T-MAG Electro Magnetic Energy Meter

User's Manual

UMTMAG15-7-01B

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IMPORTANT:

This document only has to be used together with the user's manual of MAG888 flowmeter, "Man_MAG888_KD.pdf". The flow measurement portion of the T-MAG energy meter is extensively explained there.

T-MAG User's Manual

- Accurate Thermal Energy Measurement

Introduction

The T-MAG electro-magnetic energy meter is consisted of a MAG888 electro-magnetic flowmeter and a pair of PT1000 RTD sensors (PT100 is available upon request.) It not only measures the flow rate, but also measures the temperatures of the supply and the return. It then calculates the thermal energy transfer/consumption based on EN1434 standard calculation formula.

The T-MAG has two built-in signal conditioning circuit channels to accommodate the temperature sensors in order to obtain accurate temperature data. It has a generic energy totalizer which is resettable. It also has daily/monthly energy totalizers.

1. Installation

§1.1 Unpacking

Please unpack the shipping box and check the parts and documents against the packing slip. If there is anything missing, the device is damaged, or something is abnormal, please contact us immediately and do not proceed with the installation.

WARNING!

The T-MAG can be used to measure the flow of many kinds of liquids. Some of the liquids may be hazardous. It is very important that you comply with local safety codes and regulations in installing and using electronic devices in your area.

§1.2 Installation Considerations

This section provides guidelines for installing the T-MAG.

§1.2.1 Installing the Unit

The T-MAG's electronics are inclosed in a weather-resistant and dust-tight enclosure. Therefore, the main unit can be installed indoors and outdoors. Usually, it is mounted in a meter shed or on

a location where one can easily access for meter testing and servicing. The main unit should be installed in an area that it is not exposed to continuous saturation or relative humidity of greater than 90%.

§1.2.2 Installing the Flowcell

The flowcell should be installed by or under the supervision of a professional. When installing the T-MAG in an environment involving hazardous liquids please follow proper saftey protocol. Please refer to **Appendix 6** for installation recommendations.

§1.2.3 Installing the Insertion RTD sensor and Thermalwell

For RTD sensors and thermalwell information, including spec, model selection and installation, please refer to **Appendix 3** for installation recommendations.

2. Wiring

2.1. Terminals

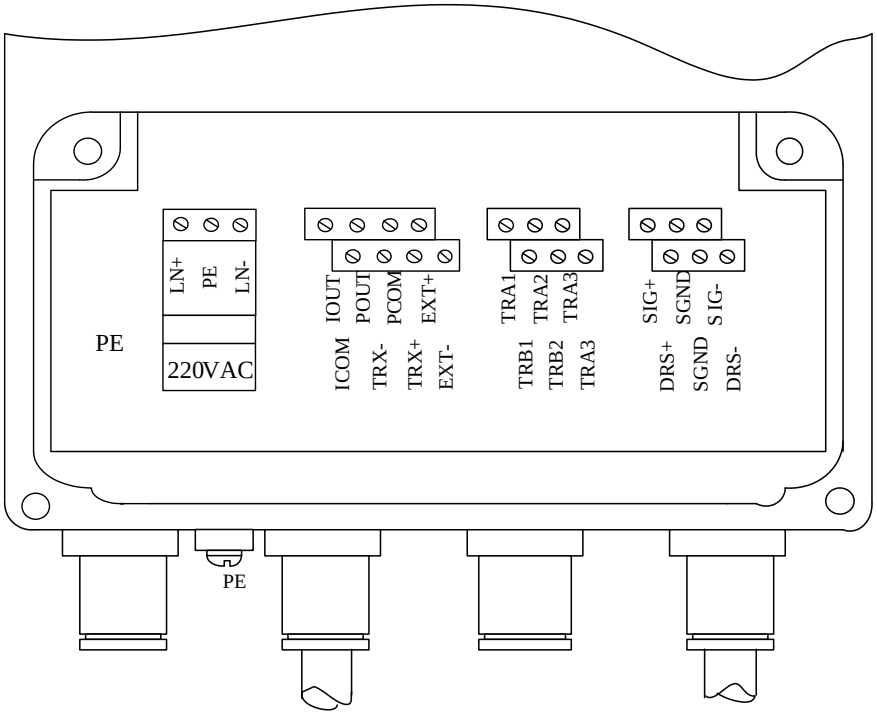


Figure 1.1 Terminal Connectors for T-MAG Meter (V16)

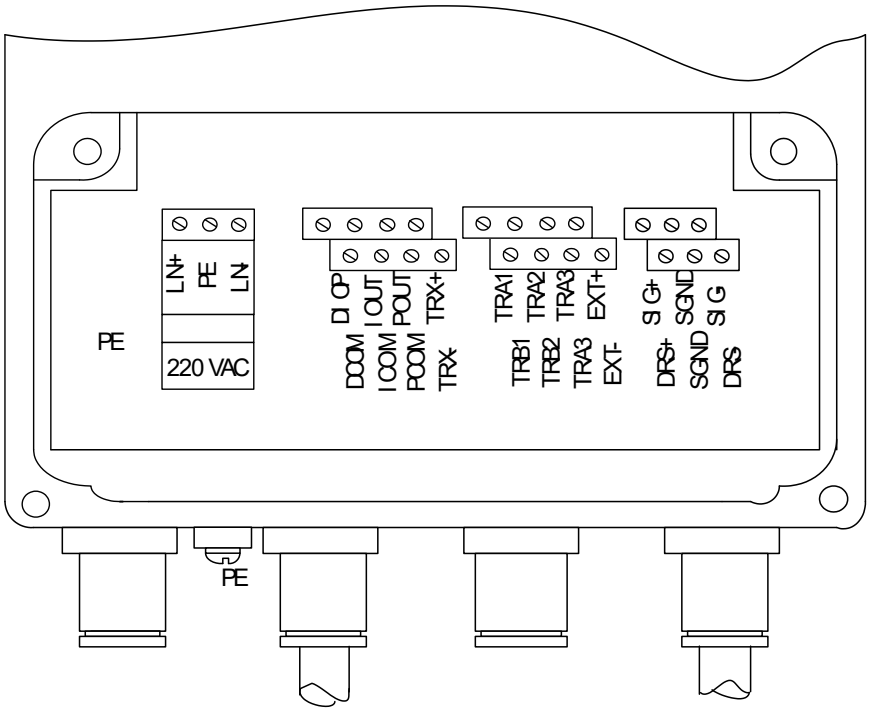


Figure 1.2 Terminal Connectors for T-MAG Meter (V20)

3. Symbols and Description of Terminal Connectors

TRA1	TempA Input	TRA2	TempA Input
TRA3	TempA Input	TRB1	TempB Input
TRB2	TempB Input	TRB3	TempB Input
SIG +	Signal 1	SGND	Signal Ground
SIG-	Signal 2	DRS +	Shielded Exciting 1
DRS-	Shielded Exciting 2	MTDR	Reserved
EXT +	Exciting Current+	EXT-	Exciting Current-
POUT	Frequency (Pulse) Output	PCOM	Frequency (Pulse) Output Ground
IOUT	Current Output	ICOM	Current Output Ground
TRX-	Communication Input	TRX+	Communication Input
LN-	85-220VAC Power Supply	LN+	85-220VAC AC Power Supply
DIOP	Reserved		Reserved

4. Basic Parameters

4.1. Heat Unit

The Heat unit can be set to MJ/h, GJ/h, KWh/h, MWh/h.

5. Heat Parameters

5.1. TempA(Temp B) Zero/Range

By default, T-MAG electromagnetic energy meter is equipped with a pair of 4-wire PT1000 RTD sensors. Please refer to Appendix 5 for details.

5.2. Heat Test

Heat test is set for user's convenience to check if the meter is faulty. When switched to "enable", the meter calculates according to settings, while the external input is ignored. Conversely, the external input works.

5.3. TempA(TempB) Value

When "Heat Test" is set to "enable", temperatures are set by software.

5.4. Sensor Position

Select "Flow inlet" if the sensors are installed at inlet; Select "Flow export" if the sensors are installed at export. Notice: calculation errors will be caused if this parameter does not correspond with the actual situation.

6. Auxiliary Parameters

6.1. Heat Total Unit

The energy meter has a 9-digit counter, with a maximum of 999999999. The heat total unit can be MJ, GJ, KWh, MWh. Heat total equivalents are:

0.001MJ, 0.010MJ, 0.100MJ, 1.000MJ
0.001GJ, 0.010GJ, 0.100GJ, 1.000GJ
0.001 KWh, 0.010 KWh, 0.100 KWh, 1.000 KWh
0.001 MWh, 0.010 MWh, 0.100 MWh, 1.000 MWh

Notice: For heat unit of KWh and MWh, there are only 8 effective digits, with a maximum of 99999999.

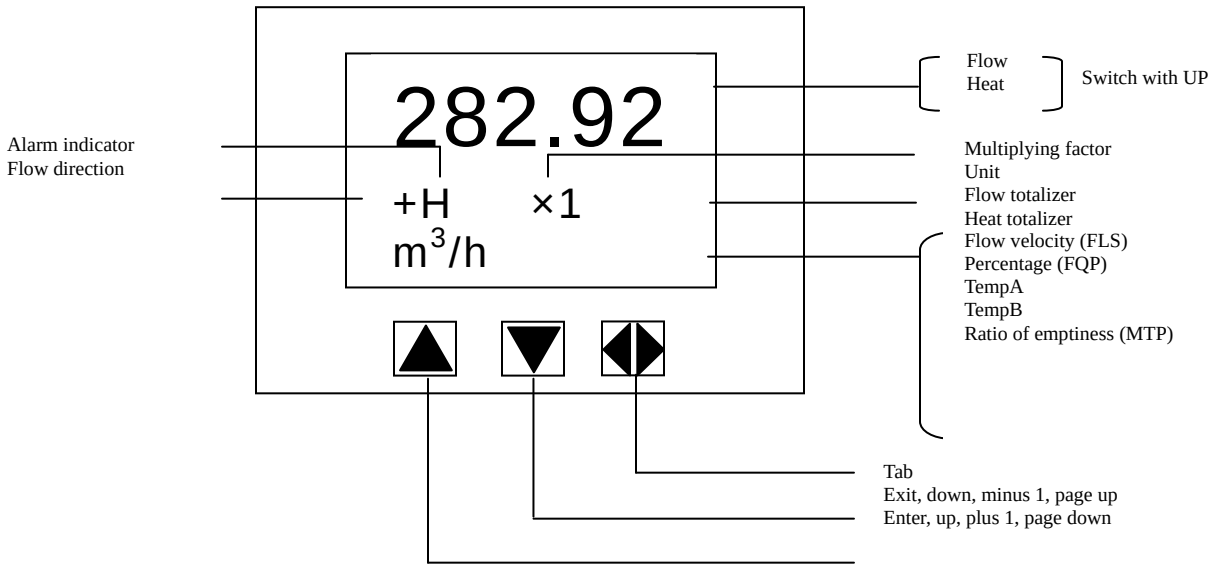
6.2. Heat Total High, Low

Set in the same way as flow total high, low. Notice: For heat unit of KWh and MWh, there are only 8 effective digits, with a maximum of 99999999.

7. Display and Operation

7.1 General Description

Upon power up you will be promoted with the measurement window; while the meter measures automatically and displays corresponding data. In the parameter setting mode, users can complete the instrument parameter settings with three panel keys.



7.2. Key Functions

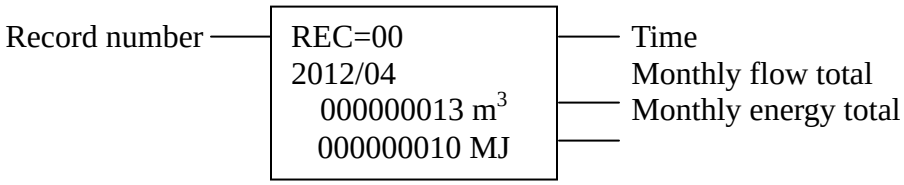
a) Key functions in measure mode
   Up: switch between heat and flow
   Down: cycle select on third line
   Tab: Enter function selections
b) Key function in Parameter Settings
   Up: plus 1, page down
   Down: minus 1, page up
   Tab: moving the cursor under “Up”, press “Up” to enter sub-menu; moving the cursor under “Down”, press “Down” to return to previous menu

7.3. Key Functions

c) Key functions in measure mode
   Up: switch between heat and flow
   Down: cycle select on third line
   Tab: Enter function selections
d) Key function in Parameter Settings
   Up: plus 1, page down
   Down: minus 1, page up
   Tab: moving the cursor under “Up”, press “Up” to enter sub-menu; moving the cursor under “Down”, press “Down” to return to previous menu

7.4. Monthly Total

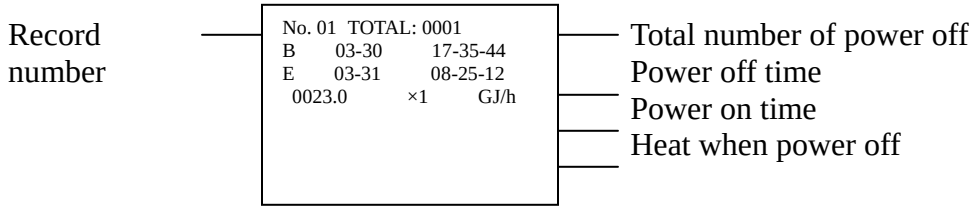
The meter has a clock powered by internal battery, which can work continuously for more than 5 years. To use the function of Monthly total and Power off timer, please ensure the internal clock is working properly.
Align the clock; Ensure sufficient battery power (change batteries every 5 years).



Monthly total can record 32 data. New data will automatically overwrite original ones when there are more than 32 records.

7.5. Power Off Timer

Set in the same way as Monthly total. It can record 32 power-off data and 9999 times.



APPENDIX

Appendix 1 Table of Parameter Setting Menu

Item No.	Menu Display	Setting Method	Value Range	Password Level
1	Language	Option	English	2
2	CommAddres	Modify	0~99	2
3	Baud Rate	Option	300~38400	2
4	Snsr Size	Option	10~2000	2
5	Heat Unit	Option	GJ/h, MJ/h, KWh/h, MWh/h	2
6	Flow Range	Modify	0~99999	2
7	Flow Rspns	Option	1~60S	2
8	Flow Direct	Option	Forward/reverse	2
9	Flow Zero	Modify	0~±9999	2
10	Flow Cutoff	Modify	Set Velocity	2
11	Total Unit	Option	$0.001m^3$~$1m^3$	2
12	HeatTotUnit	Option	MJ, GJ, KWh, MWh	2
13	Pres.Range	Option	0.6MP, 1.6MP	2
14	TempA Zero	Modify	0~59999	2
15	TempA Range	modify	0~5.999	2
16	TempB Zero	Modify	0~59999	2
17	TempB Range	Modify	0~5.999	2
18	Heat Test	Option	Enable/disable	2
19	TempA Value	Modify	0~199.9	2
20	TempB Value	Modify	0~199.9	2
21	Speed Value	Modify	0~19.999	2
22	Mtsnsr Ena	Option	Enable/disable	2
23	MtsnsrTrip	Modify	59999	2
24	Sys Alm Ena	Option	Enable/disable	2

25	ClrSum Key	Modify	0-99999	2
26	Snsr Code1	User Define	Finished Y/M (0-99999)	2
27	Snsr Code2	User Define	Product Serial No. (0-99999)	2
28	Field Type	Option	Type 1, 2	2
29	Sensor Fact	Modify	0.0000~5.9999	2
30	Line Crc Ena	Option	Enable/Disable	2
31	Lineary CRC1	User Define	Set Velocity	2
32	LinearyFact1	User Define	0.0000~1.9999	2
33	Lineary CRC2	User Define	Set Velocity	2
34	LinearyFact2	User Define	0.0000~1.9999	2
35	Lineary CRC3	User Define	Set Velocity	2
36	LinearyFact3	User Define	0.0000~1.9999	2
37	Lineary CRC4	User Define	Set Velocity	2
38	LinearyFact4	User Define	0.0000~1.9999	2
39	TotalWordLo	Modify	00000~99999	2
40	TotalWordHi	Modify	0000~9999	2
41	HeatTotalLo	Modify	00000~99999	2
42	HeatTotalHi	Modify	0000~9999	2
43	PassWord 1	Modify	00000~99999	2
44	AnalogZero	Modify	0.0000~1.9999	2
45	Anlg Range	Modify	0.0000~3.9999	2
46	Meter Fact	Modify	0.0000~5.9999	2
47	MeterCode1	Factory Set	Finished Y/M (0-99999)	2
48	MeterCode2	Factory Set	Finished Y/M (0-99999)	2
49	YEAR	Modify	0~99	2
50	MONTH	Modify	0~99	2
51	DAY	Modify	0~99	2
52	HOUR	Modify	0~99	2
53	MINUTE	Modify	0~99	2
54	SECOND	Modify	0~99	2

55	Sensor Post.	Option	Flow inlet Flow export	2

The parameters determine the status of meter, calculation method, output method and status. Proper selections and settings of parameters allow the meter working in top condition, getting high measurement accuracy and output accuracy.

2 levels of passwords can be set up, which level 1 is user's password, and level 2 is factory password. Users can reset level 1 password using level 2 password.

Users can view the parameters with whatever level password. However, different levels of passwords are needed to change parameters.

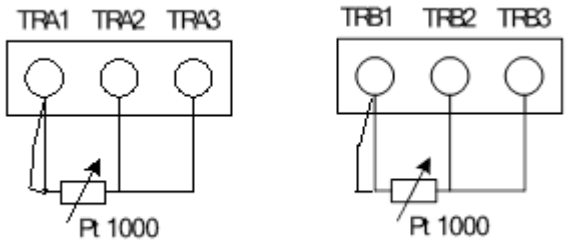
Level 1 password (default value 00521): View only

Level 2 password (fixed value 19818): Users can change parameters shown on table

Appendix 2 Instruction of Heat Measurement

1. Temperature Calibration:

   The thermal energy meter uses 4-wire PT1000 RTD sensors to measure temperature. The wiring diagram is shown below.



   Zero and range calibration are needed for RTD measurement circuits. They have been calibrated with resistance box in factory. If calibrations are still needed, operation methods are as follows.

   A. With resistance box (4-wire connection)

      Step 1: Tune standard resistance box to 1000Ω. Adjust zero correction value (usually around 32,768) in “TempA(TempB) Zero” parameter, until the first line is 0.

      Step 2: Tune standard resistance box to 1535.8Ω. Adjust zero correction value (usually around 1.2) in “TempA(TempB) Range” parameter, until the first line is 1,400.

   B. With blackbody furnace (3-wire connection)

      Step 1: Immerse the thermal resistance into ice water bath. Adjust zero correction value (usually around 32,768) in “TempA(TempB) Zero” parameter, until the first line is 0.

      Step 2: Put the thermal resistance into 140°C blackbody furnace. Adjust zero correction value in “TempA(TempB) Range” parameter, until the first line is 1,400.

2. Heat Calculation:

   When water flows through the heat sensors installed in the system, according to the flow rate given by flow transducers, TempA and TempB signal given by temperature sensors

and the time water takes to flow, the thermal energy released or absorbed by system can be calculated. The basic formula is:

$$Q = \int_{\tau 0}^{\tau 1} q_m \times \Delta h \times d\tau = \int_{\tau 0}^{\tau 1} \rho \times q_v \times \Delta h \times d\tau$$

Where,

Q – Thermal energy consumed, in J;

q_m – Mass flow, in kg/h;

q_v – Volume flow, in m^3/h;

ρ – Flow density, in kg/m^3;

Δh – Enthalpy difference, in J/kg;

τ – Time, in h.

Notice: the heat is measured with the supply/return heat capacity multiplying by flow; therefore, the result is related to the increment of cumulative flow per second. In another word, heat is counted each time cumulative flow has an increment. So, the unit of cumulative flow should not be too large, in case that it takes a long time to generate an increment. Cumulative flow is shown in 9 digits (999999999), with units of $0.001m^3$, $0.01m^3$, $0.1m^3$, and $1m^3$. Choose the one will not overflow in 2-3 years.

Note:
For RTD sensors and thermalwell information, including engineering spec, model selection and installation, please refer to document "Datasheet_RTDnThermalwell.pdf"

Appendix 3 Instruction of Insertion RTD Probe and Thermalwell

Introduction

The PT100IN-X/PT1000IN-X family RTD probes are ruggedly designed for accurate temperature measurement in a heating / cooling system. Their assemblies include spring loaded probes for improved response time and vibration resistance when used in thermowells. Their probe has G1B mounting threads (1/2" NPT thread can be ordered upon request) and 304 SS sheath. The standard probe uses a 4 lead configuration, but other configurations are available. All probes include a screw terminal block for easy connection of copper extension wire.

There are six types of insertion probes,

(1) A-type probe: direct insertion short temperature probe, model# PT100IN-A/PT1000IN-A. This type probe is normally used for small pipes, DN15–DN32 (0.2"-1.25"). It does not have thermalwell. The probe wires are pre-connected. Please refer to Fig. 1 for the mechanical structure.

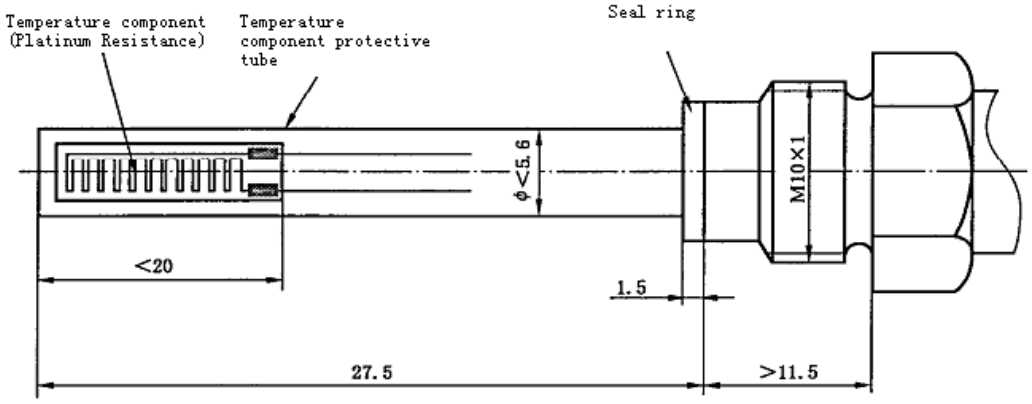


Fig. 1: Mechanical drawing for A-type insertion probe.

(2) B-, C-, D- and E- type probes: standard insertion RTD probes, model# PT100IN-B/PT1000IN-B, PT100IN-C/PT1000IN-C, PT100IN-D/PT1000IN-D and PT100IN-E/PT1000IN-E. They four models are mainly different by their probe length. They are used for different size pipes (Table 1). All the probes have an aluminum head protection and normally come with a matched thermalwell.

Please refer to Fig. 2 for the mechanical drawings of the probes and the thermalwells.

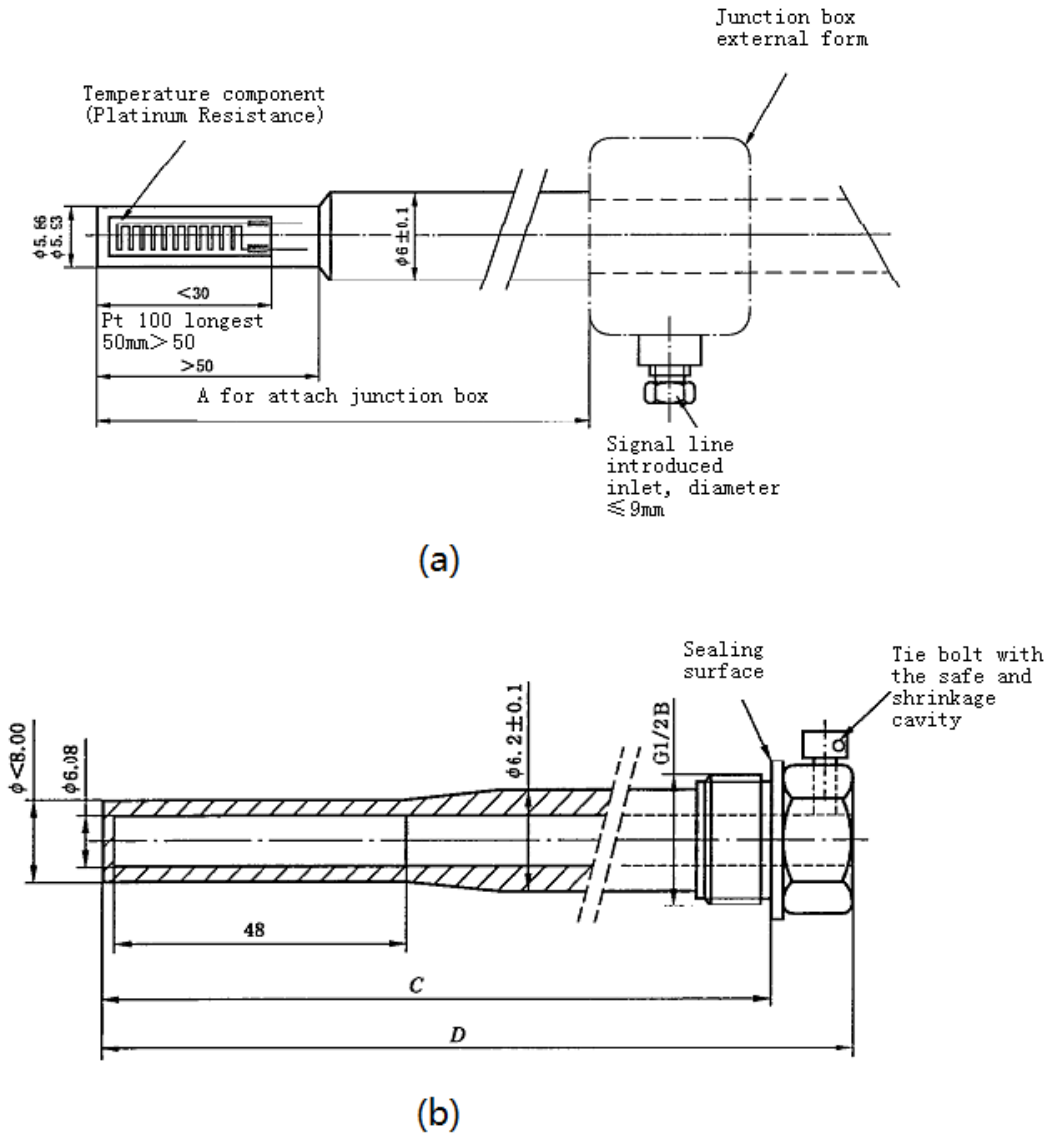


Fig. 2: (a) Mechanical drawing for PT100IN / PT1000IN insertion probe. (b) Mechanical drawing for thermalwell.

Probe Type		Probe Length A (mm)	Thermalwell Length C (mm)	Welding Base (mm)	Pipe Size Range
B	PT100IN-B/1000IN-B	105	85	60	DN40-65 /1.5”-2.5”
C	PT100IN-C/1000IN-C	105	85	23	DN80-125 / 3”-5”
D	PT100IN-D/1000IN-D	140	120	23	DN150-200 / 6”-8”
E	PT100IN-E/1000IN-E	175	155	23	DN250 / 10”
F	PT100IN-F/1000IN-F	230	210	23	≥ DN300 / 12”

Table 1: Dimensions of insertion probes and thermalwells.

The welding base in the above table is used to install the probe (type A) or the thermallwell (type

B-F). Please refer to later section for the installation details. The dimension of the welding base is defined in Fig. 3 below.

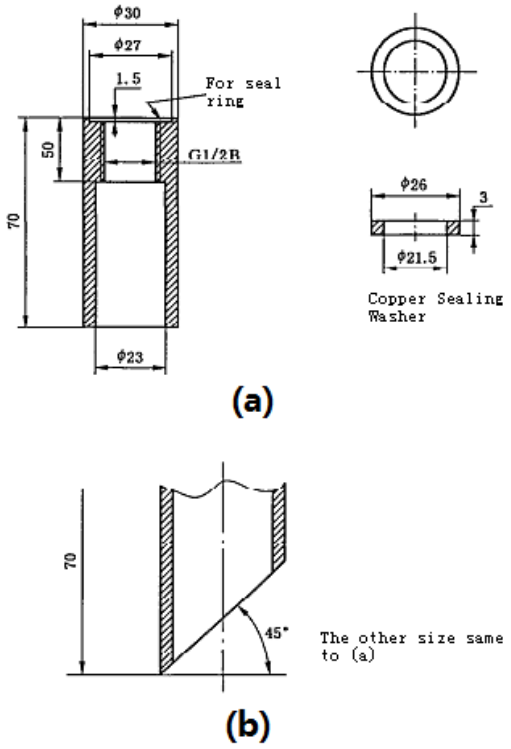


Fig. 3: Mechanical drawing of welding base for (a) vertical installation and (b) inclined installation

Temperature Probe Specification

Insert type thermal resistance, straight tube, meet EN1434 standard
1*PT1000 4-wire loop connection (PT100 is available upon request)
Measuring components: PT1000 temp sensor (PT100 is available), EN60751 ， B class (A class, 1/3DINB available).
Junction Box: J type, cast aluminum enclosure, PG9, IP65,
Working Temperature: -20~+100°C
Connection: threading, stainless steel1.4571
Protecting Tube: stainless steel1.4571, 6mm diameter or reduce 8mm to be 6mm.
Accessories: Protection tube
Connection cable working temperature 0~+200 degree C
Temperature probe can be matched and approved indoors.

Installation

Fig. 4 below shows the different installations with different type probes.

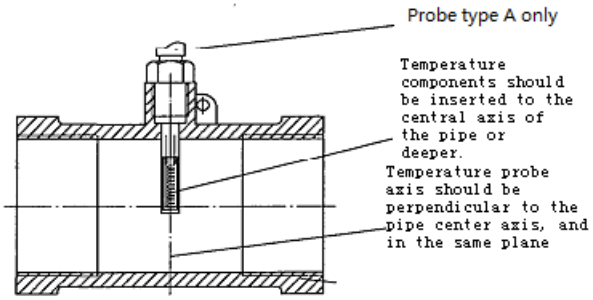
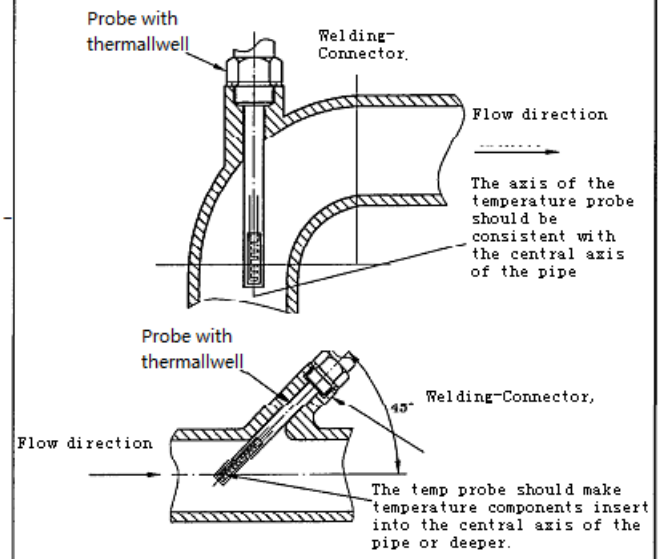
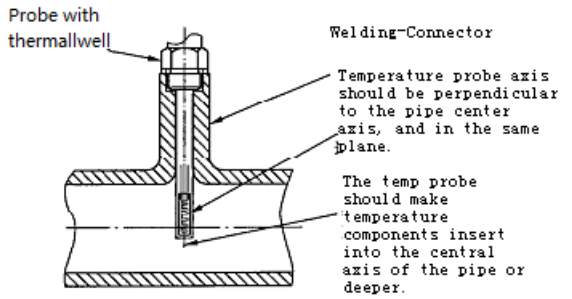
Probe Type	Size	Installation Recommendations
Type A	DN15 - DN32 (0.5" - 1.25")	
Type B	DN40 - DN65 (1.5"-2.5")	
Type D-F	>DN65 (2.5")	

Fig. 4: Installation overview

For A-type probe:

A- type probe is normally vertically installed with flow direction. Measuring components inside of the temp probe should be into the center of pipe (Fig.4.) Temp probe can also be inserted in ball valve as well (Fig. 5.)

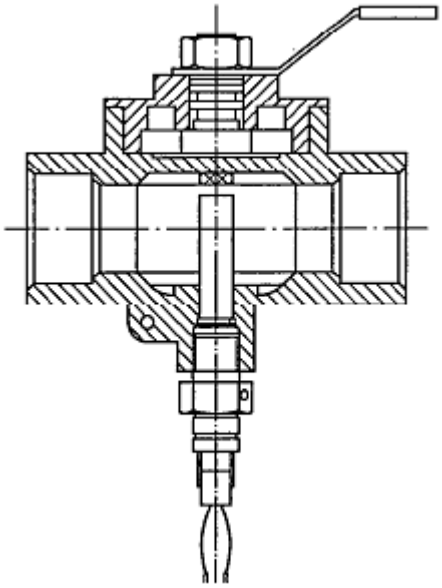


Fig. 5: Installation of A-type probe through a ball valve

For B-type probe:

B-type probe PT100IN-B / PT1000IN-B are used to measure temperature on a pipe of size DN40-65 / 1.5”-2.5”. In order to make sure the temperature sensing element is positioned in the middle of the flow, the thermalwell needs to be installed either on an elbow or on a straight pipe but inclined to the pipe (Fig. 4.)

For C- to F- type probes:

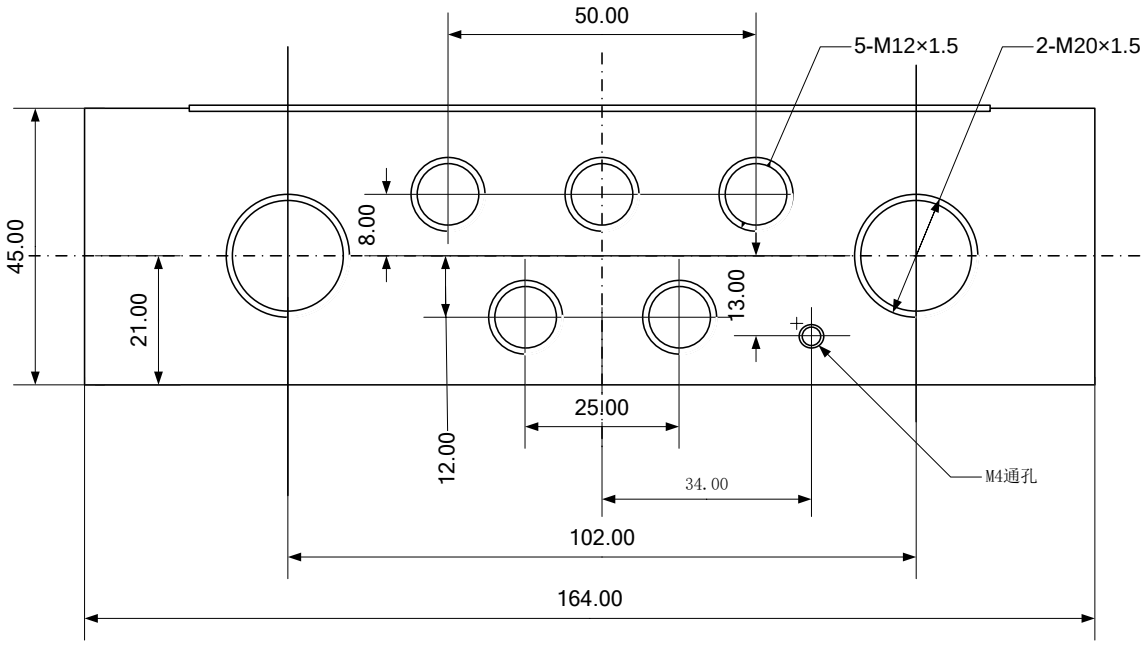
Those probes are used to measure temperature on various pipe sizes (refer to Table 1.) The installation is illustrated Fig. 4.

Appendix 4 Definition of Modbus Register Address of Electromagnetic Energy Meter

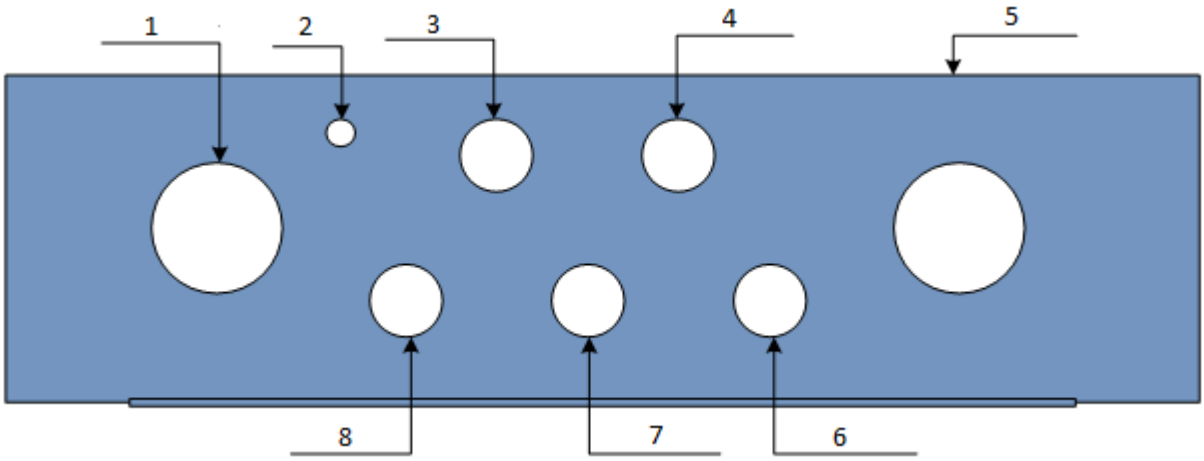
Protocol Addresses（Decimal）	Protocol Addresses（HEX）	Data Format	Register Definition
4112	0x1010	Float Inverse	Flowrate in float(M^3/h)
4114	0x1012	Float Inverse	Velocity in float
4116	0x1014	Float Inverse	Reserve
4118	0x1016	Float Inverse	Liquid conductivity in float
4120	0x1018	Long Inverse	Totalizer – integer portion
4122	0x101A	Float Inverse	Totalizer – decimal portion
4124	0x101C	Long Inverse	Reserve
4126	0x101E	Long Inverse	Reserve
4128	0x1020	Unsigned short	Heat rate unit 0: MJ/h; 1: GJ/h 2: KWh/h; 3: MWh/h
4129	0x1021	Unsigned short	Flow totalizer unit (m^3)
4130	0x1022	Unsigned short	Pressure range 0: 0.6MPa 1: 1.6MPa
4131	0x1023	Unsigned short	Energy totalizer unit 0: MJ; 1: GJ; 2: KWh; 3: MWh
4132	0x1024	Unsigned short	Empty pipe alarm 0: Normal; 1: Alarm
4133	0x1025	Unsigned short	System alarm 0: Normal; 1: Alarm
4134	0x1026	Float Inverse	Energy rate
4136	0x1028	Long Inverse	Energy totalizer
4138	0x102A	Float Inverse	Energy totalizer decimal portion
4140	0x102C	Unsigned short	TempA (°C)
4141	0x102D	Unsigned short	TempB (°C)

Appendix 5 Wire holes of energy meter

1. Bolt size

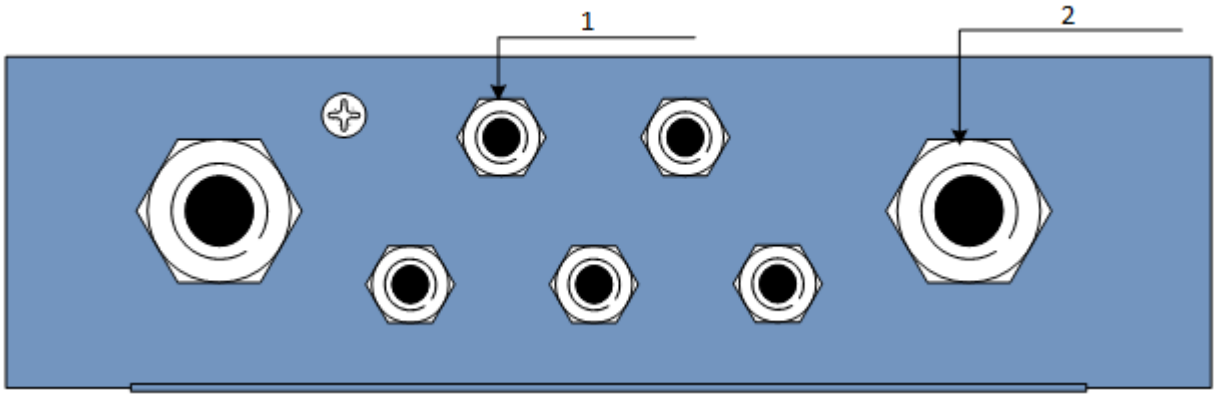


2. Wire hole definition



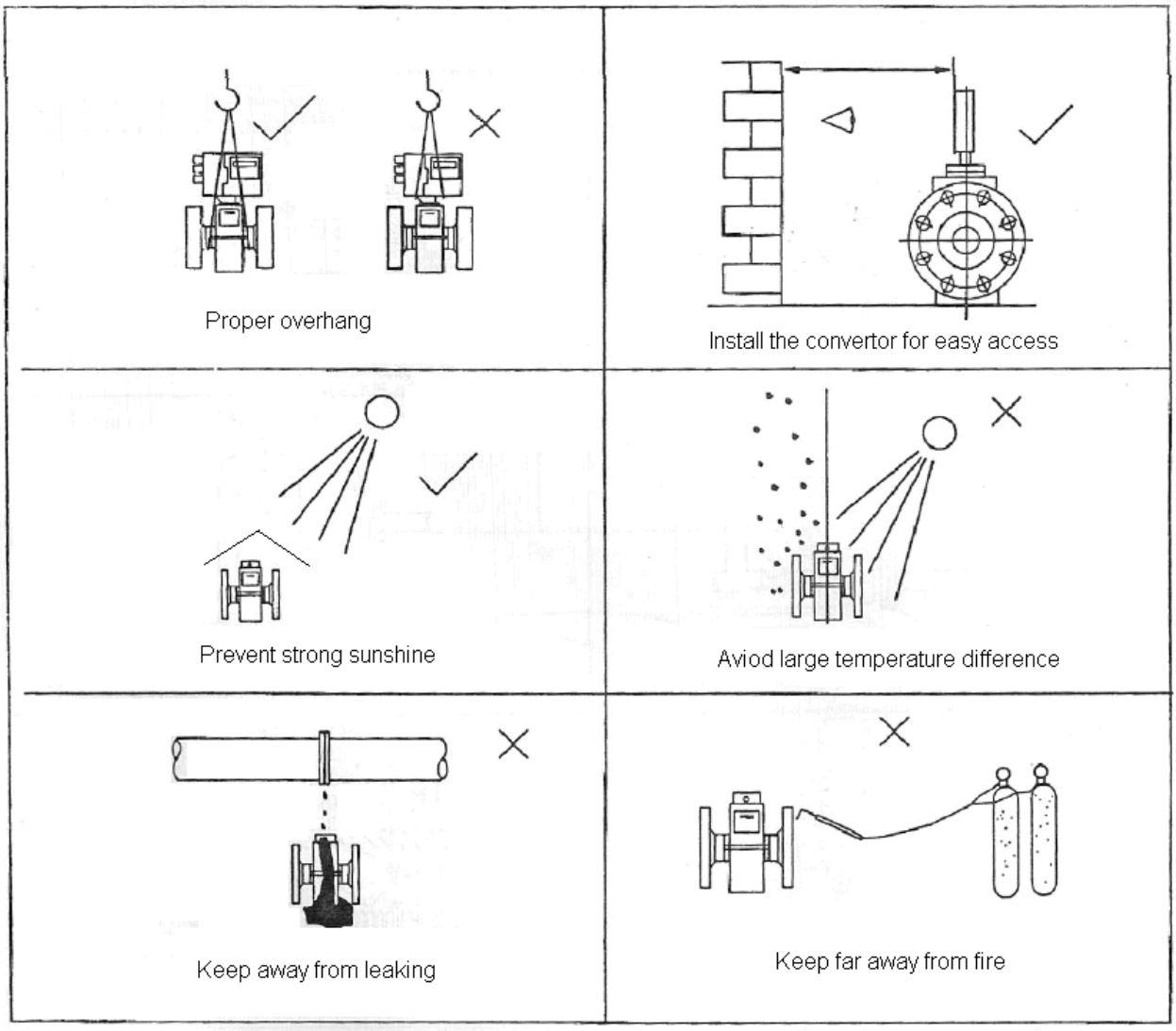
1. Power supply
2. Nail
3. Thermal resistance B
4. Thermal resistance A
5. Signal input
6. Excitation output
7. Communication port
8. Output port

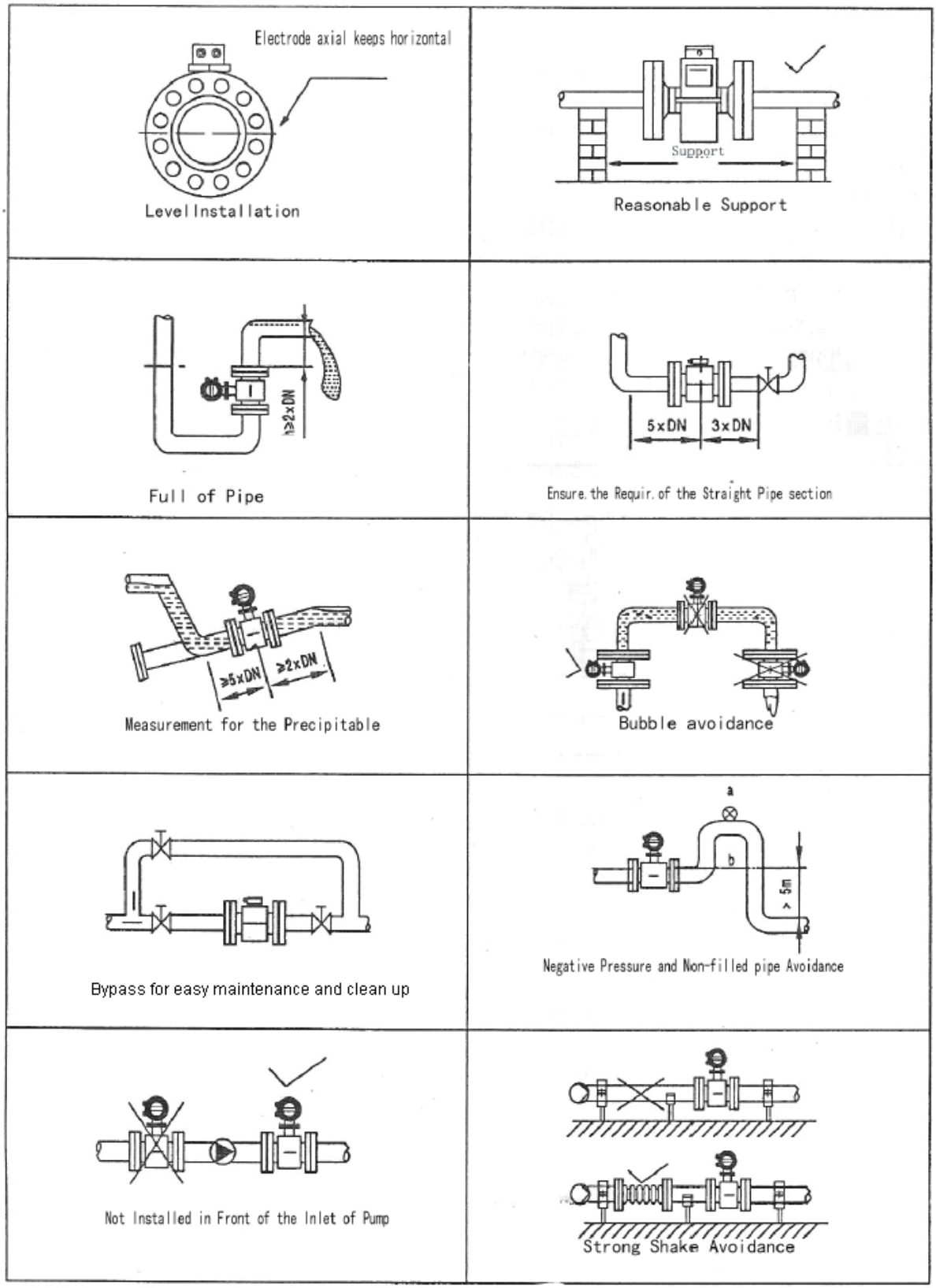
3. Bolt installation



1. Waterproof connector 5-M12
2. Waterproof connector 2-M20

Appendix 6 Flow Sensor Installation Recommendations

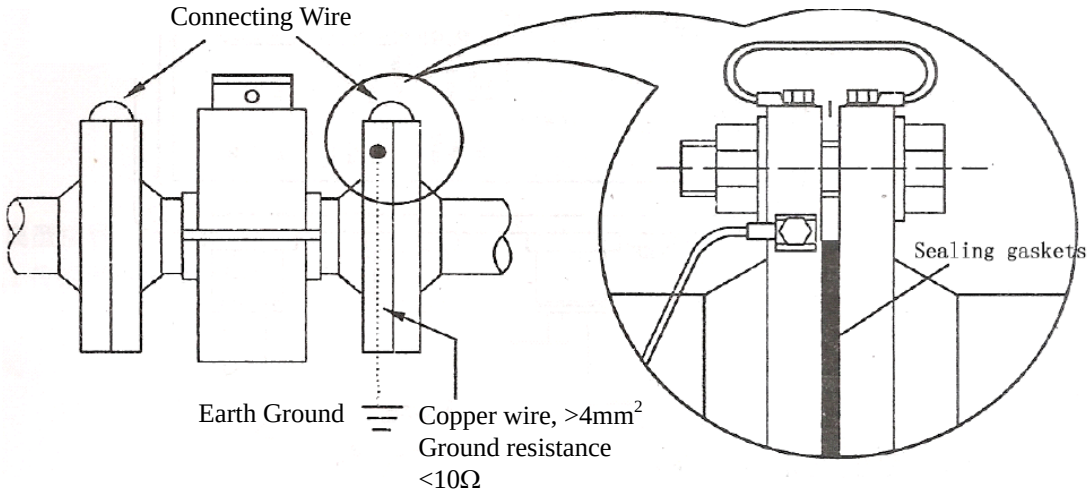



Electrode axial keeps horizontal
Level Installation
Support
Reasonable Support
h≥2×DN
Full of Pipe
5×DN
3×DN
Ensure the Requir. of the Straight Pipe section
≥5×DN
≥2×DN
Measurement for the Precipitable
Bubble avoidance
Bypass for easy maintenance and clean up
a
b
> 5m
Negative Pressure and Non-filled pipe Avoidance
Not Installed in Front of the Inlet of Pump
Strong Shake Avoidance

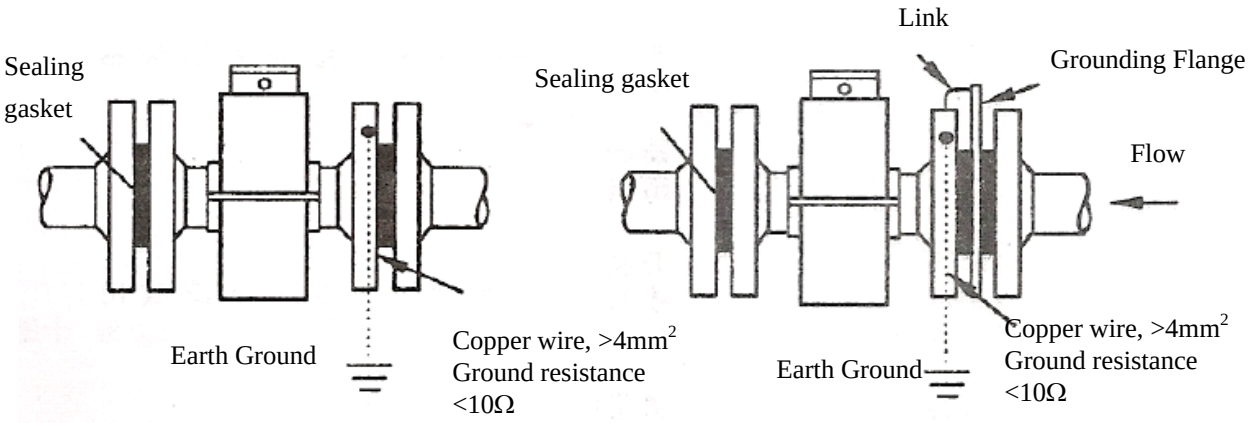
Appendix 6 Earth Grounding

The sensor body must be grounded using grounding or bonding straps or grounding rings to protect flow signal against stray electrical noise and lightning. Well-grounded installation will make noise carried through sensor body so that the measuring area within sensor body is noise-free.

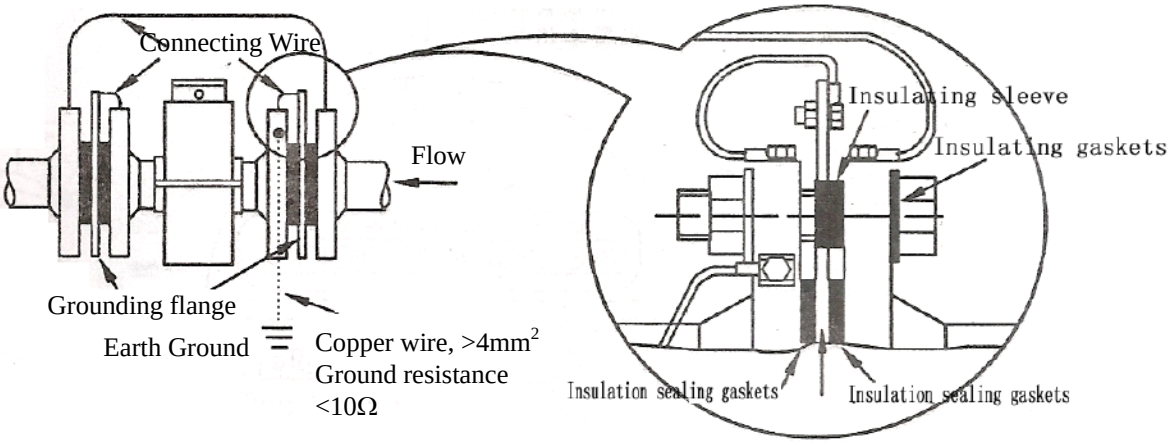
For metal pipes:



For non-metallic pipes:



For pipe lines with cathodic protection:



LIGHTNING PROTECTION NOTE

When installing, you need to connect the converter's Earth terminal with the metal enclosure, and then to the earth ground reliably, because electrical current could flow from the earth ground through the metal enclosure by the gas discharger of a lightning protection device. If the enclosure has not been connected to the earth ground reliably, once lightning, it may cause a personal accident when there is somebody operating the converter. Please refer to the below drawing for wiring details.