FIXINST

F232x

Electromagnetic Flow Meter

· Instrucion Manual ·

Preface

- Thank you for purchasing our product.
- This manual is about the various functions of the product, wiring methods, setting methods, operating methods, troubleshooting methods, etc.
- Please read this manual carefully before operation, use this product correctly to avoid unnecessary losses due to incorrect operation.
- After you finish reading, please keep it in a place where it can be easily accessed at any time for reference during operation.

Note

- Modification of this manual’s contents will not be notified as a result of some factors, such as function upgrading.
- We try our best to guarantee that the manual content is accurate, if you find something wrong or incorrect, please contact us.
- The content of this manual is strictly prohibited from reprinting or copying.

Version

U-L-PUS-CGDL/GDL-PUS-EN1

Safety Precautions

For the safe operation of this product, please strictly follow the outlined safety precautions.

About this manual

- Please ensure the instrument operators have a careful reading of this manual.
- Prior to operation, please study this manual in detail to ensure a thorough comprehension of the device’s functionality.
- This manual only describes the product’s functions. The responsibility as to the device ‘s suitability for any specific purpose lies solely in the operator.

Precautions for product protection, safety, and modification

- For your safety and the normal operation of the product and its controlling systems, the guidelines and precautions specified in this manual are supposed to be fully observed. Operating the instrument in ways not specified in this manual may compromise its protective features. Our company shall not be liable for any malfunctions or accidents resulting from non-compliance with the precautions described.
- When equipped the product and its controlling systems with lightning protection or separate safety protection circuits, it needs to be implemented by other devices.
- If you need to replace components or fittings of the product, please use the model specified by the company.
- This product is not designed for use in systems directly related to personal safety, such as nuclear power facilities, radioactive equipment, railway systems, aviation equipment, marine equipment, and medical equipment. If applied, it is the user’s responsibility to implement additional equipment or systems to ensure personal safety.
- Do not modify this product.
- The following safety symbols are used in this manual:

Hazard: Failure to take appropriate precautions may result in serious personal injury, product damage, or major property loss.

Warning: Pay special attention to critical information related to the product or specific sections of this user manual.

- Confirm whether the supply voltage is consistent with the rated voltage before operation.
- Do not use the instrument in a flammable and combustible or steam area.
- To prevent electric shock and operation errors, ensure proper grounding protection is in place.
- Thunder prevention engineering facilities must be well managed: the shared grounding network shall be grounded at the correct electric level, shielded, with wires properly routed, and an SPD surge protector applied as needed.
- Some internal components may carry high voltage. To avoid the risk of electric shock, do not open the front square panel unless it is being handled by trained personnel or maintenance staff authorized by our company.
- To avoid electric shock, disconnect the power before performing any checks.
- Check the condition of the terminal screws regularly. If loose, please tighten them before use.
- Unauthorized disassembly, modification, or repair of the product is not allowed, as it may lead to malfunctions, electric shock, or fire hazards.
- Wipe the product with a dry cotton cloth. Do not use alcohol, benzine, or other organic solvents, and avoid exposing the product to any liquids. If the product falls into the water, please cut off the power immediately to prevent leakage, electric shock, or fire hazards.

- Please check the grounding protection regularly. Do not operate the product if you think that the protection, such as grounding protection and fuses, is inadequate.
- Ventilation holes on the product housing must be kept clear to avoid malfunctions due to high temperatures, abnormal operation, shortened life, and fire.
- Please strictly follow the instructions in this manual; failure to do so may damage the product’s protective devices.

- Do not use the instrument if it is found damaged or deformed upon opening the package.
- Prevent dust, wire end, iron fines, or other objects from entering the instrument during installation, as this may cause abnormal operation or failure.
- During operation, to modify the configuration, signal output, startup, stop, and operation safety shall be fully considered. Improper operation may lead to failure and even destruction of the instrument and control equipment.
- Each part of the instrument has a certain service life, which must be maintained and repaired on a regular basis for long-term use.
- If the product comes to the end of its service life, it should be disposed of as industrial waste as a way of environmental protection.
- Disconnect the instrument when it is not in use.
- If you find smoke from the product, smell odor, abnormal noise, etc., please turn off the power switch immediately and contact the company in time.

Disclaimer

- The company does not make any guarantees for the terms beyond the scope of this product warranty.
- This company is not responsible for damage to the instrument, loss of parts, or unpredictable damage caused directly or indirectly by improper operation of the user.

No.	Items	Quantity
1	Electromagnetic flowmeter	1
2	User manual	1
3	Certificate	1
4	Test report	1

After opening the box, please confirm the scope of delivery before starting the operation. If you find that the model and quantity are incorrect or there is physical damage to the product's appearance, please contact us.

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1 Introduction

1.1 Overview

The operating principle of electromagnetic flowmeter is based on Faraday's law of electromagnetic induction. The two electromagnetic coils at the upper and lower ends as shown in Figure 1 generate a constant or alternating magnetic field. When the conductive medium flows through the electromagnetic flowmeter, the induced electromotive force can be detected between the left and right electrodes on the wall of the flowmeter tube. The magnitude of the induced electromotive force is proportional to the electrically conductive medium flow rate, the magnetic induction density of the magnetic field, and the width of the conductor (the inner diameter of the flowmeter measuring tube), and the flow rate of the medium can be obtained by calculation. The induced electromotive force equation is as follows:

$$E=K\times B\times V\times D$$

Where: E—Induced electromotive force

K—Meter constant

B—Magnetic induction density

V—Average flow speed in cross-section of measuring tube

D—Inner diameter of measuring tube

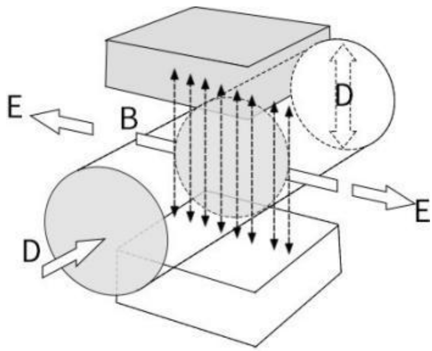


Fig.1

When measuring the flow, the fluid flows through a magnetic field which is perpendicular to the flow direction. The flow of conductive fluid induces a potential proportional to the average flow velocity, thus requiring the conductivity of the measured flowing liquid to be higher than the minimum conductivity.The induced voltage signal is detected by two electrodes and transmitted to the converter via a cable. After a series of analog and digital signal processing, the accumulated flow and real-time flow are displayed on the display of the converter.

1.2 Structure

The electromagnetic flow meters mainly consist of two parts: sensor and converter. The sensor includes a flange, a lining, an electrode, a measuring tube, an excitation coil, and a sensor casing, etc; the converter includes an internal circuit board and a converter casing.

The electromagnetic flowmeter is mainly consisted of the following parts, see Fig.2.

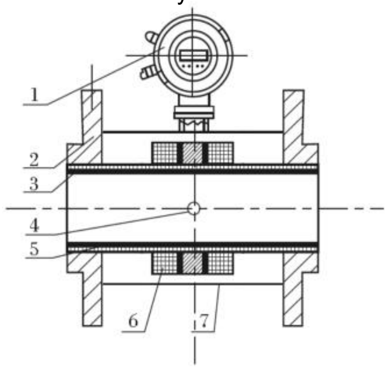


Fig.2

The electromagnetic flowmeter mainly consists of a sensor and a converter. The sensor includes a flange, a lining, an electrode, a measuring tube, an excitation coil, and a sensor casing, etc; the converter includes an internal circuit board and a converter casing.

(1) Converter: Provide stable excitation current for the sensor, meanwhile amplify the induced electromotive force obtained by the sensor and convert it to standard electrical signals or frequency signals; at the same time, it displays real-time flow and parameters for displaying, controlling and adjusting thereof.

(2) Flange: for connecting process piping.

(3) Lining: Refer to a complete layer of electrically insulating corrosion resistant material located at the inner side of measuring tube and flange sealing surface.
(4) Electrode: A pair of electrodes is installed on the wall of the measuring tube which is perpendicular to the magnetic line to detect the flow signal. The material of electrode can be selected according to the corrosion performance of the measured medium. It is also equipped with 1-2 grounding electrodes for grounding and anti-interference of flow signal measurement.
(5) Measuring tube: The measured medium flows through the measuring tube. It is made by welding non-magnetic stainless steel and flange, and the inner side is equipped with insulation lining.
(6) Excitation coil: A group of coils is arranged on the upper and lower side of external side of the measuring tube respectively to generate a working magnetic field.
(7) Casing: Protect and seal the meter.

1.3 Operating Environment

Electromagnetic flowmeters are only suitable for measuring the instantaneous flow of conductive liquids or liquid-solid two-phase fluids and are equipped with flow accumulation functions. Typically, the flowmeter’s factory parameters are preset according to the order specifications. Users do not need to configure the parameters before use, but they must check the nameplate to ensure that the parameters have been correctly preset and verify them against the actual operating conditions.

In theory, a standard electromagnetic flowmeter can be used when the conductivity of the medium is no less than 5 μS/cm. However, in practice, the measurable conductivity for standard electromagnetic flowmeters should be one to two orders of magnitude higher than the theoretical threshold, and should be at least greater than 30 μS/cm. Additionally, conductivity must be measured online to ensure accuracy. Offline measurements may result in artificially elevated conductivity values due to the dissolution of carbon dioxide and nitrogen oxides from the air into the medium.

2 Installation

2.1 Installation Tips

Note!

Please check whether the boxes are damaged or not, and whether they have been handled roughly or not. Please report the damage to the courier service and the manufacturer.

Note!

Please check the packing list to make sure the batch of goods that you have received is complete.

Note!

Please check the instrument nameplate, and confirm whether the delivered contents are consistent with your order. Check whether the power supply indicated on the nameplate is correct. If not
correct, please contact the manufacturer.

Note!

The installation diagram is for reference only, please refer to the actual product.

2.2 Storage

(1) The instrument shall be stored in a dry and clean place.

(2) Avoid exposure in direct sunlight for long.

(3) Instrument shall be stored in the original package.

2.3 Installation Requirements

The following measures are suggested to be taken to ensure reliable installation.

(1) Leave enough space on the side.

(2) Do not make the electromagnetic flowmeter subject to violent vibration.

2.4 Pipe Design

(1) Location

① The electromagnetic flowmeter should be installed in a dry, well-ventilated place that is not prone to water pooling.

② The flowmeter shall be protected from direct sunlight and rain. If installed outdoors, appropriate shielding or protective measures must be taken against sun and rain exposure. The ambient temperature ranges from -20°C to +60°C.

③ The flowmeter shall not be installed in places with large temperature variation and avoid high temperature radiation. If it must be installed therein, heat insulation and ventilation measures shall be taken.

④ The flowmeter shall avoid installing in an environment containing corrosive gases. If it is unavoidable, ventilation and anti-corrosion measures shall be taken.

⑤ The flowmeter shall be installed avoiding strong vibration as possible, such as violent pipe vibration. In this case, brackets for fixing pipes on both sides of the flowmeter shall be provided.

⑥ Part of the sensor of flowmeters with IP68 (3m under water) protection level can be placed into the water. While the flowmeter with IP65 protection level cannot be immersed into the water or installed outdoors.

(2) Avoid interference of magnetic field

Do not install flowmeters near motors, transformers, or other power sources which are prone to cause electromagnetic interference, near the frequency converter or obtain power from the power distribution cabinet of the frequency converter to avoid interference.

(3) Length of inlet and outlet runs

In order to ensure the measurement accuracy of flowmeter, it is recommended to ensure that the length of inlet runsof the sensor shall be at least 10 times of pipe diameters (10D), and the length of outlet runs be at least 5 times of pipe diameters (5D) .

(4) Maintenance space

For the convenience of installation and maintenance, enough installation space shall be reserved around the electromagnetic flowmeter.

(5) For pipes that do not allow flow disruption in the process

When installing the electromagnetic flowmeter, bypass pipes and cleaning ports shall be added. As shown in Fig.7, these devices can ensure the continuous operation of equipment system when the flowmeter is out of service.

(6) Support of electromagnetic flowmeter

Do not install the electromagnetic flowmeter on a free-vibrating pipe without any support. Instead, a mounting base shall be used to secure the measuring tube. When the electromagnetic flowmeter is required to be installed underground, the pipes at both inlet and outlet ends shall be provided with support items, and a metal protection plate shall be installed above the flowmeter.

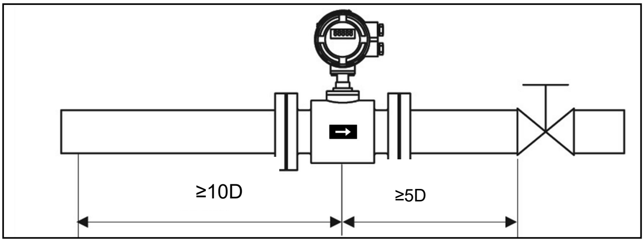


Fig.3

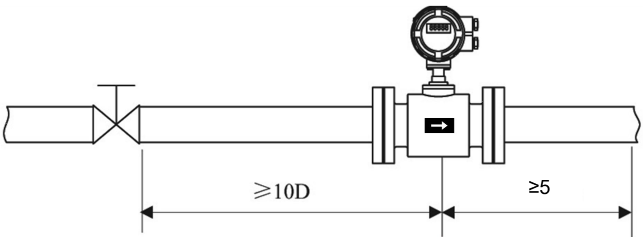


Fig.4

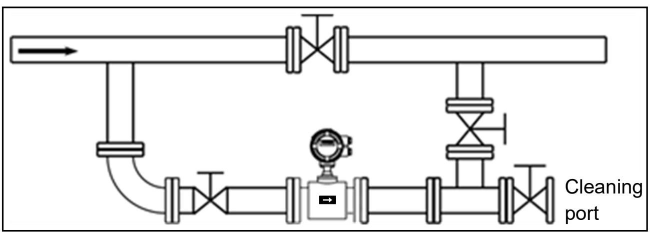


Fig.5

2.5 Installation Conditions

(1) **Flow direction**

The flowmeter can be set to automatically detect the positive and negative flow direction. The flow direction arrow on the sensor casing indicates the positive flow direction specified by the manufacturer. Generally, when installing the meter, the user shall make the flow arrow consistent with the on-site process flow.

Fig.6 shows the preferred location for installing the electromagnetic flowmeter.

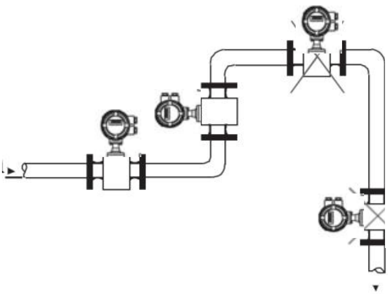


Fig.6

(2) **Installation direction of the flowmeter and sensor electrodes**

The sensor allows horizontal and vertical installation. When it's installed horizontally, the electrode shall be horizontally placed such that bubbles will not be adsorbed near the electrode in case that the medium is contained with bubbles or precipitates. Otherwise, this would cause converter signals opened and zero drift due to the fact that deposits are not covered by the electrode.

(3) **Liquids shall always be filled with pipes.**

Pipes shall be arranged to ensure that the electromagnetic flowmeter measuring tube is always filled with liquids.

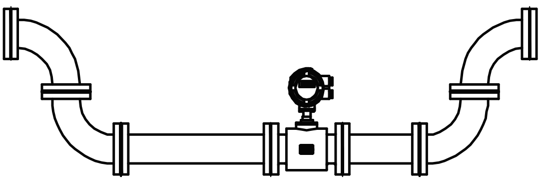


Fig.7

In case of liquids or suspensions containing solid particles, it is recommended to install electromagnetic flowmeters vertically. For one thing, the phase separation of measured medium can be prevented; for another, the sensor lining is worn evenly. In addition, impurities will not precipitate at the bottom of the measuring tube.

It shall be guaranteed that liquids flow from bottom to top to ensure that the sensor measuring tube is always filled with medium.

(4) The electromagnetic flowmeter cannot be installed on the suction side of the pump.

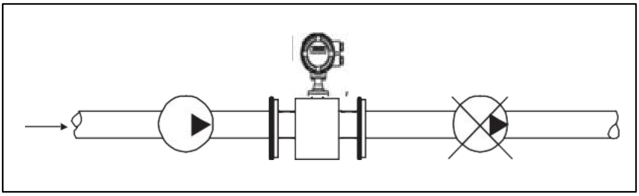


Fig.8

(5) For long pipelines, control valves are generally installed on the downstream of the electromagnetic flowmeter.

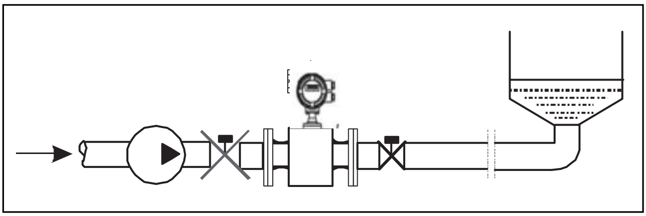


Fig.9

(6) For pipes with open discharges, the electromagnetic flowmeter shall be installed at the bottom section (lower part of the pipe).

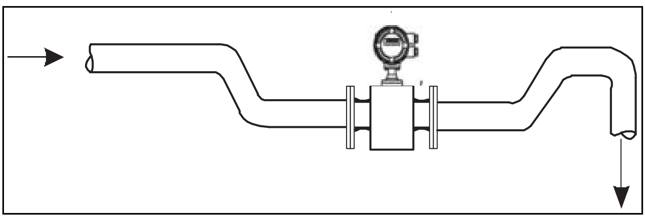


Fig.10

(7) For places where fall head of pipes is over 5 m, the air valve shall be installed on the downstream of the electromagnetic flowmeter.

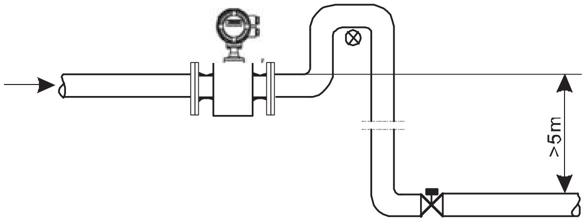


Fig.11

(8) Measurement errors caused by the ingress of foreign gas and damage to the lining caused by vacuum should be avoided.

(9) No bubbles shall be observed in the pipes.

Pipes shall be designed to prevent the air bubbles in the fluids from accumulating the measurement pipe of a sensor. If a valve exists near the flowmeter, try to mount the flowmeter on the valve's upstream side for preventing a decrease of pressure inside the pipe possibly, consequently avoiding the possibility of air bubbles.

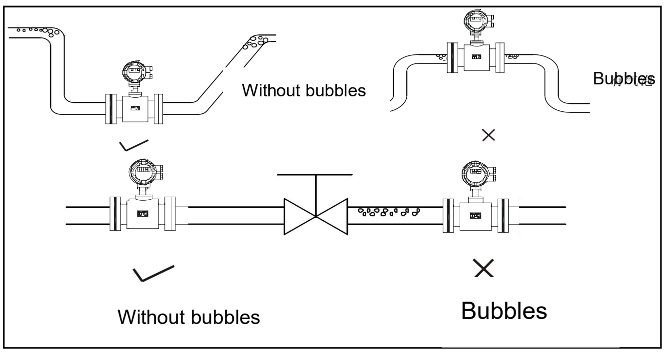


Fig.12

(10) Liquid conductivity

It's not allowed to install the electromagnetic flowmeter at a place where the liquid conductivity is extremely uneven. Injection of chemicals from the upstream of the meter can easily result in uneven liquid conductivity, which can cause serious interference to the meter flow indication. In this case, it is recommended to inject chemicals from the downstream of the meter; if chemicals must be injected from the upstream of the meter, it must be ensured that the straight pipe section on the upstream at least has 30 times of pipe diameters to ensure adequate mixing of liquids.

(11) Grounding

As the voltage of induced signal of electromagnetic flowmeter is small, it's more prone to be affected by noises or other electromagnetic signals. This is why the electromagnetic flowmeter needs to be grounded in many occasions. This functions to form an internal space for shielding external interference through the grounding of flowmeter casing, thereby improving measurement accuracy.

2.6 Mechanical Installation

2.6.1. Installation of Flowmeter Pipeline

(1) Prior to installation, the pipeline shall be calibrated to ensure that the diameter of the meter has good coaxiality with the user's pipeline. For sensors with a nominal diameter of no more than 50mm, the protrusion of its axis shall not exceed 1.5 mm; for sensors with a nominal diameter of 65~300 mm, it shall not exceed 2mm and for sensors with a nominal diameter of no less than 350 mm, it shall not exceed 4 mm.

(2) In general, foreign particles (such as welding slag) may exist in newly installed pipelines. Before the flowmeter is installed, wash away the debris. It not only prevents the lining from being damaged but also measurement error caused by foreign particles which pass through the measuring tube during measurement.

2.6.2. Precautions

Operating introduction:

(1) Avoid Damage upon Unpacking

Take care to avoid damage to the meter when you are unpacking. It is suggested not to unpack the box before transporting it to the installation site to avoid damage of meter. It's prohibited to use a stick or rope to lead through the measuring tube of sensor. Instead, follow the correct lifting as shown in the figure below.

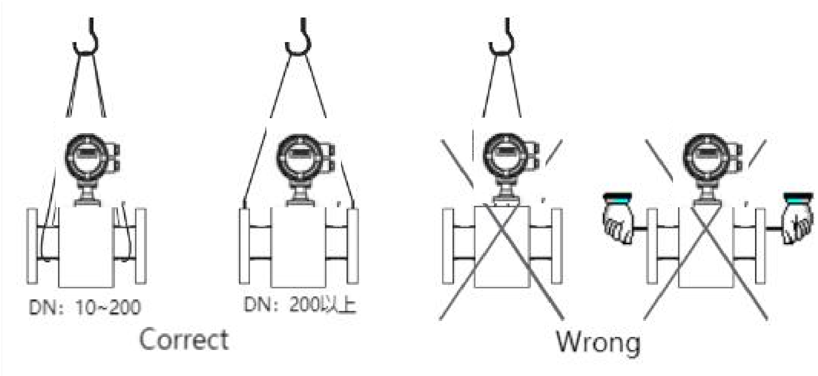


Fig.13

(2) Avoid vibration

Avoid heavy falling or pressing, especially the flange surface which cannot be stressed (otherwise, the lining may be damaged to disable operation of the meter).

(3) Protection of flange surface

After unpacking, pay attention to protect the flange. Do not place it on the unpadded floor or other uneven boards.

(4) Terminal box

It's not allowed to seal the terminal box cover before electrical wiring. After the wiring is completed, please apply the special sealant provided by our company to on the terminal box as soon as possible. Then cover terminal box and tighten the screws to ensure the tightness.

If the protection level of the electromagnetic flowmeter is IP68 at type selection, it has been subject to water-proof sealing.

(5) No operation for long duration

After the instrument is installed, it shall be avoided that the meter is not checked for long duration. If yes, please take the following measures:

A. Check the tightness of the covers and the wiring terminals to ensure that no moisture and water enters into the meter.

B. Conduct regular inspection. Check against the measures mentioned above and the terminal box for at least once a year. In the event of water entry into the meter (eg, after heavy rain, etc.), the meter shall be inspected immediately.Installation of flowmeter

2.6.3. Installation of Flowmeter

(1) Installation direction

The flow direction of the measured fluid shall be consistent with flow direction mark indicated on the flowmeter.

(2) Seal gaskets installed between flanges shall have good corrosion resistance and shall not protrude into the interior of the pipe.

(3) When welding or flame cutting is performed adjacent to sensor pipe, isolation measures shall be taken to prevent the lining from being deformed due to heat.

(4) If it is installed in a well or immersed in water, apply sealant on the terminal box of the sensor after the system is installed and debugged. (If the protection level of the electromagnetic flowmeter is IP68, it has been subject to water-proof sealing.)

(5) During on-site installation, the sensor flange should be connected to the pipeline flange using bolts. Ensure that all bolts and nuts are properly tightened. The threads must be intact, undamaged, and well-lubricated. Flat washers and spring washers should be used together. A torque wrench should be used to tighten the bolts according to the flange size and required torque. In routine operation, bolts should be regularly re-tightened to prevent loosening.

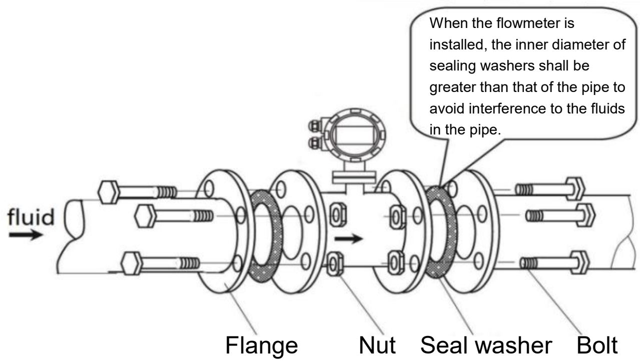


Fig.14

2.7 Sensor's Size of Inline Type Electromagnetic Flowmeter

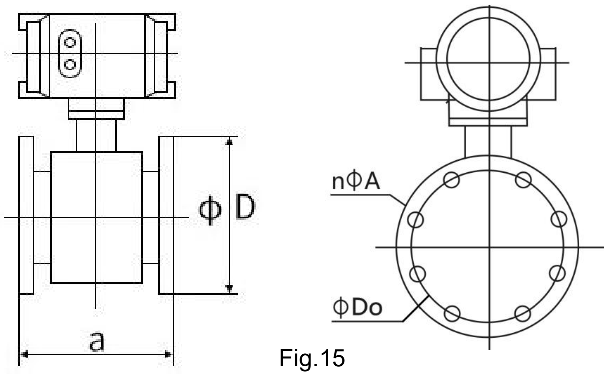


Fig.15

Table 1 Sensor size (JB/T 81 flange connection)

Unit: mm

DN	a	D	Do	n*A	Pressure resistance
10	200	90	60	4*14	1.6MPa
15	200	95	65	4*14	1.6MPa
20	200	105	75	4*14	1.6MPa
25	200	115	85	4*14	1.6MPa
32	200	135	100	4*18	1.6MPa
40	200	145	110	4*18	1.6MPa
50	200	160	125	4*18	1.6MPa
65	200	180	145	4*18	1.6MPa
80	200	195	160	8*18	1.6MPa
100	250	215	180	8*18	1.6MPa
125	250	245	210	8*18	1.6MPa
150	300	280	240	8*23	1.6MPa
200	350	335	295	12*23	1.6MPa
250	450	405	355	12*25	1.6MPa
300	500	440	400	12*23	1.0MPa
350	550	500	460	16*23	1.0MPa
400	600	565	515	16*25	1.0MPa

DN	a	D	Do	n*A	Pressure resistance
450	600	615	565	20*25	1.0MPa
500	600	670	620	20*25	1.0MPa
600	600	780	725	20*30	1.0MPa
700	700	895	840	24*30	1.0MPa
800	800	1015	950	24*33	1.0MPa
900	900	1115	1050	28*33	1.0MPa
1000	1000	1230	1160	28*36	1.0MPa

Table 2 Sensor size (JB/T 9124 flange connection)

Unit: mm

DN	a	D	Do	n*A	Pressure resistance
10	200	90	60	4*14	1.6MPa
15	200	95	65	4*14	1.6MPa
20	200	105	75	4*16	1.6MPa
25	200	115	85	4*16	1.6MPa
32	200	140	100	4*18	1.6MPa
40	200	150	110	4*18	1.6MPa
50	200	165	125	4*20	1.6MPa
65	200	185	145	8*20	1.6MPa
80	200	200	160	8*20	1.6MPa
100	250	220	180	8*22	1.6MPa
125	250	250	210	8*22	1.6MPa
150	300	285	240	8*24	1.6MPa
200	350	340	295	12*26	1.6MPa
250	450	405	355	12*29	1.6MPa
300	500	445	400	12*26	1.0MPa
350	550	505	460	16*30	1.0MPa
400	600	565	515	16*32	1.0MPa
450	600	615	565	20*36	1.0MPa
500	600	670	620	20*38	1.0MPa
600	600	780	725	20*42	1.0MPa
700	700	895	840	24*50	1.0MPa

DN	a	D	Do	n*A	Pressure resistance
800	800	1015	950	24*56	1.0MPa
900	900	1115	1050	28*62	1.0MPa
1000	1000	1230	1160	28*70	1.0MPa

2.8 Converter's Size

2.8.1. Circular Integrated Version

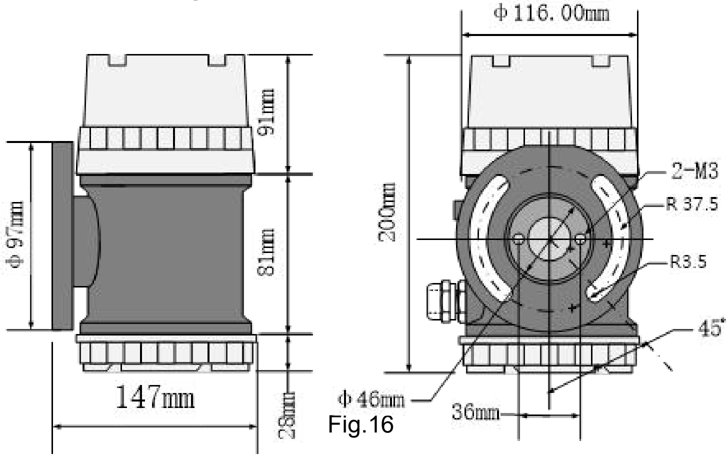


Fig.16

2.8.2. Square Remote Version

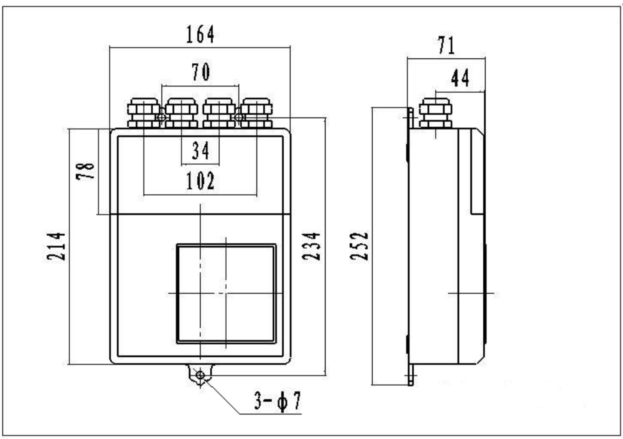


Fig.17

3 Electrical Connection

3.1 Safety Tips

Danger!

All electrical connection work must be carried out with the power supply disconnected. Please heed the nameplate for power supply specifications.

Danger!

Please observe national installation regulations.

Warning!

Please strictly observe local occupational health and safety regulations. Only properly trained personnel are allowed to work on electrical equipment.

Tips!

Please check the nameplate of the equipment, and confirm that the delivered product matches your order. Ensure that the power supply voltage on the nameplate is correct. If incorrect, contact the manufacturer or instrument supplier.

3.2 Signal Cable Connection

Danger!

Signal cables and excitation current cables may only be connected with the power supply disconnected.

Danger!

The instrument must be properly grounded to ensure operational safety.

Danger!

For instruments applied in hazardous explosive areas, refer to the specialized explosion-proof manual for safety instructions.

Warning!

Please strictly observe occupational health and safety regulations. Only personnel with proper training are permitted to work on electrical equipment.

3.3 Wiring Terminals

(1) Remote type

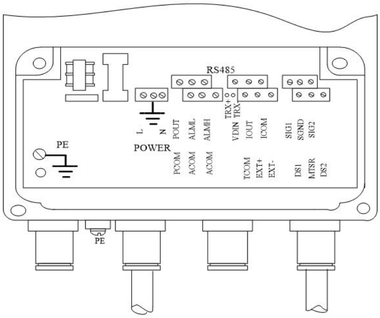


Fig.18

Table 3

Symbol	Meaning
SIG 1	Signal 1
SGND	Signal ground
SIG 2	Signal 2
DS1	Excitation current 1
DS2	Excitation current 2
EXT +	Excitation current (+)
EXT -	Excitation current (-)
VDIN	Current two-wire 24V connecting point
IOUT	Current output
ICOM	Current output ground
POUT	Frequency (pulse) output
PCOM	Frequency (pulse) output ground
ALMH	Upper limit alarm output
ALML	Lower limit alarm output
ACOM	Alarm output
TXR +	RS485- A
TXR -	RS485- B
TCOM	RS 323
L:	220V power input
N:	220V power input

(2) Integrated version (220V)

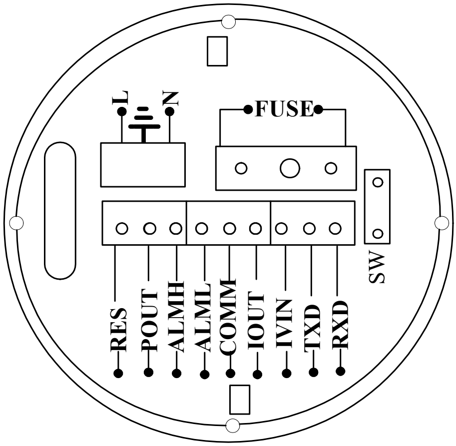


Fig.19

Table 4

Symbol	Meaning
IOUT:	Flow current output / two-wire current output
IVIN	Two-wire 24V voltage input
POUT:	Bidirectional flow frequency / pulse output
COMM:	Frequency, pulse, current common terminal (ground)
ALML:	Lower limit alarm output
ALMH:	Upper limit alarm output
RES:	Connect pull-up resistor
FUSE:	Input power fuse
TXD	RS485-A
RXD:	RS485-B
L:	220V power input

(3) Integrated version (24V)

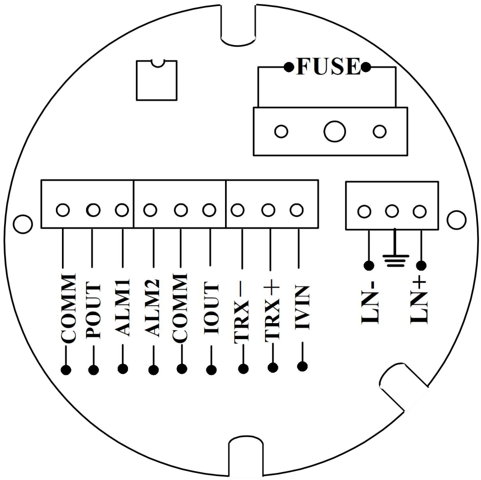


Fig.20 Integrated type (24V)

Table 5

Symbol	Meaning
POUT:	Bidirectional flow frequency / pulse output
ALM 1 :	Upper limit alarm output
ALM 2 :	Lower limit alarm output
COMM:	Frequency, pulse, current common terminal (ground)
COMM:	Frequency, pulse, current common terminal (ground)
IOUT:	Flow current output / two-wire current output
IVIN	Two-wire 24V voltage input
TRX +	RS485- A
TRX- :	RS485- B
L N+:	24V power supply +
L N - :	24 V power supply -

3.4 Output and Power Cord

All output and power cables are prepared by the user according to the actual situation. But please pay attention to meet the load current requirements.

Note: When the DIP switch next to the wiring terminal is turned to the ON position, the converter provides +28V power to the isolated OC gate frequency output (POUT) and alarm output (ALMH, ALML). Therefore, when using the frequency output and sensor matching test, the DIP switch can be turned to ON to lead the frequency signal from the POUT and PCOM wiring (Applicable to the remote type). The external power supply and load for pulse current output and alarm current output are shown in Figure 21 to Figure 25. When using an inductive load, a freewheeling diode should be added as shown. (Note: For split-type meters, the marking position is different, but the wiring method is the same.)

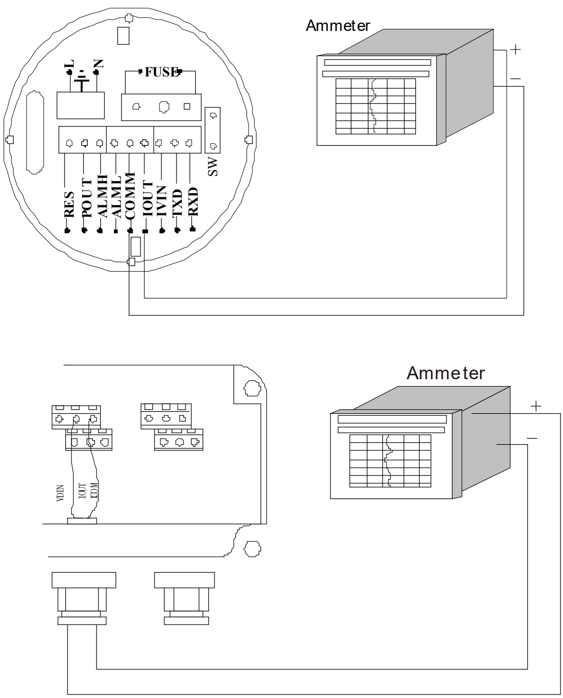


Fig.21 Current output wiring diagram

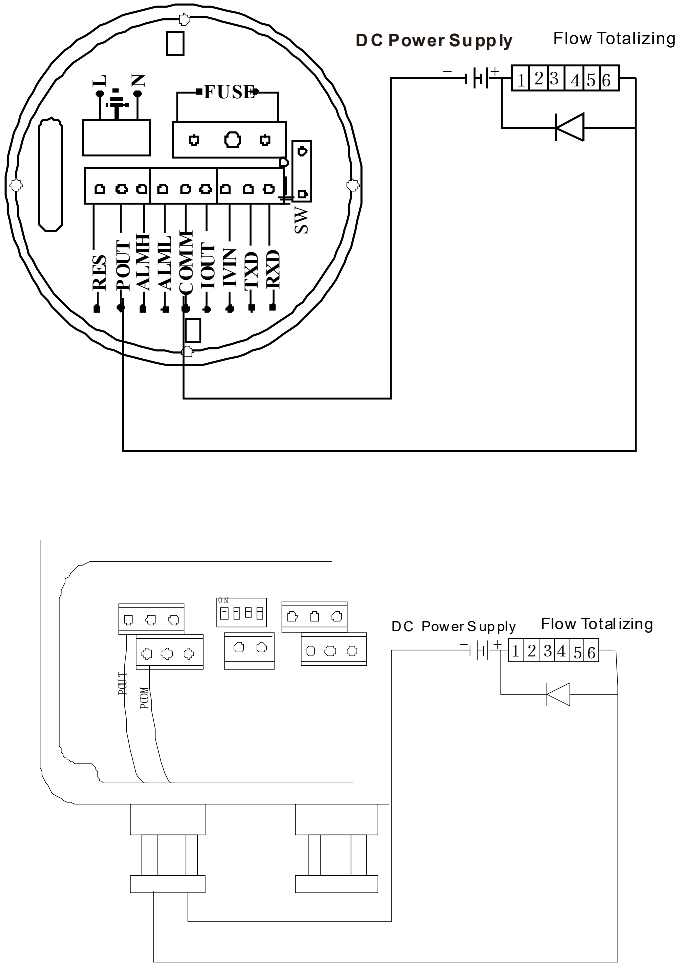
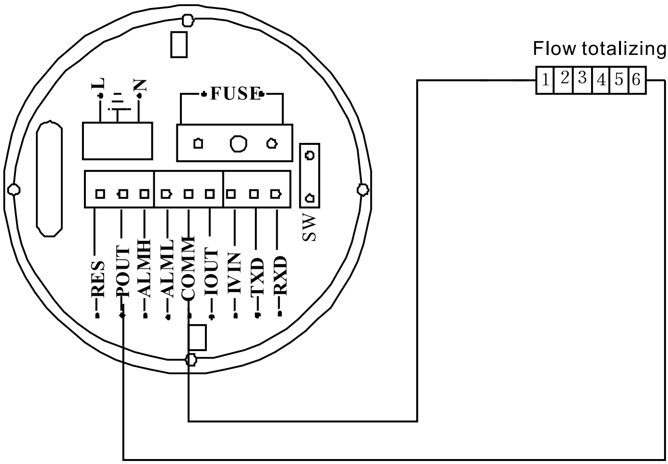


Fig.22 Wiring Diagram for Connecting External Power Supply to Electronic Counter



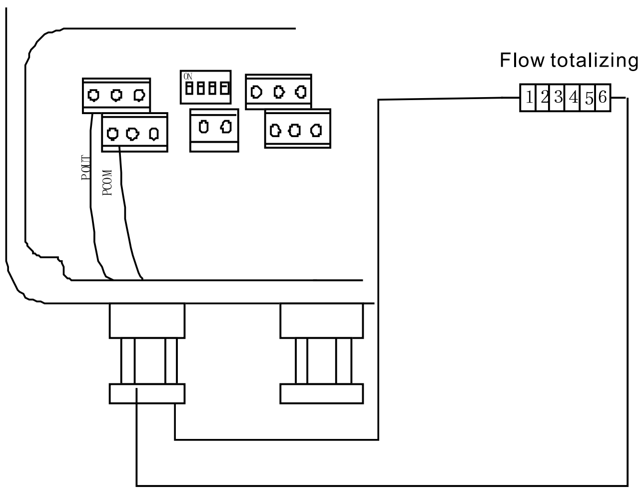


Fig.23 Wiring Diagram of the Internal Power Supply Connected to the Electronic Counter

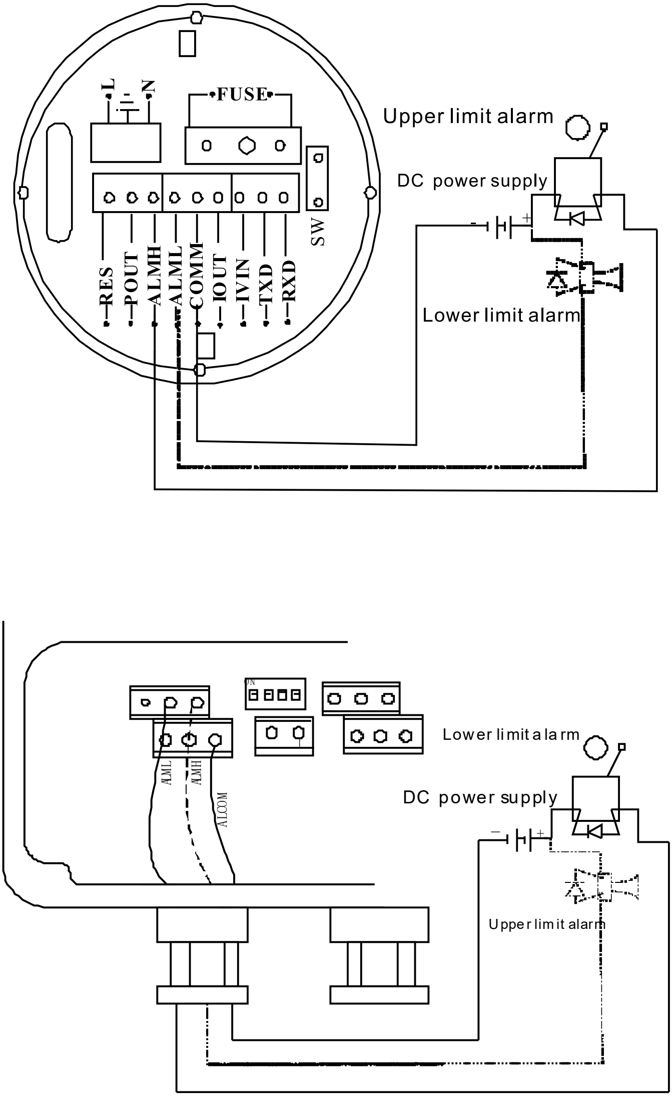


Fig.24 Wiring Diagram of the Alarm Output

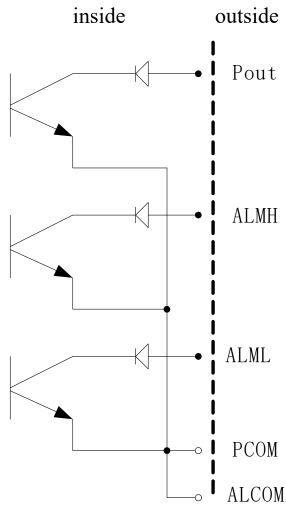


Fig.25 OC gate connection way

3.5 Grounding Requirements of Converter Installation

The converter housing grounding terminal PE should be connected to the ground with a grounding copper wire no less than 1.6 mm^2 . The grounding resistance from the converter housing to the ground should be less than 10Ω .

First, cut the Φ20 copper tube into 1700mm length (can be extended as needed) and make ground nails buried 1500mm in the ground (Note: when burying the ground nails, sprinkle a layer of charcoal on the tip of the ground nails, and then pour salt water);

Secondly, weld the 4 mm^2 copper wire to the ground nail, and finally connect the ground wire to the sensor flange, grounding ring, and pipe flange , as shown in Figure 26 .

Note: The ground wire screws, spring washers and flat washers must be made of stainless steel.

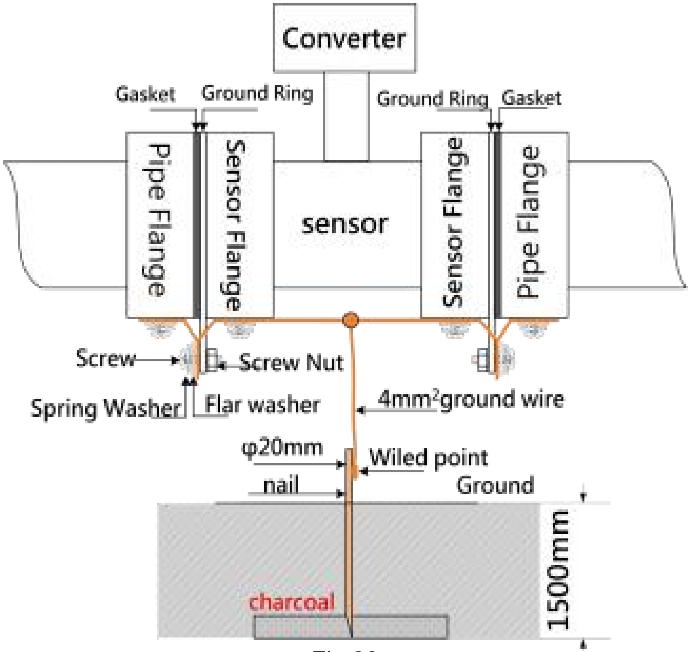


Fig.26

3.6 Digital Output and Calculation

Digital output refers to frequency output and pulse output. Frequency output and pulse output use the same output point in wiring, so users cannot select both frequency output and pulse output at the same time, but can only select one of them.

3.6.1. Frequency Output

The frequency output range is 0~5000HZ, and the frequency output corresponds to the flow percentage .

$$F = \frac{\text{Measured value}}{\text{Full scale value}} * \text{Frequency range}$$

The upper limit of the frequency output is adjustable. Users can choose 0~5000HZ, or a lower frequency: such as 0~1000HZ or 0~5000HZ.

Frequency output is generally used for control applications because it reflects the percentage flow rate. If the user uses it for metering applications, the pulse output should be selected.

3.6.2. Pulse Output Mode

The pulse output mode is mainly used for metering. One pulse output represents an equivalent flow rate, such as 1L or 1m^3, 1T .

The pulse output equivalent is divided into : 0.001L, 0.01L, 0.1L, 1L, 0.001m^3, 0.01 m^3, 0.1m^3, 1m^3, 001T, 0.01T, 0.1T, 1T. When selecting the pulse equivalent, the user should pay attention to the matching of the flow meter flow range and the pulse equivalent. For the volume flow, the calculation formula is as follows:

$Q_L = 0.0007854 \times D^2 \times V$ (L/S)

Or $Q_M = 0.0007854 \times D^2 \times V \times 10^{-3}$ (M^3/S)

Where: D—pipe diameter (mm)

V—Flow rate (m/s)

If the pipeline flow is too large and the pulse equivalent is too small, the pulse output will exceed the upper limit, so the pulse output frequency should be limited to below 3000Hz. If the pipeline flow is small and the pulse equivalent is too large, it will take a long time for the instrument to output a pulse.

In addition, it must be pointed out that pulse output is different from frequency output. Pulse output is to output a pulse when a pulse equivalent is accumulated. Therefore, the pulse output is not very uniform. Generally, a counter instrument should be used to measure pulse output, not a frequency meter.

3.6.3. Wiring of Digital Outputs

Digital output has two contacts: digital output contact, digital ground contact, and flow direction contact. The symbols are as follows:

POUT————Digital output contact

PCOM————Digital ground connection point

POUT is an open collector output. When wiring, users can refer to the following circuit:

(1) Digital level output connection

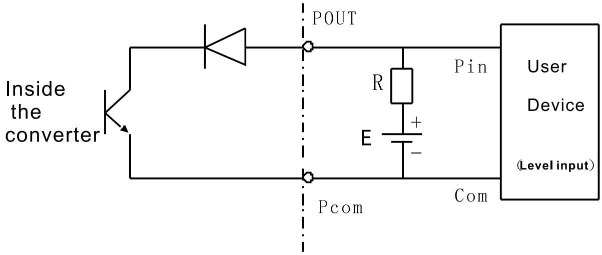


Fig.27 Digital level output connection

(2) Digital output connected to photocoupler (such as PLC, etc.)

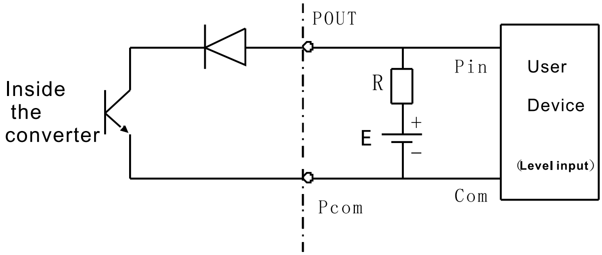


Fig.28 Digital output connected to photocoupler

Generally, the user's optocoupler requires about 10mA current, so E/R = about 10mA. E = 5 ~ 24V.

(3) Digital output connected to relay

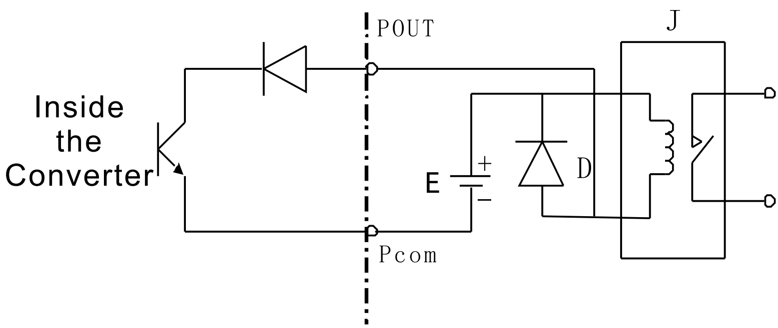


Fig.29 Digital output connected to relay

Generally, the E required by the intermediate relay is 12V or 24V. D is a freewheeling diode, which is built into most intermediate relays. If the intermediate relay itself does not contain this diode, the user should connect one externally.

The digital output parameter table is as follows :

Table 6 POUT

Parameter	Test conditions	Min.	Typical Value	Max.	Unit
Operating voltage	IC=100mA	3	24	36	V
Working current	Vol≤1.4V	0	300	350	mA
Operating frequency	IC=100mA Vcc=24V	0	5000	7500	HZ
High level	IC=100mA	Vcc	Vcc	Vcc	V
Low level	IC=100mA	0.9	1.0	1.4	V

3.7 Analog Output and Calculation

3.7.1. Analog Output

The analog current output is internally powered by 24V and can drive a load resistor of 750Ω under a 4-20mA signal system.
The analog current output corresponds to the percentage flow rate, that is:

$$I_0 = \frac{\text{Measured value}}{\text{Full scale value}} \cdot \text{Current range} + \text{Current zero-point}$$

For the 4-20mA signal system, the current zero point is 4mA.
Therefore, in order to improve the resolution of the output analog current, the user should appropriately select the flow meter range.
When the flowmeter leaves the factory, the manufacturer has calibrated the parameters of the analog output. Under normal circumstances, the user does not need to make any adjustments. If an abnormal situation occurs and the user needs to calibrate the analog output, the following operating procedures can be followed.

3.7.2. Analog Output Adjustment

(1) Calibration preparation,

Turn on the meter and run it for 15 minutes to allow the internal part of the meter to reach thermal stability. Prepare a 0.1% level ammeter, or a 250Ω resistor and a 0.1% voltmeter, and connect them as shown below.

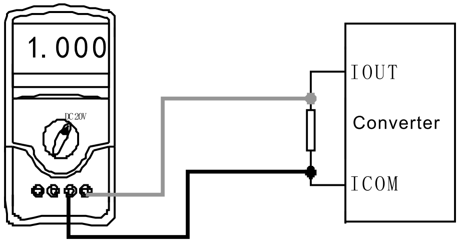


Fig.30

(2) Current “0” point correction:

Set the converter to parameter setting state, select the "current zero correction" item, enter, turn the standard signal source to the "0" position, and adjust the correction coefficient value so that the ammeter indicates exactly 4mA (±0.004mA).

(3) Current full scale correction

Select the "Current Full Scale Correction" parameter, enter, set the standard signal source to the full scale position, and adjust the converter correction factor so that the ammeter indicates exactly 20mA (±0.004mA).

After adjusting the current "0" point and full-scale value, the current function of the converter can guarantee accuracy. The linearity of the current output of the converter is within 0.1%.

(4) Current linearity check:

Set the standard signal source to 75%, 50%, and 25% to check the linearity of the output current.

3.7.3. Converter Current Output Wiring

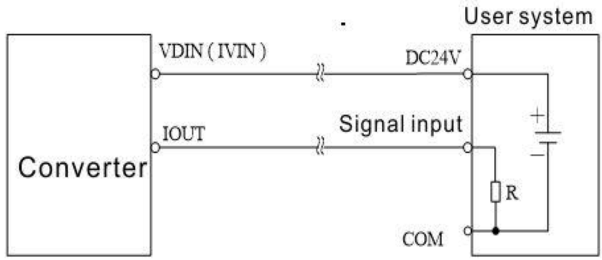


Fig.31 2-wire connection

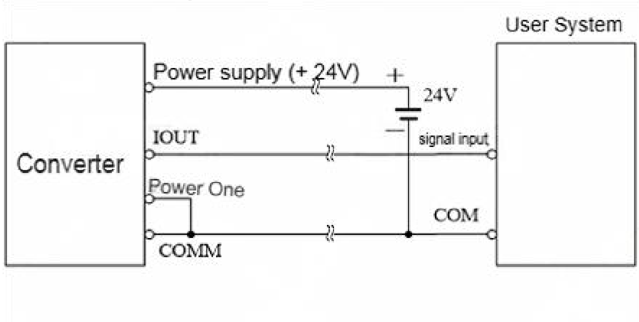


Fig.32 3-wire connection method (power supply and current output are not isolated)

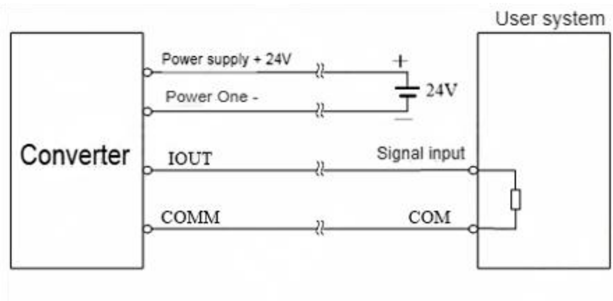


Fig.33 4 -wire connection method (power supply and current output isolation method)

4 Startup

4.1 Power on

Please check whether the installation is correct before powering on the device, including:

① The meter installation is in line with safety and compliance requirements.

② Power supply connection must be performed in accordance with the regulations.

③ Please check the correction of the electric connection.

④ Tighten the rear cover of the converter housing.

4.2 Converter Start-up

The flowmeter consists of a measuring sensor and signal converter. It is delivered in a ready-to-use state. All operating parameters and hardware settings have been configured according to users' order specifications.

Once powered on, it will perform a self-check. After that, it will immediately start the measurement and display the current value.

5 Operation

5.1 Keys and Display

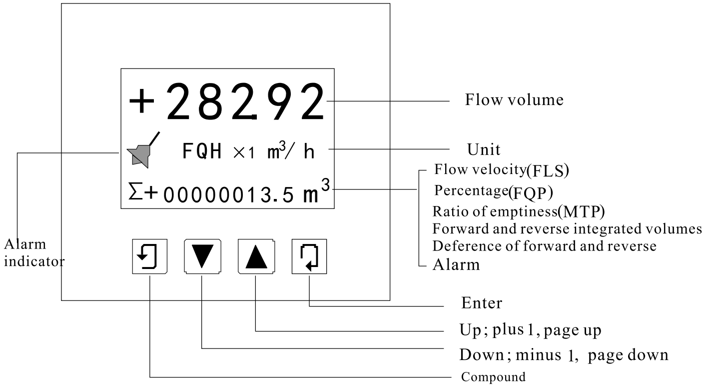


Fig.34 Keys for remote version

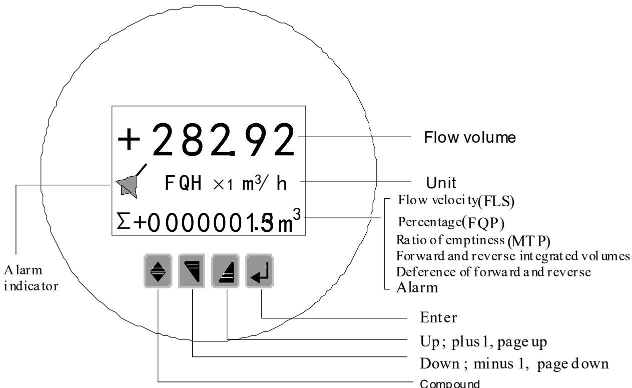


Fig.35 Keys for Integrated version

Note: In the measurement state, "Compound+Enter" keys brings to converter function panel; then users can select "parameter set"; one click of the enter key will navigate you to the password entry interface. According to the password level, you can enter the corresponding menu with passwords to start your configuration.

Re-press "Compound+ Enter" keys, parameters configuring states will be displayed. If you wants to return the operating state, please hold down the key for seconds.

5.2 Keys Function

5.2.1. Up and Dn Keys Function in Auto Measurement State

UP: cycle through the content displayed on the lower part of the screen

Compound+Enter: enters the parameter setting mode.

Enter: returns to automatic measurement mode.

LCD Contrast Adjustment: In measurement mode, use “Function+UP” keys or “Function+Down” keys to adjust the contrast to a suitable level.

5.2.2. Key Functions in Parameter Setting Mode

Dn: Decreases the digit at the cursor position by 1.

Up: Increases the digit at the cursor position by 1.

Compound + **Dn**: Moves the cursor to the left.

Compound+ **Up**: Moves the cursor to the right.

Enter: Enters or exits a submenu.

Enter: In any mode, press and hold for two seconds to return to automatic measurement mode.

Note:

(1) When using the “Compound key”, press it first and hold “Up” or “Dn” key.

(2) In parameter setting mode, if no keys is pressed for 3 minutes, the meter will automatically return to measurement mode.

(3) For flow zero-point correction, to select the flow direction, move the cursor to the far-left+ “+” or “-” sign, and use the “Up” and “Dn” key to toggle it so that it is opposite to the actual flow direction.

(4) To select the flow unit, move the cursor to the flow unit displayed in the “Flow Range Setting” menu, then use the “Up” and “Dn” key to select the desired unit.

5.3 Setting Function and Compound key’s Operation

To configure or modify the meter parameters, the meter must be switched from measurement mode to parameter setting mode. In measurement mode, press “Compound+Enter” keys once to enter the function selection screen “parameter setting”. Then press the “Enter” key to access the password input screen (Initial password: 0000). After entering the password, press “Compound+Enter” keys again to enter the parameter setting screen.

The meter has a 6-level password system. Four of these levels allow the user to define custom passwords, while the top two levels are fixed and cannot be changed. Each level corresponds to a different level of access authorization.

5.4 Function Selection Screen

Press "Compound Key + Enter Key" to enter the function selection screen. Then use the "Up" or "Dn" key to choose from three available functions on this screen:

Table 7

Parameters	Functions	Description
1	Parameter setting	Select to enter the parameter setting screen
2	Total clearing	Select to reset the totalized value of the instrument
3	Coefficient change log	Select to view the modification history of the flow coefficient

5.4.1. Parameter Setting

Press “Compound+Enter” displays “Parameter setting” function, the meter enters function selection screen. Then, press the Enter key to enter the password input interface (Default: 00000). After entering the correct password, press Function+Enter key again to enter the Parameter Setting screen.

5.4.2. Total Clearing

Press "Compound Key + Enter Key" to display the Parameter Setting option. Then, press the Up Key to scroll to Total Reset. Enter the total reset password, then press "Compound Key + Enter Key" Once the reset password automatically changes to “00000, the reset is completed, and the totalized value stored in the instrument will be cleared to zero.

5.4.3. Coefficient Change Log

Press “Compound Key + Enter Key" to display the Parameter Setting option. Then, press the “Up” Key to scroll to Coefficient Change Log to view the modification history of the flow coefficient.

5.5 Parameter Setting Menu

There are a total of 56 parameters. Users should configure these parameters based on their specific application requirements.

The parameter list is as follows:

Table 8

Code	Parameter	Setting Way	Password level	Range
1	Language	Select	2	English/Chinese
2	Comm Addres	Set count	2	0～99
3	Baud Rate	Select	2	300～38400
4	Snsr Size	Select	2	3～3000
5	Flow Unit	Select	2	L/h, L/m, L/s, m^3/h, m^3/m, m^3/s
6	Flow Range	Set count	2	0～99999
7	Flow Rspns	Select	2	1～50
8	Flow Direct	Select	2	Forward/Reverse
9	Flow Zero	Set count	2	0～±9999
10	Flow Cutoff	Set count	2	0～599.99%
11	Cutoff Ena	Select	2	Enable/Disable
12	Total Unit	Select	2	0.001m^3～1m^3, 0.001L～1L, 0.001T～1T
13	Density	Set count	2	0～3.999T/m^3

Code	Parameter	Setting Way	Password level	Range
14	SegmaN Ena	Select	2	Enable/Disable
15	Analog Type	Select	2	4～20mA
16	Pulse Type	Select	2	Freque / Pulse
17	Pulse Fact	Select	2	$0.001m^3$～$1m^3$, 0.001L～1L, 0.001T～1T
18	Freque Output	Select	2	1～ 5999Hz
19	Mtsnsr Ena	Select	2	Enable/Disable
20	Mtsnsr Trip	Set count	2	59999%
21	Alm Hi Ena	Select	2	Enable/Disable
22	Alm Hi Val	Set count	2	000.0～599.99%
23	Alm Lo Ena	Select	2	Enable/Disable
24	Alm Lo Val	Set count	2	000.0～599.99%
25	Sys Alm Ena	Select	2	Enable/Disable
26	Clr Sum Key	Set count	3	0～99999
27	Snsr Code1	User set	4	Finished Y M
28	Snsr Code2	User set	4	Product number
29	Field Type	Select	4	Type1, 2, 3
30	Sensor Fact	Set count	4	0.0000～5.9999

Code	Parameter	Setting Way	Password level	Range
31	Line CRC Ena	Select	2	Enable/Disable
32	Lineary CRC1	User set	4	Set Velocity
33	Lineary Fact 1	User set	4	0.0000～1.9999
34	Lineary CRC2	User set	4	Set Velocity
35	Lineary Fact 2	User set	4	0.0000～1.9999
36	Lineary CRC3	User set	4	Set Velocity
37	Lineary Fact 3	User set	4	0.0000～1.9999
38	Lineary CRC4	User set	4	Set Velocity
39	Lineary Fact4	User set	4	0.0000～1.9999
40	FwdTotal Lo	Correctable	5	00000～99999
41	FwdTotal Hi	Correctable	5	00000～9999
42	RevTotal Lo	Correctable	5	00000～99999
43	RevTotal Hi	Correctable	5	00000～9999
44	PlsntLmtEna	Select	3	Enable/Disable
45	PlsntLmtVal	Select	3	0.010～0.800m/s
46	Plsnt Delay	Select	3	400～2500ms
47	Pass Word 1	User correct	5	00000～99999
48	Pass Word 2	User correct	5	00000～99999

Code	Parameter	Setting Way	Password level	Range
49	Pass Word 3	User correct	5	00000～99999
50	Pass Word 4	User correct	5	00000～99999
51	Analog Zero	Set count	5	0.0000～1.9999
52	Anlg Range	Set count	5	0.0000～3.9999
53	Meter Fact	Set count	5	0.0000～5.9999
54	MeterCode 1	Factory set	6	Finished Y /M
55	MeterCode 2	Factory set	6	Product Serial No.
56	Check mode	Factory set	2	No Parity, Odd Parity, Even Parity

The meter parameters determine its operating status, calculation method, output mode, and system state. Proper selection and configuration of these parameters ensure optimal performance of the instrument, resulting in higher measurement display accuracy and output precision.

The parameter setting function is protected by a six-level password system. Among them, Levels 1–5 are user-level passwords, and Level 6 is reserved for the manufacturer. Users can use the Level 5 password to reset passwords for Levels 1 to 4.

Regardless of the password level used, users are allowed to view instrument parameters. However, different password levels are required to modify parameter settings:

Level 1 Password (default: 00521): Users can only view the instrument parameters.

Level 2 Password (default: 03210): Users can modify Parameters 1–24.

Level 3 Password (default: 06108): Users can modify Parameters 1–25.

Level 4 Password (default: 07206): Users can modify Parameters 1–38.

Level 5 Password (fixed value): Users can modify Parameters 1–52.

It is recommended that only professional personnel be granted access to the Level 5 password. The Level 4 password is mainly used for configuring total flow. As for the Level 1–3 passwords, the user organization may assign them based on internal access control requirements.

5.6 Detailed Description of Parameters

(1) Language

There are two languages, namely Chinese and English, in electromagnetic converter, which are available for users.

(2) Comm Addres

For multi meter communication, the settable range for the meter’s communication address: 01-99, 0 address reserved.

(3) Baud Rate

Selectable range: 300, 1200, 2400, 4800, 9600, 38400

(4) Snsr Size

Diameter range coming standard with electromagnetic flowmeter converter: 10-20mm.

(5) Flow unit

Flow unit can be selected in parameters. Flow units that are displayed: L/s, L/m, L/h, m^3 /s, m^3 /m, m^3 /h, T/s, T/m, T/h. Users can choose a suitable display unit according to process requirements and theirs usage habits.

(6) Range Range

It refers to when the flow upper limit value is determined, the lower limit flow value will automatically be set to “0”.

As such, if this range setting defines the meter measuring range, it means the corresponding relation among percentage display, frequency output, current output and flow is also decided.

- Displayed percentage value=(measured flow value/meter range)×100%
- Frequency output value=(measured flow value/meter range) × full-scale

frequency

- Current output value=(measured flow value/meter range) × full-scale current+zero point

Note: the pulse output of the meter is unaffected by the range setting

(7) Flow Rspns

A long measurement filter time can improve the stability of meter flow display and output signal. A shorter filtering time enable faster response, which is ideal for process control applications. The measurement filtering times is set by selecting from predefined options.

(8) Flow direct

If users finds that the fluid flow direction during commissioning is inconsistent with the design, there is no need to change the wiring of the excitation or signal lines. Instead, simply adjust the flow direction setting parameter.

(9) Flow Zero

Before performing zero-point correction, ensure that the sensor pipe is completely filled with fluid and that the fluid is stationary. The flow zero point is expressed in flow velocity (mm/s).

The converter flow zero correction is displayed as follows:

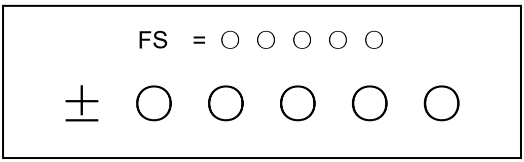


Fig.36

* Upper row display: "FS" represents the actual zero-point measurement value.

* Lower row display: Displays the flow velocity zero-point correction value.

* When the FS value is not “0”, adjust the correction value to make FS=0.

Note: If the FS value increases with the adjustment of the correction value on the lower row, you need to reverse the sign of the correction value (positive or negative) to bring the FS reading back to zero.

The correction value of the flow zero point is the corresponding constant value of the sensor, which should be recorded in the sensor record sheet and sensor label. When recorded, the sensor zero value is the flow velocity value in mm/s, and its sign is opposite to that of the correction value.

(10) Flow Cutoff:

Small signal cutfoff setting is represented by flow percentage. When this function is enabled, users can select to cut off the the signal output and the display of flow, velocity and percentage; also, it offers choices of cutting off the current output signal and frequency (pulse) output signal while maintaining flow, velocity and percentage display.

(11) Total Unit：

The converter display features a 9-digit counter, with a maximum count value of 999999999.

The accumulation flow unit can be set to L, m^3 (liter, cubic meter), etc.

Flow accumulation equivalent: 0.001L, 0.010L, 0.100L, 1.000L
0.001m^3, 0.010m^3, 0.100m^3, 1.000m^3
0.001T, 0.010T, 0.100T, 1.000T

(12) Density:

Users can select flow unit, T/s, T/m, T/h.

(13) SegmaN Ena

When the SegmaN Ena parameter is set to “Enabled”, the converter outputs pulses and current according to the flow rate as long as there is fluid flow. When the parameter is set to Disabled, if the fluid flows in the reverse direction, the converter outputs zero pulses and the current output corresponds to a signal of 0 (i.e., 4 mA).

(14) Analog Type

Users can select 4～20 mA current output.

(15) Pulse output

Two pulse output modes are available: frequency output and pulse output:

◆ Frequency output: The frequency output is a square wave, with the frequency value corresponding to the flow percentage.

Frequency value = (measured flow value/meter range) × Full-scale frequency value;

- Pulse output: The pulse output is a rectangular wave pulse train, where each pulse represents a flow equivalent flowing through the pipeline. The pulse equivalent is determined by the "pulse unit equivalent" parameter. The pulse output mode is mostly used for totalized flow measurement and is typically connected to a totalizer.

Frequency and pulse outputs are often in the form of OC gate. As such, external connection DC power supply and load is necessary.

(16) Pulse Fact:

The pulse fact refers to the flow value represented by a pulse. The instrument pulse equivalent selection range is:

Table 9

Pulse fact	Flow value	Pulse fact	Flow value
1	0.001L/p	2	0.01L/cp
3	0.1L/cp	4	1.0L/cp
5	0.001m^3/cp	6	0.01m^3 /cp
7	0.1m^3/cp	8	1.0m^3 /cp
9	0.001T/cp	10	0.01T/cp
11	0.1T/cp	12	1.0T/cp

Note: at the same flow rate, a smaller pulse fact results in a higher output pulse frequency and a lower cumulative flow error.

(17) Freque Output:

The frequency output range of the instrument corresponds to the full-scale flow rate (100%). The upper limit of the frequency output can be configured within 1 to 5000 Hz.

(18) Mtsnsr En:

The flowmeter features an empty pipe detection function without the need for additional electrodes. If the user enables the empty pipe alarm, the instrument can detect an empty pipe condition when the fluid level in the pipe falls below the measuring electrodes. Upon detecting an empty pipe condition, the analog and digital outputs are set to a zero signal, and the flow rate display on the instrument shows zero.

(19) Mtsnsr Trip:

When the pipe is full of fluid (regardless of whether there is flow), the empty pipe alarm setting can be modified, making it more convenient for the user. The upper row displays the measured conductivity value, while the lower row is used to set the empty pipe alarm threshold. When configuring the empty pipe alarm threshold, it is recommended to set the value to 3 to 5 times the measured conductivity.

(20) Alm Hi Ena:

Users can enable or disable this function.

(21) Alm Hi Val:

The upper limit alarm threshold(Alm Hi Val) is set as a percentage of the instrument range. Users can configure a value between 0% and 199.9%. When the alarm condition is met during operation, the instrument outputs an alarm signal.

(22) Alm Lo

The same as Alm Hi.

(23) Excitation alarm:

Users can enable or disable this function.

(24) Clr Sum Key

Users can set this password using the third level password or above, and then set this password within the total reset.

(25) Snsr Code

The sensor code can be used to mark the factory time and number of the matching sensor to help set the sensor coefficient.

(26) Sensor Fact

Sensor coefficient: the calibration coefficient of the electromagnetic flowmeter. This coefficient is obtained from the actual calibration and is printed on the sensor nameplate. The user must place this coefficient in the B converter parameter table.

(27) Field Type

Electromagnetic converter provides three excitation frequency options: 1/16 power frequency (mode 1), 1/20 power frequency (mode 2), 1/25 power frequency (mode 3). The excitation system of small-diameter sensors has small inductance, so 1/16 power frequency should be selected. The excitation system of large-diameter sensors has large inductance, so users can only choose 1/20 power frequency or 1/25 power frequency. During use, first select excitation mode 1. If the zero point of the flow rate of the instrument is too high, then select mode 2 or mode 3 in turn.

Note: The machine must operate under the excitation mode in which it is calibrated.

(28) Positive total high and low

The total high and low bit settings can change the values of the forward cumulative total and the reverse cumulative total, and are mainly used for instrument maintenance and instrument replacement.

The user enters with the Level 5 password and can modify the positive cumulative amount (Σ +). Generally, the cumulative amount cannot exceed the maximum value counted by the counter (999999999).

(29) Reverse total high and low

The user enters with the Level 5 password and can modify the reverse cumulative amount (Σ -). Generally, the cumulative amount cannot exceed the maximum value counted by the counter (999999999).

(30) PlsntmtEna (Spike Suppression Enable)

For flow measurement of slurries such as pulp and mud, solid particles in the fluid rub or impact the measuring electrodes, forming "spike interference". To overcome this kind of interference, the converter adopts a rate-of-change suppression algorithm. The converter is designed with three parameters to select the rate-of-change suppression characteristics.

Set this parameter to "Enable" to start the rate of change suppression algorithm. Set this parameter to "Disable" to turn off the rate of change suppression algorithm.

(31) Plsnt.mtvel (Spike Suppression Coefficient)

This coefficient is used to select the change rate of the spike interference to be suppressed. It is calculated according to the percentage of flow velocity and is divided into ten levels: 0.010m/s, 0.020m/s, 0.030m/s, 0.050m/s, 0.080m/s, 0.100m/s, 0.200m/s, 0.300m/s, 0.500m/s, and 0.800m/s. The smaller the percentage, the higher the sensitivity of the spike interference suppression. Note that in the application, the higher the sensitivity, the better. Instead, it should be selected according to the actual situation and tested.

(32) Rlsnt Delay (Spike Suppression Time)

This parameter selects the time width of the spike interference to be suppressed, in milliseconds. The converter considers the flow change with a duration less than the selected time as a spike interference. The converter considers the flow change with a duration greater than the selected time as a normal flow change. This parameter should also be selected experimentally according to the actual situation.

(33) User password 1～4

(34) Analog Zer

The converter is factory-adjusted for current output zero point, so that the current output is exactly 4mA.

(35) Analog Range

The converter is factory-adjusted to a full-scale current output of 20 mA.

(36) Meter Fact

This coefficient is a special coefficient for the converter manufacturer. The converter manufacturer uses this coefficient to normalize the electromagnetic converter measurement circuit system to ensure that the interchangeability between all electromagnetic converters reaches 0.1%.

(37) MeterCode 1 and 2

The converter code records the converter's factory date and serial number.

(38) Check Mode

The converter is equipped with standard MODBUS communication 8-bit no parity mode (No Parity), and users can choose odd parity (Odd Parity) and even parity mode (Even Parity) according to their needs.

6 Communications

6.1 Overview

The electromagnetic flowmeter has standard Modbus communication interface, supporting baud rate 1200, 2400, 4800, 9600, 19200. The master station can collect parameters such as instantaneous flow, instantaneous flow velocity, and cumulative flow, via Modbus communication network.

The electromagnetic flowmeter adopts serial parameter: 1 start bit, 8 data bits, 1 stop bit, and no parity.

Modbus communication interface adopts current insulation in physical structure. The current insulation supports 1500V and offers ESD protection, overcoming all inferences onsite and ensuring reliable performance of the communication network.

6.2 Network Structure and Wiring

The standard MODBUS communication network of the electromagnetic flowmeter is a bus network structure, supporting 1-99 flowmeters. The farthest electromagnetic flowmeter in the network usually needs to connect a 120 Ω terminal matching resistor in parallel at both ends of the communication line. The standard communication connection medium is shielded twisted pair cable.

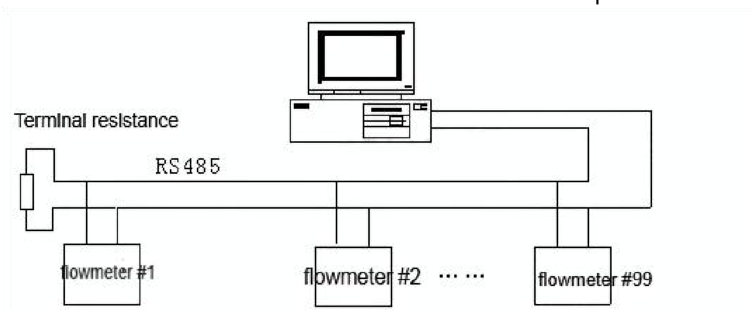


Fig.37

6.3 Modbus Protocol RTU Frame Format

Modbus protocol is master to slave station way. Every communication was started from the master, with the slave returning the data.

The electromagnetic flowmeter employs MODBUS RTU format (16-byte format), and its frame structure is shown as in table.

1) Master station command frame structure

Table 10 Master station RTU message frame

Frame Start	Device Address	Function Code	Register Address	Register length	CRC Check	Frame End
T1-T2-T3-T4	8 Bit	8 Bit	16 Bit	16 Bit	16 Bit	T1-T2-T3-T4

2) Slave station response frame structure

Table 11 Slave RTU message frame

Frame Start	Device Address	Function Code	Data	CRC Check	Frame End
T1-T2-T3-T4	8Bit	8Bit	n 8-bit	16Bit	T1-T2-T3-T4

Note:

(1) T1-T2-T3-T4 is the starting or ending of a frame. MODBUS protocol specifies that a frame start or end is determined by an inter-frame delay equivalent to 3.5 character times, as shown in figure 38.

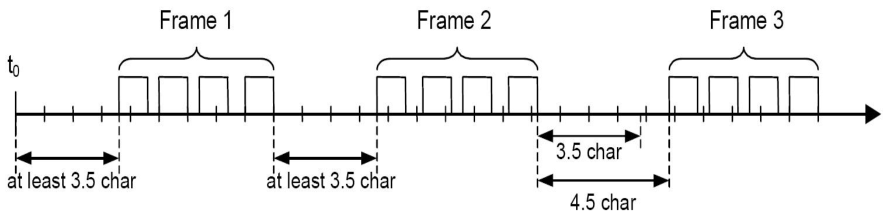


Fig.38 Modbus Frame Interval

(2) Device address: There can't be two same address in one network in the communication address of the electromagnetic flowmeter.

(3) Function code:

The function code specified by the MODBUS protocol. The electromagnetic flowmeter uses function code 4 to read the input register to collect data.

(4) Register address and the number of registers

The parameters in the master command specify the starting register address and the N×register to be read from that address.

(5) Slave response data

The data that the slave device responds: number of bytes and N ×bytes of data. Refer to MODBUS protocol for details.

6.4 Modbus Protocol Command Encoding Definition

The MODBUS function code definition is shown in Table 12. The electromagnetic flowmeter only uses function code 04.

Table 12

Function code	Item	Function
01	Read coil status	reserve
02	Read input status	reserve
03	Read Holding Registers	reserve
04	Read Input Register	Read electromagnetic flowmeter real-time information
05	Forced single coil	reserve
06	Preset Single Register	reserve
07	Read abnormal status	reserve
08	Loopback diagnostic check	reserve
09	Programming (484 only)	reserve
10	Control inquiry (only for 484)	reserve
11	Read event count	reserve
12	Read communication event log	reserve
13	Programming (184/384 484 584)	reserve
14	Inquiry (184/384 484 584)	reserve
15	Forced multi-coil	reserve

6.5 MODBUS Register Definition

6.5.1. Modbus Register Address Definition

Table 13

Protocol Addresses (Decimal)	Protocol Addresses (HEX)	Data Format	Register Definition
4112	0x1010	Float Inverse	Instantaneous flow floating point representation
4114	0x1012	Float Inverse	Instantaneous flow rate floating point representation
4116	0x1014	Float Inverse	Flow rate percentage floating point representation (retained by battery powered meters)
4118	0x1016	Float Inverse	Fluid conductivity ratio floating point representation
4120	0x1018	Long Inverse	Positive cumulative value integer part
4122	0x101A	Float Inverse	Decimal part of the positive cumulative value
4124	0x101C	Long Inverse	Reverse accumulation of integer part of value
4126	0x101E	Float Inverse	Reverse accumulation of numerical decimal part
4128	0x1020	Unsigned short	Instantaneous flow unit (Table 15)
4129	0x1021	Unsigned short	Cumulative total unit (Table 16/Table 17)
4130	0x1022	Unsigned short	Upper limit alarm
4131	0x1023	Unsigned short	Lower limit alarm
4132	0x1024	Unsigned short	Empty pipe control
4133	0x1025	Unsigned short	System alarm

6.5.2. Data Description

(1) Floating format

The electromagnetic flowmeter MODBUS adopts IEEE754 32-bit floating point format, and its structure is as follows: (taking instantaneous flow as an example)

Table 14

0x1010(34113)		0x1011(34114)	
BYTE1	BYTE2	BYTE3	BYTE4
S EEEEEEE	E MMMMMMM	MMMMMMMM	MMMMMMMM

S (Sign Bit): 1 = Negative, 0 = Positive.

E (Exponent): The actual exponent value is obtained by subtracting 127 from this field.

M (Mantissa): The 23-bit fractional part.

Conversion Formula (when E is neither all "0" nor all "1")

When the exponent (E) is neither completely 0 nor completely 1, the conversion between floating-point numbers and decimal values follows this formula:

$$V = (-1)^S 2^{(E-127)}(1+M)$$

(2) Instantaneous Flow Unit

Table 15

Code	Instant unit	Code	Instant unit	Code	Instant unit	Code	Instant unit
0	L/S	3	M3/S	6	T/S	9	GPS
1	L/M	4	M3/M	7	T/M	10	GPM
2	L/H	5	M3/H	8	T/H	11	GPH

(3) Accumulative flow unit

Table 16

Code	0	1	2	3
Accumulation Unit	L	M3	T	USG

Table 17

Code	0	1	2	3	4	5
Accumulation unit	L	L	L	M3	M3	M3
Code	6	7	8	9	10	11
Accumulation unit	T	T	T	USG	USG	USG

(4) Alarm

Upper limit alarm; lower limit alarm; Empty pipe alarm; System alarm

0-No alarm; 1-Alarm

6.6 Communication Data Parsing

The decimal parts of the instantaneous flow rate, instantaneous flow velocity, flow rate percentage, fluid conductivity percentage, and forward and reverse cumulative values are transmitted in floating-point format.

6.6.1. Reading Instantaneous Flow Rate

The master sends the command (in hexadecimal)

Table 18

01	04	10	10	00	02	74	CE
Device address	Function code	Register address High byte	Register address High byte	Register length High byte	Register length Low byte	CRC High byte	CRC Low byte

The master receives the data:

Table 19 The master receives the data:

01	04	04	C4	1C	60	00	2F	72
Device address	Function code	Data length	4-byte floating point number (Instantaneous flow)				CRC High byte	CRC Low byte

Floating point number C4 1C 60 00

1100 0100 0001 1100 0110 0000 0000 0000

Floating point byte 1 Floating point byte 2 Floating point byte 3 Floating point byte 4

S=1: The mantissa sign is 1, indicating a negative number.

E = 10001000: exponent is 136

M = 001 1100 0110 0000 0000 0000, the mantissa is

$$V=(-1)^1 2^{(136-127)}\left(1+\frac{1}{8}+\frac{1}{16}+\frac{1}{32}+\frac{1}{512}+\frac{1}{1024}\right)=-625.5$$

6.6.2. Reading Instantaneous Flow Velocity

Master station sends command:

Table 20

01	04	10	12	00	02	D5	0E
Device address	Function code	Register address high byte	register address high byte	Register length high byte	Register length low byte	CRC High byte	CRC Low byte

The master receives the data:

01	04	04	C4	1C	60	00	2F	72
Device address	Function code	Data length	4-byte floating point number (Instantaneous flow)				CRC High byte	CRC Low byte

The floating point number is: C1 B0 80 00

1100 0001 1011 0000 1111 1000 0000 0000

S = 1

E = 10000011

M = 011 0000 1111 1000 0000 0000

$$V=(-1)^1 2^{(131-127)}\left(1+\frac{1}{4}+\frac{1}{8}+\frac{1}{256}\right)=-22.0625$$

6.6.3. Read Accumulative Flow Rate

To fully represent the 9-digit cumulative value of the electromagnetic flowmeter, the cumulative flow is divided into an integer part and a decimal part. The integer part is represented using a long integer variable, and the decimal part is represented using a floating-point number.

Cumulative flow: 1587 m³

Command sent by the master to read the integer part of the cumulative flow:

Table 21

01	04	10	18	00	02	F5	0C
Device address	Function code	Register address high byte	Register address high byte	Register length high byte	Register length low byte	CRC High byte	CRC Low byte

The master receives the data:

Table 22

01	04	04	00	00	70	71	1E	60
Device address	Function code	Data length	4 bytes long integer (Integer part of cumulative amount)				CRC High byte	CRC Low byte

The integer part of the cumulative flow is = 28785

The master station sends a command to collect the decimal value of the accumulated flow:

Table 23

01	04	10	1A	00	02	54	CC
Device address	Function code	Register address high byte	Register address high byte	Register length high byte	Register length low byte	CRC high byte	CRC Low byte

The master receives the data:

Table 24

04	04	3F	00	00	00	3B	90
Device address	Data length	4-byte floating point number (Decimal part of cumulative amount)				CRC high byte	CRC Low byte

The floating point number is: 3F 00 00 00

0011 1111 0000 0000 0000 0000 0000 0000

S = 0

E = 0111111 126

M = 000 0000 0000 0000 0000 0000

$$V = (-1)^{1}\,2^{(126-127)} = 0.5$$

6.6.4. Read Instantaneous Flow Unit

The master sends an 8-byte command to read the instantaneous flow unit:

Table 25

01	04	10	20	00	01	34	C0
Device address	Function code	Register address high byte	Register address high byte	Register length high byte	Register length low byte	CRC high byte	CRC Low byte

The master station receives 7 bytes of data sent back by the slave station:

Table 26

01	04	02	00	05	79	33
Device address	Function code	Data length	2-byte integer (Instantaneous flow unit)		CRC high byte	CRC Low byte

According to Table 3, the flow unit is M^3/H

6.6.5. Read Total Flow Unit

The master sends an 8-byte command to read the instantaneous flow unit:

Table 27

01	04	10	21	00	01	65	00
Device address	Function code	Register address high byte	Register address high byte	Register length high byte	Register length low byte	CRC high byte	CRC Low byte

The master station receives 7 bytes of data sent back by the slave station:

Table 28

01	04	02	00	01	78	F0
Device address	Function code	Data length	2-byte integer (Cumulative unit)		CRC high byte	CRC Low byte

6.6.6. Read Alarm State

The master station sends 8-byte command:

Table 29

01	04	10	24	00	01	75	01
Device address	Function code	Register address high byte	Register address high byte	Register length high byte	Register length low byte	CRC high byte	CRC Low byte

The master station receives 7 bytes of data sent back by the slave station:

Table 30

01	04	02	00	01	78	F0
Device address	Function code	Data length	2-byte integer (Alarm)		CRC high byte	CRC Low byte

Status 01 means empty pipe is on alarm.

Other alarm types follow in a similar manner.

7 Maintenance and Care

Intelligent converters have self-diagnose function. Without trouble of power and hardware circuit, the normal trouble can be alarmed correctly. This information displays on the left of LCD. The trouble is like this:

FQH ---- Flow high limit alarm; FQL ---- Flow low limit alarm;

FGP ---- Flow empty pipe alarm; SYS ---- System exciting alarm.

7.1 Troubleshooting

7.1.1. No Display

a. Check the power supply connection;

b. Check the power fuse;

c. Check the compliance of power voltage with requirements;

d. Check the contrast of LCD and regulate it to working state;

e. If the above items a, b, and c are all normal, but item d — the contrast adjustment of the display — is not functioning, please return the converter to the manufacturer for repair.

7.1.2. Excitation Alarm

a. Check whether the excitation wiring EXI and EX2 are open.

b. Is the total resistance of the sensor excitation coil less than 150Ω?

c. If both a and b are normal, the converter is faulty.

7.1.3. Empty Pipe Alarm

a. Whether the measured medium is full of the measuring pipe.

b. Short-circuit the three points of the converter's signal input terminals SIG1, SIG2 and the grounding terminal SGND with a wire. In this case, if the "empty pipe alarm" prompt is not displayed, it indicates that the converter is work normally, and it is possible that the conductivity of the measured fluid is low or there are errors in the settings of the empty pipe threshold and the empty pipe range.

c. Check whether the signal connection is correct;

d. Check whether sensor is normal

① Set the flow rate to zero and observe — the displayed conductivity ratio should be less than 100%.

② When there is flow, measure the resistance between terminals SIG1 and SGND, and SIG2 and SGND, respectively. The resistance should be less than 50 kΩ (for water-based media). (It is recommended to use an analog multimeter for this measurement, where the charging and discharging behavior during the test can be observed.)

e. Measure the DC voltage between DS1 and DS2 using a multimeter. It should be less than 1V. If the voltage exceeds this value, it indicates the sensor electrodes may be contaminated and should be cleaned.

7.1.4. Inaccuracy of Measured Flow

A. Check whether the measuring tube of the sensor is completely filled with fluid.

B. Check whether the signal wiring is properly connected.

C. Verify that the sensor coefficient and sensor zero point are correctly set according to the sensor nameplate and factory calibration certificate.

8 Technical Parameters

8.1 Technical Parameters

Table 31 Technical Parameters

Measuring System		
Standards	JB/T9248-2015	
Measuring principle	Faraday's law of electromagnetic induction	
Function	Real-time measurement and flow accumulation of instantaneous flow, flow velocity, mass flow (when density remains constant)	
Module structure	The measuring system consists of a measuring sensor and a signal converter	
Measuring principle	Faraday's law of electromagnetic induction	
Converter		
Protection Level	Integrated type	IP65
	Remote type	Meter head: IP65
		Body: IP65/IP68
Sensor		
DN	DN10~DN 1000	
Process connection	Flange: JB/T 81 flange or GB/T 9124 flange, other standard flanges can be customized . Clamp: Conforms to ISO 2852 clamp standard. Clamps above DN50 need to be customized after consultation.	
Rated pressure level (High-pressure version is customizable)	DN10~DN250, PN<1.6MPa	
	DN300~DN1000, PN<1.0MPa	
	There may be difference between specifications, please refer to the nameplate as the standard; high pressure version can be customized.	
Liner material	Neoprene (CR), UR, PTFE (F4), F46, Teflon (PFA)	

Electrode	Stainless steel 316L, Hastelloy (HB and HC), titanium, tantalum, platinum- iridium alloy	
Protection level	Remote version: IP67 (IP68 available)	Integrated version: IP65
Medium temperature	Remote version: CR: -10 ℃ ~70 ℃ UR: -10 ℃ ~60 ℃ PTFE/F46 : -10 ℃ ~120 ℃ PFA: -10 ℃ ~180 ℃	Integrated version: CR: -10 ℃ ~70 ℃ UR: -10 ℃ ~60 ℃ PTFE/F46 : -10 ℃ ~120 ℃ PFA: -10 ℃ ~120 ℃
Buried depth	≤5m (Only for remote type of IP68)	
Submerging depth	≤3m (Only for remote type of IP68)	
Sensor cable	Only for the remote type; Standard cable length: 10m; Maximum customizable cable length: ≤100m	
Communication		
Serial communication	RS-485	
MODBUS Interface	RTU format, physical interface RS-485, electrical isolation 1000V	
Function	Empty pipe identification	
Measurement accuracy		
Accuracy	Flow rate: ±0.5 % of measured value (flow rate ≥1 m/s); ±0.5 % of measured value ±2mm/s (flow rate < 1 m/s)	
Repeatability	0.16 %	
User Interface		
Graphics Display	High-definition backlit LCD display	
Display functions	9 measurement value screens (measurement, status, etc.)	
Language	Chinese/English	
Unit	No. 5 “flow unit” in Table 8 in sector.5.5 “Parameter Setting Menu”	

Operating unit	4 mechanical push buttons
Environment	
Ambient temperature	-10℃~55℃
Storage temperature	-40℃~65℃
Conductivity	
Water	Min. 20μS/cm (actual measurable conductivity should be greater than 30μS/cm)
Other	Min. 5μS/cm (actual measurable conductivity should be greater than 30μS/cm)
Material	
Sensor housing	Carbon steel
Converter	Standard die-cast aluminum
Electrical Connection	
Power voltage	85VAC~250VAC, 45Hz~63Hz, 20VDC~36VDC
Power rate	≤20W
Signal cable	Only for the remote type
Output	
Current output	(4~20) mA, (0~750) Ω
Frequency output	Frequency output range: (1～5000) Hz Output electrical isolation: photoelectric isolation. Isolation current voltage: >1000VDC Frequency output drive: field effect tube output; maximum current voltage 36VDC; maximum load current 250mA
Pulse output	Output pulse equivalent: (0.001～1.000) m3/cp (0.001～1.000) Ltr /cp (0.001～1.000) T/c Output pulse width: 50ms, automatically converted into square wave at high frequency

	Output current isolation: photoelectric isolation, current voltage: >1000VDC Pulse output drive: field effect tube output, maximum power voltage 36VDC, maximum load current 250mA
Alarm output	Alarm output contact: ALMH--upper limit alarm; ALML--lower limit alarm Output current isolation: photoelectric isolation. Maximum current voltage: >1000VDC Alarm output drive: Darlington output, maximum current voltage 36VDC, maximum load current 250mA

8.2 Accuracy

Reference conditions

① Medium: Water

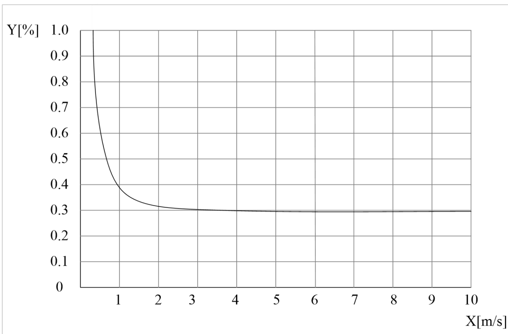
② Temperature: 20℃

③ Pressure: 0.1MPa

④ Front straight pipe section: ⩾10DN, rear straight pipe section: ⩾5DN

⑤ X[m/s]: flow velocity

⑥ Y[%]: deviated value(mV) of the actual measured



8.3 Electrode Material

Table 32

Material	Corrosion resistance
Molybdenum-containing stainless steel (0Cr18N12Mo2Ti)	Applicable: domestic/industrial water, sewage, weak acid and alkali salt solution, concentrated nitric acid at room temperature. Not suitable for: hydrofluoric acid, hydrochloric acid, chlorine, bromine, iodine and other media.
Hastelloy B	Applicable: Non-oxidizing acids such as hydrochloric acid and hydrofluoric acid of a certain concentration, non-oxidizing hydrochloric acid, and alkali solutions such as sodium hydroxide with a concentration not less than 70% Incompatible with: oxidizing acids such as nitric acid
Hastelloy C	Applicable: corrosion by oxidizing acids, such as nitric acid, mixed acid, or sulfuric acid; also resistant to corrosion by oxidizing salts or environments containing other oxidants, such as hypochlorite solutions above room temperature; very good corrosion resistance to seawater. Not applicable: reducing acids such as hydrochloric acid and chlorides
Titanium	Applicable: Chlorides, hypochlorites, seawater, oxidizing acids. Not applicable: Reducing acids such as hydrochloric acid and sulfuric acid
Tantalum	Applicable: Most acidic liquids such as concentrated hydrochloric acid, nitric acid, sulfuric acid, including boiling point hydrochloric acid, nitric acid and sulfuric acid below 175°C. Not applicable: Alkali, hydrofluoric acid, fuming sulfuric acid.
Pt - Ir alloy	Various acids, bases, salts, excluding aqua regia.

Note: Due to the wide variety of media, their corrosiveness is affected by temperature, concentration, flow rate and other complex factors, so this table is for reference only. Users should make their own choices based on actual conditions. For general media, you can refer to the relevant anti-corrosion manual. For media with complex components such as mixed acid, corrosion tests should be conducted on the selected materials.

8.4 Flow Rate& Flow Velocity Reference Table

Table 33 Flow Rate& Flow Velocity Reference Table

Flow Velocity (m/s) / Flow rat (m^3/h) / DN(mm)	0.1	0.2	0.4	0.5	1	5	10	15
DN10	0.0283	0.0565	0.1131	0.1414	0.2827	1.4137	2.8274	4.2411
DN15	0.0636	0.127	0.254	0.318	0.636	3.1809	6.362	9.543
DN20	0.113	0.226	0.452	0.565	1.131	5.6549	11.310	16.965
DN25	0.176	0.353	0.707	0.884	1.767	8.8357	17.671	26.507
DN32	0.290	0.579	1.158	1.448	2.895	14.476	28.953	43.429
DN40	0.452	0.905	1.810	2.262	4.524	22.619	45.239	67.858
DN50	0.707	1.414	2.827	3.534	7.069	35.343	70.690	106.03
DN65	1.195	2.389	4.778	5.973	11.946	59.730	119.46	179.19
DN80	1.810	3.619	7.238	9.048	18.100	90.478	181.00	271.43
DN100	2.827	5.655	11.310	14.137	28.274	141.37	282.74	424.12
DN125	4.418	8.836	17.671	22.090	44.179	220.89	441.79	662.68
DN150	6.362	12.723	25.447	31.809	63.617	318.09	636.17	954.26
DN200	11.310	22.619	45.239	56.549	113.10	565.49	1131.0	1696.5
DN250	17.671	35.343	70.686	88.357	176.71	883.57	1767.1	2650.7
DN300	25.447	50.893	101.79	127.23	254.47	1272.3	2544.7	3817.0
DN350	34.636	69.272	138.54	173.18	356.36	1731.8	3463.6	5195.4
DN400	45.239	90.478	180.96	226.19	452.39	2261.9	4523.9	6785.8
DN450	57.256	114.51	229.02	286.28	572.56	2862.8	5725.6	8588.3
DN500	70.686	141.37	282.74	353.43	706.86	3534.3	7060.6	10603
DN600	101.79	203.58	407.15	508.94	1017.9	5089.4	10179	15268
DN700	138.54	277.09	554.18	692.72	1385.4	6927.2	13854	20782
DN800	181.00	361.91	723.82	904.78	1809.6	9047.8	18096	27143
DN900	229.02	458.04	916.09	1145.1	2290.2	11451	22902	34353
DN1000	282.74	565.49	1131.0	1413.7	2827.4	14137	28274	42412
DN1200	407.15	814.30	1628.6	2035.8	4071.5	20357	40715	61072
DN1400	554.18	1108.4	2216.7	2770.9	5541.8	27709	55418	83126
DN1600	723.82	1447.7	2895.3	3619.1	7238.2	36191	72382	108573

9 Insertion Electromagnetic Flowmeter Series

9.1 Function and Applications

Insertion electromagnetic flowmeter (Sensor for short) and electromagnetic converter (converter for short) combined is composed of electromagnetic flowmeter (flowmeter for short) is designed for measuring volumatric flow of all conductive liquid in the pipes.

Sensor’s features:

① No moving parts in sensor; simple structure ensuring reliable performance.

② Insertion design allows for easy installation and disassembly without shutting off the water supply, even under low-pressure or pressurized conditions, making it especially suitable for fluid measurement in pipelines and facilitating the flowmeter's maintenance and repair.

③ Measurement accuracy is unaffected by the temperature, pressure, density, viscosity, conductivity (⩾30) and other parameters of the medium to be measured.

④ Almost no pressure loss in sensor with reduced energy consumption.

⑤ Lower manufacturing and installation costs compared to conventional electromagnetic flowmeters, making it particularly suitable for flow measurement in medium- to large-diameter pipelines.

⑥ Adapting advanced low frequency square excitation wave, ensuring zero-point stability, strong anti-interference performance, and reliable operation.

⑦ Wide measuring range. The full-scale flow velocity inside the pipeline can be freely set from 1 m/s to 10 m/s. The output signal is linearly proportional to the flow rate.

⑧ The flowmeter offers standard DC current outputs of 0-10 mA or 4-20 mA, as well as a frequency output of 1-5 kHz.

With its comprehensive advantages, the flowmeter (sensor) has found wide applications in industries such as chemical engineering, chemical fiber, metallurgy, fertilizer production, papermaking, water supply and drainage, and wastewater treatment, as well as in agricultural irrigation. It is well-suited for measuring the flow of conductive liquids and for use in automated process control systems.

9.2 Structure and Format

The product type is insertion electromagnetic flowmeter. It is connected to the pipeline via a mounting base, ball valve, compression nut and positioning screw.

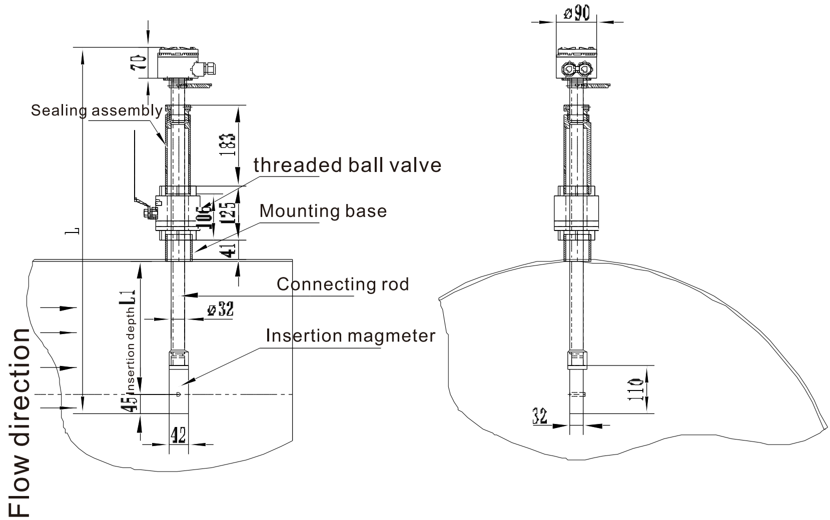
The sensor is available in two structural types: measuring tube type and flat-electrode type.

- The measuring tube type is suitable for measuring clean media.
- The flat-electrode type is suitable for measuring liquids containing impurities.

9.3 Technical Performance

<table>
<tr><td>Applicable pipe diameter</td><td colspan="2">DN100 to DN3000</td></tr>
<tr><td>Flow velocity measuring range</td><td colspan="2">0–1 to 0–10 m/s; full - scale range adjustable continuously within 1–10 m/s</td></tr>
<tr><td>Accuracy</td><td colspan="2">±1.5% F.S when flow velocity>1 m/s</td></tr>
<tr><td>Conductivity of measured medium</td><td colspan="2">Greater than 30 μS/cm</td></tr>
<tr><td>Maximum operating pressure</td><td colspan="2">1.6 MPa</td></tr>
<tr><td>Electrode materials</td><td colspan="2">316L, HC (Hastelloy C), etc.</td></tr>
<tr><td>Measuring tube (measuring head) material</td><td colspan="2">ABS</td></tr>
<tr><td>Maximum temperature of measured medium</td><td colspan="2">60°C (for ABS material)</td></tr>
<tr><td rowspan="3">Flowmeter output signals - DC current</td><td rowspan="2">DC current</td><td>(0–10) mA, load resistance 0–1 kΩ;</td></tr>
<tr><td>(4–20) mA, load resistance 0–500 Ω;</td></tr>
<tr><td colspan="2">Frequency: 1–5 kHz</td></tr>
<tr><td>Connection method</td><td colspan="2">Flanged ball valve or threaded (screw) ball valve</td></tr>
<tr><td>Pipe specification</td><td colspan="2">15D upstream of straight pipe, 10D downstream</td></tr>
</table>

9.4 Structure



Note: If integrated converter is used, the meter height shall be increased 81mm.

Fig.39 Product dimensions of remote magmeter (unit: mm)

Table 34 Insertion Type Total Length

Insertion length	
Specification	length
DN≤200	630 mm
400≥DN≥250	730 mm
1200≥DN＞400	830 mm
2000≥DN＞1400	1030 mm

Insertion depth L1: pipe diameter ≤ DN400, insertion depth is ½ DN ;

For pipe diameters > DN400, the insertion depth is ¼ DN

■ Sensor

The sensor, as illustrated, is primarily composed of a measuring head (or measuring tube), excitation system, insertion rod, terminal box (or integrated display unit), mounting base, and sealing and positioning mechanism.

- **Measuring Head (or Measuring Tube):**

The measuring head (or measuring tube) is positioned at the velocity point of the fluid within the pipeline and is used to detect the flow velocity at that point. It consists of an insulating end cap or conduit equipped with a pair of electrodes. Apart from the electrode ends or the inner wall of the measuring tube, all other parts are insulated from the measured fluid.

- **Excitation System:**

The excitation system generates the working magnetic field and consists of an excitation coil and an iron core. It is encapsulated in an insulated and sealed manner within the insertion rod.

- **Insertion Rod:**

Made of stainless steel, the insertion rod houses the measuring head. Excitation and electrode leads are routed through the insertion rod, sealed against the measured medium, and connected to the junction box. A direction indicator is welded onto the insertion rod to ensure that the magnetic field, flow direction, and electrode axis remain mutually perpendicular during installation—fulfilling the requirements of Faraday's law of electromagnetic induction.

- **Terminal Box:**

Located at the top of the sensor, the junction box contains terminals for connecting the sensor to the converter. (Note: For the integrated display unit version, it is also located at the top of the sensor and functions in conjunction with the sensor.)

- **Mounting Base:**

The mounting base is welded to the measured pipeline and serves as the interface for the ball valve and the insertion-type electromagnetic flow sensor.

- **Sealing and Positioning Mechanism:**

Comprising a stainless-steel threaded compression seat, a compression nut, rubber gasket, and positioning screw, this mechanism seals the insertion-type sensor and enables it to withstand a certain level of operating pressure.

9.5 Installation and Operation

9.5.1. Installation

(1) Installation environment

- ➢ Be away from devices with strong magnetic field, such as motor, or VFDS.
- ➢ Be free from strong vibration while pipes are securely fixed; and environmental changes are slight.
- ➢ Places where are easy for installation and maintenance.

(2) Installation site

- ❖ The installation location must ensure that the pipeline is always completely filled with the measured fluid.
- ❖ Select a location with minimal flow pulsation—i.e., away from pumps, valves, elbows, and other components that create local resistance.
- ❖ When measuring multi-phase fluids (solid-liquid or gas-liquid), choose a position where phase separation is less likely to occur.
- ❖ Avoid locations where negative pressure may occur.
- ❖ The diameter or circumference of the pipeline at the measurement point should be easy to determine, and the pipe should have minimal ovality.

9.5.2. Straight Pipe Length

A straight pipe section of at least 15D should be provided upstream of the sensor, and at least 10D downstream, where D is the inner diameter of the pipe.

9.5.3. Flow Control and Regulating Valves

The flow control valve should be installed upstream of the sensor in the measured pipeline. The flow regulating valve should be installed at least 3D downstream of the sensor. During measurement, the flow control valve is typically kept fully open.

9.5.4. Welding of the Mounting Base

Before installation, a 50 mm diameter hole should be drilled in the measured pipeline. The hole size should match the outer diameter of the connecting pipe on the mounting base. The welding of the mounting base to the pipeline is shown in Figure 41.

The technical requirements for welding are as follows:

(1) The axis of the mounting base must be perpendicular to the axis of the

pipeline.

(2) Flat welding using stainless steel welding rods should be employed. After welding, the flange end face must remain parallel to the pipeline axis. The weld should be firm and capable of withstanding a pressure of 1.6 MPa without leakage.

9.5.5. Sensor Installation

① Remove welding slag and burrs from the mounting base on the measured pipe.

② Shut off the upstream flow control valve or use low-pressure water supply.

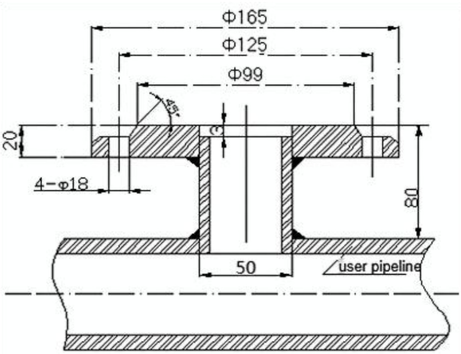


Fig.40

③ Determine the insertion depth of the insertion-type electromagnetic flowmeter (i.e., the position of the two electrodes on the sensor within the pipeline).

④ Install a DN50 ball valve onto the mounting base as shown in Figure 40. Make sure the longer cavity of the ball valve faces upward. Check that the valve can open and close fully. Tighten the compression nut and positioning screw. Ensure the sensor's direction indicator aligns with the fluid flow direction.

⑤ Determining the insertion depth of the insertion-type electromagnetic flow sensor:

- For pipelines with diameter D ≤ 400 mm, the insertion depth should be half the pipe diameter (D/2).
- For D > 400 mm, the insertion depth should be one-quarter of the pipe

diameter (D/4).

(Note: The instrument coefficients for these two depths are different.)

9.5.6. Grounding

The flow signal generated by the sensor is extremely weak, typically in the microvolt or millivolt range. Therefore, preventing external electrical interference is critical for reliable flowmeter operation. Grounding is an effective measure to mitigate electrical interference.

The key grounding requirement is to ensure the measured medium is grounded. The grounding terminals of both the sensor and the converter should be connected to the metal shielding of the flow signal cable, and, through the insertion rod, connected to the measured medium.

If the measured pipeline is non-metallic, the sensor's grounding terminal should be directly connected to earth with a grounding wire. The grounding resistance must be less than 10 Ω.

9.5.7. Adjustment and Operation

(1) If the flow rate of the measured pipeline is known, the flow range can be set based on the flow rate and the range setting method described in the converter's installation and operation manual.

(2) Once all preparations are complete, first open the upstream flow control valve of the sensor, then slowly open the downstream flow regulating valve. Observe the converter: the flow reading should increase gradually. If the reading is negative, turn off the power and swap the signal wires "SIG1" and "SIG2."

(3) Based on the actual measured flow, reset the flow range and meter coefficient as needed by referring to the converter's manual.

(4) If the sensor is installed outdoors or buried underground, after connecting the terminal wires, it should be sealed using the sealant provided by the manufacturer.

(5) First, open the upstream flow control valve; then open the downstream flow regulating valve to let the fluid discharge for a few minutes so that any entrained gas can be expelled. Next, close both valves, ensuring the pipeline

is fully filled with fluid but without flow. Finally, follow the instructions in the converter's manual to perform zero calibration.

9.6 Maintenance, Repair and Common Troubleshooting

9.6.1. Maintenance

The sensor generally does not require regular maintenance. However, if the measured medium tends to cause scaling or deposits on the surface or inner wall of the electrodes and measuring head (measuring tube), periodic cleaning is necessary. The cleaning interval should be determined based on the rate of buildup. When cleaning the electrodes and measuring head (measuring tube), be careful not to damage the insulation materials or electrodes.

9.6.2. Repair

If a sensor malfunctions, refer to the diagnostic methods in Section 9.6.3 to check whether the excitation or measurement system is functioning properly. If a fault is confirmed, please contact the manufacturer. Users should not attempt to repair the sensor themselves.

When disassembling the sensor, be sure to close the ball valve.

9.6.3. Troubleshooting

Trouble	Possible causes	Solutions
Flow reading is negative	1. Sensor direction indicator is opposite to the flow direction 2. SIG1 and SIG2, or EXT1 and EXT are wired in reverse	1. Rotate the sensor 180° 2. Reconnect the converter wires correctly
Converter output exceeds range	1. Flowmeter range is smaller than actual flow 2. Pipe is not completely filled with fluid. 3. Excitation coil is open-circuited	1. Eliminate gas from the pipeline 2. Clean the electrode 3. Reconnect the wiring

Trouble	Possible causes	Solutions
Output signal fluctuates	1. Gas present at the sensor electrodes causing poor contact with the medium 2. Deposits on the electrodes	1. Eliminate the gas from the pipeline 2. Clean the electrodes
Output signal drifts to zero	1. Sensor has become waterlogged 2. Electrodes are covered	1. Replace the sensor 2. Clean the electrode

Appendix 1 DIP Switch Description (Integrated Version)

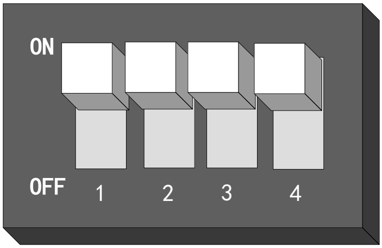


Fig.41

Switch 1 Definition:

- ✧ ON: Supplies pull-up voltage (24V) to the ALML alarm output terminal.
- ✧ OFF: Not connected.

Switch 2 Definition:

- ✧ ON: Provides an OC gate pulse output with a pull-up resistor (weak pull-up, 10kΩ) for flow calibration.
- ✧ OFF: Not connected.

Switch 3 Definition:

- ✧ ON: Supplies pull-up voltage (24V) to the ALMH output terminal.
- ✧ OFF: Not connected.

Switch 4 Definition:

- ✧ ON: Connects RS485 communication terminal resistor (standard resistor: 120Ω).
- ✧ OFF: Not connected.

Note:

The terminal resistor is used for long-distance communication. For short distances, it should remain disconnected.

Appendix 2 Flow Coefficient Modification Record Function

According to the new requirements of the National Metrological Verification Regulation for Electromagnetic Flowmeters, the electromagnetic flow converter must record a set of three flow characteristic parameters: the converter correction coefficient (factory calibration coefficient), the sensor calibration coefficient (sensor coefficient value), and the sensor zero point (zero-flow correction). It also automatically logs the number of times these parameters are modified (MR count). Each time any of the three parameters is changed, the modification count increases by one. Users are not allowed to alter the MR count.

In the verification certificate, users must record both the sensor calibration coefficient and the MR count. Any subsequent changes will result in a different MR count. By checking the modification count, it is possible to determine whether any flow characteristic parameters have been altered.

The electromagnetic flow converter can store the historical records of up to 32 modifications of flow characteristic parameters for users to review. The operation is as follows:

While in measurement mode, enter the converter's "Parameter Settings" screen. Then press the "Up" key to scroll to the "Coefficient Modification Records" screen. Enter this menu to view the coefficient modification records.

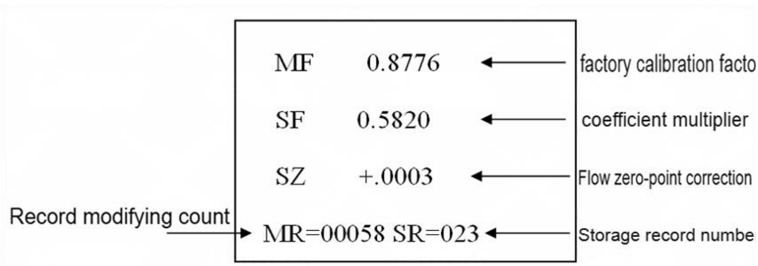


Fig.42

Note: The first item displayed in this menu is the serial number of the most recent parameter modification. To view previous records, press the "Down" key to browse through history. Up to 32 records—from the most recent to earlier changes—can be accessed. Finally, users should log the MR count for reference.

Appendix 3 Notes on the Nonlinearity Correction Function

The nonlinearity correction function is primarily used for linear adjustment at low flow rates. This function is designed with four correction segments, consisting of four velocity correction points and four corresponding correction coefficients.

The nonlinearity correction coefficients are applied on top of the original sensor calibration coefficient. Therefore, it is necessary to first disable the nonlinearity correction function, mark the sensor coefficient, and then enable the nonlinearity correction function to proceed with correction. Based on the nonlinear sections of the sensor, set the correction points and corresponding coefficients accordingly. If set properly, recalibration may not be required.

Assume that the flow velocity calculated using the sensor coefficient is the original velocity, and the velocity after applying nonlinearity correction is referred to as the corrected velocity. The corrected velocity is defined as follows:

When Correction Point 1 > Original Velocity ≥ Correction Point 2:
Corrected Velocity = Correction Coefficient 1 × Original Velocity

When Correction Point 2 > Original Velocity ≥ Correction Point 3:
Corrected Velocity = Correction Coefficient 2 × Original Velocity

When Correction Point 3 > Original Velocity ≥ Correction Point 4:
Corrected Velocity = Correction Coefficient 3 × Original Velocity

When Correction Point 4 > Original Velocity ≥ 0:
Corrected Velocity = Correction Coefficient 4 × Original Velocity

Note:
When setting correction points, the following order must be maintained:
Correction Point 1 > Correction Point 2 > Correction Point 3 > Correction Point 4
The default (neutral) correction coefficient is 1.0000.
A coefficient greater than 1.0000 is considered positive correction (amplification), while a coefficient less than 1.0000 is considered negative correction (reduction).

Appendix 4 Lightning Protection Function Instructions

When installing the device, users must ensure that the grounding terminal of the converter is securely connected to the housing and properly grounded. This is because the lightning protection gas discharge tube conducts lightning surge current to the ground through the housing.

If the housing is not reliably grounded, and someone is operating the converter during a lightning strike, it may result in personal injury.

For details, please refer to the connection diagram.

(1) Circular Integrated Version (220V)

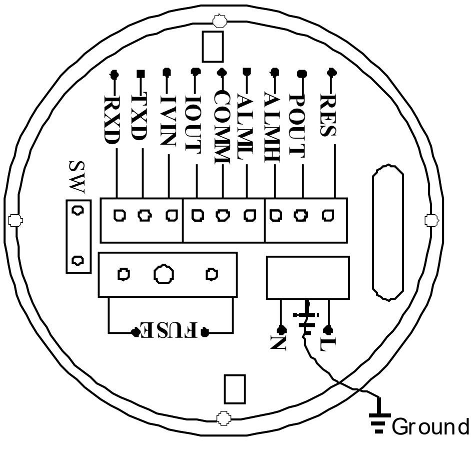


Fig.43

(2) Circular Integrated Version (24V)

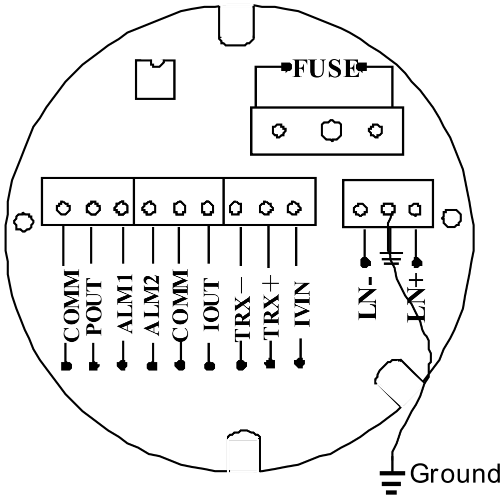


Fig.44

(3) Square Remote Version

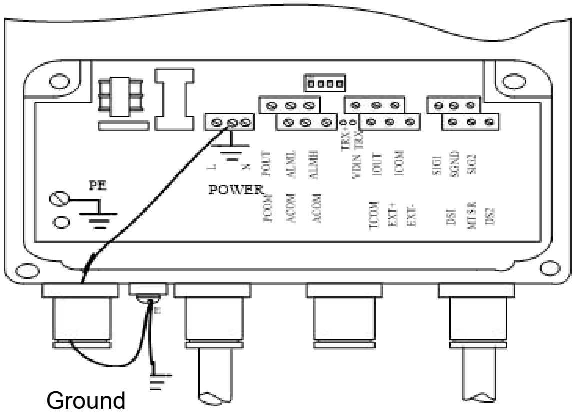


Fig.45

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