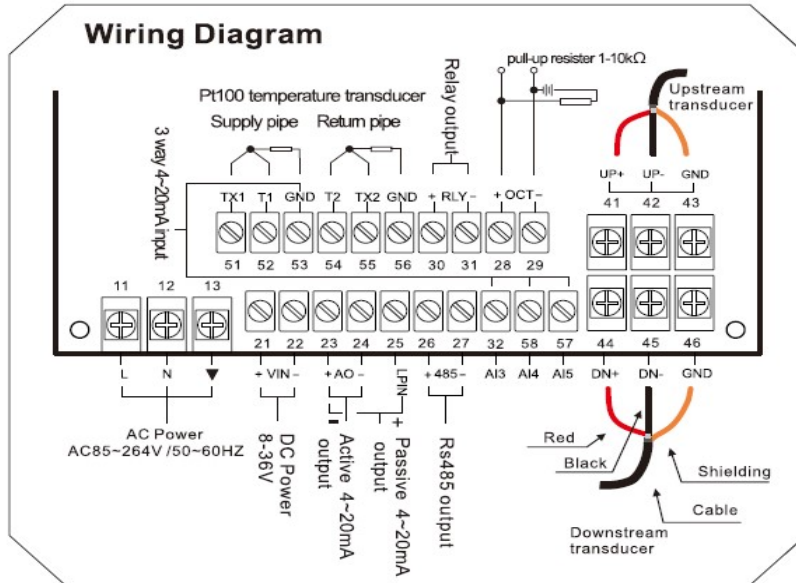


DIN-rail mounting by using PCB bracket

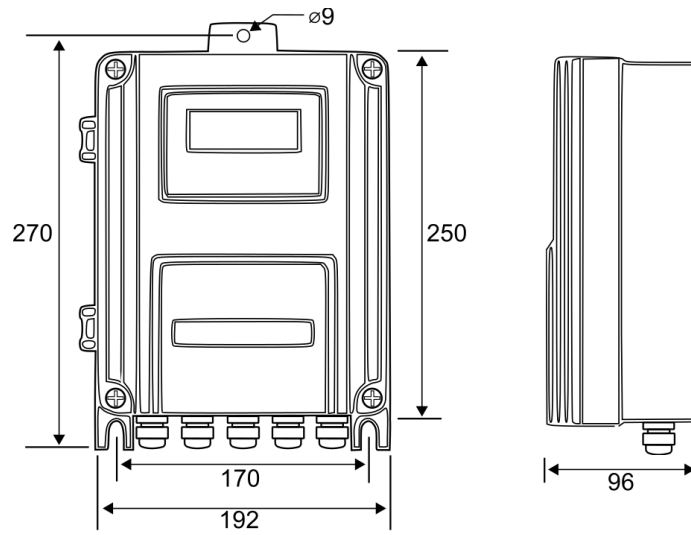


★ FMT-25W-AB type can be installed on a wall, in panel box or explosion-proof enclosure

4.2 FMT-25W-AB Wiring Diagram

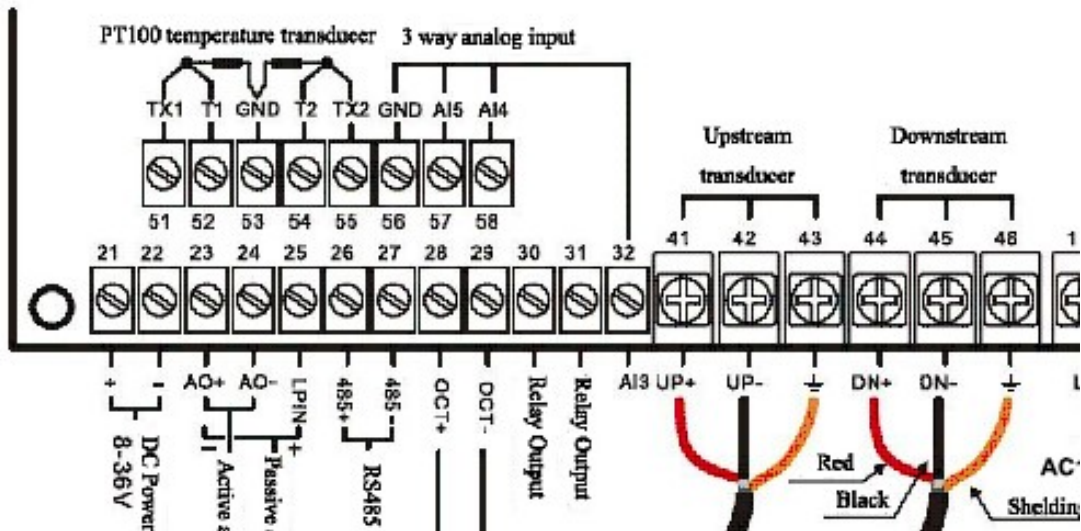


4.3 FMT-25W-AE Mounting



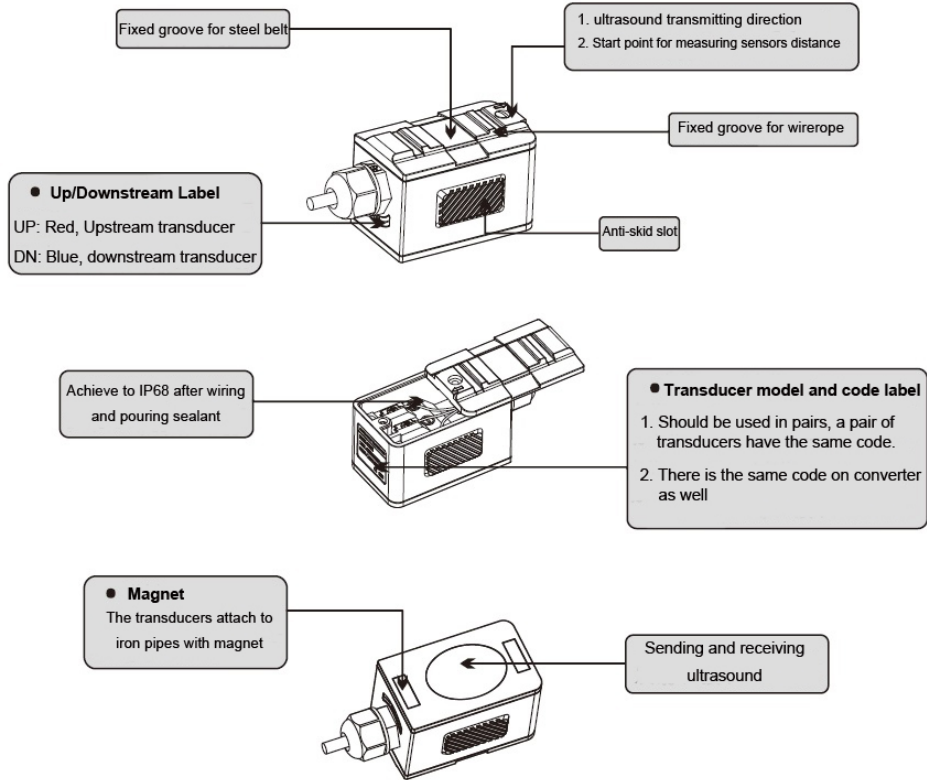
Dimensions in mm

4.4 FMT-25W-AE Wiring Diagram

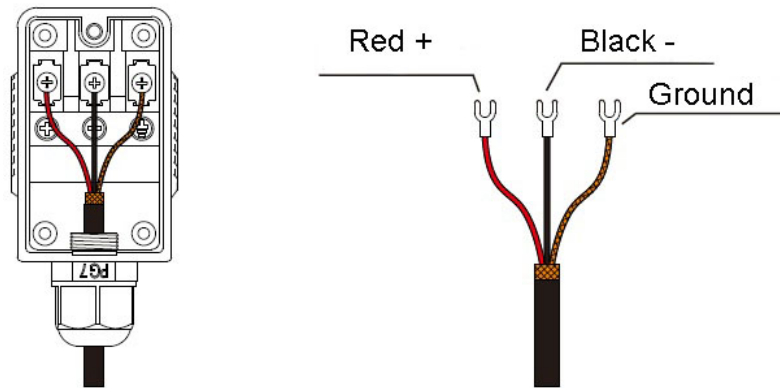


5 Transducer Introduction and Wiring Diagram

5.1 Clamp Transducer

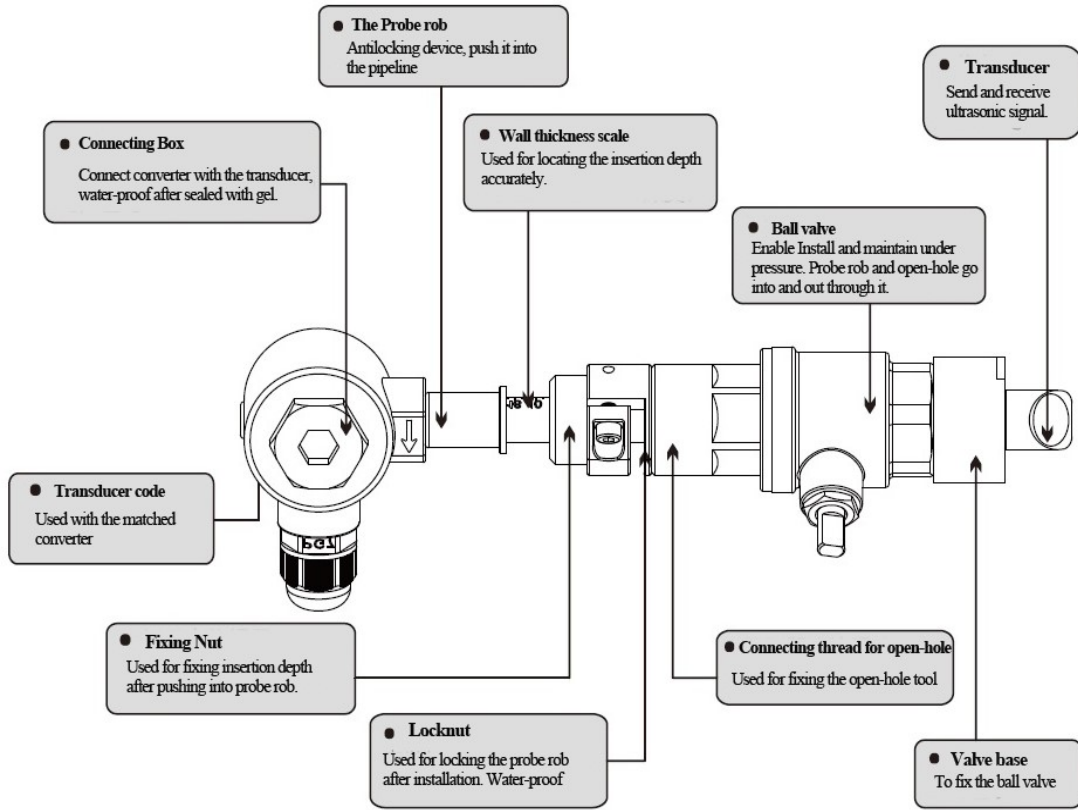


5.2 Clamp-on Transducer Wiring Diagram

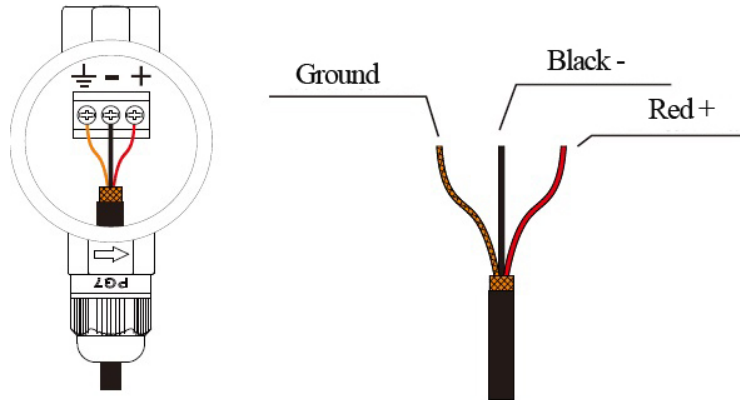


5.3 Insertion Transducers

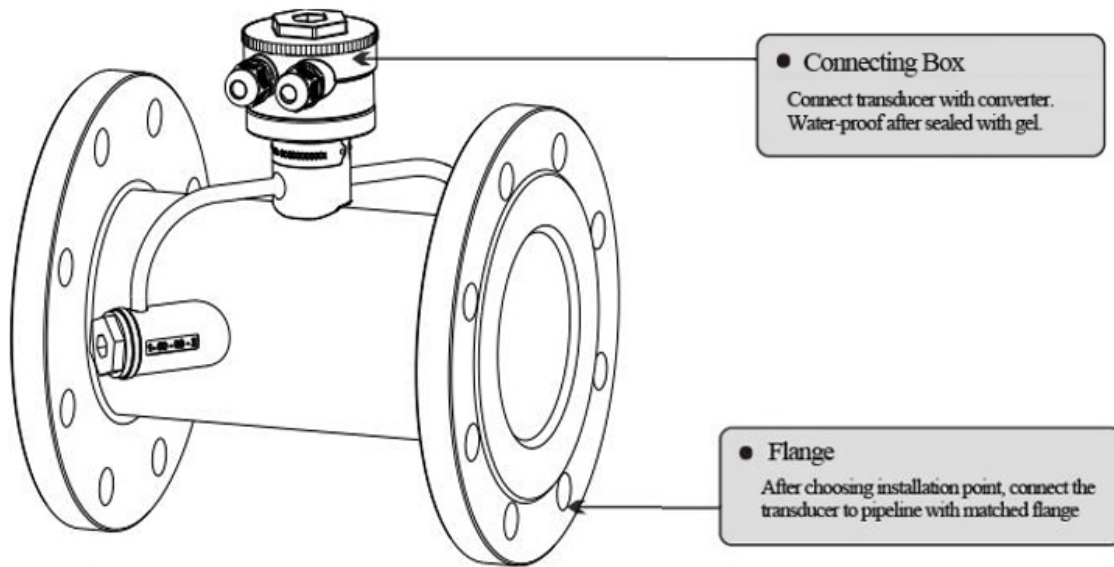
Insertion Transducer Overview



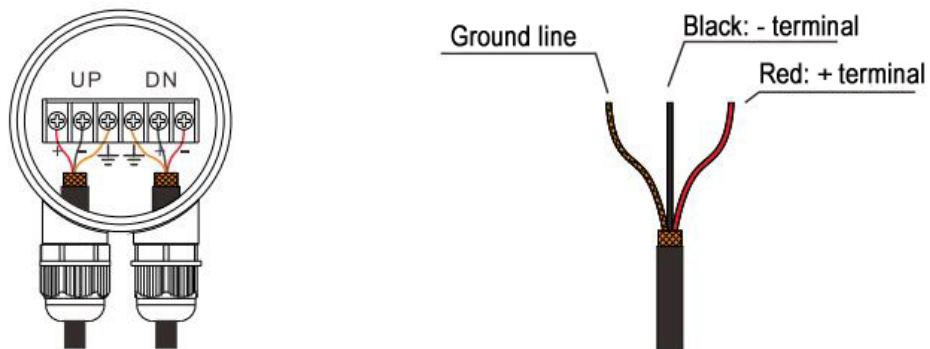
Insertion Transducers Wiring Diagram



5.4 Inline Transducers



Inline Transducer Wiring Diagram

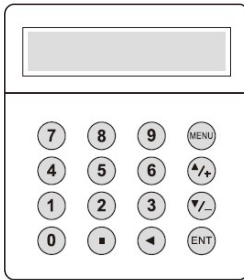


6 Display and Programming

6.1 Display and Keyboard

Display is 2×20 characters LCD with backlight, available to set backlight time and contrast.

16-key Keyboard



0 - **9** and **.** are used for inputting numbers or menu numbers.

◀ is used for back left or delete the last character.

▲/+ and **▼/-** are used for entering into the last and next menu. It also can be used as ± sign when inputting numbers.

MENU is used for accessing the menu. Press this key first, then type the number keys to enter into the matched menu.

ENT is the ENTER key, used for confirming the contents you input or choose.

6.2 Programming

The user interface of this flow meter comprises of over 100 different menu windows that are numbered M00, M01, M02 ... M99. To enter a menu: Press the **MENU** key first, followed by the two-digit menu number. For example to enter menu item M35, press

MENU **3** **5**.

To move between the adjacent menus, press **▲/+** and **▼/-** keys.

Note: Some menu items are accessed by pressing non-numeric keys. For example to view the window for “last power off flow rate” as shown in table 6.3 as M+3, you would enter

MENU **+** **3**.

6.3 Program Menu Details

Menu No.	Function
M00	Display flow rate and NET totalizer. If the net totalizer is turned off(refer to M34), the net totalizer value shown on the screen is the value prior to its turn off. Select all totalizer unit in menu M31.
M01	Display flow rate, velocity.
M02	Display flow rate and POS(positive) totalizer. If the positive totalizer is turned off, the positive totalizer value shown on the screen is the value prior to its turn off.
M03	Display flow rate and NEG(negative) totalizer. If the negative totalizer is turned off, the negative totalizer value shown on the screen is the value prior to its turn off.
M04	Display date and time, flow rate. The date and time setting method is found in MENU60.
M05	Display energy rate(instantaneous Caloric)and total energy (Caloric).
M06	Display temperatures, inlet T1, outlet T2.
M07	Display analog inputs, AI3/AI4, current value and its corresponding temperature or pressure or liquid level value.
M08	Display all the detailed error codes. Display working condition and system error codes. 'R' stands for normal; others refer to Chapter 5 for details.
M09	Display today's total NET flow.
M10	Window for entering the outer perimeter of the pipe. If pipe outer diameter is known, skip this menu and go to Menu 11to enter the outer diameter.
M11	Window for entering the outer diameter of the pipe. Valid range:0 to 18000mm. Note: you just need to enter either the outer diameter in M11 or the perimeter in M10.
M12	Window for entering pipe wall thickness You may skip the menu and enter inner diameter in M13 instead.
M13	Window for entering the inner diameter of the pipe If pipe outer diameter and wall thickness are enter correctly, the inner diameter will be calculated automatically, thus no need to change anything in the window
M14	Window for selecting pipe material Standard pipe materials (No need to enter material sound speed) include: (0) carbon steel (1) stainless steel (2) cast iron (3) ductile iron (4) copper (5) PVC (6) aluminum ,(7) asbestos (8) fiberglass (9) other(need to enter material sound speed in M15)

M15	Window for entering the pipe material speed, only for non-standard pipe materials
M16	Window for selecting the liner material, select none for pipes without any liner. Standard liner materials(no need to enter the liner sound speed) include: None, No liner (1) Tar Epoxy (2) Rubber (3) Mortar (4) Polypropylene (5) Polystyrol (6)Polystyrene (7) Polyester (8) Polyethylene (9) Ebonite (10) Teflon (11) Other (need to enter liner sound speed in M17)
M17	Window for entering the non-standard liner material speed.
M18	Window for entering the liner thickness, if there is a liner
M19	Window for entering the ABS thickness of the inside wall of the pipe
M20	Window for selecting fluid type For standard liquids(no need to enter fluid sound speed) include: (0) Water (1) Sea Water (2) Kerosene (3) Gasoline (4) Fuel oil (5) Crude Oil (6) Propane at -45C (7) Butane at 0C (8)Other liquids(need to enter sound speed in M21 and viscosity in M22) (9) Diesel Oil (10)Caster Oil (11)Peanut Oil (12) #90 Gasoline (13) #93 Gasoline (14) Alcohol (15) Hot water at 125C
M21	Window for entering the sound speed of non- standard liquid, used only when option item 8 'Other' is selected in M20
M22	Window for entering the viscosity of the non-standard liquids, used only when option item 8 'Other' is selected in M20
M23	Window for selecting transducer type, There are 22 types as following 0. Standard-M (The medium size) 1. Insertion Type C 2. Standard-S 3. User Type 4. Standard B 5. Insertion Type B(45) 6. Standard-L (The large size transducers) 7. JH-Polysonics 8. Standard-HS (small size transducer for H 9. Standard-HM (middle size transducer for Handheld flow meter) 10. Standard-M1 (middle size transducer #1) 11. Standard-S1 (small size transducer #1) 12. Standard-L1 (large size transducer #1) 13. PI-Type 14. FS410 (middle size transducer for FUJI flow meter) 15. FS510 (large size transducer for FUJI flow meter) 16. Clamp-on TM-1 (medium size transducer for FMT-25W) 17. Insertion TC-1 (for Taosonic Instrument) 18. Calmp-on TS-1 (small size transducer for FMT-25W) 19. Clamp-on TS-1 20. Clamp-on TL-1 (large size transducer for FMT-25W) 21. Insertion TLC-2 (For Taosonics) 22. Clamp-on M2 23. Clamp-on L2

M24	<p>Window for selecting the transducer mounting methods</p> <p>Four methods can be selected: (0) V-method (1) Z-method (2) N-method (3) W-method</p>
M25	<p>Display the transducer mounting spacing or distance</p>
M26	<p>(1) A switch for the parameters in flash memory will be loaded when power is turned on. The default option is that the parameters will be loaded. If this switch is not turned on, the system will try to use the parameters in the system RAM, if these parameters are ok, otherwise the system will load the parameters in flash memory</p> <p>(2) Function to store the current parameters into the flash memory, so that these parameters will be solidified and will be loaded as the default parameters every time when power is turned on.</p>
M27	<p>Entry to store to or restore from the internal Flash memory, as many as 9 different pipe parameter configurations</p> <p>To save or load the current setup parameter, use the going up or going down keys to change the address number, press 'ENT' key, and use going down or going up keys to select to save to or load from the memory.</p>
M28	<p>Entry to determine whether or not to hold (or to keep) the last good value when poor signal condition occurs. YES is the default setup.</p>
M29	<p>Entry to setup empty signal threshold. When the signal is less than this threshold, the pipe is regarded as empty pipe, and the flow meter will not totalize flow. This is based on the fact that, for most occasions, when pipe is empty, the transducer would still receive signal, just smaller than normal, As a result, The flow meter would show normal operation, which is not correct.</p> <p>Make sure that the entered value must be less than the normal signal strength. When much noisy signals are received, to make sure the flow meter will not incorrectly totalize flow, there is also a 'Q' threshold should be entered in M.5</p>
M30	<p>Window for selecting unit system. The conversion English to Metric or vice versa will not affect the unit for totalizers.</p>
M31	<p>Window for selecting flow rate unit system.</p> <p>Flow rate can be in</p> <ul style="list-style-type: none"> 0. Cubic meter short for (m3) 1. Liter (l) 2. USA gallon (gal) 3. Imperial Gallon (igl) 4. Million USA gallon (mgl) 5. Cubic feet (cf) 6. USA liquid barrel (bal) 7. Oil barrel (ob) <p>The flow unit in terms of time can be per day, per hour, per minute or per second. So there are 32 different flow rate units in total for selection.</p>
M32	<p>Window for selecting the totalizers unit. Available units are the same as those in M31</p>

M33	Window for setting the totalizer multiplying factor The multiplying factor ranges from 0.001 to 10000. Factory default is 1
M34	Turn on or turn off the NET totalizer
M35	Turn on or turn off the POS (positive) totalizer
M36	Turn on or turn off the NEG(negative) totalizer
M37	(1) Totalizer reset (2) Restore the factory default settings parameters. Press the dot key followed by the backspace key. Attention, It is recommended to make note on the parameters before doing the restoration
M38	Manual totalizer used for easier calibration. Press a key to start and press a key to stop the manual totalizer.
M39	Language selection. The selection could also be changed automatically by the system, if English LCD display is used as the display device.
M3A	Setup for local segmental LCD display. Enter 0 or 1 for the non-auto-scan mode; Enter 2~39 for the auto-scan mode. In the auto-scan mode the display will automatically scan displaying from 00 to the entered number of the local segmental LCD display.
M40	Flow rate damper for a stable value. The damping parameter ranges from 0 to 999 seconds. 0 means there is no damping. Factory default is 10 seconds
M41	Low flow rate (or zero flow rate) cut-off to avoid invalid accumulation.
M42	Zero calibration/Zero point setup. Make sure the liquid in the pipe is not running while doing the setup.
M43	Clear the zero point value, and restore the solidified zero point value.
M44	Set up a flow bias. Generally this value should be 0.
M45	Flow rate scale factor. The default value is '1'. Keep this value as '1', when no calibration has been made.
M46	Networks address identification number. Any integer can be entered except 13(ODH, carriage return), 10(OAH, line feeding), 42(2AH), 38, 65535. Every set of the instrument in a network environment should have a unique IDN. Please refer to the chapter for communication.
M47	System locker to avoid modification of the system parameters. If password is forgotten, you could send a command 'LOCK0' to the serial input to unlock. Or you can write 0 to REGISTER49-50 under MODBUS protocol.
M48	Entry to linearity correcting data inputs. By using of this function, the non-linearity of flow meter will be corrected. Correcting data shall be obtained by careful calibration.
M49	Displays the input contents for the serial port. By checking the displays, you can know if the communication is ok.
M50	Switches for the built-in data logger. There are as many as 22 different items can be chosen. To turn this function, select 'YES' the system will ask for selecting the items. There are 22 items available. Turn on all those items you want to output

M51	Window to setup the time of the scheduled output function (data logger, or Thermo-printer). This includes start time, time interval and the number of outputs. When a number great than 8000 is entered for the times of output, It means the output will be continuous. The minimum time interval is 1 second and the maximum is 24 hours.
M52	Data logging direction control. (1) If 'Send to RS485' is selected, all the data produced by the data logger will be transmitted out through the RS-232/RS485 interface (2) If 'To the internal serial BUS is selected, the data will be transmitted to the internal serial bus which allows a thermal printer, or a 4-20mA analog output module, to be connected to it.
M53	Display analog inputs, AI5, current value and its corresponding temperature or pressure or liquid level value.
M54	Pulse width setup for the OCT (OCT1) output. Minimum is 6 mS, maximum is 1000 mS
M55	Select analog output (4-20mA current loop, or CL) mode. Available options: (0) 4-20mA output mode (setup the output range from 4-20mA) (1) 0-20mA output mode (setup the output range from 0-20mA, This mode can only be used with Version-15 flow meter) (2) RS232 Serial port controls 0-20mA (3) 4-20mA corresponding fluid sound speed (4) 20-4-20mA mode (5) 0-4-20mA mode (can only be used with Version-15 flow meter) (6)20-0-20mA mode(can only be used with Version-15 flow meter) (7) 4-20mA corresponding flow velocity (8)4-20mA corresponding heat flow rate See Appendix B for more details on the output
M56	4mA or 0mA output value, Set the value which corresponds to 4mA or 0mA output current (4mA or 0mA is determined by the setting in M55)
M57	20mA output value, Set the value which corresponds to 20mA output current
M58	Current loop verification. Check if the current loop is calibrated correctly.
M59	Display the present output of current loop circuit.
M60	Setup system date and time. Press ENT for modification. Use the dot key to skip the digits that need no modification.
M61	Display Version information and Electronic Serial Number (ESN) that is unique for each flow meter. The users may employ the ESN for instrumentation management
M62	RS-232/RS485 setup. All the devices connected with flow meter should have matched serial configuration. The following parameters can be configured: Baud rate (300 to 19200 bps), parity, data bits (always is 8), stop bits (1).

M63	<p>Select communication protocol. Factory default is 'MODBUS ASCII. this is a mode for MODBUS-ASCII, Meter-BUS, Fuji Extended Protocol, Huizhong's various protocols. If you are going using MODBUS-RTU you have to select 'MODBUS_RTU'.</p>
M64	<p>AI3 value range. Used to enter temperature/pressure values that are corresponding to 4mA and 20mA input current. The display values have no unit, so that they can present any physical parameter.</p>
M65	<p>AI4 value range. Used to enter temperature/pressure values that are corresponding to 4mA and 20mA input current.</p>
M66	<p>AI5 value range. Used to enter temperature/pressure values that are corresponding to 4mA and 20mA input current.</p>
M67	<p>Windows to setup the frequency range (lower and upper limit) for the frequency output function. Valid range is 0Hz-9999Hz. Factory default value is 0-1000 Hz. For Version-12, Version-13, Version-14 flow meters, you need a hardware module, which shall be plugged to the Serial Expanding Bus, for the frequency output function. Please remember to order the module if you need frequency output function. For Version-15 flow meter, you need to indicate on your orders that you need the frequency function; Otherwise you will get a flow meter which has no frequency output circuits.</p>
M68	<p>Window to setup the minimum flow rate value which corresponds to the lower frequency limit of the frequency output.</p>
M69	<p>Windows to setup the maximum flow Rate value that corresponds to the upper frequency limit of the frequency output.</p>
M70	<p>LCD display backlight control. The entered value indicates how many seconds the backlight will be on with every key pressing. If the enter value is great than 50000 seconds, It means that the backlight will always keeping on.</p>
M71	<p>LCD contrast control. The LCD will become darker or brighter when a value is entered.</p>
M72	<p>Working timer. It can be cleared by pressing ENT key, and then select YES.</p>
M73	<p>Window to setup the lower limit of flow rate for Alarm#1. When the flow rate is below the set value, Alarm#1 equals 'on'</p>
M74	<p>Window to setup the upper limit of flow rate for Alarm#1. When the flow rate is above the set value, Alarm#1 equals 'on' There are two alarms in the flow meter, and every alarm can be pointed to alarm output devices such as the BUZZER or OCT output or RELAY output. For example, if you want the Alarm#1 is to output by the OCT circuit, you need to set M78 at selection item 6.</p>
M75	<p>Window to setup the lower limit of flow rate for Alarm#2.</p>

M76	Window to setup the upper limit of flow rate for Alarm#2.
M77	<p>Buzzer setup.</p> <p>If a proper input source is selected, the buzzer will beep when the trigger event occurs. The available trigger sources are:</p> <p>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. Reverse Alarm #2 8. Batch Controller 9. POS Int Pulse 10.NEG Int Pulse 11.NET Int Pulse 12.Energy POS Pulse 13.Energy NEG Pulse 14.Energy NET Pulse 15.MediaVel=>Thresh 16.MediaVelo<Thresh 17.ON/OFF viaRS485 18.Daily Timer (M51) 19.Timed alarm #1 20. Timed alarm #2 21.Batch Total Full 22. Timer by M51 23. Batch 90% Full 24. Key Stroking ON 24.Disable BEEPER</p>
M78	<p>OCT (Open Collect Transistor Output)/OCT1 setup</p> <p>By selecting a proper input source, the OCT circuit will close when the trigger event occurs. The available trigger sources are:</p> <p>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. Reverse Alarm #2 8. Batch Controller 9. POS Int Pulse 10.NEG Int Pulse 11.NET Int Pulse 12.Energy POS Pulse 13.Energy NEG Pulse 14.Energy NET Pulse 15.MediaVel=>Thresh 16.MediaVelo<Thresh 17.ON/OFF viaRS485 18. Daily Timer (M51) 19.Timed alarm #1 20. Timed alarm #2 21.Batch Total Full 22.Timer by M51 23.Batch 90% Full 24.Flow Rate Pulse 25.Disable OCT</p> <p>The OCT circuit does not source voltage at its output. It must be connected with an external power and pull-up resistant for some occasions. When the OCT circuit is close, it will draw current. The maximum current shall not be over 100mA. Attention: the maximum voltage applied to OCT can not be over 80 volts.</p>

<p>M79</p>	<p>Relay or OCT2 setup By selecting a proper input source, the RELAY will close when the trigger event occurs The available trigger sources are: 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. Reverse Alarm #2 8. Batch Controller 9. POS Int Pulse 10.NEG Int Pulse 11.NET Int Pulse 12.Energy POS Pulse 13.Energy NEG Pulse 14.Energy NET Pulse 15.MediaVel=>Thresh 16.MediaVelo<Thresh 17.ON/OFF viaRS485 18. Timer (M51 Daily) 19.Timed alarm #1 20. Timed alarm #2 21.Batch TotalFull 22.Timer by M51 23.Batch 90% Full 24.Disable RELAY</p> <p>The RELAY is a SPST, rated for 110VAC max and have a current rating of 0.5A resistive load. Note. For compatibility with the former version7, the term RELAY was used rather than OCT2, but in fact it is an OCT output.</p>
<p>M80</p>	<p>Window for selecting the trigger signal for the built-in batch controller. Available trig sources: 0. Key input (press ENT key to start the batch controller) 1. Serial port 2. AI3 rising edge (when AI3 receives 2mA or more current) 3. AI3 falling edge (when AI3 stop receiving 2mA or more current) 4. AI4 rising edge (when AI3 receives 2mA or more current) 5. AI4 falling edge (when AI3 stop receiving 2mA or more current) 6. AI5 rising edge (when AI3 receives 2mA or more current) 7. AI5 falling edge (when AI3 stop receiving 2mA or more current) 8.Timer periodically (define the start time and interval time in M51) 9.Timer daily (define the start time and interval time in M51)</p> <p>For the input analog current signal, 0 mA indicates "0", 4mA or more indicates '1'. By selecting item #8, the batch totalizer can be started periodically by the internal timer located at Menu51. When the batch totalizer is full, a signal which indicate the batch is full can be direct to either the OCT or the RELAY terminals to stop the pump or other devices. By selecting item #9, the batch totalizer could act as totalizer which runs for only a period of the day so that a alarm signal could be produced if the total flow during that time period is over a certain amount of. For example, if you want a alarm signal which stand for the total flow is over 100 cubic meters during the period of every day from 20:00 to 06:00, setups is like</p>

	<p>M51 start time =20:00:00 M51 interval =10:00:00 M51 log times =9999 (means always) M80 select item #9 M81 input 100 (Unit is defined in M30,M31,M32)</p>
M81	<p>The built-in batch controller Set the flow batch value(dose) The internal output of the batch controller can be directed either to the OCT or the RELAY output circuits. M81 and M80 should be used together to configure the batch controller. Note: Because the measuring period is 500mS, the flow for every dos should be keeping at 60 seconds long to get a 1% dose accuracy.</p>
M82	<p>View the daily, monthly and yearly flow totalizer and thermal energy totalizer value. The totalizer values and errors for the last 64 days, 32 last 32 months and last 2 years are stored in the RAM memory, To view them, use the 'ENT' and 'UP' 'Down' keys.</p>
M83	<p>Automatic Amending Function for automatic offline compensation. Select 'YES' to enable this function, select 'NO' to disable it. When the function is enabled, The flow meter will estimate the average flow uncounted (or 'lost') during the offline session and add the result to the totalizer. The estimation of the uncounted flow is made by computing the product of the offline time period and the average flow rate, which is the average of the flow rate before going offline and the one after going on line.</p>
M84	<p>Set the thermal energy unit: 0. GJ 1. KC 2.KWh 3. BTU</p>
M85	<p>Select temperature sources 0. from T1,T2 (factory default) 1. from AI3,AI4</p>
M86	<p>Select the Specific Heat Value. Factory default is 'GB'. Under this setting, the flow meter will calculate the enthalpy of water based on the international standard. If the fluid is other than water, you should select option '1. Fixed Specific Heat', and enter the specific heat value of the fluid.</p>
M87	<p>Turn on or turn off the Energy totalizer.</p>
M88	<p>Select thermal energy totalizer multiplying factor. Factory default is '1'.</p>
M89	<p>1. Display the temperature difference 2. Window for entering the lowest temperature difference.</p>
M8.	<p>Heat meter is on InletOutlet Select the heat meter installation place.</p>

M90	<p>Display signal strengths S (one for upstream and one for downstream), and signal quality Q value.</p> <p>Signal strength is presented by 00.0 to 99.9, the bigger the value, the bigger the signal strength will be, and more reliable readings will be made.</p> <p>Q value is presented by 00 to 99, the bigger the better. It should at least be great than 50 for normal operations.</p>
M91	<p>Displays the Time Ratio between the Measured Total Transit Time and the Calculated time. If the pipe parameters are entered correctly and the transducers are properly installed, the ratio value should be in the range of 100±3%. Otherwise the entered parameters and the transducer installation should be checked.</p>
M92	<p>Displays the estimated fluid sound velocity. If this value has an obvious difference with the actual fluid sound speed, pipe parameters entered and the transducer installation should be checked again.</p>
M93	<p>Displays total transit time and delta time(transit time difference)</p>
M94	<p>Displays the Reynolds number and the pipe factor used by the flow rate measurement program. Pipe factor is calculated based on the ratio of the line-average velocity and the cross-section average velocity.</p>
M95	<p>(1) Display the positive and negative energy totalizers (2) Upon entering this window, the circular display function will be started automatically. The following windows will be displayed one by one, each window will stay for 8 seconds: M95>>M00>>M01>>M02>>M02>>M03>>M04>>M05>>M06>>M07>>M08>>M90>>M91>>M92>> M93>>M94>>M95. This function allows the user to visit all the important information without any manual action. To stop this function, simply press a key. Or switch to a window other than M95.</p>
M96	<p>This is not a window but a command for the thermal printer to advance 5 lines of paper.</p>
M97	<p>This is not a window but a command to print the pipe parameters. By default, the produced data will be directed to the internal serial bus (thermal printer). You can also direct those data to the serial communication port.</p>
M98	<p>This is not a window but a command to print the diagnostic information. By default, the produced data will be directed to the internal serial bus (thermal printer). You can also direct those data to the serial communication port.</p>
M99	<p>This is not a window but a command to copy the current display window. By default, the produced data will be directed to the internal serial bus (thermal printer). You can also direct those data to the serial communication port. By use of the window copying function, you can hardcopy very window displaying manually by switching windows, or you can obtain the window displaying data by communication.</p>
M+0	<p>Browse the 32 recorded instrument power-on and power-off date and time with the flow rate at the time of power on and off</p>
M+1	<p>Displays the total working time of the flow meter. When the backup battery is removed, the total working time will be reset to zero.</p>

M+2	Displays the last power-off date and time
M+3	Displays the last power-off flow rate
M+4	Displays how many times of has been powered on and powered off.
M+5	A scientific calculator for the convenience of field working. All the values are in single accuracy. The calculator can be used while the flow meter is conducting flow measurement. Water density and PT100 temperature can also be found in this function.
M+6	Set fluid sound speed threshold Whenever the estimated sound speed (displayed in M92) exceeds this threshold, an alarms signal will be generated and can transmitted to BUZZER or OCT or RELAY. This function can used to produce an alarm or output when fluid material changes.
M+7	Displays total flow for this month(only for the time past)
M+8	Displays total flow for this year(only for the time past)
M+9	Display the not-working total time in seconds. The total failure timer will also include the time when power off, if the back-up battery is applied.
M.2	Entry to solidify the zero point. Password protected.
M.5	Setup the Q value threshold. If the present Q is below this threshold, flow rate will be set to 0. This function is useful when flow meter is installed in noisy environment or on airy pipes.
M.8	The maximum flow rates for today and this month.
M.9	Serial port tester with CMM command output for very second.
M-0	Entry to hardware adjusting windows only for the manufacturer
M-1	4-20mA output adjustment
M-2	4mA calibration for AI3 input
M-3	20mA calibration for AI3 input
M-4	4mA calibration for AI4 input
M-5	20mA calibration for AI4 input
M-6	4mA calibration for AI5 input
M-7	20mA calibration for AI5 input
M-8	Lower Temperature Zero setup for the PT100
M-9	Higher Temperature Zero setup for the PT100
M-A	Temperature Calibration at 50°C
M-B	Temperature Calibration at 84.5°C

6.4 Quick Program Setup

Accurately measured parameters can have a big influence on measurement precision and reliability. It is suggested to measure the actual perimeter and wall thickness of the pipeline. Ultrasonic thickness gauge can be used to measure the pipe thickness. Measured parameters setup is from Menu10 to Menu29. Please complete each one.

>>> Following parameters need to be inputted before measurement:

1. Outer diameter unit: mm
2. Pipe thickness unit: mm
3. Pipe material
4. Lining parameters: thickness and sound velocity (If have lining)
5. Liquid type
6. transducer type
7. transducer mounting type

>> **The above parameters setup generally follow the steps below:**

1. Press keys **MENU** 1 1 to enter M11 window to input the pipe outer diameter, and then press **ENT** key.
2. Press key **▼/-** to enter M12 window to input the pipe outer diameter and then press **ENT** key.
3. Press key **▼/-** to enter M14 window, and press **ENT** key to enter the option selection mode. Use keys **▲/+** and **▼/-** to select the pipe material, and then press **ENT** key.
4. Press key **▼/-** to enter M16 window, press **ENT** key to enter the option selection mode. Use keys **▲/+** and **▼/-** to select the liner material, and then press **ENT** key. Select "No Liner" if there is no liner.
5. Press key **▼/-** to enter M20 window, press **ENT** key to enter the option selection mode. Use keys **▲/+** and **▼/-** to select the proper liquid, and then press **ENT** key.
6. Press key **▼/-** to enter M23 window, press **ENT** key to enter the option selection mode. Use keys **▲/+** and **▼/-** to select the proper transducer type, and then press **ENT** key.
7. Press key **▼/-** to enter M24 window, press **ENT** key to enter the option selection mode. Use keys **▲/+** and **▼/-** to select the proper transducer mounting method, and then press **ENT** key.
8. Press key **▼/-** to enter M25 window and get the transducer installation distance.
9. Press **MENU** 2 6 to store the parameters setup.

7 Transducers Installation

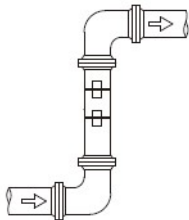
7.1 Choose installation points

Choosing a proper installation point is a key for a transducer successful installation.

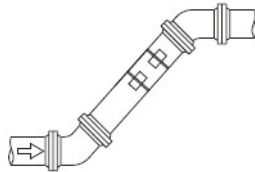
Following factors must be considered: Full pipe, shaking, steady flow, scaling, temperature, pressure, EMI and instrument well.

>> Full pipe

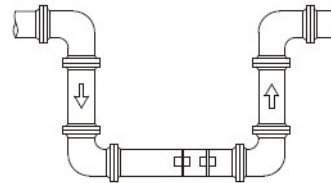
Following situations can be full filled of liquid:



Vertical upward



Obliquely upward



Lowest point

>> Vibration

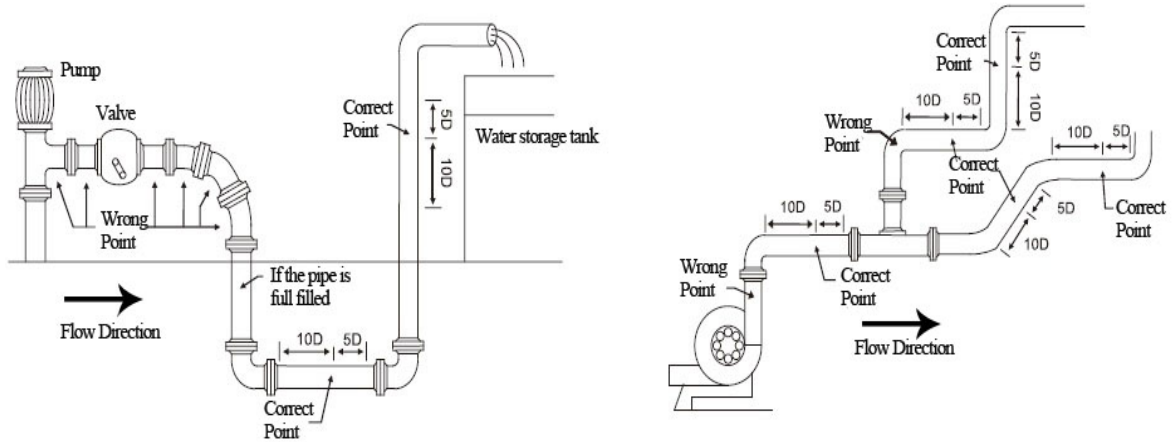
There cannot be obvious vibration at the installation point, otherwise the pipe needs to be tightened.

>>Steady flow

Steady flow is helpful for ensuring measurement accuracy.

Standard requirements for steady flow are:

1. The pipe should be far away from pump outlet and half-open valves.
10D to upstream and 5D to downstream. (D means outer diameter)
2. 30D to pump outlet and half-open valve.



>> Scaling

Inside pipe scaling can have a negative effect on ultrasonic signal transmission, and will decrease the inner diameter as well. As a result, the measurement accuracy cannot be guaranteed. Please try to avoid choosing an installation point with inside scaling.

>>Temperature

The liquid temperature at the installation point should be within the working range of transducers. Avoid points like the outlet of boiler water and heat exchanger. Return water pipe would be a better choice.

Temperature range of standard clamp on and insertion transducers: $-30 \sim 90^{\circ}\text{C}$

Temperature range of high temperature clamp on and insertion transducers: $-30 \sim 160^{\circ}\text{C}$

>>Pressure

The maximum pressure for standard insertion and inline transducer is 1.6MPa

Out of this range requires a customized transducer.

>>EMI (electromagnetic interference)

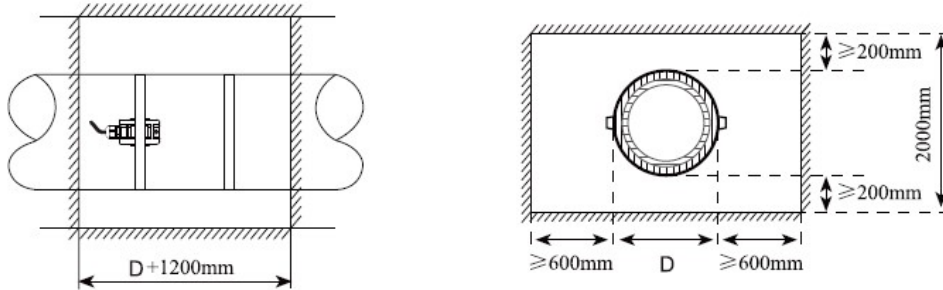
The ultrasonic flow meter, transducer and signal cable can be impacted by EMI sources such as high frequency power converters, radio and microwave transmitters, GSM base stations and high-tension power cables. Please try to avoid these areas when choosing installation points.

The shielding of the flow meter, transducer and signal cable should be connected to earth ground.

It is better to use isolated power supply. Do not use the same power supply as the frequency converter.

>>**Instrument well**

When measuring underground pipes or when there is a need to protect the measurement points, an instrument well is required. To ensure that there is enough installation space, the size of instrument well should meet the following dimensions.



D means the pipe diameter

7.2 Clamp-on Transducer Installation

△Before installation, please verify the parameters of pipeline and liquid to ensure the installation accuracy.

Installation procedure

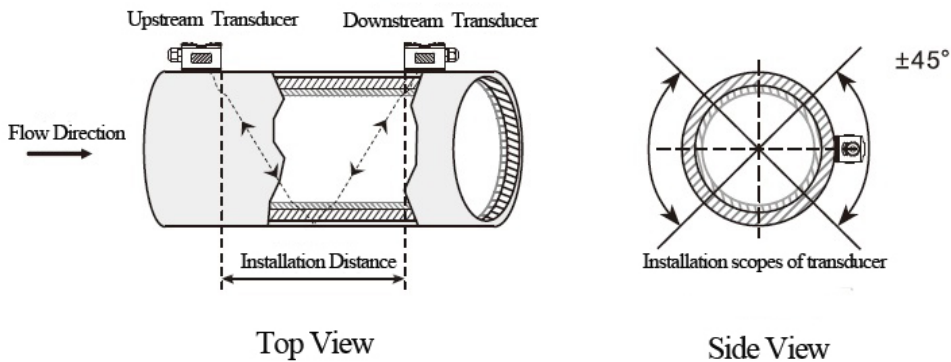
Select an installation method → Input the measurement parameters → Clean the pipe surface → Install the` transducers → Check the installation

Select an installation method

There are two different methods for clamp on transducers: V method and Z method.

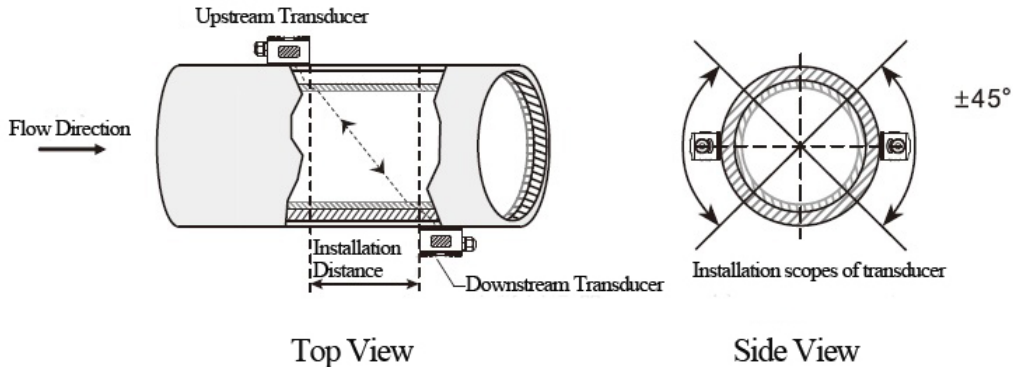
>> **V method**

The V method should be used for pipe sizes DN25 - DN200(with nominal diameter 25 to 200mm). Align the pair of transducers horizontally so that the central line is parallel with the pipeline axis.



>> **Z method**

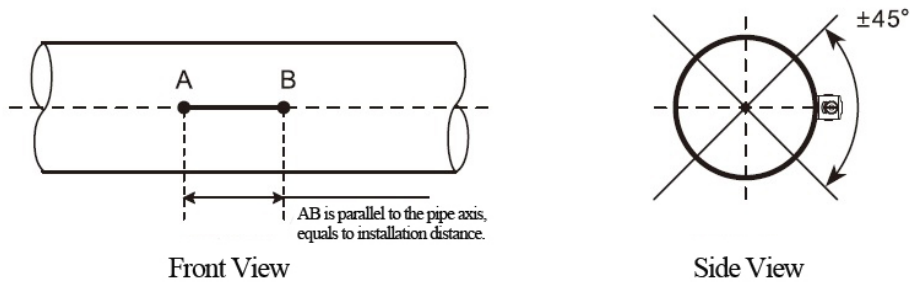
The Z method should be used for pipe sizes DN200 - DN6000(nominal diameter 200 to 600mm). It can also be used when the V method doesn't work well. Make sure the vertical distance of two transducers equals to the installation distance, and the two transducers are on the same axis surface.



Positioning installation points

>> **V method**

The line between two transducers should be parallel to pipe axis, and equal to the distance shown in the meter. As shown, A, B are the two installation points.



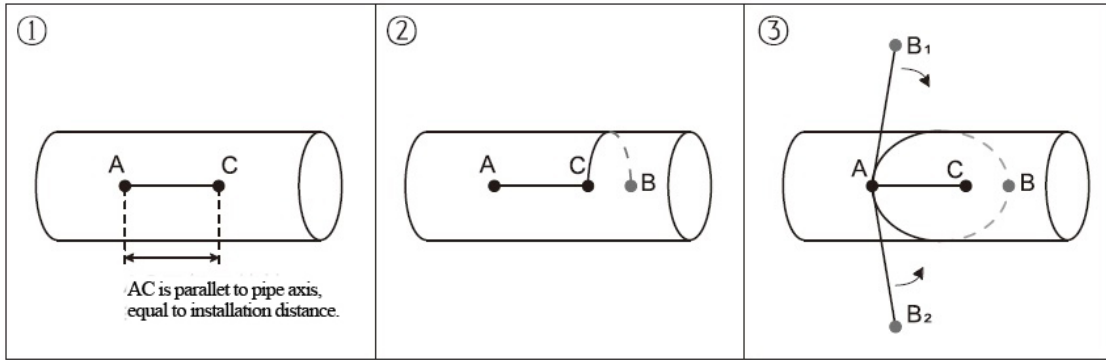
>> **Z method**

⊕ Points A and C are on the same side of the pipe and parallel to the pipe axis. The distance between them should be equal to the value calculated by the meter.

⊙ Point B is perpendicular to the pipe axis and on the opposite side of the pipe to point C.

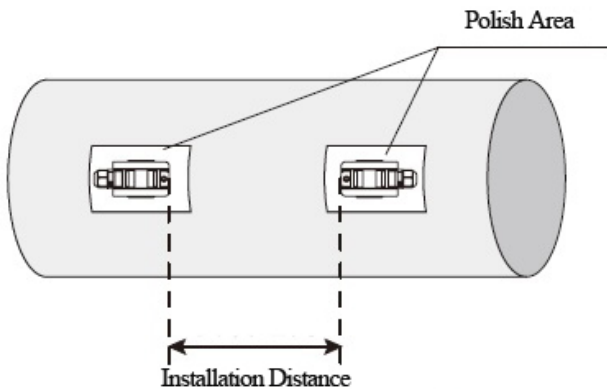
⊗ Check. Measure the distance between A and B from both sides of the pipe, get AB1 and AB2. If $AB_1 = AB_2$, then B is the correct point. If not, need to positioning point B and C again.

As shown, A, B are the two installation points.



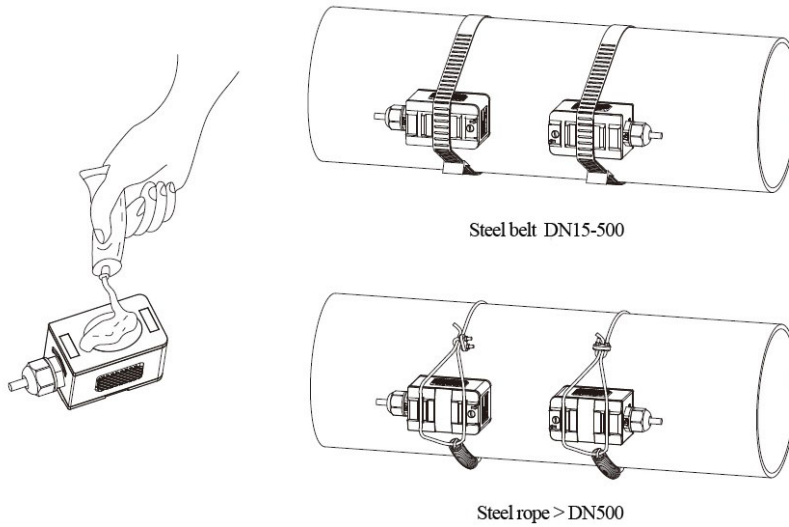
Clean the surface of installation points

Paint, rust and anti-corrosive coating on installation points need to be cleaned. It's good to use a polishing machine to get the metal clean as shown below:



Install transducers

After transducer wiring and sealing, please evenly smear 2-3mm of acoustical gel on the transducer's emitting surface. Then put the transducers on the installation points and fix with steel belt or steel rope.



Check Installation

Please see details in section 7.5

7.3 Insertion Transducer Installation

△Before installation, please verify the meter settings for the pipeline and liquid to ensure the installation accuracy.

Installation procedure

Select an installation method → Input the measurement parameters → Positioning installation points → Fix ball valve base → Open hole under pressure → Install transducers → Check the installation

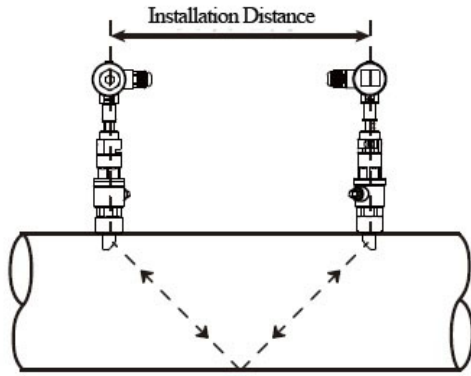
Select installation method and positioning installation points

Insertion type transducers are suitable for pipe sizes > 50mm.

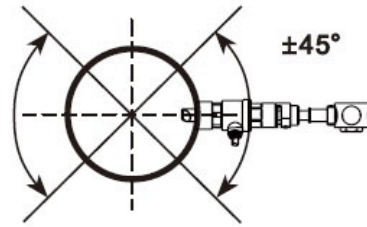
Two different installation methods: V method and Z method. Generally, use the Z method and only use the V method when there is a lack of space.

>> V method

The V method can be used for pipe sizes DN50mm - 300mm. Set the pair of transducers in horizontal alignment with the central line parallel with the pipeline axis and the transmit direction must be opposite to one another



Top View

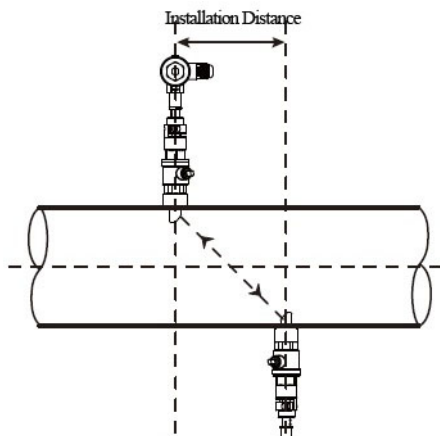


Transducer Installation Scope

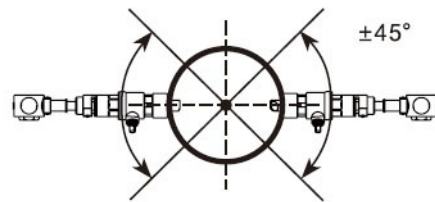
Side View

>> Z method

The Z method can be used for all pipes > DN50mm. Make sure the vertical distance of the two transducers is equal to the installation distance and the two transducers are on the same axis surface. The transmit direction must be opposite to one another.



Top View



Transducer Installation Scopes

Side View

>> **Parallel insertion**

If there is insufficient installation space or the transducers can be only installed on the top of pipeline, parallel insertion transducers are a good choice. (Pipe size ≥ 300)

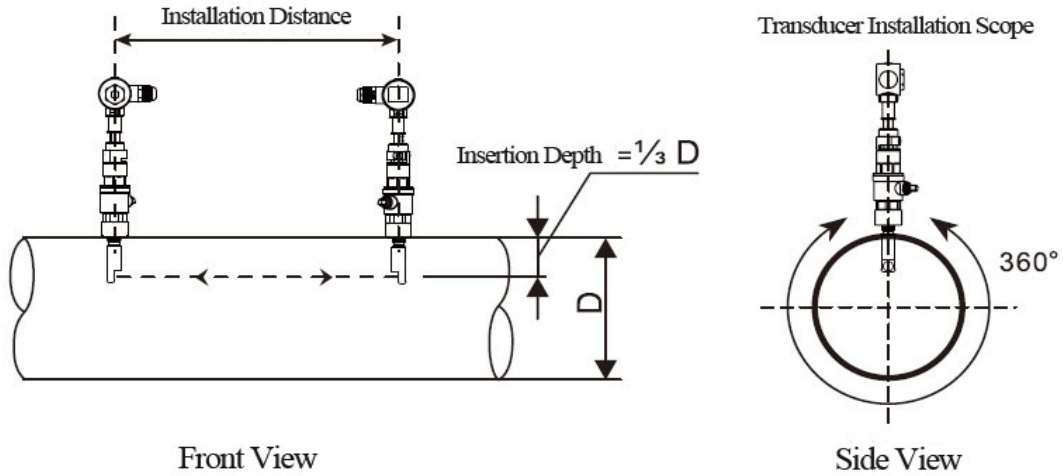
Positioning of parallel insertion transducer need to meet the 3 factors as follow:

Installation distance = Vertical distance of two transducers along the pipe axis direction

Make sure two transducers are in the same horizontal line,

Insertion depth = $1/3$ inner diameter

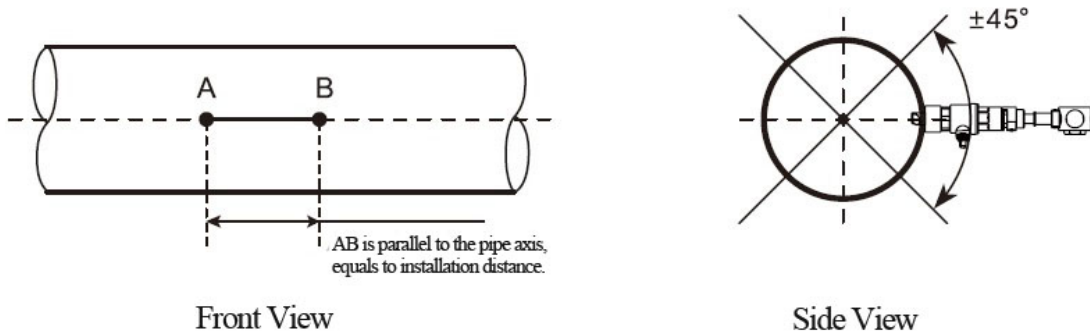
Users can set the distance between transducers by themselves. Recommend 300~500mm



Positioning installation points

>> **V method**

The line between two transducers is parallel to pipe axis, and equal to the distance shown in the meter. As shown, A, B are the two installation points.



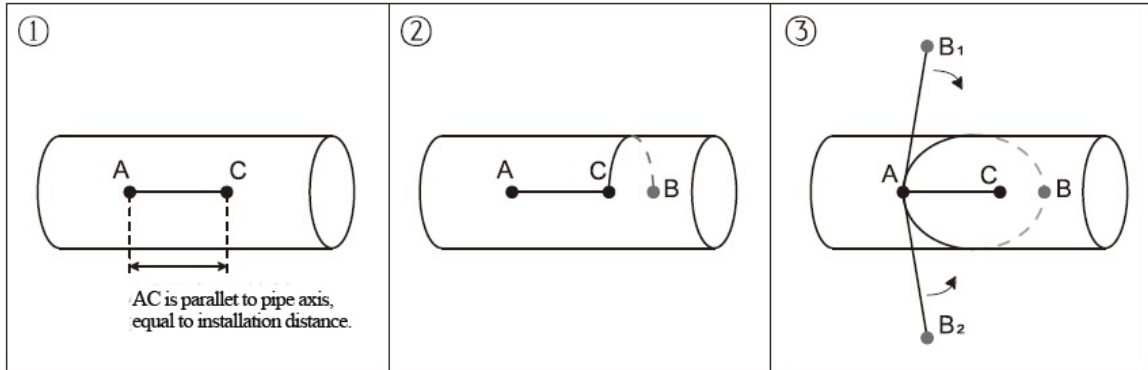
>> Z method

① Points A and C on the same side of pipeline at distance apart calculated by the meter. . AC is parallel to the pipe axis.

② Point B is perpendicular to the pipe axis, opposite to point C.

③ Measure the distance between A and B from both sides of the pipe to get AB₁ and AB₂. If AB₁ = AB₂, then B is in the correct location. If not you need to positioning point B and C again.

As shown, A, B are the two installation points.



Fix the ball valve base

>> Welding

For carbon steel pipes, the ball valve base can be welded directly. Make sure that the central point of ball valve base is overlapped with the transducer installation point.

Matters that need attention:

Please take the PTFE sealing gasket out from the base before welding.

Please clean the pipe surface around welding point before welding. Pay attention that there should not be any air hole during welding which can cause leaking. Welding strength must be ensured.

Do not sputter weld slag on the base thread.

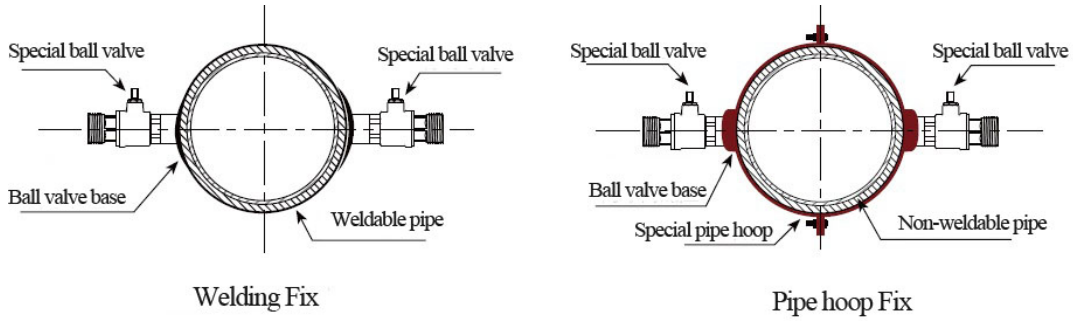
Do not deform the base during welding.

After welding, tighten ball valve into the base.

>> Pipe hoop Fix

For pipes that can't be welded directly like cast iron pipe, cement pipe, copper pipe and composite pipes, a customized pipe hoop is recommended.

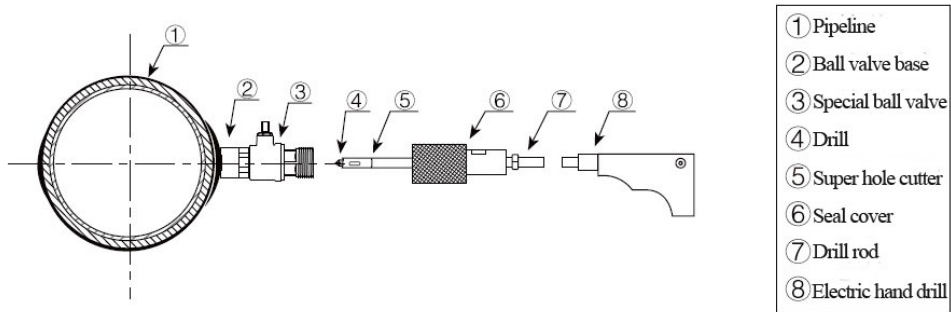
The hoop center should be overlapped with the transducer installation point. Please compress the sealing gasket tightly to avoid leaking.



Open hole

After finishing the installation of ball valve and base, insert the open-hole tool into ball valve and lock it. Then open the ball valve, start drilling, from slow to fast. close the ball valve after drilling.

See more details in the video of insertion transducer installation.

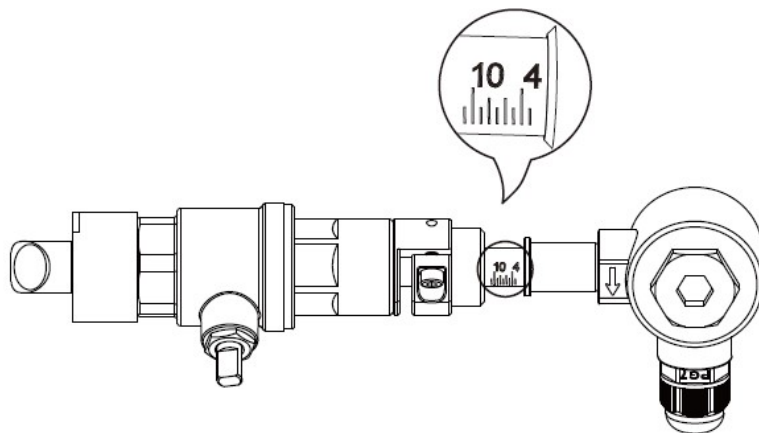


Install transducer and adjustment

Adjust the proper insertion depth and transmission direction to get good ultrasound signal.

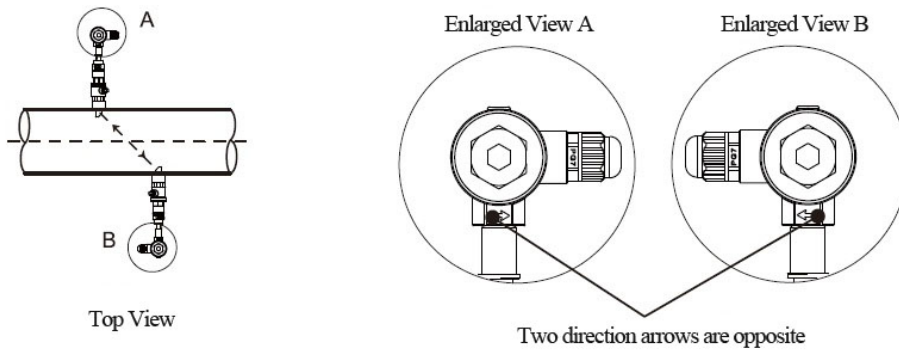
>> Insertion depth adjustment

Adjust the depth scale according to pipe wall thickness, and completely push in the transducer rod.



>> Transmission direction

There is a indicating arrow on the transducer junction box. The arrow direction on two transducers should be opposite “ ➡ ➡ ” and parallel to the pipe axis.



>>Operation steps

Tighten the locknut into the ball valve and adjust the insertion depth scale.

Open ball valve, completely and push in the upstream transducer rod. Adjust the transmission direction parallel with pipe axis and point to the installation point downstream of the transducer. Lock it after adjustment.

Install the downstream transducer in the same way. Adjust the transmission direction to get the best signal strength and while watching Menu91 if the value is between 97% ~ 103%, the installation is correct. If not, you need to re-adjust the insertion depth and transmit direction until it meets the signal strength requirement.

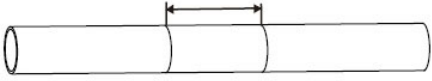

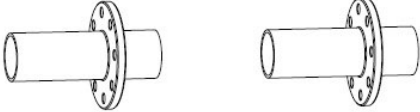
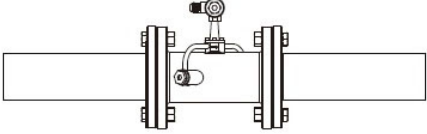

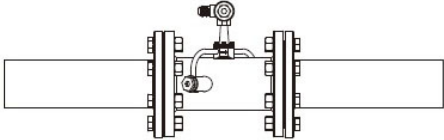
Check installation

Please see details in section 7.5

7.4 In-line type transducer installation

After choosing the installation point, install the transducer in the pipeline with companion flanges. Then connect the transducer to converter with special signal cable. Installation is complete.

Installation method

<p>① Confirm installation size</p> <p>Length of transducer $L + 2 \times \text{thickness of seal gasket} + 10\text{mm}$</p> 	<p>② Cutting pipeline</p> 
<p>③ Equip companion flanges</p> 	<p>④ Positioning the flanges</p>  <p>Twist 3 screws and averagely positioning the flanges. Fixing with spot welding.</p>
<p>⑤ Welding the flanges</p>  <p>Remove the inline transducer and full-length welding flanges.</p>	<p>⑥ As the flanges cooled, put in the seal gasket and tighten the screws. Then connect to converter with signal cable</p> 

Check installation

Please see details in section 7.5

7.5 Checking the Installation

The flow meter includes the detection ability. M90 is used for checking signal strength and quality. M91 is used for checking the ratio of measured and theoretical transmission time (transmission time ratio).

Check signal strength and quality

M90 is used for checking the signal strength and signal quality(Q value) of upstream and downstream transducers.

Signal strength is represented by numbers 00.0 ~ 99.9, 00.0 means no signal and 99.0 means maximum signal. Generally, the flow meter can work properly when signal strength is > 60.0

Signal quality (Q value) is represented by numbers 00 ~ 99. 00 means signal is the worst and 99 means that the signal is best. The flow meter can work properly when Q > 60.

During the installation, please adjust the transducer to make the signal strength and signal quality as large as possible. This will ensure that the flow meter has long term stable operation and will provide the most accurate measurement.

Signal strength and Q value	Installation Judgement
< 60	Cannot work
60~75	Poor
75~80	Good
>80	Excellent

Check transmission time ratio

M91 is used for displaying transmission time ratio. This is a percentage ratio between theoretical transmission time and measured transmission time. It shows the relation between set parameters and actual transducer installation distance. This ratio should be between 97% ~ 103%.

If not in the range of 97%~103%, this means that the parameters and transducer installation distance are inconsistent. Please check.

8 Complete the Installation

- 1) Commonly used menus. M00 or M02 are for meter reading. M30~M33 are for unit selection. M40 is for selecting damping factor, generally 5~10 sec. M60 is for correcting time and date. M26 is for storing parameters.
- 2) To avoid signal reduction and improve signal quality, it is better to use the customized signal cable from flow meter manufacturer.
- 3) The length of cables between converter and transducer should be as short as possible, cannot exceed 200m.
- 4) The temperature and humidity of working environment should be in the range of technical specifications. Avoid direct sunlight on LCD.

9 Specifications

Main Unit Specifications

Principle: Transit-time

Accuracy: +/-1% of reading at rates >0.2mps

Linearity: 0.5%

Repeatability: 0.2%

Response Time: 0-999 seconds, user configurable

Flow Totalizers: 7-digit totals for net, positive and negative flow respectively

Display: LCD with backlight showing instantaneous flow rate, accumulated flow rate, fluid velocity, heat flow

Fluid Velocity: up to 32 m/s, bidirectional

Rate Units: Cubic Meter, Liter, USA Gallon, Imperial Gallon, Million USA Gallon, Cubic Feet, USA Liquid Barrel, Oil Barrel,(Time can be per day, per hour, per minute or per second)

Inputs: Two PT100 temperature sensor for heat flow measurement, one 4-20mA

Outputs: One channel isolated 4-20mA or 0-20mA. Isolated RS485 output, one channel open collector output, one relay

RS485 Communication Protocol: MODBUS ASCII, MODBUS RTU or Fuji Extended Protocol

Power: 8-36Vdc, 100-264 Vac 50/60HZ(FMT-25W-AE), 85-264 Vac 50/60HZ(FMT-25W-AB)

Power Consumption: Less than 1.5W

Temperature Range:-30°C to 80°C

Humidity: 85% RH

Transducer Specifications

Pipe Size: 1 to 240 inches transducer dependent(small:1-4 in., medium:2-28 in., large:12-240 in.)

Cable Length: 15 Ft

Protection Rating: IP68

Pipe/Liquid Specifications

Pipe Material: Standard entry for Carbon steel, Stainless Steel, Cast Iron, Ductile Iron, Copper, PVC, Aluminum, Fiberglass-epoxy, other pipes by entering material sound speed

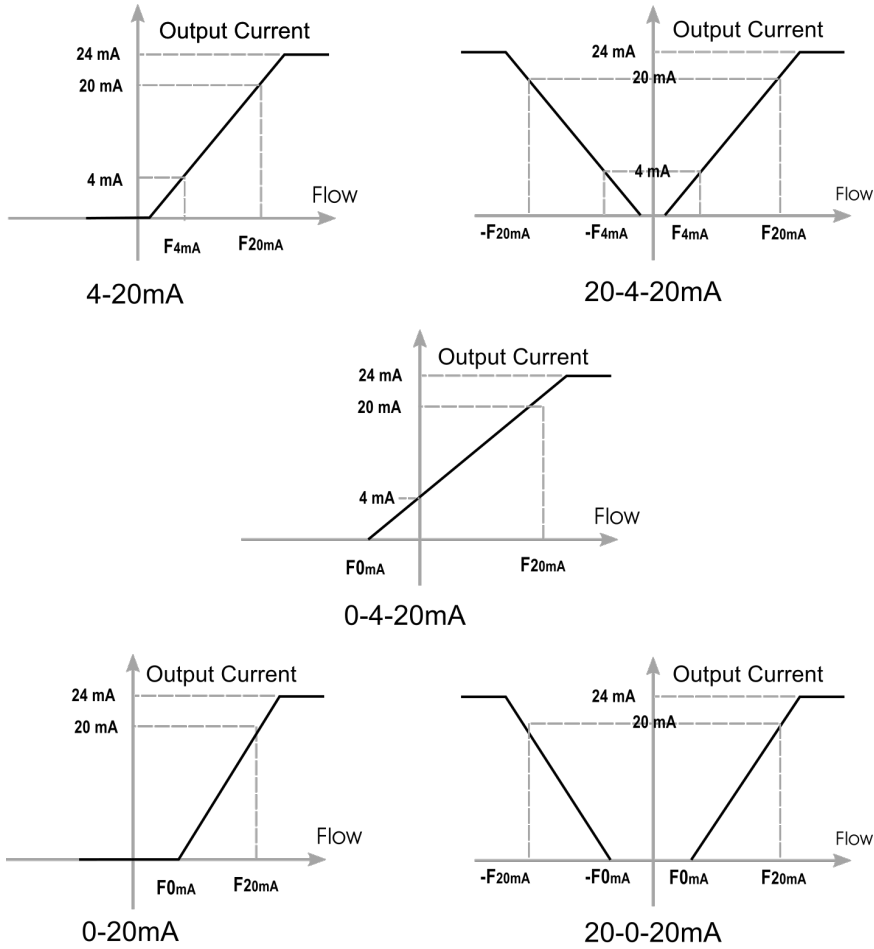
Liquids: Direct entry for water, salt(sea) water, kerosene, gasoline, fuel oil, crude oil, liquid propane, butane, diesel oil, castor oil, peanut oil, alcohol, other liquids supported by entering sound speed and viscosity

Appendix A. Sound speed data of liquid (unit: m/s)

Liquids	Sound speed
Water (20°C)	1482
Aceton	1190
Methanol	1121
Ethanol	1168
Alcohol	1440
Butanone	1310
Acetaldehyde	1180
Glycerin	1923
Petrol	1250
66# Petrol	1171
80# Petrol	1139
0# Diesel	1385
Phenol	1330
Ethyl benzene	1340
Toluene	1170
Phenixin	938
Coal oil	1420
Petroleum	1290
Pine oil	1280
Chlorylene	1050
Castor oil	1502
Glycol	1620
Peanut oil	1472

Appendix B

mA Current Signal Output



F_{0mA} , F_{4mA} - Scaled output for 0ma or 4ma set in M56
 F_{20mA} - Scaled output for 20ma set in M57

Warranty Terms

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