

# Electromagnetic Flow Measurement



**ISOMAG**   
The friendly magmeter

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*Isoil Industria is a worldwide leading supplier of electromagnetic flowmeters. On the market since 1958, the company has been concentrating its efforts and expertise through the years towards the evolution of the electromagnetic flow-meters technology. It is worldwide recognized and present in all Countries through distributors and agents, and with a branch office in Brasil.*

## CERTIFICATION AND COMPLIANCE

<b>ISOIL INDUSTRIA CERTIFICATIONS</b>	
Reference	Title
UNI EN ISO 9001:2008	Quality Management System
OHSAS 18001 : 2007	Occupational Health and Safety Series
CH-MI001-07008-01	2004/22/CE European Measurement Instrument Directive, Annex MI001, Meters for cold water – Std. OIML R 49-1/2 – MOD. D
CH-MI004-08008-02	2004/22/CE European Measurement Instrument Directive, Annex MI004, Meters for hot water & Heat Meters – standard UNI EN 1434/1/2/3/4:2007 – MOD. D
R49/2006-CH1-09.02	OIML R49-1/2:2006 – Water Meters intended for measurement of cold potable water or hot water
WRAS – BS 6920	Water Regulations Advisory Scheme, Effects on Quality of Water
3A – SSI : Sanitary Standards	Certification for use of meters in Sanitary Applications Standard : 28-04
<b>ISOIL INDUSTRIA - ISOMAG PRODUCT LINE COMPLIANCE</b>	
Reference	Title
ISO 4064	Measurement of water flow in fully charged closed conduits – Meters for cold and hot potable water – Specifications, Installations and Testing
UNI EN14154: 2007	European Regulation for Water Meters
EN61010-1:2010	Safety requirements for electrical equipment for measurement, control, and laboratory use
EN61326-1:2006	European Union's EMC standard for electrical equipment for measurement, control, and laboratory use
EN13480-3:2007	European Pressure Equipments Directive (PED) 97/23/CE
2006/95/CE	European Low Voltage Directive
2004/108/CE	European Electromagnetic Compatibility Directive
CH-MI001-07008-01	2004/22/CE European Measurement Instrument Directive, Annex MI001, Meters for cold water – Std. OIML R 49-1/2 – MOD. B
CH-MI004-08008-02	2004/22/CE European Measurement Instrument Directive, Annex MI004, Meters for hot water & Heat Meters – standard UNI EN 1434/1/2/3/4:2007 – MOD. B

## ISOMAG™ METERS

### The ideal flow-meter for your application

ISOMAG™ is a line of electromagnetic flow meters including several electronics (converters) able to energize and read data from a set of sensors (flanged, wafer, threaded or insertion type).

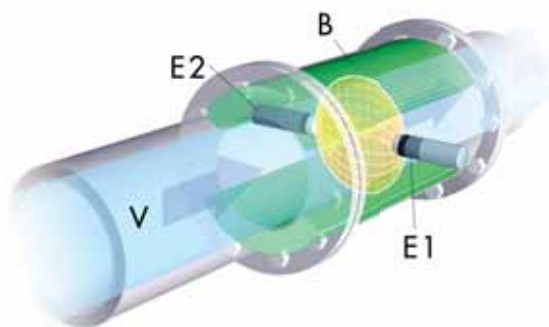
- From DN03 to DN 2000 and more
- Wide range of process connections
- Battery powered system
- GSM/GPRS wireless communication
- High speed converter
- PID controller
- Energy meter
- Sanitary approval
- MID-MI001 & OIML R49 approvals
- MID-MI004 (EN1434) approval

### Flow-meters used in different industries

Mag meters are suitable for a high variety of applications, where liquids to be measured have a conductivity of at least 5  $\mu\text{S}/\text{cm}$  such as:

- Agriculture
- Building automation
- Chemical&Pharmaceutical
- Energy
- Filling
- Food & Beverage
- Pulp & Paper
- Water & Waste Water
- NRW
- DMAs

## MEASURING PRINCIPLE



The operating principle of magnetic flow-meters is based upon Faraday's Law of electromagnetic induction which states that 'a voltage will be induced in a conductor moving through a magnetic field'.

The magnitude of the induced voltage  $e$  is directly proportional to the velocity  $v$  of the conductor width  $L$ , and  $B$  being the strength of the magnetic field.

This is the formula:  $e = k \times B \times L \times v$

Magnetic field coils placed on opposite sides of the pipe generate a magnetic field. As the conductive process liquid moves through the field with average velocity  $v$ , electrodes sense the induced voltage. The width of the conductor is represented by the distance between electrodes. An insulating liner prevents the signal from shorting to the pipe wall. The only variable in this application of Faraday's law is the velocity of the conductive liquid  $v$  because field strength is controlled constant and electrode spacing is fixed.

Therefore, the output voltage  $e$  is directly proportional to liquid velocity, resulting in the linear output of the magnetic flow-meter.

Flowrate  $Q$  is calculate as  $Q = \text{const.} \times e$

Insertion probes are a valid alternative to full bore meters for use in survey applications such as leakage monitoring and network analysis and in permanent locations where cost or space limitations preclude the use of conventional closed pipe meters. The principle is the same, the lay of Faraday, but the magnetic field in this case is only punctual, while in the full bore case all area is interested.

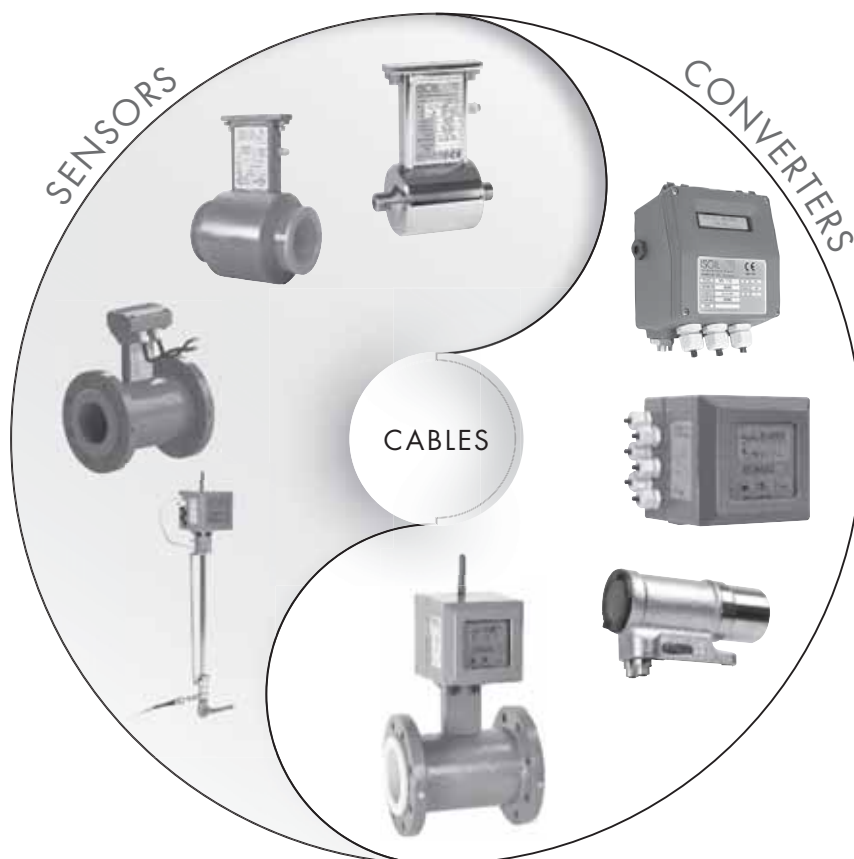
*Insertion probes are installed either at 1/8 or 7/8 of the internal diameter of the pipe, where the mean velocity vector passes, or in the middle of the pipe, where the maximum speed vector passes.*



**Pipe must always be full.**

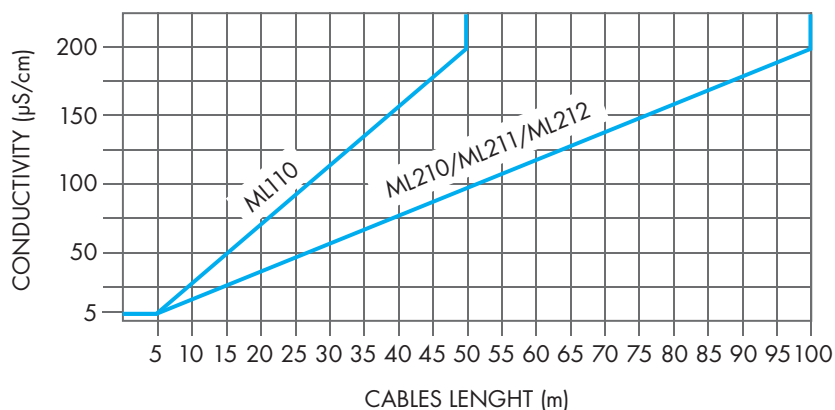
## MEASURING SYSTEM

An electromagnetic flow-meter is made of a sensor, which is the primary element installed in the pipeline and a converter, which is the secondary element, energizing the coils inside the sensor and detecting the electrical signal. Sensors can be flanged, flangeless or insertion type and with different kind of internal liners. The electronic can be mounted on top in compact version, or separated by cables in remote version. A wide variety of converters answers to the request in terms of accuracy, communication protocols and powering needs.



*It is recommended to install the connection cables away from, or protect against sources of electromagnetic noise.*

**Allowed cable length according to conductivity level.**



A distance up to 500 meters is possible by adding a pre-amplifier on top of the sensor.

## DIAMETER SELECTION

Selecting the proper sensor diameter is mandatory to obtain a good result in the measure.

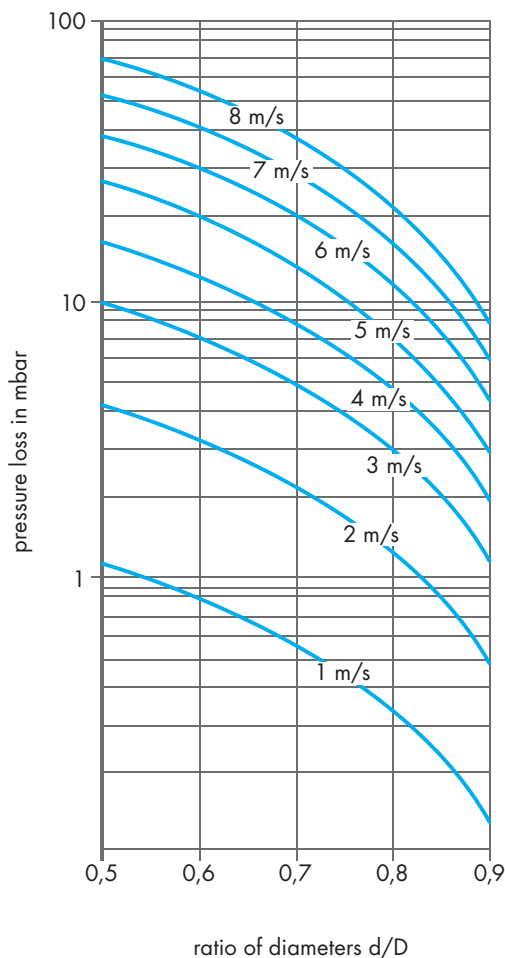
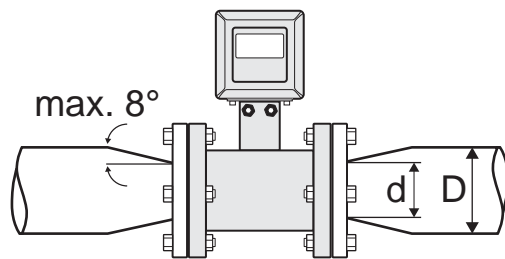
*The first practical rule is selecting the sensor diameter according to the pipe diameter. However, it is often necessary to increase the flow rate value by reducing the sensor diameter. This might lead to an increase of the cost of the installation which is by the way compensated by the lower cost of the meter.*

*As a recommendation, the velocity of the fluid inside the meter should be:*

- $1 < v < 3$  m/s for an optimal working condition;
- $v < 2$  m/s with abrasive fluids in order for the liquid not to have high velocity causing possible damage to the internal liner;
- $v > 2$  m/s with coating fluids in order not to incur in deposit of solid parts on the electrodes.

*The correct balancing of the above elements should help in the selection of the proper sensor diameter.*

### Adapters and pressure loss calculation



### Nominal diameters and measuring range

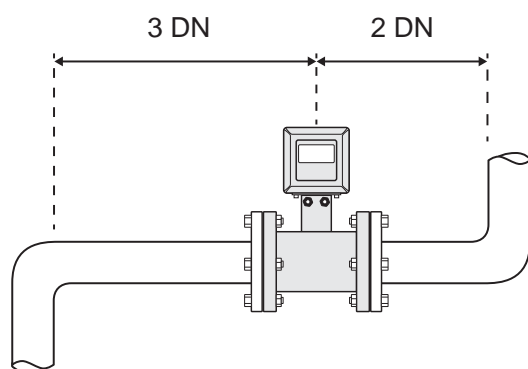
DN mm	Minimum Full scale value $v=0,4$ m/s	Maximum Full scale value $v=10$ m/s
3	0.....10 l/h	0.....250 l/h
6	0.....40 l/h	0.....1000 l/h
10	0.....120 l/h	0.....2800 l/h
15	0.....240 l/h	0.....6000 l/h
20	0.....500 l/h	0.....11500 l/h
25	0.....0,72 m <sup>3</sup> /h	0.....18 m <sup>3</sup> /h
32	0.....1,16 m <sup>3</sup> /h	0.....29 m <sup>3</sup> /h
40	0.....1,80 m <sup>3</sup> /h	0.....45 m <sup>3</sup> /h
50	0.....2,88 m <sup>3</sup> /h	0.....72 m <sup>3</sup> /h
65	0.....4,80 m <sup>3</sup> /h	0.....120 m <sup>3</sup> /h
80	0.....7,20 m <sup>3</sup> /h	0.....180 m <sup>3</sup> /h
100	0.....11,20 m <sup>3</sup> /h	0.....280 m <sup>3</sup> /h
125	0.....18,00 m <sup>3</sup> /h	0.....450 m <sup>3</sup> /h
150	0.....25,60 m <sup>3</sup> /h	0.....640 m <sup>3</sup> /h
200	0.....45,20 m <sup>3</sup> /h	0.....1130 m <sup>3</sup> /h
250	0.....70,80 m <sup>3</sup> /h	0.....1770 m <sup>3</sup> /h
300	0.....100,80 m <sup>3</sup> /h	0.....2520 m <sup>3</sup> /h
350	0.....138,00 m <sup>3</sup> /h	0.....3450 m <sup>3</sup> /h
400	0.....180,00 m <sup>3</sup> /h	0.....4500 m <sup>3</sup> /h
450	0.....228,80 m <sup>3</sup> /h	0.....5720 m <sup>3</sup> /h
500	0.....284,00 m <sup>3</sup> /h	0.....7100 m <sup>3</sup> /h
600	0.....408,00 m <sup>3</sup> /h	0.....10200 m <sup>3</sup> /h
700	0.....560,00 m <sup>3</sup> /h	0.....14000 m <sup>3</sup> /h
800	0.....720,00 m <sup>3</sup> /h	0.....18000 m <sup>3</sup> /h
900	0.....920,00 m <sup>3</sup> /h	0.....23000 m <sup>3</sup> /h
1000	0.....1140,00 m <sup>3</sup> /h	0.....28500 m <sup>3</sup> /h
1200	0.....1600,00 m <sup>3</sup> /h	0.....40000 m <sup>3</sup> /h
1400	0.....2200,00 m <sup>3</sup> /h	0.....55000 m <sup>3</sup> /h
1600	0.....2880,00 m <sup>3</sup> /h	0.....72000 m <sup>3</sup> /h
1800	0.....3640,00 m <sup>3</sup> /h	0.....91000 m <sup>3</sup> /h
2000	0.....4520,00 m <sup>3</sup> /h	0.....113000 m <sup>3</sup> /h
2400	0.....6400,00 m <sup>3</sup> /h	0.....160000 m <sup>3</sup> /h

## INSTALLATION

Please note the following instructions to ensure a correct procedure from the unpacking to the correct measurements and in order to avoid damage to the measuring installation.

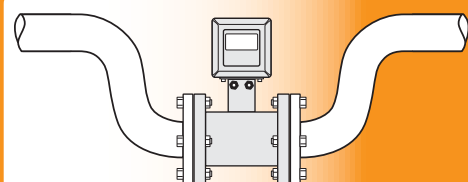
- Inspect the cartons carefully for damage or signs of rough handling. Report damage to the carrier and to the local office of the manufacturer.
- Check the packing list to check if you received completely all that you ordered.
- Packages may contain soft and hard information material.
- Look at the device nameplate to ensure that the device is delivered according to your order.
- Check for the correct supply voltage printed on the nameplate.

## INLET AND OUTLET



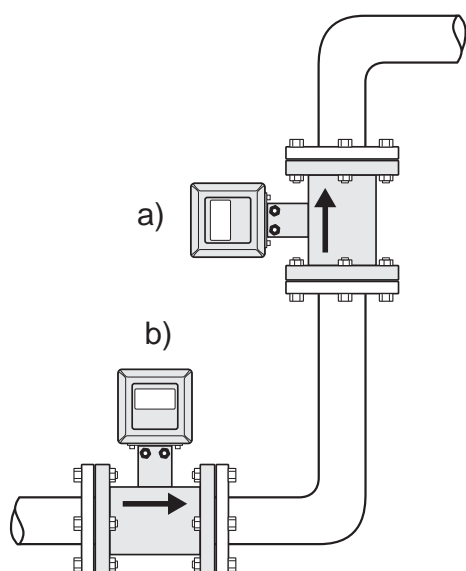
Any mean of turbulence, such as valves, elbows, T-pieces, etc might cause inaccuracies in the meter's reading. The effect of such turbulences varies according to the installation and surrounding conditions and are not predictable.

*In case of presence of other devices nearby the meter straight pipeline length must be verified according to plant layout and/or international standards recommendations such as ISO 7145 – BS 1042.*



*In spite of the fact that ISOMAG meters have been tested and certified to be able to work also with no upstream and downstream straight DN, the recommendation is to foreseen at least 3 DN in the inlet and 2 x DN in the outlet.*

## MOUNTING POSITION



### Vertical

*Optimum position for upward flow direction:*

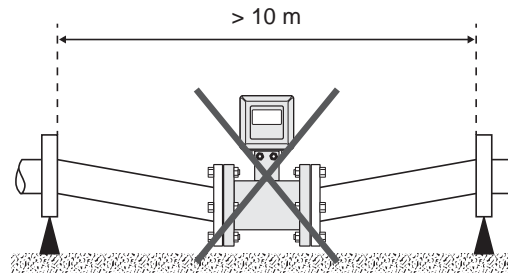
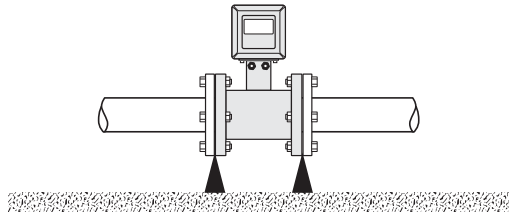
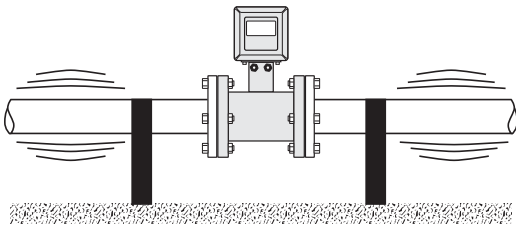
- entrained solids will sink;
- fatty particles will rise out of range of the measuring electrodes if the fluid stops flowing;
- pipe will remain always full even if the fluid stops flowing.

### Horizontal

- install sensor in line with the pipe axis;
- pipe flange faces must be parallel to each other.

## VIBRATIONS

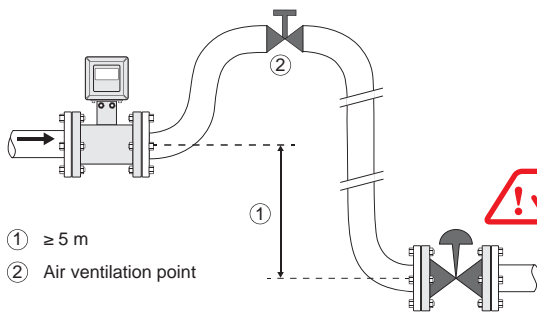
- Avoid vibrations in the pipe.
- Separate mounting of sensor and converter might help in reducing the negative effect of vibrations on the measuring.
- Long pipes need mechanical supports to minimize the effect of the vibrations.



## AIR VENTING

Air in the pipe may cause, among others:

- faulty water meter readings;
- corrosion;
- acceleration of cavitation.



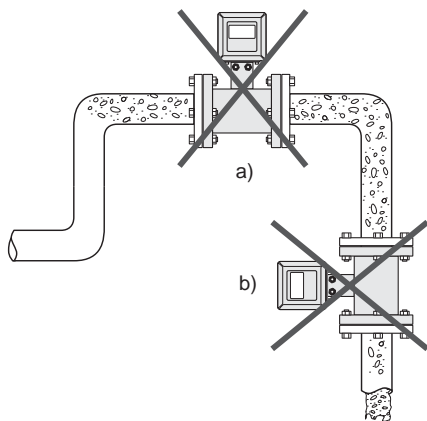
If installed as shown on the left, please ensure a  $>5$  m downward pipe to avoid vacuum

## MOUNTING LOCATION AND PARTIALLY FILLED PIPES

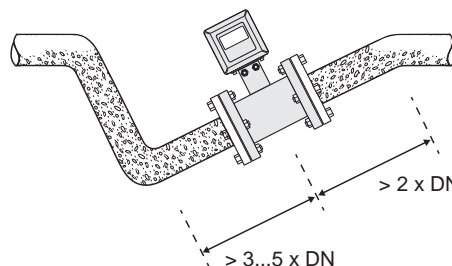
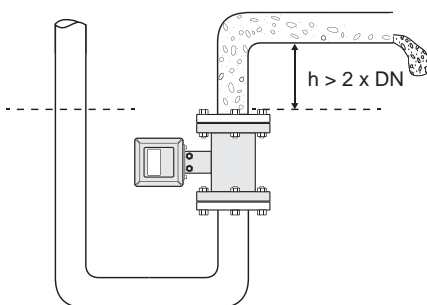
A mandatory requirement for an accurate measurements is that pipes are filled. Therefore the following installation sites have to be avoided:

In case of installation like in the picture besides:

- do not mount sensors at the lowest point (solids may accumulate);
- use a siphon-type installation.



a) highest point (accumulation of air);  
b) in front of a free pipe outlet in a downward pipe.  
The picture on the left shows the alternative installation.



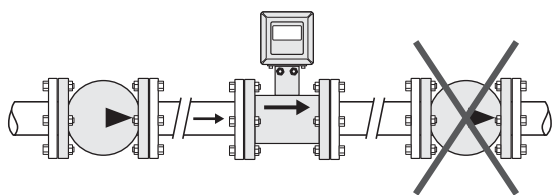
In any case ISOMAG meters have an Empty Pipe System which helps in case of such a situation of no water in the pipe.



The minimum conductivity of the liquid medium to ensure correct functionality of the empty pipe detection is  $20 \mu\text{S}/\text{cm}$



## PUMPS INSTALLATIONS



A mandatory requirement for an accurate measurements is that pipes are filled. Therefore the following installation sites have to be avoided:

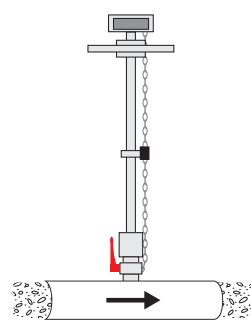
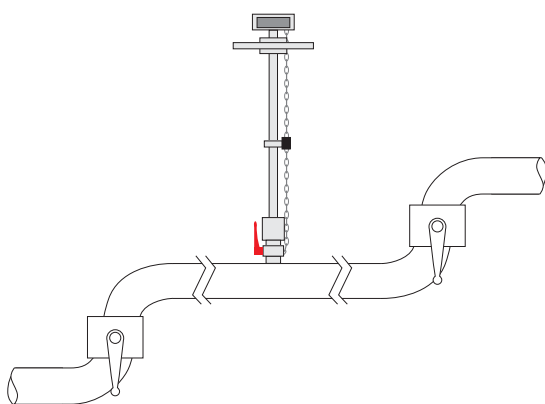


**Sensors must not be installed on the inlet of pumps. Such installation might create vacuum.**

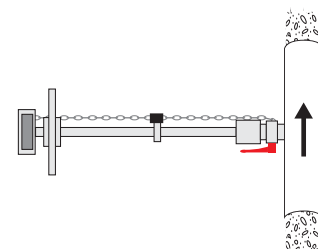
## INSERTION PROBES

Insertion probes follow the same rules as the full bore ones. All requirements specified in the previous paragraphs are still valid also for this type of meters.

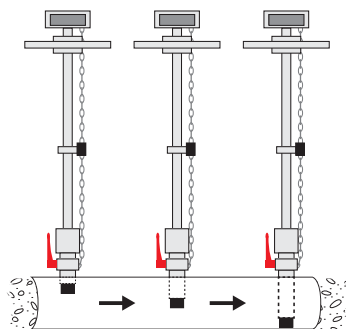
Install the sensor away from disturbances (curves, T junctions, valves and equipment that protrudes in to the pipe).



Pipe must be always full.



When installing in vertical pipes, ascending flow direction is recommendable.



Probes can be installed at 1/8, 1/2 or 7/8 of the internal diameter of the pipe.

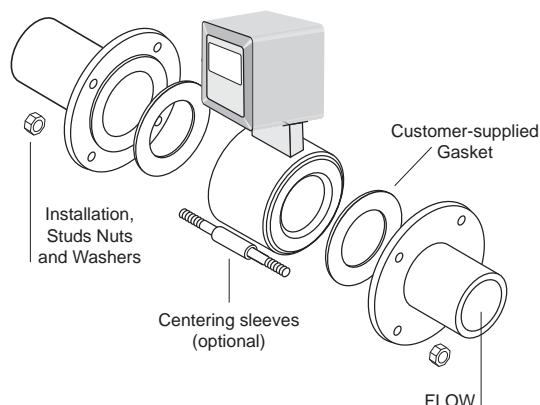
## WAFER SENSORS

Place the sensor between flanges. The studs should be aligned with the markings on the rings that correspond to the flange you are using

Insert the remaining studs, washers and nuts.

Tighten to the torque specifications as indicated in the technical data sheet. Do not over tighten the bolts. Otherwise the liner may be damaged.

Note: The sensor requires a gasket at each of its connections to adjacent devices or piping. The gasket must be a full face gasket to cover the entire sealing surface of the meter, and the material selected must be compatible with the process fluid and operating conditions. Metallic or spiral-wound gaskets can damage the liner. Gaskets are required on each side of a grounding ring.

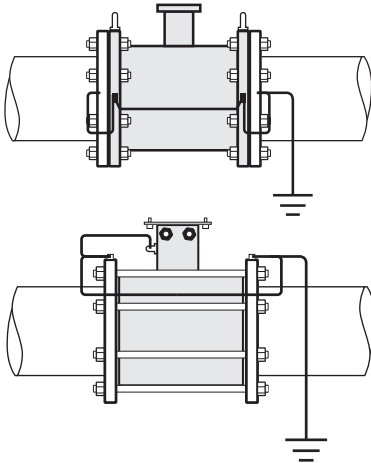


## GROUNDING

Proper grounding of magnetic flow-meters (in accordance with the applicable safety regulations) is important for an accurate and reliable measurement performance. In addition to safety reasons, the EMF must be grounded also for metrological reasons. The signal voltage induced in the electrodes has a value of approximately one millivolt or less. The signal converter can only process such small signals without interference if this voltage is referred to a fixed potential (ground).

### Grounding in pipelines that are electrically conductive inside (e.g. stainless steel pipelines)

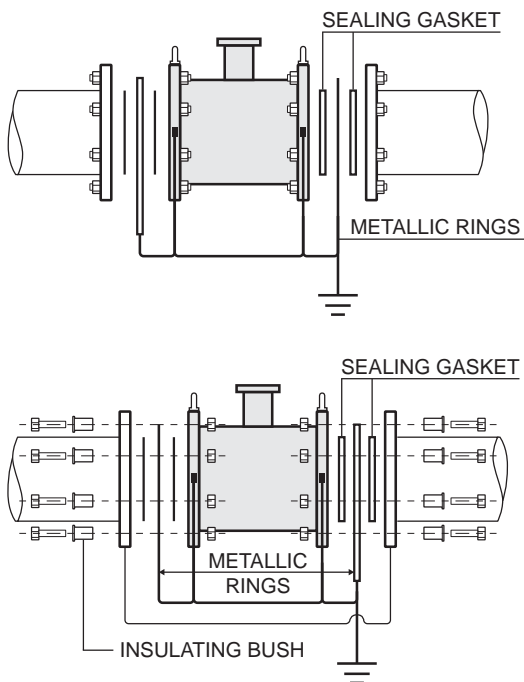
The EMF is electrically connected to the pipeline in an equipotential bonding sense. The pipeline is grounded, thus providing a fixed reference potential for the process liquid and the signal voltage.



### Grounding in pipelines with electrically insulating inside walls

In pipelines made of plastics or concrete, or those which have an insulating lining or coating inside, the process liquid needs to be grounded by additional measures.

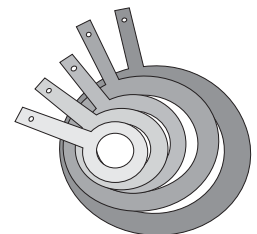
For this purpose, metal grounding rings are normally used whose inside face is in contact with the process liquid and which are fitted and grounded between the pipe and flowmeter flanges.



### Grounding in pipelines with cathodic protection

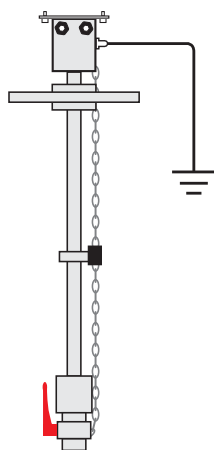
For pipelines with cathodic protection meters must be correctly grounded and isolated from pipeline using insulating bushes on both to avoid risk of making cathode protection ineffective.

*Grounding rings are often used in pipes to ground unwanted electrical signals. In flow measurement, grounding rings are commonly installed upstream and downstream of magnetic flow meters. Grounding rings provide an electrical grounding pathway around the flow meter to safely eliminate accumulated voltage or induced current in the flowing conductive fluid. Additionally grounding rings act as a protective "wear plate" to prevent erosion of the leading edge of the flow meter liner.*



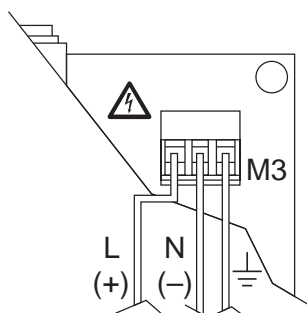
*Grounding can also be achieved by using additional ground electrodes in the EMF, which in some cases are less expensive than grounding rings.*

## GROUNDING OF INSERTION PROBES



Insertion probes requirements are the same as full bore meters, therefore they require sensor and liquid to be at the same potential. Always connect both sensor and converter to a proper ground.

## GROUNDING OF THE ELECTRONICS



For the correct operation of the meter both sensor and the converter are required to be grounded.

## IP68

IP s l (i) s = solids, l = liquids and i = impact (optional)

### First Index - Foreign Bodies Protection, Solids

Index	Protection against Human/Tool Contact	Protection against solid objects (foreign bodies)
0	No special protection	
1	Back of hand, Fist	Large foreign bodies, $\varnothing > 50\text{mm}$
2	Finger	Medium-sized foreign bodies, $\varnothing > 12$
3	Tools and wires etc with a thick. $> 2.5\text{mm}$	Small foreign bodies, $\varnothing > 2.5\text{mm}$
4	Tools and wires etc with a thick. $> 1\text{mm}$	Granular foreign bodies, $\varnothing > 1\text{mm}$
5	Complete protection, (limited ingress permitted)	Dust protected; dust deposits are permitted, but their volume must not affect the function of the unit.
6	Complete protection	Dust-proof

The term "protection class" generally indicates the type of protector of a device or the internal workings of a device against direct contact and against the infiltration of foreign bodies, such as objects, dust or water.

The resistance to stress arising from prevailing working conditions is defined using international protection (IP) classes.

These protection classes are, in turn, indicated in IP standards (DIN EN 60529), whereby a combination of two digits specifies the level of protection.

The first digit indicates the level of resistance to foreign bodies and dust, the second digit the level of resistance to water infiltration.

### Second Index - Water Protection, Liquids

Index	Protection against water	Protection from condition
0	No special protection	
1	Water dripping/falling vertically	Condensation/Light rain
2	Water sprayed at an angle (up to 15° degrees from the vertical)	Light rain with wind
3	Spray water (any direction up to 60° degrees from the vertical)	Heavy rainstorm
4	Spray water from all directions, (limited ingress permitted)	Splashing
5	Low pressure water jets from all directions, (limited ingress permitted)	Hose down, residential
6	High pressure jets from all directions, (limited ingress permitted)	Hose down, commercial. eg. Ship decks
7	Temporary immersion, 15 cm to 1m	Immersion in tank
8	Permanent Immersion, under pressure	For use on Titanic recovery vehicle

A higher value of the relevant digit (first digit 0-6, second digit 0-8) indicates a higher level of protection.

IP68 protection grade means that the instrument has complete protection against dust infiltration (first digit 6) and it is suitable for continuous immersion in water.

As a standard, immersion is usually guaranteed up to 1 meter. However, higher depths are possible.

## CALIBRATION

The only way to properly calibrate any meter is using either a Master Meter or a Volumetric Prover or a Weigh Scale.

For this purpose, you mainly need to refer to the manufacturer or to an authorized laboratory.

Anyhow, this might result unpractical and in any case need to stop the line, remove the meter and ship to calibration place.

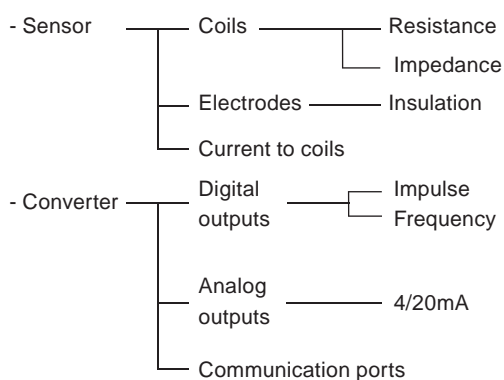
Currently, time intervals for re-calibration might be different country by country according to local rules / laws; you might need to refer to your local authorities to check if such a kind of requirements is regulated in your own country.

In addition to local rules, where the meter generates revenues (water billing, in example) it might be interest of the owner to have the meters inspected at defined intervals.

## VERIFICATION

Easier to perform and good practice as preventive maintenance plan, in-situ verification can be performed on regular basis without interrupting the service.

Electromagnetic Flow Meters are electronic equipments with linear operation. As far as main vital parameters remain unchanged in time, the meter will reasonably maintain original operating performances.



**ISOCAL Verificator**

In some countries, a full verification is requested to be performed every second year.

Between two full verifications, electronics only are requested to be verified by flow simulators.



**ISO-CHECK Flow Simulator**