EPV Vortex Flowmeter
Operation Manual

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Contents

1. Reading Labels

Thanks for purchasing FineTek's Product. This operation manual describes the product features, working principles, operation and maintenance methods. It makes the user fully understand how to use the product correctly, so as to prevent dangerous situations such as device damage or operator injury.

- Please read this operation manual completely and carefully before using the product.
- Please contact the company if this operation manual can't satisfy your demands.
- The content of the operation manual is updated based on the version upgrade, which will be uploaded to the website for the user to access.
- Please don't disassemble or repair the product on your own, as this will make you disqualified from availing of the warranty service. Please send the product back to the company for repair and calibration, or just contact the company.
- Explanation of warning signs:

Danger→ It indicates that wrong operation will cause death or major disasters.

Note→ It indicates that wrong operation will cause injury and device damage to some extent.

Electric shock→ It warns of possible electric shock.

Fire→ It warns of possible fire.

Prohibited→ It indicates the prohibited wrong behavior.

2. Product Warranty

2.1 New Product Warranty

- We don't charge for the inspection, part/s and repair for the product of the company that has a defect within 12 months from the delivery date and meets the warranty terms.
- If the product defect is not due to human error during its transportation, user may change to a new unit from the company within 7 days from delivery date.
- When the product needs to be sent back to the factory for repair, please send the whole set, and don't disassemble the parts. Moreover, please be sure it is completely packed to avoid damage and causing more loss and defect during the transportation.
- The warranty is not available for causes that fall under the following circumstances, for which the company shall charge for the inspection, part/s and repair according to the actual condition:
  - The product or its parts are beyond the warranty period.
  - Fault or damage is caused by not following the instruction and use nvironment described on the operation manual.
  - The product damage is caused by a force majeure factor (natural disasters, floods, fire, earthquakes, lightning, typhoon, etc.), human destruction (scratches, dropping, latch broken, tapping, cracks and punching), human error (using improper voltage, high-humidity, water leakage, stain, corrosion, loss, improper storage, etc.) and other abnormal factors.
  - The damage is caused by the customer or the 3rd party through the installation, addition, expansion, modification and repair of parts not authorized or certified by the company.
  - The volume label information is wrong or unclear, so the product serial number can't be confirmed.

2.2 Repair Warranty

A **6-month** warranty service is provided for the repaired part of the product, during which the same product can be repaired free of charge in case of the same fault.

2.3 Service Network

Company	Address	Telephon	Fax
Taipei Headquarters (Taiwan)	No.16, Tzuchiang St., Tucheng Industrial Park, New Taipei City 23678	+886 2-2269-6789	+886 2-2268-6682
Taichung Sales office (Taiwan)		+886 4-2465-2820	+886 4-2463-9926
Kaohsiung Sales office (Taiwan)		+886 7-333-6968	+886 7-536-8758
Fine automation Co., Ltd. (China)	No. 451, Duhui Road, Zhuanqiao Township, Minhang District, Shanghai City 201109	+86 021-64907260	+86 021-6490-7276
FineTek Pte Ltd. (Singapore Branch)	37 Kaki Bukit Place, Level 4 Singapore 416215	+65 6452-6340	+65 6734-1878
FineTek GmbH (Germany Branch)	Bei den Kämpen 26 21220 Seevetal-Ramelsloh, Germany	+49 (0) 4185 8083 0	+49 (0) 4185 8083 80
FineTek Co., Ltd. (Indonesia Branch)	PERGUDANGAN TUNAS BITUNG JL. Raya Serang KM. 13,8, Blok C3 No. 12&15, Bitung Cikupa, Tangerang 15710	+62 021-2958-1688	+62 021-2923-1988

3. Product Inspection

3.1 Check Content

- Vortex Flowmeter 1 set
- User Manual 1 copy
- Product inspection list 1 copy

3.2 Safety Inspection

- Check the external package for deformations or damage before opening it; take photo(s) as evidence for possible compensation.
- After opening the package, check the content for deformations or damages; take photo(s) as evidence for possible compensation.
- Please carry out these checks as soon as you open the package to ensure that the
- contents and quantities match what you had purchased.
- If any of the aforementioned problems occur, please contact our company within seven days of receiving the product (with picture(s) attached). Failure to do so will result in no reimbursement, replacement, or repair.

3.3 Moving And Carrying

- Please refrain from dropping the product, knocking it against other objects, or exerting an excessive amount of force on it. Electric shock and damage may occur.
- Do not pull the probe of the cable with excessive force to prevent the cable from falling off or deviating from its normal position.

4. Product Features

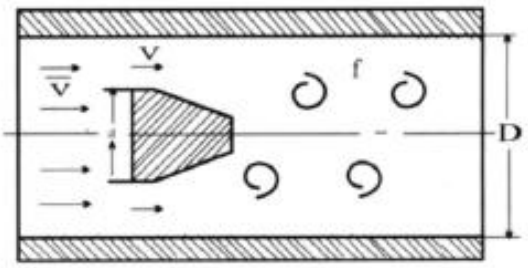
4.1 Product Features

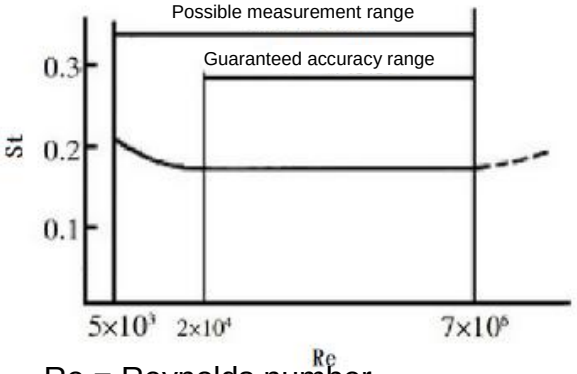
- 7~30Vdc power supply
- No movable mechanical parts, durable industrial design, high reliability.
- Measures volumetric flow of three types: liquids, gases, and steam.
- Temperature and pressure compensation functions can be performed through internal temperature transducers and external pressure gauges.
- LCM A liquid display module can show both instantaneous flow and total flow.
- 4-20mA output, pulse output, and S485 Modbus communication.
- User-friendly operation through three language interfaces: traditional Chinese, simplified Chinese, and English.

4.2 Working Principle

A vortex flowmeter's measurement principle involves measuring flow velocity based on the Karman Vortex Street Theory.

The Karman Vortex Street Theory refers to the unstable boundary layer separation of a bluff body submerged in a fluid under specific circumstances. Two asymmetrically arranged vortices will form on either side of the bluff body's downstream face, the vortex release frequency and the average speed of the flow that flows through the generator is related to the characteristic width of the vortex generator.





The working theory and formula are described as follows:

$$f=St\times\frac{V}{d}$$

Re = Reynolds number
St = Strouhal number
f = Karmen vortex frequency
V=flow velocity
d= bluff body face width

4.3 Working Principle

- Various liquid and gas mediums during chemical engineering production
- processes.
- Boiler steam applications, such as textile, food, feed industries, and so on.

5. Product Specifications

5.1 Specifications

Measuring techniques	Vortex street measurement method
Measurement mediums	Liquid / Gas / Steam (Note1)
Pipe dimensions	DN25、DN40、DN50、DN65、DN80、DN100
Flow range (Note2)	Upper limit of liquid flow velocity：10m/s; Upper limit of gas and steam flow velocity:80m/s
Measurement precision	Liquids: ±1%
	Gases and steam:±1%(Flow velocity≤35m/s)； ±1.5% (Flow velocity：35~80m/s)
Repetition	0.20%
Fluid temperature range	-30~250°C
Environmental temperature range	-30~80 °C
Working pressure range	-0.1MPa(-1kg/cm²) ~ Flange rating
Structural energy	Integrated flange type
Continuation pattern	Flange type
Pipe materials	SUS304
Junction box material	Aluminum alloy
Protection level	IP67
Power input	10.5~36Vdc
Screen dimensions	LCM 128*64 Pixel backlight-type
Push key	3 Press to operate
Temperature compensation	Built-in probe PT100
Voltage is supplied by a pressure gauge.	12Vdc
Current is supplied by a pressure gauge.	50mA
Pressure detection mode	0~5V / 0.5~4.5V / 1~5V
Communication interface	RS-485(Modbus)；BaudRate：9600,19200,38400,57600
Analog output	4~20mA / 0-20mA (Max. Load 700Ω)
Pulse mode	Pulse NO / Pulse NC / Frequency / Vortex Pulse
Pulse width	Automation (Pulse width50%)
Pulse Specifications	NPN Crystal output 32Vdc / 200mA
Pulse Output frequency	0~8KHz

Note 1: The pipe must be fully filled with liquid/gas/steam (Please avoid using multi-phase fluids and viscous fluids.)

※ Multi-phase liquids refer to mixtures of both liquids and gases.

Note 2: The flow measurement range varies due to fluid viscosity and Reynolds number. Refer to attachments 6.2~6.4.

5.2 Measurable water flow range

Pipe diameter	Guaranteed precision flow rates (M^3/h)	
	Lowest	Highest
25	1.7	18
40	2.6	44
50	3.3	73
65	4.7	109
80	7.2	144
100	14.1	248

Note: When water is at 15 ˚C, 1 atm , P=1000 kg/m^3.

5.3 Measurable air flow range

Pipe diameter	Guaranteed precision flow rates (M^3/h)	
	Lowest	Highest
25	21.7	141
40	32.8	361
50	42.1	565
65	52.6	877
80	62.3	1230
100	81.5	2120

Note: When air is at 15 ˚C, 1 atm , P=1.2257 kg/m^3.

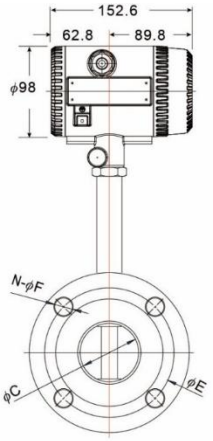
5.4 Measurable saturated steam flow range under working pressure

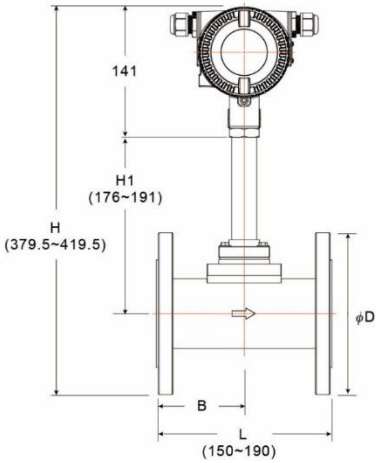
Pipe diameter	Flow limit	0.1 MPa	0.2 MPa	0.4 MPa	0.6 MPa	0.8 MPa	1 MPa	1.5 MPa	2 MPa	2.5 MPa	3 MPa
25	Min.	18.9	20	20.5	24.1	27.1	30	36	41	49	58
	Max.	169.7	247.7	400	548	696	843	1209	1575	1945	2318
40	Min.	29.2	32	40.6	47.7	53.8	59	72	93	116	138
	Max.	405	591	954	1310	1662	2012	2884	3759	4640	5532
50	Min.	44	53	67.3	79	89	98	119	156	192	229
	Max.	671	979	1580	2170	2753	3333	4778	6228	7688	9166
65	Min.	55.4	66	85	99	117	123	150	199	242	290
	Max.	990	1452	2340	3218	4084	4946	7092	9243	11412	13607
80	Min.	84.9	103	130	152	171	189	231	300	371	442
	Max.	1295	1891	3050	4188	5314	6435	9224	12024	14842	17694
100	Min.	148	179	227	267	300	330	402	524	647	772
	Max.	2261	3300	5326	7310	9276	11232	16102	20986	25907	30883

Note: The maximum flow velocity is lower than80m/s.

Saturated steam parameters										
Pressure (MPa)	0.1	0.2	0.4	0.6	0.8	1	1.5	2	2.5	3
temperature (℃)	120.4	134	152	165	175	184	201	215	227	235
Steam density(kg/m^3)	1.136	1.658	2.676	3.674	4.66	5.644	8.091	10.545	13.02	15.52

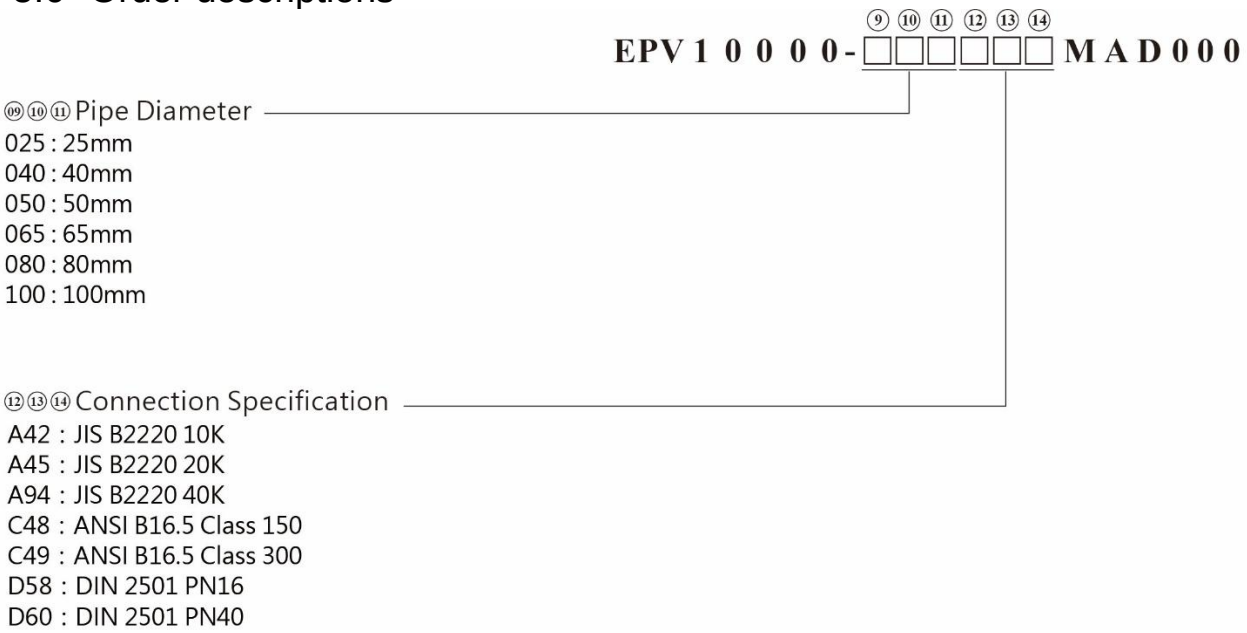
5.5 Exterior Specifications





Code	Flange specifications	D	E	F	N	H	L	B	C	H1
DN25	JIS 10K	125	90	19	4	378.5	150	75	25	175
	JIS 20K	125	90	19	4	378.5				
	JIS 40K	130	95	19	4	381				
	ANSI 150	107.95	79.38	15.88	4	370.0				
	ANSI 300	123.83	88.9	19.05	4	377.9				
	DIN PN16	115	85	14	4	373.5				
	DIN PN40	115	85	14	4	373.5				
DN40	JIS 10K	140	105	19	4	386.5	150	75	38.4	175.5
	JIS 20K	140	105	19	4	386.5				
	JIS 40K	160	120	23	4	396.5				
	ANSI 150	127	98.43	15.88	4	380				
	ANSI 300	155.58	114.3	22.23	4	394.3				
	DIN PN16	150	88	18	4	391.5				
	DIN PN40	150	88	18	4	391.5				
DN50	JIS 10K	155	120	19	4	398.8	170	85	49.5	180.3
	JIS 20K	155	120	19	8	398.8				
	JIS 40K	165	130	19	8	403.8				
	ANSI 150	152.4	120.65	19.05	4	397.5				
	ANSI 300	165.1	127	19.05	8	403.9				
	DIN PN16	165	125	18	4	403.8				
	DIN PN40	165	125	18	4	403.8				
DN65	JIS 10K	175	140	19	4	418.5	190	95	62.3	190
	JIS 20K	175	140	19	8	418.5				
	JIS 40K	200	160	23	8	431				
	ANSI 150	177.8	139.7	19.05	4	419.9				
	ANSI 300	190.5	149.23	22.23	8	426.3				
	DIN PN16	185	145	18	4	423.5				
	DIN PN40	185	145	18	8	423.5				
DN80	JIS 10K	185	150	19	8	426.1	200	100	73.9	192.6
	JIS 20K	200	160	23	8	433.6				
	JIS 40K	210	170	23	8	438.6				
	ANSI 150	190.5	152.4	19.05	4	428.9				
	ANSI 300	209.55	168.28	22.23	8	438.4				
	DIN PN16	200	160	18	8	433.6				
	DIN PN40	200	160	18	8	433.6				
DN100	JIS 10K	210	175	19	8	448.2	220	110	97.1	202.2
	JIS 20K	225	185	23	8	455.7				
	JIS 40K	250	205	25	8	468.2				
	ANSI 150	228.6	190.5	19.05	8	457.5				
	ANSI 300	254	200.03	22.23	8	470.2				
	DIN PN16	220	180	18	8	453.2				
	DIN PN40	235	190	23	8	460.7				

5.6 Order descriptions



5.7 Wiring Instructions

5.7.1 Electrical specifications

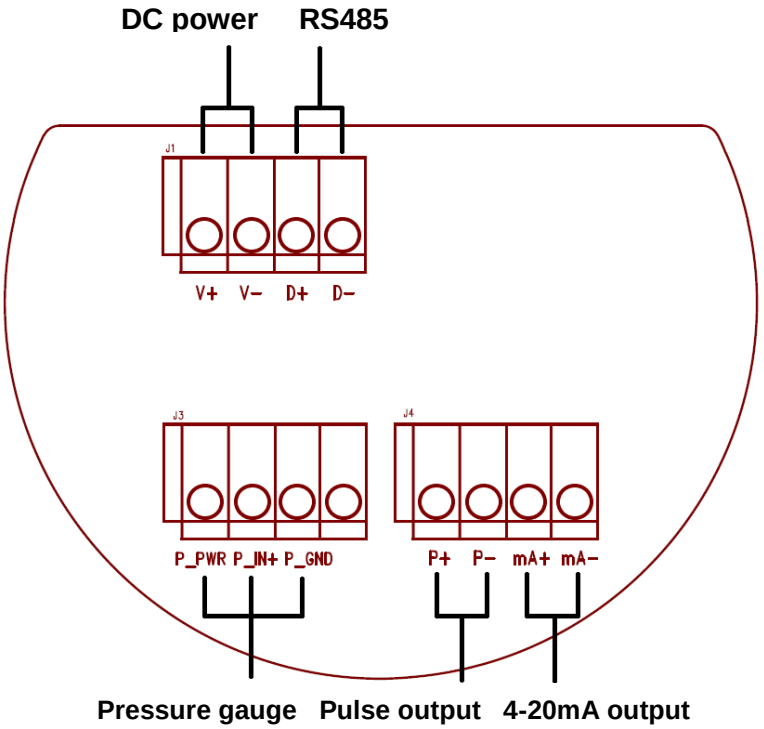
Input voltage: 10.5~24VDC

Input current: 300mA @12VDC ； 150mA @24VDC

5.7.2 Electrical Specifications

Pay attention to the following safety prompts before use.

Wiring is only permitted when the vortex flowmeter is in power interrupted mode.



Function	Terminal socket name	Remarks
DC power	V+	10.5~36VDC
	V-	
RS485	D+	
	D-	
Pressure gauge	P PWR	12VDC 50mA
	P IN+	0~5V / 0.5~4.5V / 1~5V
	P GND	
Pulse output	P+	
	P-	
4-20mA output	MA+	
	MA-	

6. Installation Instructions

For detailed operating instructions and methods, please refer to the instructions below:

- There are provisions for flowmeter design, testing, and power supply. Users must strictly follow the instructions to ensure that the flowmeter operates safely and normally.

6.1 Environmental safety

The user must comply with the following requirements to safeguard their physical safety and the safety of the equipment.

- Before selecting the position for installing the flow meter, the user must read the instructions provided in this Manual. The user is also required to consider the safety requirements for the environment where the flow meter, equipment and machine are installed.
- The flow meter shall be installed and serviced by people possessing a certain level of knowledge required for the flow meter.
- Correctly install the flowmeter to ensure the safety and reliability of the seal.
- Please take appropriate precautions to prevent accidental electrocution.

Mechanical installation

- Determine whether the flowmeter was damaged during installation.
- When installing, select a pipe location that produces less vibration. If necessary, mount a pipe support.
- The vortex flowmeter should be installed in the same direction as the fluid.
- The pipe connection screws should be securely fastened.
- Determine whether the pipe junction has abnormalities.
- The pressure exerted on the pipe must not exceed the specified maximum working pressure.
- Does the voltage of the operating power meet the indicated specifications?
- Make sure the pipe is filled with fluid. Avoid multi-phase fluids and viscous fluids.

6.2 Circuit installation

- It is recommended that wire with insulated rubber be used. The outer diameter of the wire insulation should be 4.8~7.8mm.
- The resistance of cables should not exceed 10Ω under standard 24VDC power supply conditions.
- The total impedance of the cable drawn from the current output terminal shall not be higher than the specified nominal value.
- The pulse or frequency output is generally NPN crystal output. An external power connection is required.

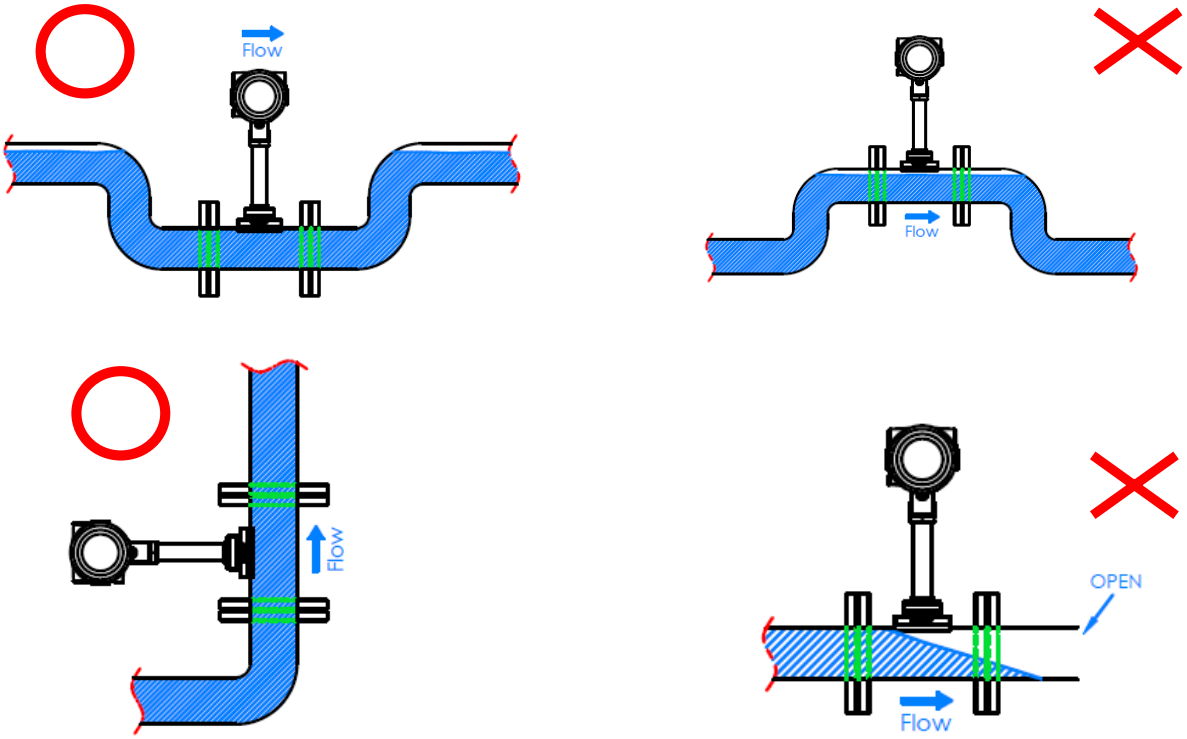
6.3 Installation position

Notes for basic installation:

- The vortex flowmeter should be installed in the same direction as the fluid.
- When installing, select a pipe location that produces less vibration. If necessary, mount a pipe support.
- Do not install the transducer in the pipeline connection area or in a pipe area with a welded gap. The smooth area of the pipe surface should be selected.
- To prevent interference with the testing signal, do not install multiple devices in the adjacent area.
- Do not use the same power source with inverter, the flow meter should be powered by an isolated power source
- Please ensure the pipe is fully filled with fluid, and refrain from using multi-phase and viscous fluids.
- Please review the requirements for liquid measurement and installation, air and steam measurement and installation, external pressure gauge installation, and straight pipe segments.

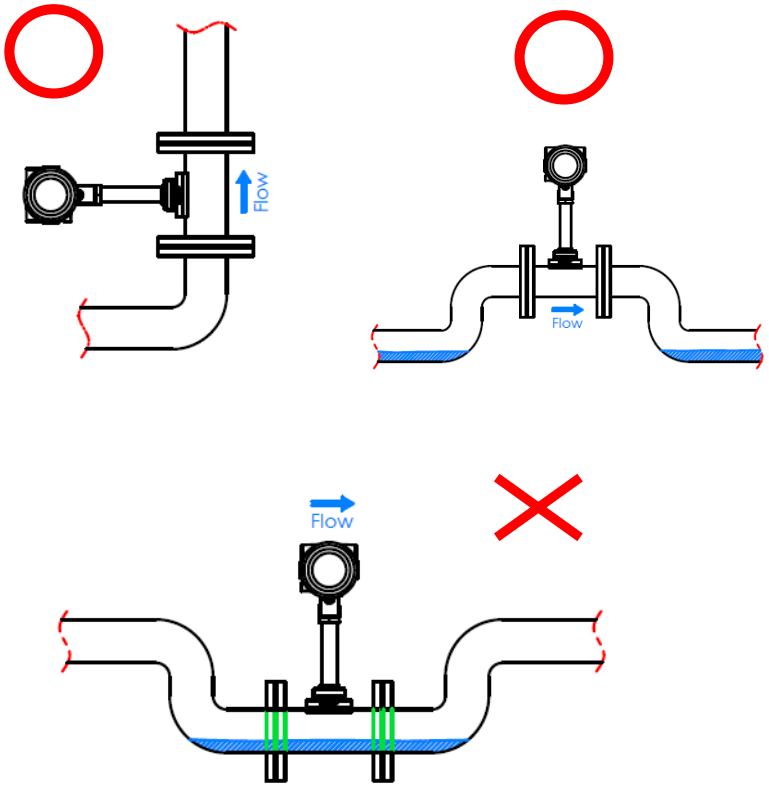
6.4.1 Liquid measurement

During liquid measurement, to avoid the liquid in the measuring tube from being in a non-full state, please install the flowmeter in the part that is fully filled with water.

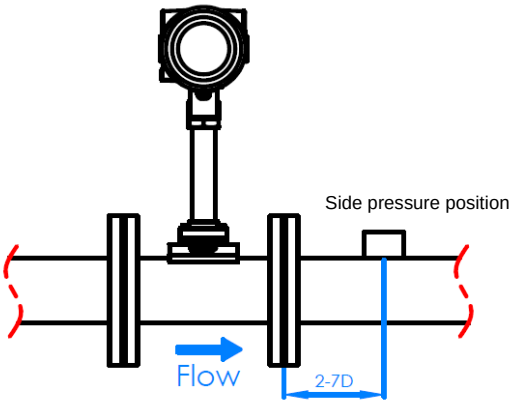


6.4.2 Air/steam measurement

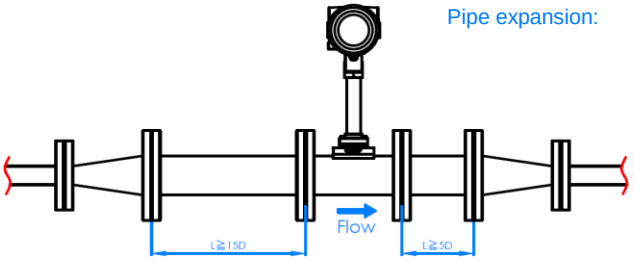
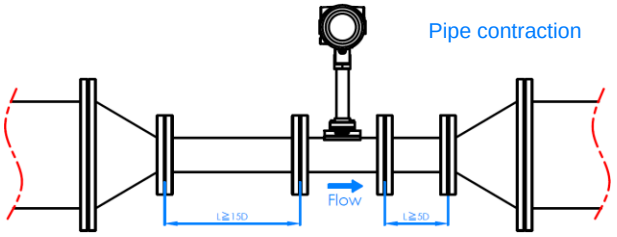
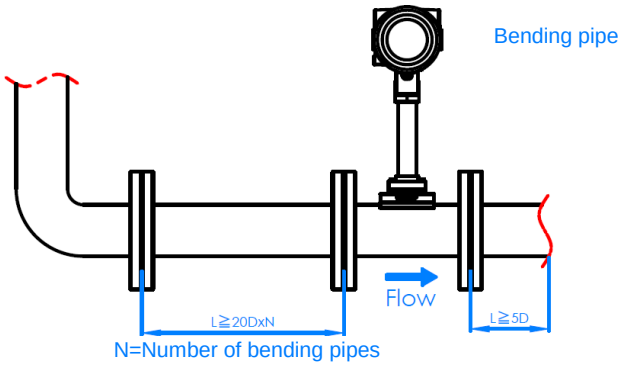
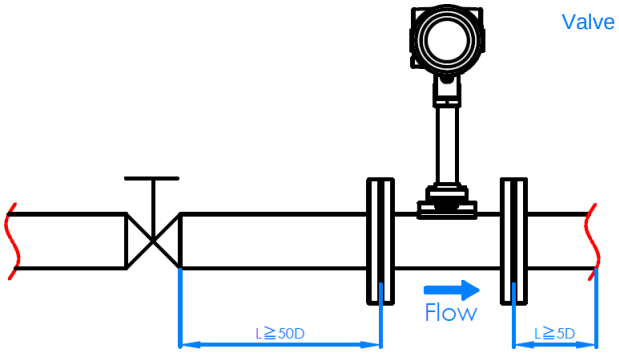
To prevent condensation in the tube during air/steam measurement, place the flowmeter high and away from water. Remember to drain the pipe.



6.4.3 The external pressure gauge should be installed between 2D and 7D distance downstream.



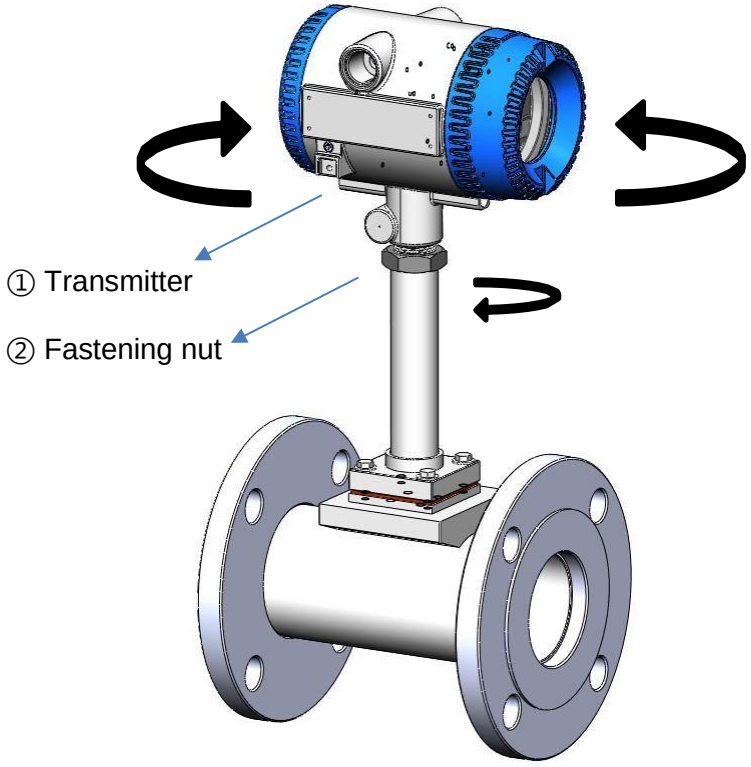
6.4.4 Straight pipe segment requirements

Divergent pipe Upstream straight pipe segment≧15D Downstream straight pipe segment≧5D	
Convergent pipe Upstream straight pipe segment ≧15D Downstream straight pipe segment ≧5D	
Bending pipe: The upstream is based on the number of bending pipes, the upstream straight pipe segment ≧20D×N Downstream straight pipe segment ≧5D	
Control valve : Install the valve at the flowmeter's low stream, with a length of ≧5D If installed in the upstream, the upstream straight pipe segment≧50D Downstream straight pipe segment≧5D	

(D=Outer diameter of the pipe)

Change of installation direction

6.5.1 Transmitter direction adjustments



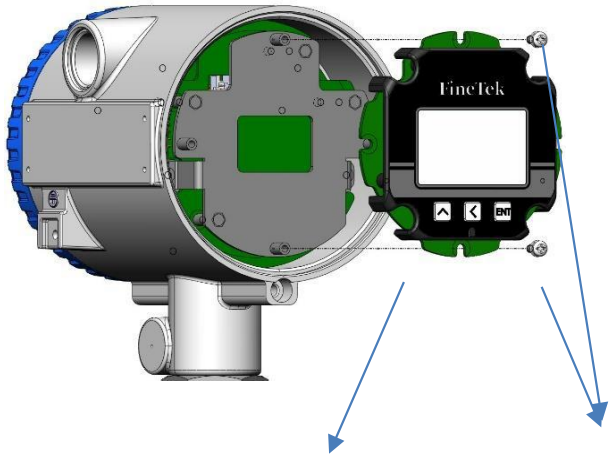
(1) Because the vortex flowmeter should be installed in accordance with the fluid direction, the transmitter direction can be adjusted as needed. First, turn off the power to the flowmeter.

(2) As illustrated, unscrew the fastening nut② and adjust ①the direction of the transmitter.

(3) To secure the transmitter, tighten the fastening nuts②.

Reminder: Do not disassemble the transmitter to avoid breaking the transducer cable.

6.5.2 Adjust the direction of the display screen module.



① Display screen ② Fastening screws

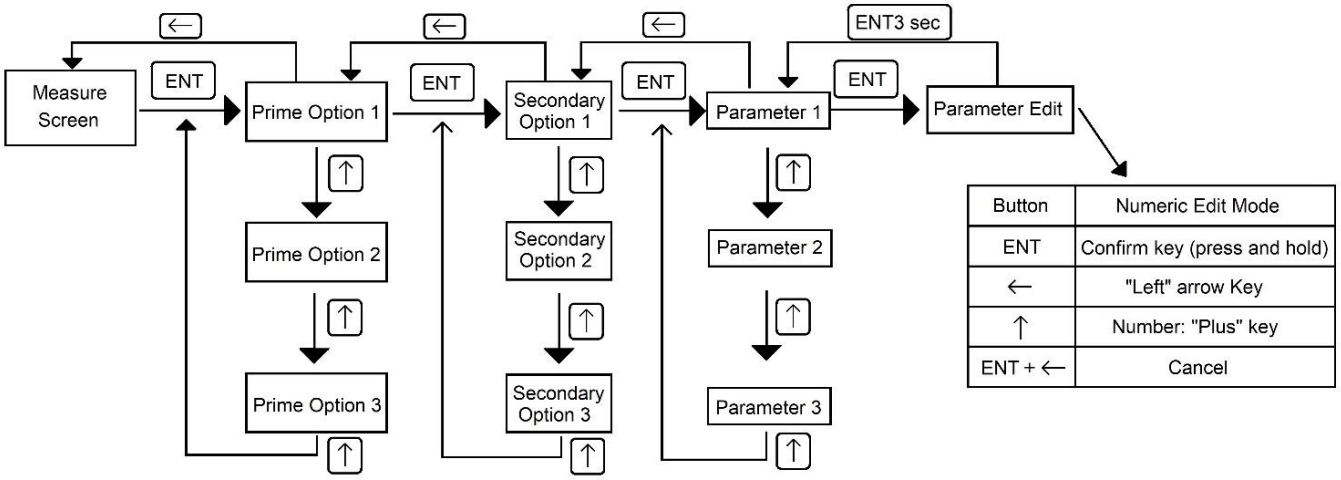
(1)The direction of the screen module can be changed depending on how the vortex flowmeter is installed. First, turn off the power to the flowmeter

(2)After opening the front cover of the screen, unscrew the fastening nut ② as shown to adjust the direction of the ① display screen.

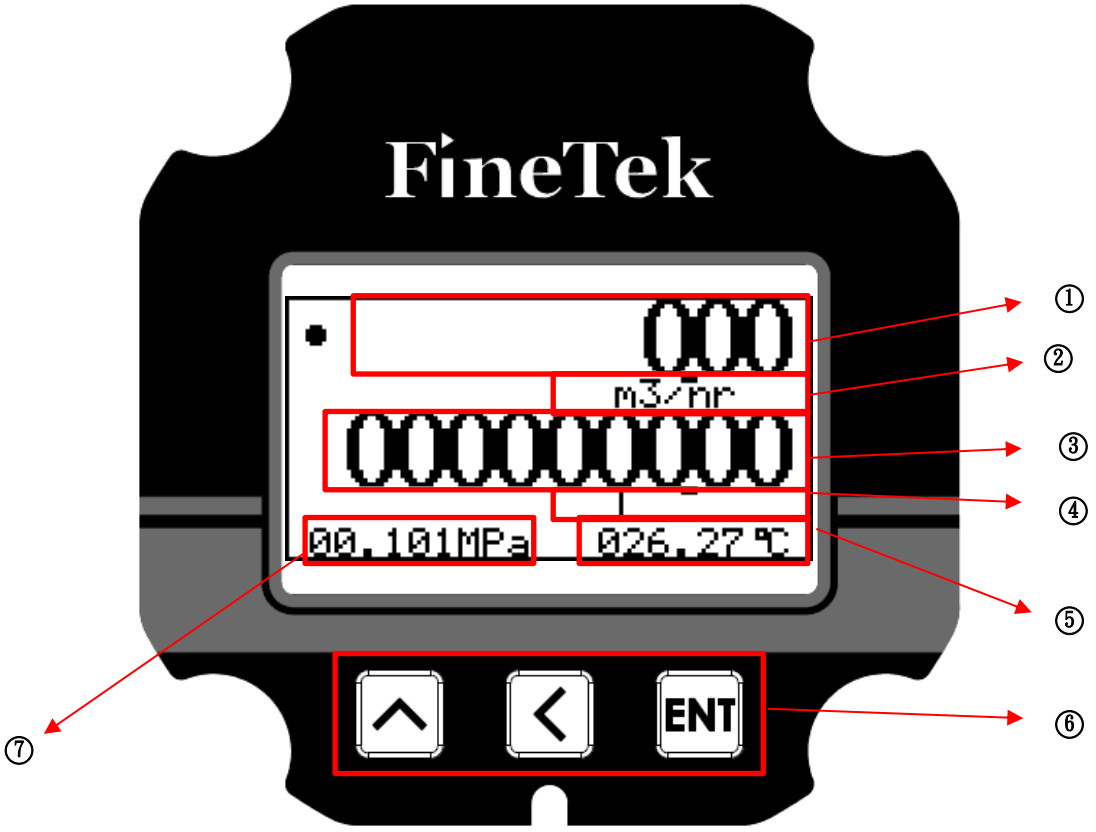
(3)To secure the display screen, screw the fastening screws② into place, followed by the front cover.

7. Description Of Parameter Functions

7.1 Menu process setting



7.2 Introduction of the display interface



① Instantaneous flow
② Instantaneous flow unit/time
③ Total flow
④ Total flow unit
⑤ Medium temperature
⑥ Operating key
⑦ Pressure of medium (is not displayed when pressure compensation is not activated.)

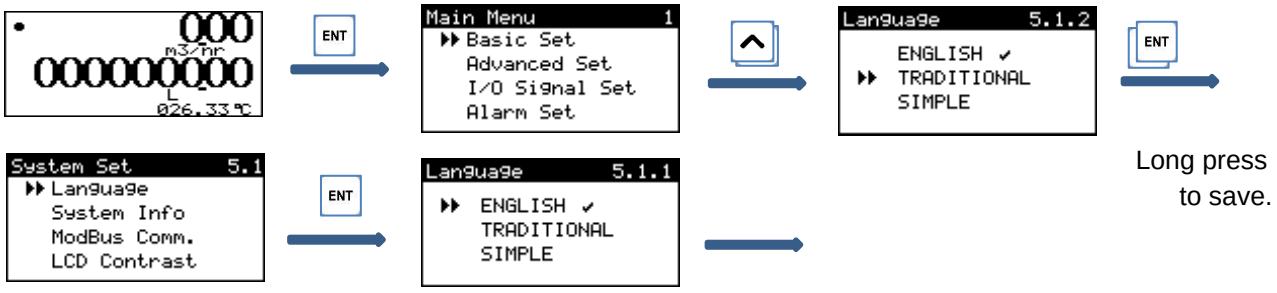
7.2.1 Description of the key functions

			Parameter Setting Interface		
Push key	Main Screen	Menu Mode	Read Only	Numeric Edit Mode	List Edit Mode
ENT	Enter menu	Enter submenu		Enter (press and hold)	Enter (press and hold)
←		Go back	Go back	"Left" arrow key	Go back
↑		Menu item (down)		Number: "Plus" button	Option: Page down
ENT+ ←				Cancel	

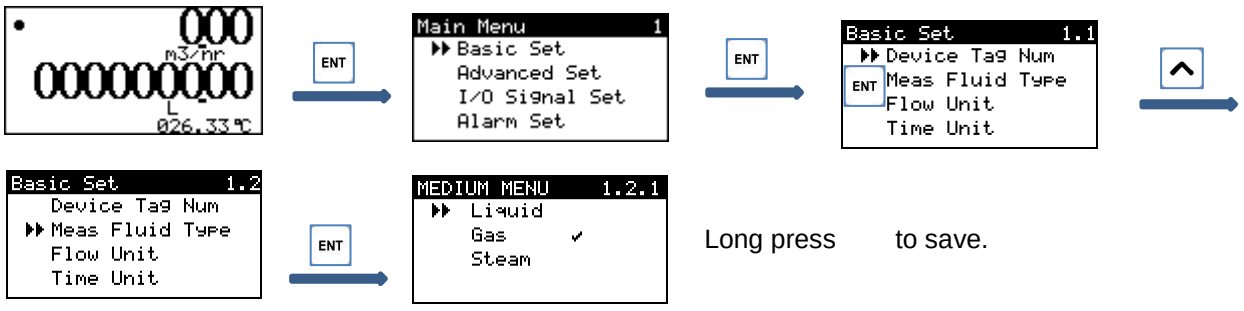
7.3 Functional process setting

7.3.1 Language adjustment methods

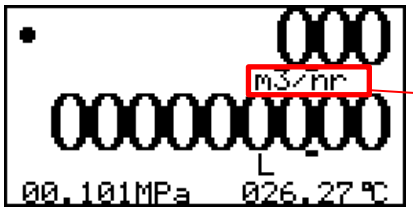
Press [ENT] on the measurement screen image to enter Main Menu



7.3.2 Press [ENT] on the type of measured fluid setting and measurement screen image.

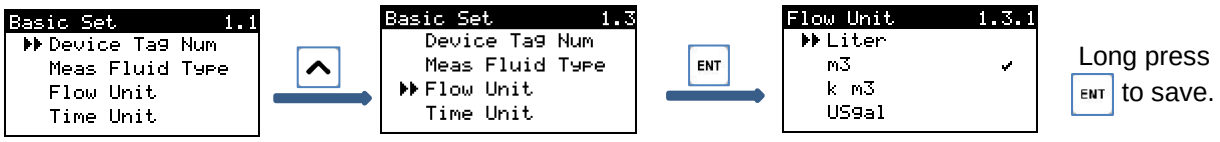


7.3.3 Instantaneous flow unit setting



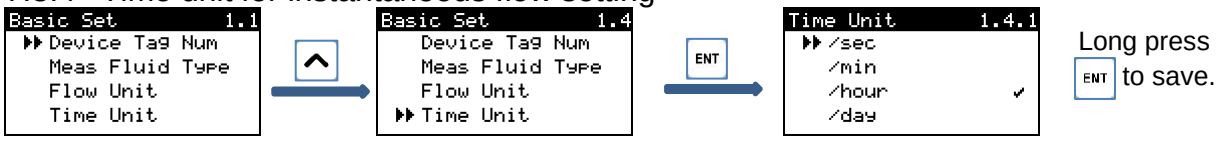
Flow rate = Instantaneous flow unit + Instantaneous flow time unit
(7.3.2) (7.3.3)

In the basic setting screen, press [^] to select the instantaneous flow unit.



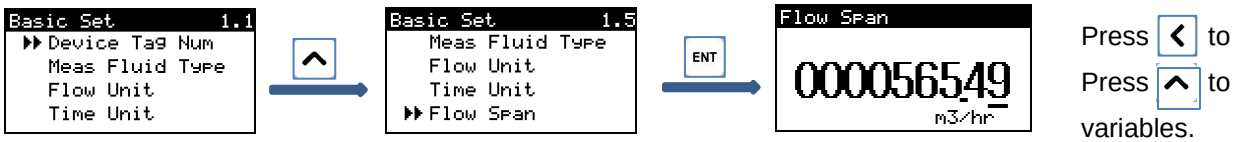
Long press [ENT] to save.

7.3.4 Time unit for instantaneous flow setting



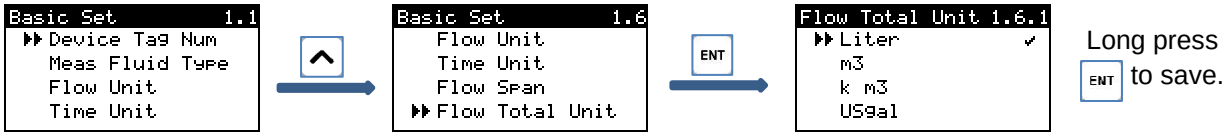
Long press [ENT] to save.

7.3.5 Flow rate span setting



Press [<] to select.
Press [^] to change variables.
Long press [ENT] to save.

7.3.6 Total flow unit setting



Long press [ENT] to save.

7.4 Pressure compensation function settings.

Our vortex flowmeter includes a built-in temperature transducer and an external pressure gauge that can perform temperature and pressure compensation based on the fluid type. The temperature compensation function activates automatically depending on the fluid type, while the pressure compensation function is set based on the fluid type.

Fluid type

Liquid: Temperature and pressure compensation is not required.

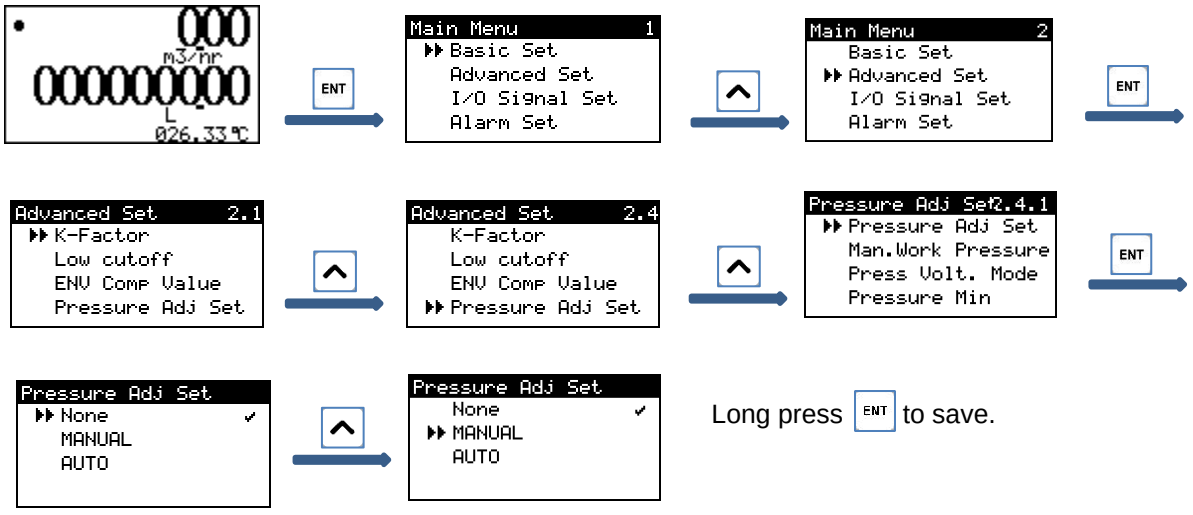
Gas: Changes with temperature and pressure; therefore, compensation function activation is required.

Steam: For saturated steam, temperature or pressure compensation are sufficient. As a result, the flowmeter will automatically apply temperature compensation; for superheated steam, the pressure compensation function must be activated.

7.4.1 Pressure compensation function-Manual settings.

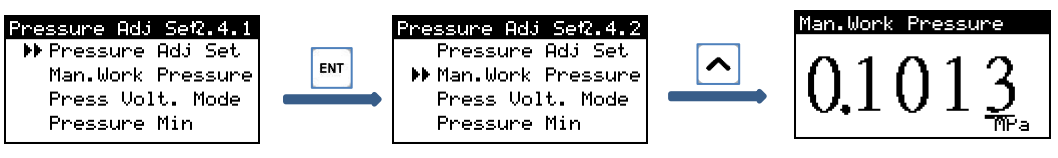
If there is no external pressure gauge but the pipe pressure value is known, manually adjust pressure compensation.

(1) Activate the pressure compensation function-Manual settings:



Long press ENT to save.

(2) Manual settings of working pressure



Press ‹ to select.

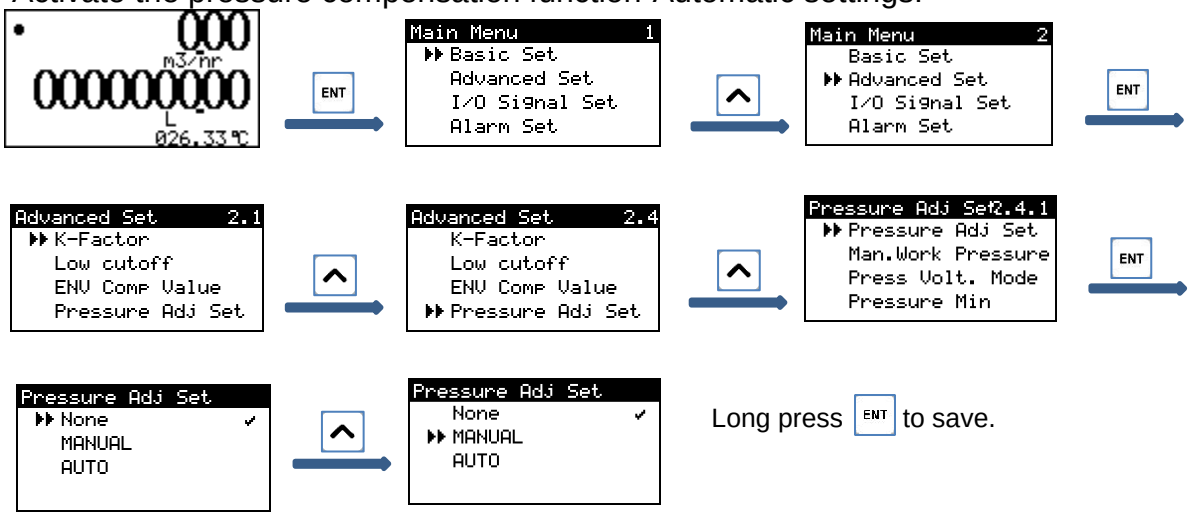
Press ^ to change variables.

Long press ENT to save.

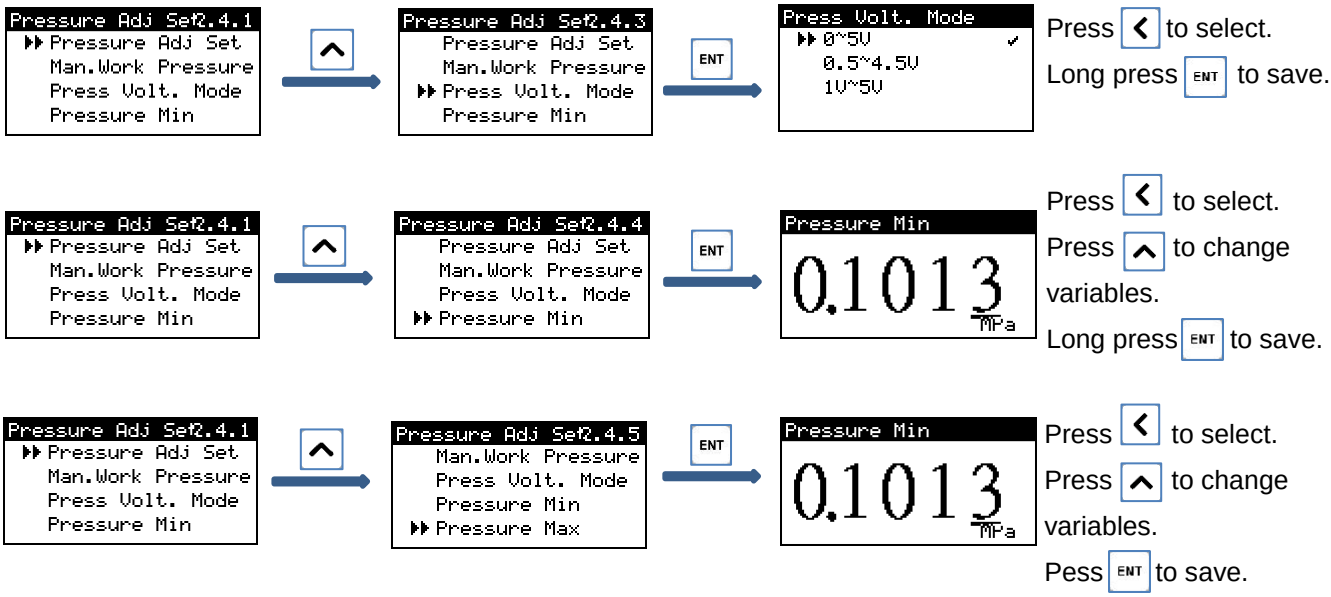
7.4.2 Pressure compensation function-Automatic settings

Detect the pipe pressure value through the external pressure gauge to perform automatic pressure compensation. Activate the pressure compensation function-Manual settings:

(1) Activate the pressure compensation function-Automatic settings:



(2) External pressure gauge setting:



Description of parameter function setting

Menu 1	Menu 2	Menu 3	Unit	Factory Value	Setting Range	Description of function
Basic Setting (1)	Device Tag Num (1.1)	N/A	-	00001	00001	Tag number for customer-end factory management
	Meas Fluid Type (1.2)	N/A	N/A	Gas	Liquid Gas Steam	Select the measured medium phase.
	Flow Unit (1.3)	N/A	-	m3	Liter (Volume) m3 (Volume) k m3 (Volume) Usgal (Volume) k USgal (Volume) bbl (Volume) k bbl (Volume) kg (Mass) t (Mass) NL (Normal) Nm3 (Normal) kNm3 (Normal) MNm3 (Normal)	The instantaneous flow rate is displayed automatically as “instantaneous flow unit + instantaneous flow time unit”.
	Time Unit (1.4)	N/A	-	/hour	/sec /min /hour /day	The instantaneous flow rate is displayed automatically as “instantaneous flow unit + instantaneous flow time unit”.
	Flow Span (1.5)	N/A	= Flow Unit + Time Unit	565.486	0000000.01~9999999.99	The system will correspond the span value set directly to 4-20mA output and frequency output value.
	Flow Total Unit (1.6)	N/A	-	Liter	Liter (Volume) m3 (Volume) k m3 (Volume) Usgal (Volume) k USgal (Volume) bbl (Volume) k bbl (Volume) kg (Mass) t (Mass) NL (Normal) Nm3 (Normal) kNm3 (Normal) MNm3 (Normal)	The system will display a setting unit for the Total Flow automatically.
	Total Reset (1.7)	N/A		No	No YES	Delete the total flow currently displayed.
Advanced Setting (2)	K-Factor (2.1)	N/A	P/L	Corrected K value	000.0001~999.9999	Vortex street parameters
	Low cutoff (2.2)	N/A	%	0.5	000.00~100.00	In the event of low flow or vibration, locate low-flow display masking. (Only displayed and accumulated when the flow rate is determined to exceed the specified value)
	ENV Comp Value (2.3)	N/A	-	1	0.0001~9.9999	Adjust compensation based on the status of work on-site.

	Pressure Adj Set (2.4)	Pressure Adj Set (2.4.1)	-	None	None MANUAL AUTO	Working pressure compensation is required for gas and superheated steam, but not for the rest. The manual settings have no pressure gauge; however, if the working pressure is known, simply enter the working pressure setting value. The Automatic settings use the 0-5 input to determine the working pressure.
Menu 1	Menu 2	Menu 3	Unit	Factory Value	Setting Range	Description of function
Advanced Setting (2)	Pressure Adj Set (2.4)	Pressure Adj Set (2.4.1)	-	None	None MANUAL AUTO	Working pressure compensation is required for gas and superheated steam, but not for the rest. The manual settings have no pressure gauge; however, if the working pressure is known, simply enter the working pressure setting value. The Automatic settings use the 0-5 input to determine the working pressure.
		Man.Work Pressure (2.4.2)	Mpa abs	0.101325	0.0000~9.9999	Manually set the working pressure setting value.
		Press Volt. Mode(2.4.3)	-	0~5V	0~5V 0.5~4.5V 1V~5V	Select the external pressure transmitter voltage input mode.
		Pressure Min (2.4.4)	Mpa abs	0.101325	0.0000~9.9999	Automatically measure the working pressure and the pressure represented by the lower limit voltage input.
		Pressure Max (2.4.5)	Mpa abs	1.101325	0.0000~9.9999	Automatically measure the working pressure and the pressure represented by the upper limit voltage input.
		P Min Fine-Tune (2.4.6)	count	0	-4095 ~ 4095	Adjust and automatically measure the baseline of working pressure lower limit voltage.
		P Max Fine-Tune (2.4.7)	count	0	-4095 ~ 4095	Adjust and automatically measure the baseline of working pressure upper limit voltage.
	Normal Temp/Pre (2.5)	Normal Temperature (2.5.1)	℃	0	000.00~999.99	Normal environmental temperature setting
		Normal Pressure (2.5.2)	Mpa abs	0.101325	0.0000~9.9999	Normal environmental pressure setting
	Other Material (2.6)	Material ADJ Set (2.6.1)	-	No	No YES	After activating the medium compensation function, temperature/pressure automatic measurement and compensation will be disabled.
		Dynamic Viscosity (2.6.2)	mPa·s	0.01868	000.0001~999.9999	The dynamic viscosity of a medium at working temperatures and pressures. (Preset: air, 1atm, 30℃)
		Working Density (2.6.3)	kg/m3	1.1649	0000.001~9999.999	The density of a medium under the working temperature and pressure. (Preset: air, 1atm, 30℃)
		STD Density (2.6.4)	kg/m3	1.1649	0000.001~9999.999	The density of a medium under the standard temperature and pressure (Preset: air, 1atm, 30℃)

	Total Flow Init Value (2.7)	N/A	Flow Total Unit	0	000000000~999999999	Set the starting value of the total flow (Operation commences only after clearing the total flow)

Menu 1	Menu 2	Menu 3	Unit	Factory Value	Setting Range	Description of function
I/O Signal Setting (3)	Damping Time (3.1)	N/A	second(s)	6	1~60	Output the mean value of the actual flow rate.
	Pulse Out Mode (3.2)	N/A	-	Pulse NO	Pulse NO Pulse NC Frequency Vortex Pulse	The starting state of the pulse output contact point, or frequency is used to express the flow rate; frequency represents the vortex frequency. Pulse No, NC is the potential state (high and low) of the total output. The frequency output must be combined with the options “flow range” and “maximum frequency setting” during the setting.
	Pulse Out Unit (3.3)	N/A	Total Unit/pulse	1	0000.001~9999.999	When “Pulse No, Nc” is selected, set the flow each pulse represents.
	Max Frequency (3.4)	N/A	Hz	2000	1~8000	When “Frequency output” is selected, the flow rate output is proportionally outputted based on the “full range of flow rates” and “maximum frequency setting”.
	Curr. Mode (3.5)	N/A	-	4-20	4-20 0-20	Select the current output mode.
	4mA Fine-Tune (3.6)	N/A	count	0	-9999 ~ 9999	Adjust the baseline of 4mA output.
	20mA Fine-Tune (3.7)	N/A	count	0	-9999 ~ 9999	Adjust the baseline of 20mA output.
Alarm Setting (4)	Curr Func (4.1)	N/A	-	OFF	OFF ON	Turn on and off the current alarm function.
	Low Limit Current (4.2)	N/A	mA	4	4.00~20.00	Set the current lower limit as the alarm baseline. (When it is lower than the setting value, the current output will be 3.6mA).
	High Limit Current (4.3)	N/A	mA	20	4.00~20.00	Set the current upper limit as the alarm baseline. (When it is higher than the setting value, the current output will be 22mA).

Menu 1	Menu 2	Menu 3	Unit	Factory Value	Setting Range	Description of function
System Setting (5)	Language (5.1)	N/A	-	English	English Traditional Chinese Simplified Chinese	The system will display the desired language.
	System Info (5.2)	System Parameter (5.2.1)			flow rate Temperature measurement value Pressure measurement value Actual vortex frequency value Caliber of converted vortex frequency value K-Factor Digital resistance value	For information reading only.
		FFT Graph (5.2.2)	-	-	Vortex signal FFT	For information reading only.
		Original image of vortex signal (5.2.3) (WAVE Graph)	-	-	Original image of vortex signal	For information reading only.
	ModBus Comm. (5.3)	Modbus ID (5.3.1)	N/A	1	001~255	Basic communication setting
		BaudRate (5.3.2)	BPS	9600	9600,19200,38400,57600	
		Parity (5.3.3)	N/A	None	None Even Odd	
		Stop bit (5.3.4)	N/A	1	1,2	
	LCD Contrast (5.4)	N/A	%	50	0/10/20/30/40/50/60/70/80/90/100	Select the displayed contrast and brightness.
	Recovery Default (5.5)	N/A	N/A	No	No YES	
Simulation(6) (Return to normal mode after leaving this menu)	Flow Speed (6.1)	N/A	m/s	0	00.000~99.999	Simulate the flow velocity and display the corresponding flow, so that the system can respond accordingly. (The MENU timeout mechanism does not appear in the Menu, no inclusion in the cumulant during simulation).
	Output Curr. (6.2)	N/A	mA	0	00.000~24.000	The system will react after the current output. The MENU timeout mechanism does not appear in the Menu.
	Output Freq. (6.3)	N/A	Hz	0	0000.0~9999.9	The pulse port will output the corresponding frequency. The MENU timeout mechanism does not appear in the Menu.

Information (7)		N/A	N/A	actual value	F.W Version F.W S/N DATE ID	

8. Transportation Requirements

8.1 Transportation requirements

To avoid product damage during transportation, please keep the packaging intact until it reaches the installation site, as it was during the manufacturer's dispatch and forwarding. During storage, the storeroom should meet the following requirements:

- Have the necessary precautions to prevent rain and moisture.
- Reduce vibration and prevent collisions during storage.
- Temperature range -20～70 °C
- Moisture under 80%

9. Maintenance

9.1 Daily maintenance

- Carry out inspections on the pressure sensor regularly to ensure that it is not obstructed by impurities or damaged. If it is obstructed, take appropriate cleaning measures. If it is damaged, replace the equipment.
- Before disassembling and reinstalling the equipment, ensure that the pressure pipe has discharged its pressure to prevent liquid leakage.
- When discarding the equipment, do so according to the national regulations and be environmentally friendly.
- When returning goods, ensure that the product is free of dirt, particularly hazardous or toxic substances. Should use proper packaging to avoid damaging the equipment.

10. Error message And Troubleshooting

If the flowmeter malfunctions and cannot meet the precision requirements, please try to rule out the problem using the table descriptions below.

Problem	Check	Troubleshooting
There is a screen image. The instantaneous flow has no numerical values, but the pipe has flow.	■ Determine whether the fluid's flow direction and the flowmeter installation direction are correct.	■ Change the direction of the flowmeter installation.
	■ Carry out inspections to ensure the fluid flow is within the measurable flow range.	■ Refer to 5.2 ~ 5.4 for the measurable flow ranges of various fluids.
	■ Determine whether the pipe is fully filled with the medium to be measured.	■ Multi-phase fluids cannot be measured. ■ Change the installation position to ensure the pipe is completely filled with fluid.
	■ Determine whether the length of the straight pipe segment is sufficient.	■ Refer to 6.4.4 for the straight pipe segment requirements.
	■ Is the correct measured fluid selected?	■ Select the correct measured fluid.
	■ Carry out inspections to ensure the low-flow value is too high.	■ Decrease the low-flow value.
The instantaneous flow is quantifiable but there is no flow through the pipe.	■ Carry out inspections to ensure the low-flow masking value is too small.	■ Increase the low-flow masking value.
	■ Carry out inspections on whether the pipe is vibrating vigorously.	■ Set up a pipe support device to eliminate the effects of vibration.
Unable to achieve precision.	■ Is the pipe filled with the measured medium?	■ Multi-phase fluids cannot be measured. ■ Change the installation position to completely fill the pipe with fluid.
	■ Is the length of a straight pipe sufficient?	■ Refer to 6.4.4 for the straight pipe segment requirements.
	■ Determine whether the measured liquid type selection is correct.	■ Set to the correct measured fluid type.

	■ Determine whether the pressure compensation function selection is correct.	■ Activation of pressure compensation is not required for liquids. ■ Activation of pressure compensation is required for air. ■ Activation of pressure compensation is not required if the steam used is saturated steam. ■ Activation of pressure compensation is required if the steam is superheated steam.
	■ Determine whether the flowmeter output connection is correct.	■ Reconnect and make sure the circuit is unobstructed.
	■ Carry out inspections on the flowmeter display to check whether the flow ■ has exceeded the set flow range.	■ Increase the flowmeter flow range.
	■ Carry out inspections to ensure the range setting is correct.	■ Ensure the flowmeter's range ■ matches that of the equipment that receives its signals.
The instantaneous flow rate is unstable.	■ Determine whether the length of the straight pipe is sufficient.	■ Refer to Figure 6.4.4 for requirements on the straight pipe segment.
	■ Check if the sealing gasket has partially blocked the pipe.	■ Reinstall the sealing gasket.
	■ Check if viscous substances adhered to the choked device. ■ (Normal previous output; abnormality after an extended period.)	■ Remove any viscous substances that are attached to the choked device.
	■ Check the pipe for intense vibrations.	■ Set up a pipe support to eliminate the impact of vibration.
	■ Check the average signal input time.	■ Increase the average signal input time.

There is no screen image on the boot.	■ Check to ensure the power, ■ switch, fuse, and other power supplies of the flowmeter are normal.	■ Exclude abnormalities to ensure that the flowmeter receives a proper power supply. ■ The flowmeter may be damaged. Please contact the manufacturer.
RS-485 Communication failure	■ Determine whether D+ and D- cable connection is reversed or disconnected.	■ Readjust the wiring.
	■ Verify whether the RS-485 converter can operate normally.	■ If the RS-485 cannot operate normally, please replace the RS-485 converter. ■ Contact the manufacturer.
No pulse output.	■ Check to ensure that there are additional power supply output(s).	■ The factory setting is passive NPN output, requiring an external power supply.

11. MODBUS Communication Protocol

Address(Hex)	Address(Dec)	Variable Name	Data Type	Unit	Range	Definition	Authority
0x1000	4096	gt_modbus_slave_fine_tek_id	UINT16	N/A		"IF"	Read only(Header)
0x1001	4097	gt_modbus_slave_fine_tek_id	UINT16	N/A		"EN"	Read only(Header)
0x1002	4098	gt_modbus_slave_fine_tek_id	UINT16	N/A		"T-"	Read only(Header)
0x1003	4099	gt_modbus_slave_fine_tek_id	UINT16	N/A		"KE"	Read only(Header)
0x1004	4100	PFC_PRODUCT_TYPE	UINT16	N/A		"EP"	Read only(Header)
0x1005	4101	PFC_PRODUCT_NUMBER	UINT16	N/A			Read only(Header)
0x1006	4102	PFC_PRODUCT_VERSION	UINT16	N/A			Read only(Header)

Address(Hex)	Address(Dec)	Variable Name	Data Type	Unit	Range	Definition	Authority
0x1028	4136	PFC_PRESSURE_kPa	UINT16	kPa		Current pressure value (When pressure compensation is not turned on, the default is 101kPa)	Read only
0x1029	4137	PFC_ADC_TEMPERATURE	FLOAT32	℃		Temperature	Read only
0x102A	4138						
0x102B	4139	PFC_DISPLAY_FLOW_RATE	FLOAT32	Rate Unit		The instantaneous flow value displayed on the screen	Read only
0x102C	4140						
0x102D	4141	PFC_FlowTotal_FRAM_FWD_VAL	FLOAT64	L		Current total	Read only
0x102E	4142						
0x102F	4143						
0x1030	4144						
0x1031	4145	PFC_DISPLAY_FLOW_SPEED	FLOAT32	m/s		instantaneous flow rate	Read only
0x1032	4146						
0x1057	4183	PFC_FlowTotal_FRAM_FWD_VAL_NL	FLOAT64	NL		Total accumulated value of standard flow rate	Read only
0x1058	4184						
0x1059	4185						
0x105A	4186						
0x105B	4187	PFC_FlowTotal_FRAM_FWD_KG	FLOAT64	Kg		Accumulated value of total mass flow rate	Read only
0x105C	4188						
0x105D	4189						
0x105E	4190						

Address(Hex)	Address(Dec)	Variable Name	Data Type	Unit	Range	Definition	Authority
0x1082	4226	PFC_TAG_NUM	UINT16	N/A	1 ~ 65535	Device Tag Num (1.1)	Read /Write
0x1083	4227	PFC_MATERIAL	UINT16	N/A	0: Liquid 1: Gas 2: Steam	Meas Fluid Type (1.2)	Read /Write
0x1084	4228	PFC_BASIC_SET_FLOW_UNIT	UINT16	N/A	0: L 1: M3 2: K_M3 3: US_GAL 4: K_US_GAL 5: BBL 6: K_BBL 7: KG 8: TON 9: NL 10: NM3 11: K_NM3 12: M_NM3	Flow Unit (1.3)	Read /Write
0x1085	4229	PFC_BASIC_SET_FLOW_TIME_UNIT	UINT16	N/A	0:/sec 1:/min 2:/hour 3:/day	Time Unit (1.4)	Read /Write
0x1086	4230	PFC_BASIC_SET_FLOW_TOTAL_UNIT	UINT16	N/A	0: L 1: m3 2: k m3 3: Usgal 4: k USgal 5: bbl 6: k bbl 7: kg 8: ton 9: NL 10: Nm3 11: k Nm3 12: M Nm3	Flow Total Unit (1.6)	Read /Write
0x1087	4231	PFC_LOAD_RESET_SETTING	UINT16	N/A	0: No 1: YES	Total Reset (1.7)	Read /Write
0x1088	4232	PFC_PRESSURE_ENA	UINT16	N/A	0. none 1. MANUAL 2. AUTO	Pressure Adj Set (2.4.1)	Read /Write
0x1089	4233	PFC_AUTO_P_TYPE	UINT16	N/A	0: 0 ~ 5V 1: 0.5 ~ 4.5V 2: 1 ~ 5V	Press Volt. Mode (2.4.3)	Read /Write
0x108A	4234	PFC_P_Min_offset	UINT16	N/A	-4095 ~ 4095	P Min Fine-Tune (2.4.6)	Read /Write
0x108B	4235	PFC_P_Max_offset	UINT16	N/A	-4095 ~ 4095	P Max Fine-Tune (2.4.7)	Read /Write
0x108C	4236	PFC_OTHER_MEDIAL_ENA	UINT16	N/A	0: disable 1: enable	Material ADJ Set (2.6.1)	Read /Write
0x108D	4237	PFC_MOVING_AVG_SEC	UINT16	sec	1 ~ 60	Damping Time (3.1)	Read /Write
0x108E	4238	PFC_PulseOutType	UINT16	N/A	0: Pulse NO 1: Pulse NC 2: Freq 3: Vortex Freq	Pulse Out Mode (3.2)	Read /Write
0x108F	4239	PFC_Max_Freq	UINT16	Hz	1 ~ 10000	Max Frequency (3.4)	Read /Write
0x1090	4240	PFC_CURRENT_TOP_BOTTOM	UINT16	mA	0: 4 ~ 20mA 1: 0 ~ 20mA	Curr. Mode (3.5)	Read /Write
0x1091	4241	PFC_4mA_offset	UINT16	N/A	-9999 ~ 9999	4mA Fine-Tune (3.6)	Read/Write
0x1092	4242	PFC_20mA_offset	UINT16	N/A	-9999 ~ 9999	20mA Fine-Tune (3.7)	Read/Write
0x1093	4243	PFC_ALARM_ENA	UINT16	N/A	0: OFF 1: ON	Curr Func (4.1)	Read /Write
0x1094	4244	PFC_LANGUAGE	UINT16	N/A	0. English 1. Traditional Chinese 2. Simplified Chinese	Language (5.1)	Read /Write
0x1095	4245	PFC_MODBUS_ID	UINT16	N/A	0 ~ 255	Modbus ID(5.3.1)	Read /Write
0x1096	4246	PFC_MODBUS_BAUDRATE	UINT16	N/A	0:9600bps 1:19200bps 2:38400bps 3:57600bps	BaudRate(5.3.2)	Read /Write
0x1097	4247	MODBUS_SLAVE_PARITY	UINT16	N/A	0. None 1. Even 2. Odd	Parity(5.3.3)	Read /Write
0x1098	4248	MODBUS_SLAVE_STOP_BIT	UINT16	N/A	0. 1 1. 2	Stop bit(5.3.4)	Read /Write
0x1099	4249	PFC_LCD_CONTRAST	UINT16	%	0 ~ 100	LCD Contrast (5.4)	Read /Write
0x109A	4250	PFC_RESTORE_FACTORY_SETTING	UINT16	N/A	0: No 1: YES	Recovery Default (5.5) (Different from UI)	Read /Write

Address(Hex)	Address(Dec)	Variable Name	Data Type	Unit	Range	Definition	Authority
0x10B8	4280	PFC_FLOW_SPAN_MULT	FLOAT32	Flow Rate Unit	0.01 ~ 9999999.99	Flow Span (1.5)	Read /Write
0x10B9	4281						
0x10BA	4282	PFC_BASIC_SET_K_FACTOR	FLOAT32	P/L	0.0001 ~999.9999	K-Factor (2.1)	Read /Write
0x10BB	4283						
0x10BC	4284	PFC_DISPLAY_SWITCH_LOW_LIMIT	FLOAT32	%	000.00 ~ 100.00	Low cutoff (2.2)	Read /Write
0x10BD	4285						
0x10BE	4286	PFC_BASIC_SET_K1_FACTOR	FLOAT32	N/A	0.0001 ~ 9.9999	ENV Comp Value (2.3)	Read/Write
0x10BF	4287						
0x10C0	4288	PFC_PRESSURE_MANUAL	FLOAT32	Mpa(abs)	0.0001 ~ 9.9999	Man.Work Pressure (2.4.2)	Read /Write
0x10C1	4289						
0x10C2	4290	PFC_PRESSURE_MIN	FLOAT32	Mpa(abs)	0.0001 ~ 9.9999	Pressure Min (2.4.4)	Read /Write
0x10C3	4291						
0x10C4	4292	PFC_PRESSURE_MAX	FLOAT32	Mpa(abs)	0.0001 ~ 9.9999	Pressure Max (2.4.5)	Read /Write
0x10C5	4293						
0x10C6	4294	PFC_TEMPERATURE_NORMAL	FLOAT32	℃	000.00 ~ 999.99	Normal Temperature (2.5.1)	Read /Write
0x10C7	4295						
0x10C8	4296	PFC_PRESSURE_NORMAL	FLOAT32	Mpa(abs)	0.0001 ~ 9.9999	Normal Pressure (2.5.2)	Read /Write
0x10C9	4297						
0x10CA	4298	PFC_Viscosity	FLOAT32	mPa·s	000.0001~999.9999	Dynamic Viscosity (2.6.2)	Read /Write
0x10CB	4299						
0x10CC	4300	PFC_OTHER_DENSITY	FLOAT32	kg/m3	0000.001~9999.999	Working Density (2.6.3)	Read /Write
0x10CD	4301						
0x10CE	4302	PFC_STD_DENSITY	FLOAT32	kg/m3	0000.001~9999.999	STD Density (2.6.4)	Read /Write
0x10CF	4303						
0x10D0	4304	PFC_TOTAL_INIT_VALUE	FLOAT64	Total Unit	0 ~ 999999999	Total Flow Init Value (2.7)	Read/Write
0x10D1	4305						
0x10D2	4306						
0x10D3	4307						
0x10D4	4308	PFC_PULSE_OUT_UNIT	FLOAT32	Total Unit/Pulse	0000.001 ~ 9999.999	Pulse Out Unit (3.3)	Read /Write
0x10D5	4309						
0x10D6	4310	PFC_DISPLAY_CURRENT_LOW_LIMIT	FLOAT32	mA	4~20	Low Limit Current (4.2)	Read /Write
0x10D7	4311						
0x10D8	4312	PFC_DISPLAY_CURRENT_HIGH_LIMIT	FLOAT32	mA	4 ~ 20	High Limit Current (4.3)	Read/Write
0x10D9	4313						
0x10DA	4314	PFC_FlowTotal_FRAM_FWD_VAL	FLOAT64	Liter		Current total	Read /Write
0x10DB	4315						
0x10DC	4316						
0x10DD	4317						
0x1100	4352	PFC_FlowTotal_FRAM_FWD_VAL_NL	FLOAT64	NL		Total accumulated value of standard flow rate	Read /Write
0x1101	4353						
0x1102	4354						
0x1103	4355						
0x1104	4356	PFC_FlowTotal_FRAM_FWD_KG	FLOAT64	KG		Accumulated value of total mass flow rate	Read /Write
0x1105	4357						
0x1106	4358						
0x1107	4359						

12. Appendices

12.1 Table of density of saturated steam

Temperature [℃]	Pressure [MPa]	Density [kg/m3]
100	0.1014	1.672
101	0.1051	1.617
102	0.1089	1.564
103	0.1128	1.514
104	0.1168	1.465
105	0.1209	1.418
106	0.1252	1.373
107	0.1295	1.33
108	0.134	1.288
109	0.1386	1.248
110	0.1434	1.209
111	0.1483	1.172
112	0.1533	1.136
113	0.1584	1.101
114	0.1637	1.068
115	0.1692	1.036
116	0.1748	0.9952
117	0.1805	0.9749
118	0.1864	0.946
119	0.1925	0.9181
120	0.1987	0.8912
120	0.1987	0.8912
121	0.2051	0.8653
122	0.2116	0.8402
123	0.2183	0.816
124	0.2252	0.7926
125	0.2322	0.77
126	0.2395	0.7482
127	0.2469	0.7271
128	0.2545	0.7068
129	0.2623	0.6871
130	0.2703	0.668
131	0.2785	0.6496
132	0.2869	0.6318
133	0.2954	0.6145
134	0.3042	0.5979

Temperature [℃]	Pressure [MPa]	Density [kg/m3]
135	0.3132	0.5817
136	0.3225	0.5661
137	0.3319	0.551
138	0.3415	0.5364
139	0.3514	0.5222
140	0.3615	0.5085
141	0.3719	0.4952
142	0.3825	0.4823
143	0.3933	0.4698
144	0.4044	0.4577
145	0.4157	0.446
146	0.4273	0.4346
147	0.4391	0.4236
148	0.4512	0.4129
149	0.4635	0.4025
150	0.4762	0.3925
151	0.4891	0.3827
152	0.5023	0.3732
153	0.5157	0.364
154	0.5295	0.3551
155	0.5435	0.3465
156	0.5578	0.3381
157	0.5725	0.3299
158	0.5874	0.322
159	0.6027	0.3143
160	0.6182	0.3068
160	0.6182	0.3068
161	0.6341	0.2995
162	0.6503	0.2925
163	0.6669	0.2856
164	0.6837	0.2789
165	0.7009	0.2724
166	0.7185	0.2661
167	0.7364	0.26
168	0.7546	0.254
169	0.7732	0.2482

Temperature [℃]	Pressure [MPa]	Density [kg/m3]
170	0.7922	0.2426
171	0.8115	0.2371
172	0.8312	0.2318
173	0.8513	0.2266
174	0.8718	0.2215
175	0.8926	0.2166
176	0.9138	0.2118
177	0.9355	0.2071
178	0.9575	0.2026
179	0.98	0.1982
180	1.003	0.1938
181	1.026	0.1896
182	1.05	0.1856
183	1.074	0.1816
184	1.099	0.1777
185	1.124	0.1739
186	1.149	0.1702
187	1.175	0.1666
188	1.201	0.1631
189	1.228	0.1597
190	1.255	0.1564
191	1.283	0.1531
192	1.311	0.1499
193	1.34	0.1469
194	1.369	0.1438
195	1.399	0.1409
196	1.429	0.138
197	1.46	0.1352
198	1.491	0.1325
199	1.523	0.1298
200	1.555	0.1272
200	1.555	0.1272
201	1.588	0.1247
202	1.621	0.1222
203	1.655	0.1198
204	1.689	0.1174
205	1.724	0.1151
206	1.76	0.1128
207	1.796	0.1106
208	1.833	0.1085
209	1.87	0.1064

Temperature [℃]	Pressure [MPa]	Density [kg/m3]
210	1.908	0.1043
211	1.946	0.1023
212	1.985	0.1003
213	2.025	0.09839
214	2.065	0.09652
215	2.106	0.09468
216	2.147	0.09288
217	2.189	0.09113
218	2.232	0.08941
219	2.276	0.08773
220	2.32	0.08609
221	2.364	0.08449
222	2.41	0.08292
223	2.456	0.08138
224	2.502	0.07988
225	2.55	0.0784
226	2.598	0.07696
227	2.647	0.07555
228	2.696	0.07418
229	2.746	0.07283
230	2.797	0.0715
231	2.849	0.07021
232	2.901	0.06894
233	2.954	0.0677
234	3.008	0.06649
235	3.063	0.0653
236	3.118	0.06413
237	3.174	0.06299
238	3.231	0.06187
239	3.289	0.06078
240	3.347	0.05971
240	3.347	0.05971
241	3.406	0.05865
242	3.466	0.05762
243	3.527	0.05661
244	3.589	0.05562
245	3.651	0.05465
246	3.715	0.0537
247	3.779	0.05277
248	3.844	0.05186
249	3.91	0.05096

12.2 Table of density of superheated steam

Pressure [MPa]	Temperature [℃]	Density [kg/m3]
0.1	100	0.590
0.1	105	0.581
0.1	110	0.573
0.1	115	0.565
0.1	120	0.558
0.1	125	0.550
0.1	130	0.543
0.1	135	0.536
0.1	140	0.529
0.1	145	0.523
0.1	150	0.516
0.1	155	0.510
0.1	160	0.504
0.1	165	0.498
0.1	170	0.492
0.1	175	0.487
0.1	180	0.481
0.1	185	0.476
0.1	190	0.470
0.1	195	0.465
0.1	200	0.460
0.1	205	0.455
0.1	210	0.451
0.1	215	0.446
0.1	220	0.441
0.1	225	0.437
0.1	230	0.432
0.1	235	0.428
0.1	240	0.424
0.1	245	0.420
0.1	250	0.416

Pressure [MPa]	Temperature [℃]	Density [kg/m3]
0.2	120	1.129
0.2	125	1.114
0.2	130	1.098
0.2	135	1.084
0.2	140	1.069
0.2	145	1.055
0.2	150	1.042
0.2	155	1.029
0.2	160	1.016
0.2	165	1.004
0.2	170	0.992
0.2	175	0.980
0.2	180	0.968
0.2	185	0.957
0.2	190	0.946
0.2	195	0.936
0.2	200	0.925
0.2	205	0.915
0.2	210	0.906
0.2	215	0.896
0.2	220	0.886
0.2	225	0.877
0.2	230	0.868
0.2	235	0.859
0.2	240	0.851
0.2	245	0.842
0.2	250	0.834

Pressure [MPa]	Temperature [℃]	Density [kg/m3]
0.3	135	1.644
0.3	140	1.621
0.3	145	1.599
0.3	150	1.577
0.3	155	1.557
0.3	160	1.537
0.3	165	1.517
0.3	170	1.498
0.3	175	1.480
0.3	180	1.462
0.3	185	1.445
0.3	190	1.428
0.3	195	1.412
0.3	200	1.396
0.3	205	1.380
0.3	210	1.365
0.3	215	1.350
0.3	220	1.336
0.3	225	1.322
0.3	230	1.308
0.3	235	1.294
0.3	240	1.281
0.3	245	1.268
0.3	250	1.256

Pressure [MPa]	Temperature [℃]	Density [kg/m3]
0.4	145	2.154
0.4	150	2.124
0.4	155	2.094
0.4	160	2.066
0.4	165	2.039
0.4	170	2.013
0.4	175	1.988
0.4	180	1.963
0.4	185	1.939
0.4	190	1.916
0.4	195	1.893
0.4	200	1.871
0.4	205	1.850
0.4	210	1.829
0.4	215	1.809
0.4	220	1.789
0.4	225	1.770
0.4	230	1.751
0.4	235	1.733
0.4	240	1.715
0.4	245	1.697
0.4	250	1.680

Pressure [MPa]	Temperature [℃]	Density [kg/m3]
0.5	155	2.644
0.5	160	2.606
0.5	165	2.571
0.5	170	2.536
0.5	175	2.503
0.5	180	2.471
0.5	185	2.440
0.5	190	2.410
0.5	195	2.381
0.5	200	2.353
0.5	205	2.325
0.5	210	2.299
0.5	215	2.273
0.5	220	2.247
0.5	225	2.222
0.5	230	2.198
0.5	235	2.175
0.5	240	2.152
0.5	245	2.130
0.5	250	2.108

Pressure [MPa]	Temperature [℃]	Density [kg/m3]
0.6	160	3.158
0.6	165	3.113
0.6	170	3.069
0.6	175	3.027
0.6	180	2.987
0.6	185	2.949
0.6	190	2.911
0.6	195	2.875
0.6	200	2.840
0.6	205	2.806
0.6	210	2.773
0.6	215	2.741
0.6	220	2.710
0.6	225	2.679
0.6	230	2.650
0.6	235	2.621
0.6	240	2.593
0.6	245	2.565
0.6	250	2.539

Pressure [MPa]	Temperature [℃]	Density [kg/m3]
0.7	165	3.666
0.7	170	3.612
0.7	175	3.561
0.7	180	3.512
0.7	185	3.465
0.7	190	3.419
0.7	195	3.376
0.7	200	3.333
0.7	205	3.292
0.7	210	3.253
0.7	215	3.214
0.7	220	3.177
0.7	225	3.141
0.7	230	3.105
0.7	235	3.071
0.7	240	3.037
0.7	245	3.005
0.7	250	2.973

Pressure [MPa]	Temperature [℃]	Density [kg/m3]
0.8	175	4.104
0.8	180	4.046
0.8	185	4.000
0.8	190	3.935
0.8	195	3.883
0.8	200	3.833
0.8	205	3.785
0.8	210	3.738
0.8	215	3.693
0.8	220	3.649
0.8	225	3.606
0.8	230	3.565
0.8	235	3.525
0.8	240	3.486
0.8	245	3.448
0.8	250	3.411

Pressure [MPa]	Temperature [℃]	Density [kg/m3]
0.9	175	4.653
0.9	180	4.589
0.9	185	4.523
0.9	190	4.459
0.9	195	4.399
0.9	200	4.340
0.9	205	4.284
0.9	210	4.230
0.9	215	4.177
0.9	220	4.126
0.9	225	4.077
0.9	230	4.029
0.9	235	3.983
0.9	240	3.938
0.9	245	3.894
0.9	250	3.852

Pressure [MPa]	Temperature [℃]	Density [kg/m3]
1.0	180	5.145
1.0	185	5.066
1.0	190	4.992
1.0	195	4.922
1.0	200	4.854
1.0	205	4.790
1.0	210	4.727
1.0	215	4.667
1.0	220	4.609
1.0	225	4.553
1.0	230	4.498
1.0	235	4.446
1.0	240	4.395
1.0	245	4.345
1.0	250	4.297

Pressure [MPa]	Temperature [℃]	Density [kg/m3]
1.1	190	5.534
1.1	195	5.453
1.1	200	5.376
1.1	205	5.302
1.1	210	5.231
1.1	215	5.163
1.1	220	5.097
1.1	225	5.034
1.1	230	4.972
1.1	235	4.913
1.1	240	4.855
1.1	245	4.799
1.1	250	4.745

Pressure [MPa]	Temperature [℃]	Density [kg/m3]
1.2	190	6.086
1.2	195	5.994
1.2	200	5.906
1.2	205	5.822
1.2	210	5.742
1.2	215	5.665
1.2	220	5.591
1.2	225	5.520
1.2	230	5.451
1.2	235	5.385
1.2	240	5.320
1.2	245	5.258
1.2	250	5.198

Pressure [MPa]	Temperature [℃]	Density [kg/m3]
1.3	195	6.544
1.3	200	6.445
1.3	205	6.350
1.3	210	6.260
1.3	215	6.174
1.3	220	6.091
1.3	225	6.012
1.3	230	5.935
1.3	235	5.861
1.3	240	5.790
1.3	245	5.721
1.3	250	5.654

Pressure [MPa]	Temperature [℃]	Density [kg/m3]
1.4	195	7.103
1.4	200	6.992
1.4	205	6.886
1.4	210	6.786
1.4	215	6.690
1.4	220	6.598
1.4	225	6.510
1.4	230	6.425
1.4	235	6.343
1.4	240	6.264
1.4	245	6.188
1.4	250	6.114

Pressure [MPa]	Temperature [℃]	Density [kg/m3]
1.5	200	7.551
1.5	205	7.432
1.5	210	7.319
1.5	215	7.213
1.5	220	7.111
1.5	225	7.013
1.5	230	6.920
1.5	235	6.830
1.5	240	6.743
1.5	245	6.660
1.5	250	6.579

Pressure [MPa]	Temperature [℃]	Density [kg/m3]
1.6	205	7.986
1.6	210	7.861
1.6	215	7.743
1.6	220	7.631
1.6	225	7.524
1.6	230	7.421
1.6	235	7.322
1.6	240	7.227
1.6	245	7.136
1.6	250	7.048

Pressure [MPa]	Temperature [℃]	Density [kg/m3]
1.7	210	8.413
1.7	215	8.282
1.7	220	8.158
1.7	225	8.040
1.7	230	7.928
1.7	235	7.820
1.7	240	7.717
1.7	245	7.617
1.7	250	7.521

Pressure [MPa]	Temperature [℃]	Density [kg/m3]
1.8	210	8.973
1.8	215	8.829
1.8	220	8.693
1.8	225	8.564
1.8	230	8.441
1.8	235	8.324
1.8	240	8.211
1.8	245	8.103
1.8	250	7.999

Pressure [MPa]	Temperature [℃]	Density [kg/m3]
1.9	210	9.548
1.9	215	9.385
1.9	220	9.236
1.9	225	9.095
1.9	230	8.961
1.9	235	8.834
1.9	240	8.712
1.9	245	8.595
1.9	250	8.482

Pressure [MPa]	Temperature [℃]	Density [kg/m3]
2.0	215	9.952
2.0	220	9.788
2.0	225	9.634
2.0	230	9.488
2.0	235	9.350
2.0	240	9.218
2.0	245	9.091
2.0	250	8.970

Pressure [MPa]	Temperature [℃]	Density [kg/m3]
2.1	215	10.532
2.1	220	10.349
2.1	225	10.181
2.1	230	10.022
2.1	235	9.872
2.1	240	9.730
2.1	245	9.593
2.1	250	9.463

Pressure [MPa]	Temperature [℃]	Density [kg/m3]
2.2	220	10.920
2.2	225	10.736
2.2	230	10.564
2.2	235	10.402
2.2	240	10.248
2.2	245	10.101
2.2	250	9.961

Pressure [MPa]	Temperature [℃]	Density [kg/m3]
2.3	220	11.518
2.3	225	11.301
2.3	230	11.114
2.3	235	10.939
2.3	240	10.773
2.3	245	10.615
2.3	250	10.464

Pressure [MPa]	Temperature [℃]	Density [kg/m3]
2.4	225	11.875
2.4	230	11.673
2.4	235	11.483
2.4	240	11.304
2.4	245	11.135
2.4	250	10.973

Pressure [MPa]	Temperature [℃]	Density [kg/m3]
2.5	230	12.240
2.5	235	12.036
2.5	240	11.843
2.5	245	11.661
2.5	250	11.488

Pressure [MPa]	Temperature [℃]	Density [kg/m3]
2.6	230	12.817
2.6	235	12.596
2.6	240	12.389
2.6	245	12.194
2.6	250	12.010

Pressure [MPa]	Temperature [℃]	Density [kg/m3]
2.7	230	13.405
2.7	235	13.166
2.7	240	12.943
2.7	245	12.734
2.7	250	12.537

Pressure [MPa]	Temperature [℃]	Density [kg/m3]
2.8	230	13.998
2.8	235	13.745
2.8	240	13.506
2.8	245	13.282
2.8	250	13.071

Pressure [MPa]	Temperature [℃]	Density [kg/m3]
2.9	235	14.334
2.9	240	14.077
2.9	245	13.837
2.9	250	13.612

Pressure [MPa]	Temperature [℃]	Density [kg/m3]
3.0	235	14.934
3.0	240	14.657
3.0	245	14.400
3.0	250	14.160