

Function

All electromagnetic flowmeters are based on Faraday's law of induction:

$$U_M = B \cdot v \cdot d \cdot k$$

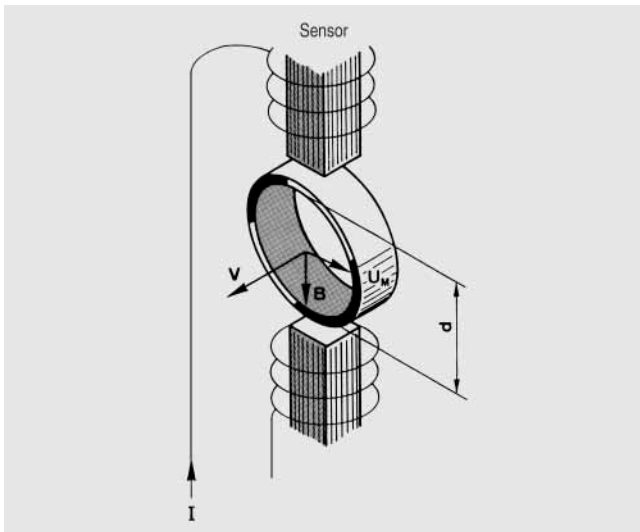
U_M = Measured voltage induced in the medium perpendicular to the magnetic field and the flow direction. The voltage is tapped at two point electrodes.

B = Magnetic flux density which permeates the flowing medium perpendicular to the flow direction.

v = flow velocity of medium

d = internal diameter of metering tube

k = proportionality factor or sensor constant



Function and measuring principle of electromagnetic measurement

An electromagnetic flowmeter generally consists of a magnetically non-conducting metering tube with an internal electrically non-conducting surface, magnet coils connected in series and mounted diametrically on the tube, and at least two electrodes which are inserted through the pipe wall and are in contact with the measured medium. The magnet field coils through which the current passes generate a pulsed electromagnetic field with the magnetic flux density B perpendicular to the pipe axis.

This magnetic field penetrates the magnetically non-conducting metering tube and the medium flowing through it, which must have a minimum electrical conductivity.

According to Faraday's law of induction, a voltage U_M is generated in an electrically conducting medium, and is proportional to the flow velocity v of the medium, the magnetic flux density B , and the distance between the electrodes d (internal diameter of pipe).

The signal voltage U_M is tapped by the electrodes which are in contact with the medium, and passed through the insulating pipe wall. The signal voltage U_M which is proportional to the flow velocity is converted by an associated transmitter into appropriate standard signals such as 4 to 20 mA.

SITRANS F M diagnostics

The diagnostic functions are all internal tools in the meter:

- Identification in clear text and error log
- Error categories: function; warning; permanent and fatal errors
- Transmitter self-check including all outputs and the accuracy
- Sensor check: coil and electrode circuit test
- Overflow
- Empty pipe: partial filling; low conductivity; electrode fouling

SITRANS F M Verificator (MAG 5000 and 6000)

The SITRANS F M Verificator is an external tool designed for MAG 5000 and MAG 6000 with MAG 1100, MAG 1100 F, MAG 3100, MAG 3100 P or MAG 5100 W sensors to verify the entire product, the installation and the application.

The goal is to improve operation, reduce downtime and maintain measurement accuracy as long as possible.

The SITRANS F M Verificator is highly advanced and carries out the complex verification and performance check of the entire flowmeter system, according to unique SIEMENS patented principles. The whole verification test is automated and easy to operate so there is no opportunity for human error or influence. The system is traceable to international standards and tested by WRC (Water Research Council).



SITRANS F M Verificator

- Stand alone Verificator to measure a number of selected parameters in the flow sensor and a transmitter which affects the integrity of the flow measurement
- Up to 20 measurements can be stored in the Verificator
- The Verificator can be connected via a serial cable to a PC enabling download of the data. A Windows OC program enables printing and management of verificator reports.

Verification - Steps

Verification of a SITRANS F M flowmeter consists of the following test routines:

1. Transmitter test
2. Flowmeter and cable insulation test
3. Sensor magnetism test

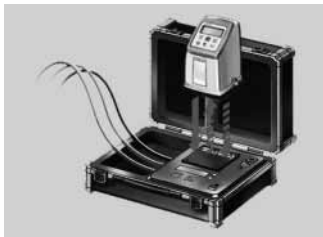
SITRANS F flowmeters

SITRANS F M

System information SITRANS F M electromagnetic flowmeters

1. Transmitter test

The transmitter test is the traditional way of on-site testing on the market and checks the complete electronic system from signal input to output.

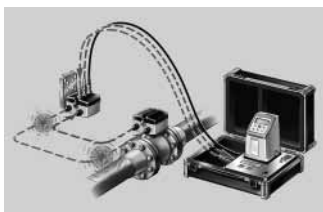


Transmitter test

Using the excitation power output, which is generated to drive the magnetic field of the sensor, the vericator simulates flow signal to the transmitter input. By measuring the transmitter outputs the vericator calculates its accuracy against defined values. Test includes:

- Excitation power to drive the magnetic field
- Signal function from signal input to output
- Signal processing – gain, offset and linearity
- Test of analogue and frequency output

2. Insulation test



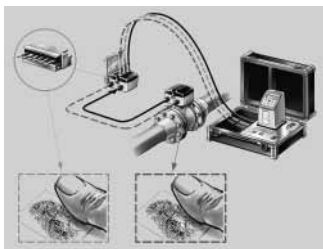
Flowmeter insulation test

The verification test of the flowmeter insulation is a „cross talk“ test of the entire flowmeter which ensures that the flow signal generated in the sensor is not affected by any external influences.

In the "cross-talk" test the vericator generates a high voltage disturbance within the coil circuit and then looks for any "crosstalk" induced in the flow signal circuit. By generating dynamic disturbances close-coupled to the flow signal, the flowmeter is tested for noise immunity to a maximum level:

- EMC influence on the flow signal
- Moisture in sensor, connection and terminal box
- Non-conductive deposit coating the electrodes within the sensor
- Missing or poor grounding, shielding and cable connection.

3. Sensor magnetism test



Sensor magnetism test

The verification of the sensor magnetism is a "boost" test of the magnetic field coil. The test ensures that the magnetism behaviour is like the first time, by comparing the current sensor magnetism with the "fingerprint" which was determined during initial calibration and stored in the SENSORPROM memory unit.

In the "boost" test the vericator changes the magnetic field in certain pattern and with high voltage to get quick stable magnetic condition. This unique test is fulfilled without any interference or compensation of surrounding temperature or interconnecting cabling.

- Changes in dynamic magnetic behaviour
- Magnetic influence inside and outside the sensor
- Missing or poor coil wire and cable connection

Certificate

The test certificate generated by a PC contains:

- Test result with passed or failed
- Installation specification
- Flowmeter specification and configuration
- Vericator specification with date of calibration ensuring traceability to international standards.

SIEMENS MAGFLO® Verification Certificate																																							
Customer:			MAGFLO® Identification:																																				
Name			TAG No./Name	0																																			
Address			Sensor Code No.	083G4054																																			
			Sensor Serial No.	089904T361																																			
			Transmitter Code No.	083F5003																																			
Phone			Transmitter Serial No.	5870228520																																			
Email			Location																																				
Results:																																							
Verification file name or No.			File #1																																				
Transmitter			Insulation		Passed																																		
Sensor			Magnetic Circuit		Passed																																		
<table border="1"> <thead> <tr> <th rowspan="2">Velocity</th> <th colspan="3">Current Output</th> <th colspan="3">Frequency Output</th> </tr> <tr> <th>Theoretical</th> <th>Actual</th> <th>Deviation</th> <th>Theoretical</th> <th>Actual</th> <th>Deviation</th> </tr> </thead> <tbody> <tr> <td>0.5m/s</td> <td>4.800mA</td> <td>4.801mA</td> <td>0.08%</td> <td>0.500kHz</td> <td>0.500kHz</td> <td>-0.01%</td> </tr> <tr> <td>1.0m/s</td> <td>5.600mA</td> <td>5.600mA</td> <td>-0.02%</td> <td>1.000kHz</td> <td>1.000kHz</td> <td>0.01%</td> </tr> <tr> <td>3.0m/s</td> <td>8.800mA</td> <td>8.796mA</td> <td>-0.09%</td> <td>3.000kHz</td> <td>3.000kHz</td> <td>0.01%</td> </tr> </tbody> </table>						Velocity	Current Output			Frequency Output			Theoretical	Actual	Deviation	Theoretical	Actual	Deviation	0.5m/s	4.800mA	4.801mA	0.08%	0.500kHz	0.500kHz	-0.01%	1.0m/s	5.600mA	5.600mA	-0.02%	1.000kHz	1.000kHz	0.01%	3.0m/s	8.800mA	8.796mA	-0.09%	3.000kHz	3.000kHz	0.01%
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Current Output 4.20mA			Frequency Output 0-10kHz																																				
Transmitter Settings:																																							
Basic		Qmax	50.0000 m³/h																																				
		Flow Direction	Positiv																																				
		Low flow Cut-off	1.50%																																				
		Empty Pipe	OFF																																				
Output		Current Output	OFF																																				
		Time Constant	N/A																																				
		Relay Output	N/A																																				
		Error Level	N/A																																				
		Digital Output	Pulse																																				
		Frequency Range	N/A																																				
		Time Constant	N/A																																				
		Volume/pulse	1 m³/p																																				
		Pulse width	N/A																																				
		Pulse polarity	N/A																																				
Totalizer 1 value before test		0.00000 m³																																					
Totalizer 1 value after test		0.56992 m³																																					
Totalizer 2 value before test		0.00000 m³																																					
Totalizer 2 value after test		0.56992 m³																																					
Operating time in days		3																																					
Sensor Details:																																							
Size		DN 80 3 IN																																					
Cal. Factor		1.0																																					
Correction Factor		1.0																																					
Excitation Freq.		6.25Hz																																					
Vericator Details (083F5060)																																							
Serial No.		017807N242																																					
Device No.		63462																																					
Software Version		1.40																																					
PC-Software Version		5.00																																					
Cal. date		2006.01.01																																					
ReCal. date		2006.01.01																																					
Comments																																							
These tests verify that the flowmeter is functioning within 2% deviation of the original test parameters. Verification is traceable to National and International Standards.																																							
Date and signature _____																																							
2006.01.01																																							

Description	Order No.
SITRANS F M Vericator	
• 11 ... 30 V DC, 11 ... 24 V AC, 115 ... 230 V, 50 Hz	FDK-083F5060
• 11 ... 30 V DC, 11 ... 24 V AC, 115 ... 230 V, 60 Hz	FDK-083F5061

Note:

It is mandatory to have the Vericator return to the factory once a year for check and re-verification.

Technical specifications

Flowmeter Calibration and traceability

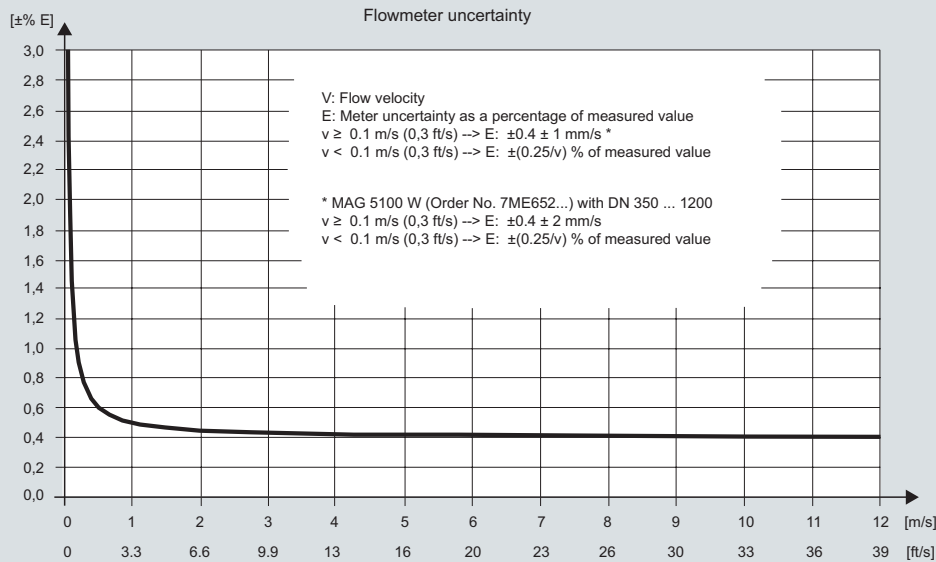
To ensure continuous accurate measurement, flowmeters must be calibrated. All measuring instrumentation, used in the calibration of the flowmeters, has either been calibrated by a UKAS or DANAK accredited laboratory or has been calibrated against certified master sensors. This provides an unbroken chain of measurement-traceability to national standards.

Siemens Flow Instruments can provide accredited calibration in the flow range from 0.0001 m³/h to 4350 m³/h.

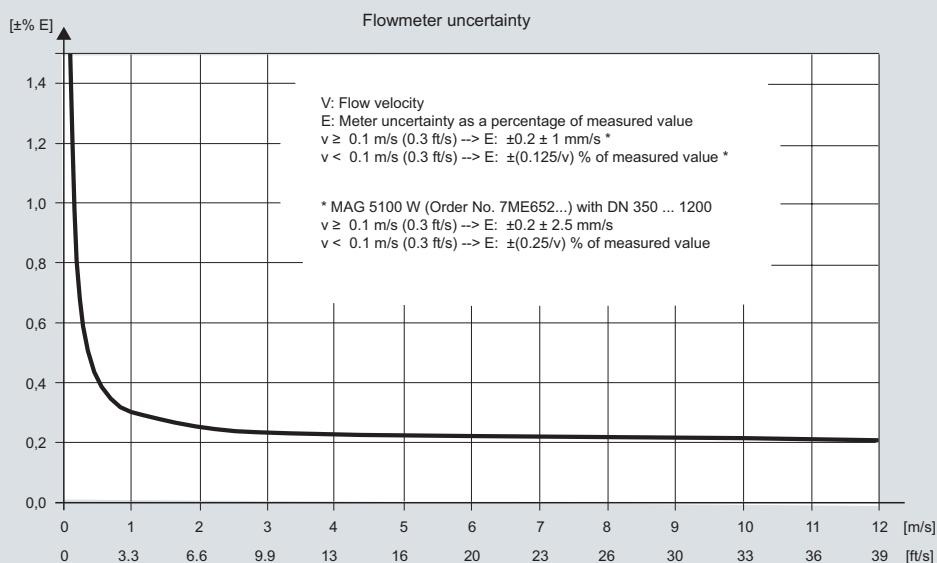
Flowmeter uncertainty

The accreditation bodies DANAK and UKAS have signed the ILAC MRA agreement (International Laboratory Accreditation Corporation - Mutual Recognition Arrangement). Therefore the accreditation ensures international traceability and recognition of the test results in 39 countries world wide, including the US (NIST traceability).

A calibration certificate is shipped with every sensor and calibration data are stored in the SENSORPROM memory unit.



MAG 5000 with MAG 1100, MAG 1100 F, MAG 5100 W, MAG 3100 and MAG 3100 P



MAG 6000 and MAG 6000 I with MAG 1100 (not PFA), MAG 1100 F (not PFA), MAG 5100 W, MAG 3100 and MAG 3100 P

SITRANS F flowmeters

SITRANS F M

System information SITRANS F M electromagnetic flowmeters

Reference conditions

Reference conditions (ISO 9104 and DIN EN 29104)

Temperature medium	20 °C ± 5 K (68 °F ± 9 °F)
Temperature ambient	20 °C ± 5 K (68 °F ± 9 °F)
Supply voltage	$U_n \pm 1\%$
Warming-up time	30 minutes
Incorporation in conductive pipe section	
• Inlet section	10 x DN (DN ≤ 1200/48") 5 x DN (DN > 1200/48")
• Outlet section	5 x DN (DN ≤ 1200/48") 3 x DN (DN > 1200/48")
Flow conditions	Fully developed flow profile

Additions in the event of deviations from reference conditions

Current output	As pulse output ($\pm 0.1\%$ of actual flow + 0.05% FSO)
Effect of ambient temperature	
• Display / frequency / pulse output	$< \pm 0.003\%/K$ act.
• Current output	$< \pm 0.005\%/K$ act.
Effect of supply voltage	$< 0.005\%$ of measuring value on 1% change
Repeatability	$\pm 0.1\%$ of actual flow for $v \geq 0.5$ m/s (1.5 ft/s) and conductivity $> 10 \mu S/cm$

Certificates

• EN 10204 2.1	Certificate of conformity, stating that the delivered parts are made of the material quality that was ordered
• EN 10204 2.2	Test report certificate, a non batch specific material analysis of the ordered material
• EN 10204 3.1	Material analysis certificate, a batch specific analysis of the material issued by an independent inspector

4

Technical specifications PROFIBUS PA/DP

General specifications

PROFIBUS device profile	3.00 Class B
Certified	Yes, according to Profile for process control devices v3.00.
MS0 connections	1
MS1 connections	1
MS2 connections	2

Electrical specification DP

Physical layer specifications

Applicable standard	EN 50170 vol. 2
Physical Layer (Transmission technology)	RS 485
Transmission speed	≤ 1.5 Mbits/s
Number of stations	Up to 32 per line segment, (maximum total of 126)

Cable specification (Type A)

Cable design	Two wire twisted pair
Shielding	CU shielding braid or shielding braid and shielding foil
Impedance	35 up to 165 Ω at frequencies from 3 ... 20 MHz
Cable capacity	< 30 pF per meter
Core diameter	> 0.34 mm ² , corresponds to AWG 22
Resistance	< 110 Ω per km
Signal attenuation	Max. 9 dB over total length of line section
Max. bus length	200 m at 1500 kbit/s, up to 1.2 km at 93.75 kbit/s. Extendable by repeaters

Electrical specification PA

Physical layer specifications

Applicable standard	EN 50170
Physical Layer (Transmission technology)	IEC-61158-2
Transmission speed	31.25 Kbits/second
Number of stations	Up to 32 per line segment, (maximum total of 126)
Max. basic current [I _B]	14 mA
Fault current [I _{FDE}]	0 mA
Bus voltage	9 ... 32 V (non Ex)

Preferred cable specification (Type A)

Cable design	Two wire twisted pair
Conductor area (nominal)	0.8 mm ² (AWG 18)
Loop resistance	44 Ω/km
Impedance	100 Ω ± 20%
Wave attenuation at 39 kHz	3 dB/km
Capacitive asymmetry	2 nF/km
Bus termination	Passive line termination at both
Max. bus length	Up to 1.9 km. Extendable by repeaters

IS (Intrinsic Safety) data

Required sensor electronics	Compact or remote mounted SITRANS F M MAG 6000 I Ex d
FISCO	Yes
Max. U _I	17.5 V
Max. I _I	380 mA
Max. P _I	5.32 V
Max. L _I	0 μH
Max. C _I	0 nF

FISCO cable requirements

Loop resistance R _C	15 ... 150 Ω/km
Loop inductance L _C	0.4 ... 1 mH/km
Capacitance C _C	80 ... 200 nF/km
Max. Spur length in IIC and IIB	30 m
Max. Trunk length in IIC	1 km
Max. Trunk length in IIB	5 km

PROFIBUS parameter support

The following parameters are accessible using a MS0 relationship from a Class 1 Master. MS0 specifies cyclic Data Exchange between a Master and a Slave.

Cyclic services:

Input (Master view)	Parameter	MAG 6000/MAG 6000 I
	Mass flow	
	Volume flow	✓
	Temperature	
	Density	
	Fraction A ¹⁾	
	Fraction B ¹⁾	
	Pct Fraction A ¹⁾	
	Totalizer 1	✓
	Totalizer 2 ²⁾	✓
	Batch progress ²⁾	✓
	Batch setpoint	✓
	Batch compensation	✓
	Batch status (running ...)	✓
Output (Master view)	Set Totalizer 1+2	✓
	Set Mode Totalizer 1+2	✓
	Batch control (start, stop ...)	✓
	Batch setpoint	✓
	Batch compensation	✓

¹⁾ Requires a SENSORPROM containing valid fraction data.

²⁾ Value returned is dependent on the BATCH function. When ON, Batch progress is returned. When OFF, TOTALIZER 2 is returned.

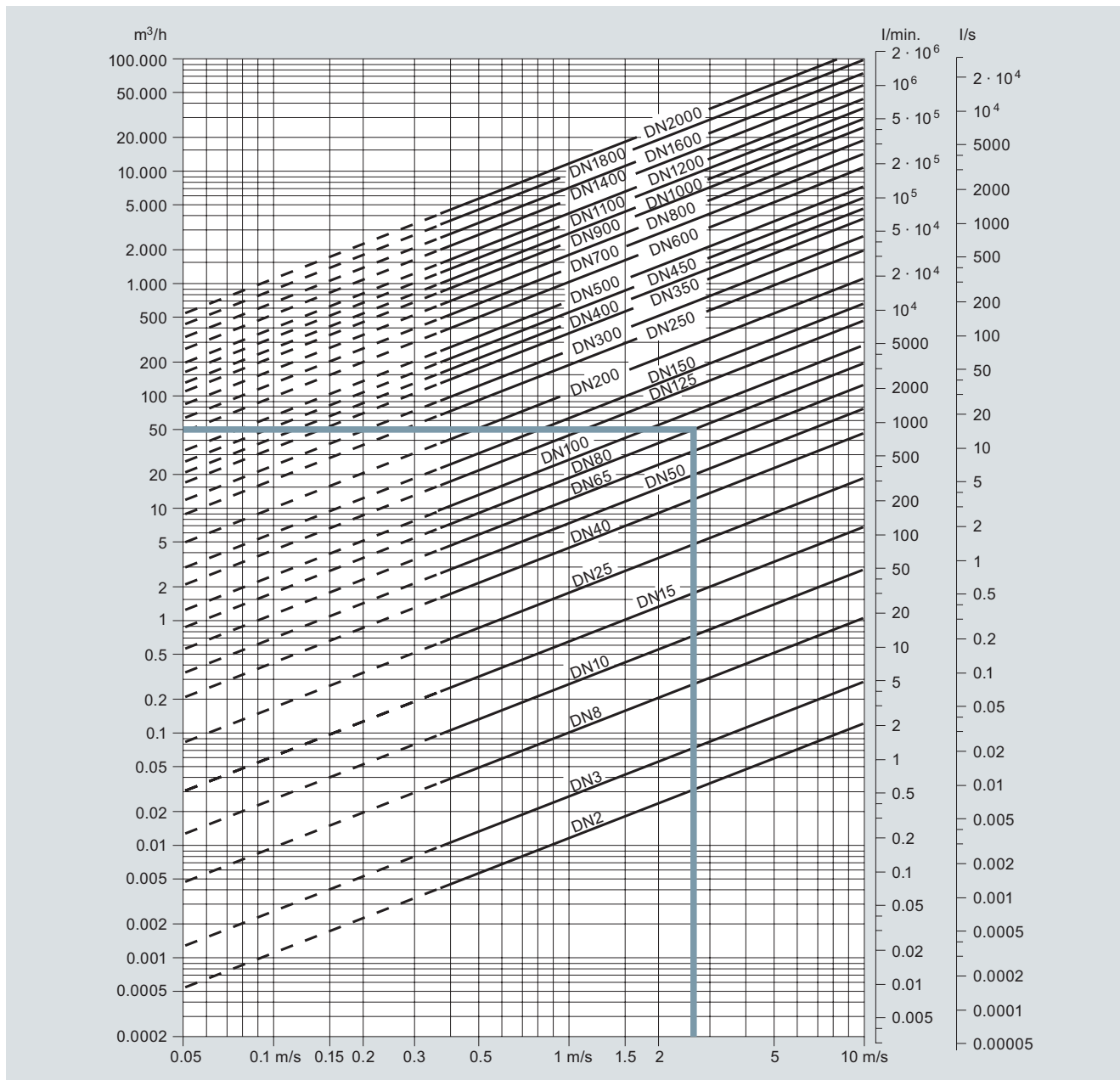
SITRANS F flowmeters

SITRANS F M

System information SITRANS F M
electromagnetic flowmeters

Selection of sensor

Metric



Sizing table (DN 2 ... DN 2000)

The table shows the relationship between flow velocity v , flow quantity Q and sensor dimension DN.

Guidelines for selection of sensor

Min. measuring range: 0 to 0.25 m/s

Max. measuring range: 0 to 10 m/s

Normally the sensor size is selected so that the nominal flow velocity v lies within the measuring range 1 to 3 m/s.

Example:

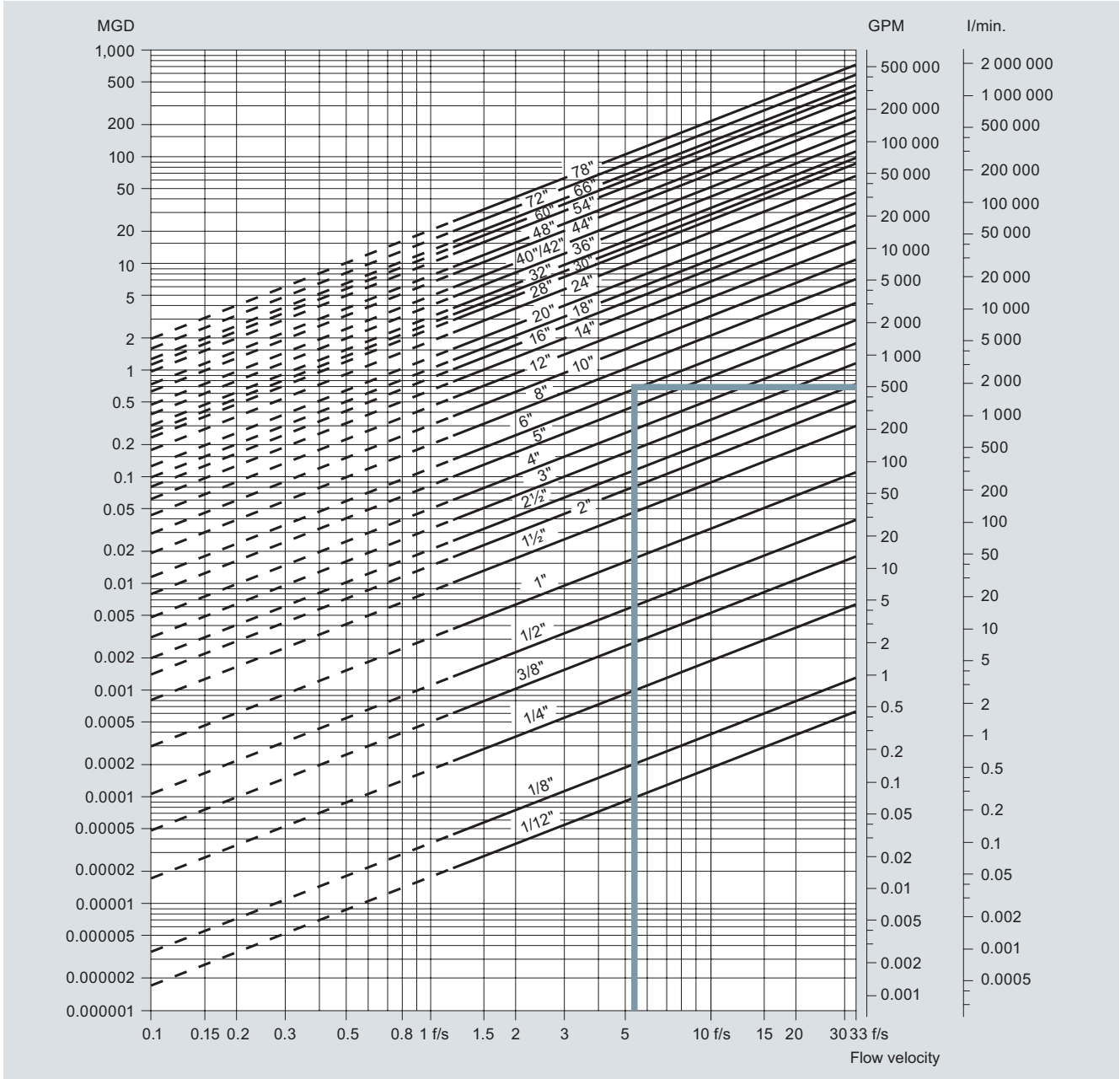
Flow quantity of 50 m³/h and a sensor dimension of DN 80 gives a flow velocity of 2.7 m/s, which is within the recommended measuring range of 1 to 3 m/s.

Flow velocity calculation formula	Units
$v = 1273.24 \cdot Q / DN^2$ or	v : [m/s], Q : [l/s], DN : [mm]
$v = 353.68 \cdot Q / DN^2$	v : [m/s], Q : [m³/h], DN : [mm]

Link to "Sizing program":

<https://pia.khe.siemens.com/index.aspx?nr=11501>

Imperial



Sizing table (1/12" ... 78")

The table shows the relationship between flow velocity v , flow quantity Q and sensor dimension size.

Guidelines for selection of sensor

Min. measuring range: 0 to 0.8 ft/s

Max. measuring range: 0 to 33 ft/s

Normally the sensor size is selected so that the nominal flow velocity v lies within the measuring range 3 to 10 ft/s.

Example:

Flow quantity of 500 GPM and a sensor dimension of 6" gives a flow velocity of 5.6 ft/s, which is within the recommended measuring range of 3 to 10 ft/s.

Flow velocity calculation formula	Units
$v = 0.408 \cdot Q / (\text{Pipe I.D.})^2$ or	v : [ft/s], Q : [GPM], Pipe I.D. : [inch]
$v = 283.67 \cdot Q / (\text{Pipe I.D.})^2$	v : [ft/s], Q : [MGD], Pipe I.D. : [inch]

Link to "Sizing program":

<https://pia.khe.siemens.com/index.aspx?nr=11501>

SITRANS F flowmeters

SITRANS F M

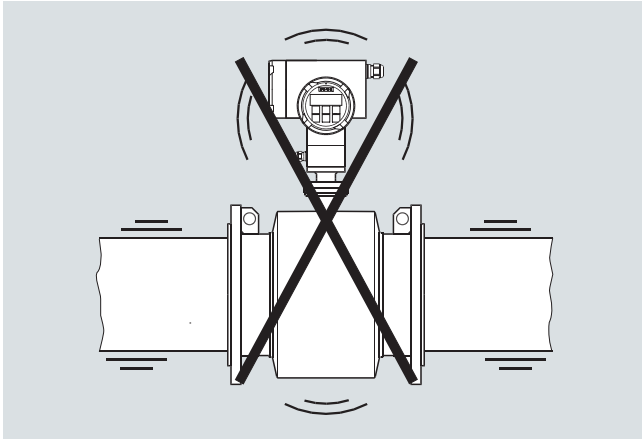
System information SITRANS F M electromagnetic flowmeters

Installation conditions

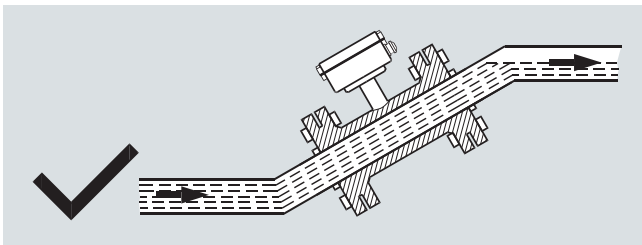
Vibrations

Strong vibrations should be avoided.

In applications with strong vibrations, remote mounting of the transmitter is recommended.



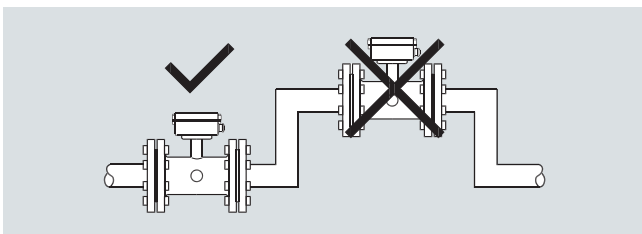
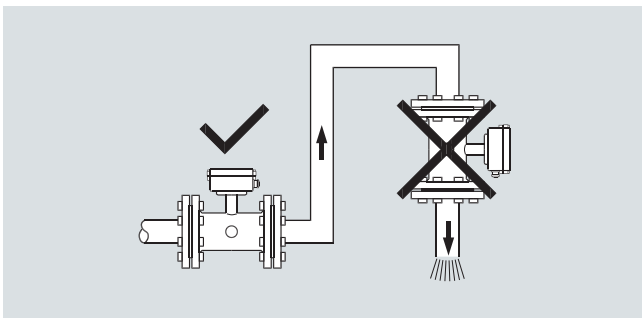
The sensor must always be completely filled with liquid.



Install in pipelines which are always full

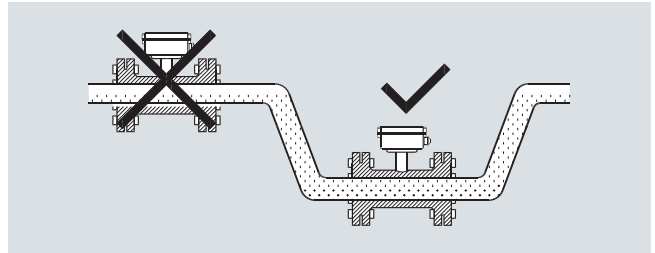
The sensor must always be completely filled with liquid. Therefore avoid:

- Installation at the highest point in the pipe system
- Installation in vertical pipes with free outlet



Do not install in pipelines which can run empty

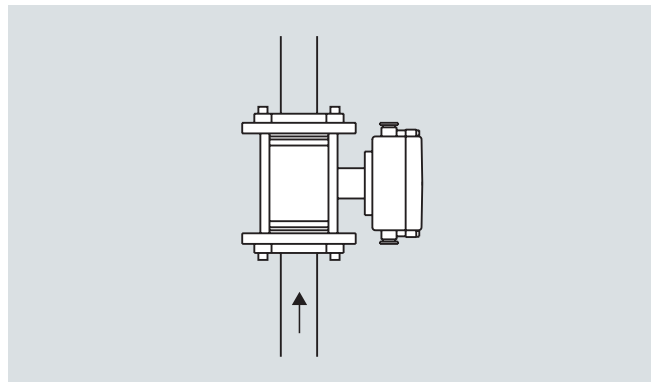
For partially filled pipes or pipes with downward flow and free outlet the flowmeter should be located in a U-Tube.



Install in U-tubes when pipe is partially filled

Installation in vertical pipes

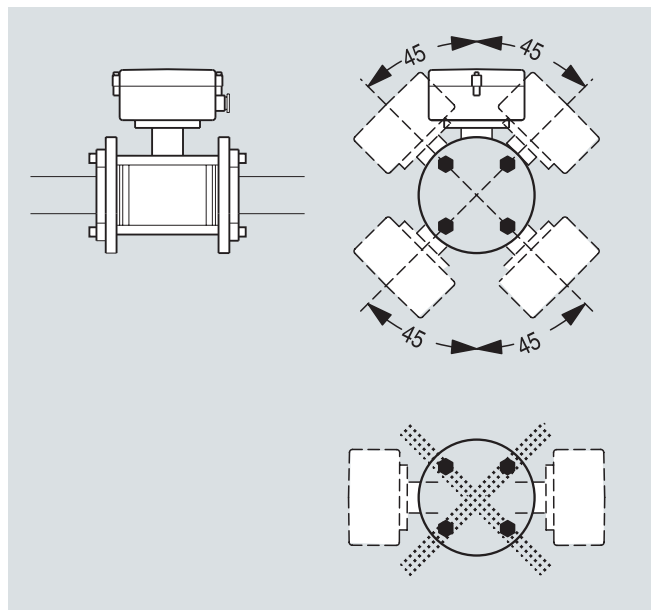
Recommended flow direction: upwards. This minimizes the effect on the measurement of any gas/air bubbles in the liquid.



Install in vertical pipes with upward flow direction

Installation in horizontal pipes

The sensor must be mounted as shown in the below figure. Do not mount the sensor as shown in the lower figure. This will position the electrodes at the top where there is possibility for air bubbles and at the bottom where there is possibility for mud, sludge, sand etc.



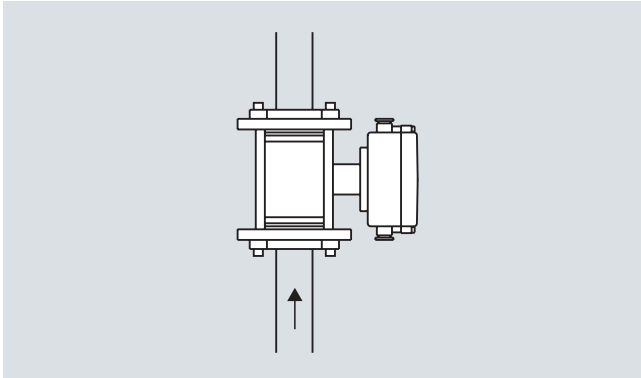
SITRANS F flowmeters

SITRANS F M

System information SITRANS F M electromagnetic flowmeters

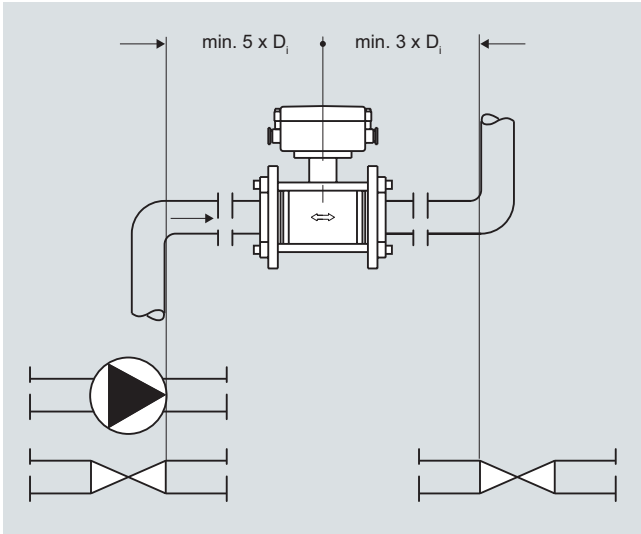
Measuring abrasive liquids and liquids containing particles

Recommended installation is in a vertical/inclined pipe to minimize the wear and deposits in the sensor.



Install in vertical pipelines with upward flow direction if measuring abrasive liquids

Inlet and outlet conditions



Installation between elbows, pumps and valves: standard inlet and outlet pipe sections

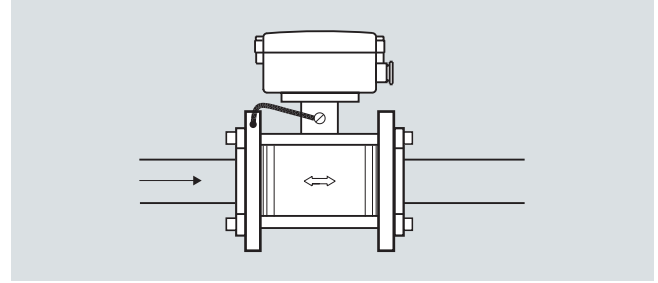
To achieve maximum accurate flow measurement it is essential to have straight length of inlet and outlet pipes and a certain distance between the flowmeter and pumps or valves.

It is also important to center the flowmeter in relation to pipe flange and gaskets.

Ambient temperature-Installation

Temperature changes can cause expansion or contraction in the pipe system. To avoid damage on the sensor use of proper gasket and torque should be ensured. For more information see sensor instruction.

Potential equalization

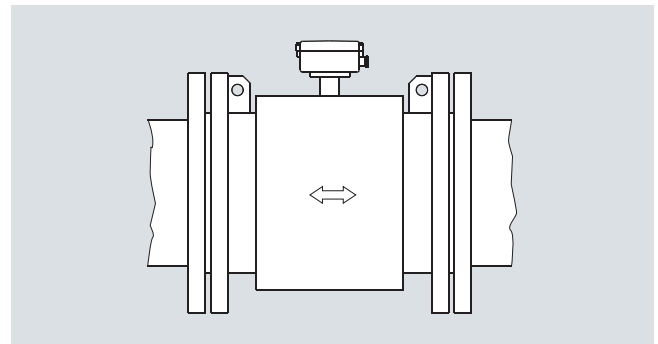


Potential equalization

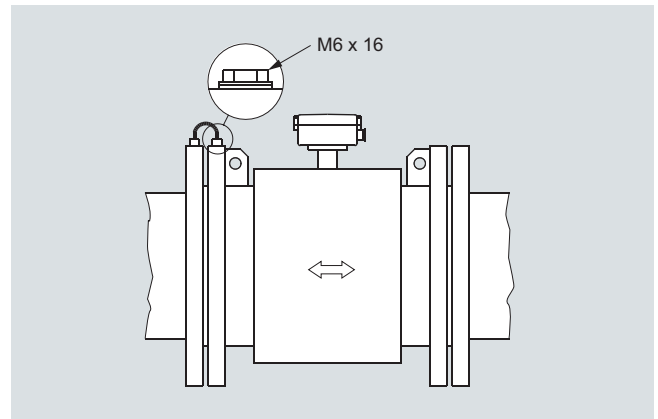
The electrical potential of the liquid must always be equal to the electrical potential of the sensor. This can be achieved in different ways depending on the application:

- Wire jumper between sensor and adjacent flange (MAG 1100, MAG 3100)
- Direct metallic contact between sensor and fittings (MAG 1100 F)
- Build-in grounding electrodes (MAG 3100, MAG 5100 W)
- Optional grounding/protection flanges/rings (MAG 1100, MAG 3100, MAG 8000)
- Optional graphite gaskets on MAG 1100 (standard for MAG 1100 High Temperature)
- MAG 8000 installed in plastic or coated pipes: two grounding rings to be used.

Grounding



MAG 3100 (not PTFE and PFA), MAG 5100 W: with earthing electrodes in conductive and non-conductive pipes (no further action necessary)

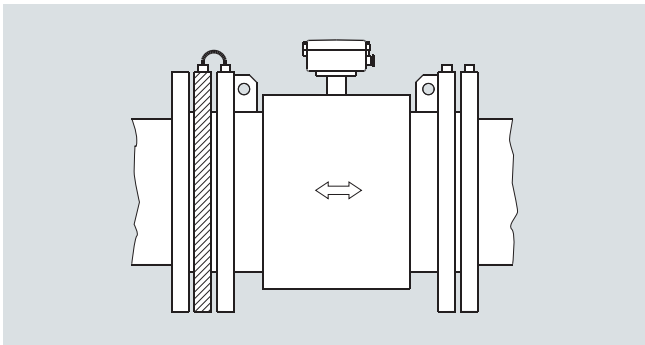


MAG 1100, MAG 3100 (PTFE and PFA): without earthing electrodes in conductive pipes (MAG 1100 use graphite gasket)

SITRANS F flowmeters

SITRANS F M

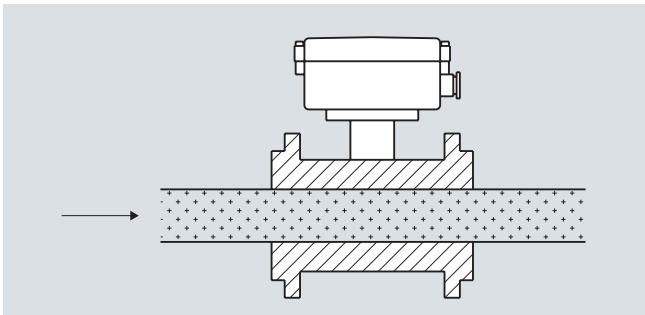
System information SITRANS F M electromagnetic flowmeters



Without earthing electrodes in non-conductive pipes use grounding ring (MAG 1100 use graphite gasket)

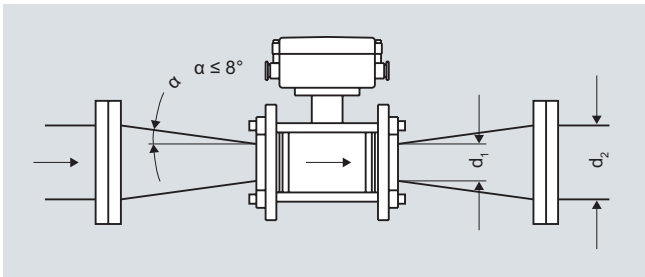
MAG 1100 F grounding via process connections. MAG 8000 grounding see MAG 8000 pages.

Vacuum



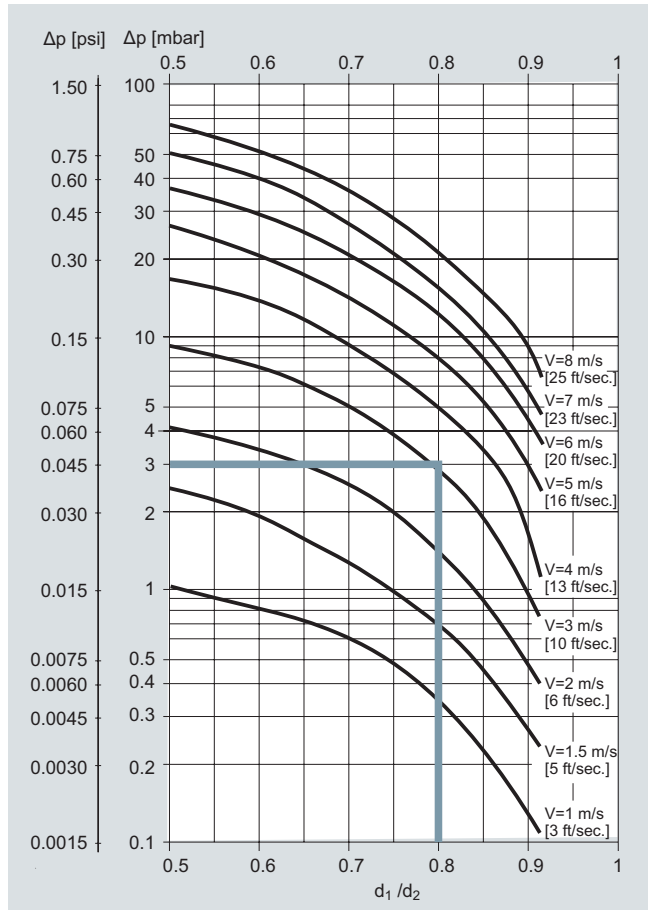
Avoid a vacuum in the measuring pipe, because this can damage certain liners.

Installation in large pipes



Reduction in nominal pipe diameter

The flowmeter can be installed between two reducers (e.g. DIN 28545). Assuming that at 8° the following pressure drop curve applies. The curves are applicable to water.

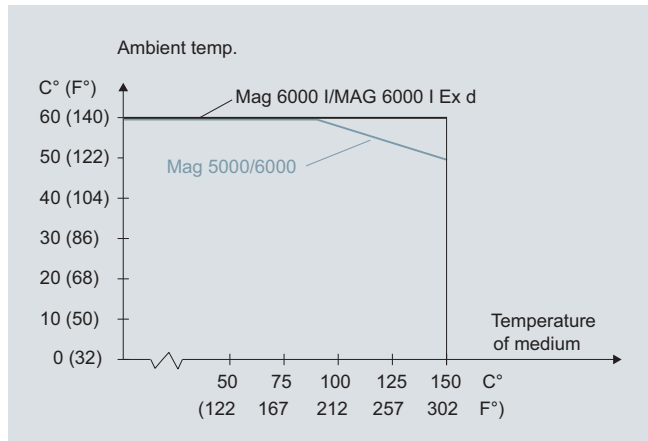


Pressure drop as function of diameter reduction between reducers

Example:

Flow velocity (v) of 3 m/s (10 ft/s) in a sensor with a diameter reduction DN 100 (4") to DN 80 (3") ($d_1/d_2 = 0.8$) gives a pressure drop of 2.9 mbar (0.04 psi).

Ambient temperature



Max. ambient temperature as a function of temperature of medium

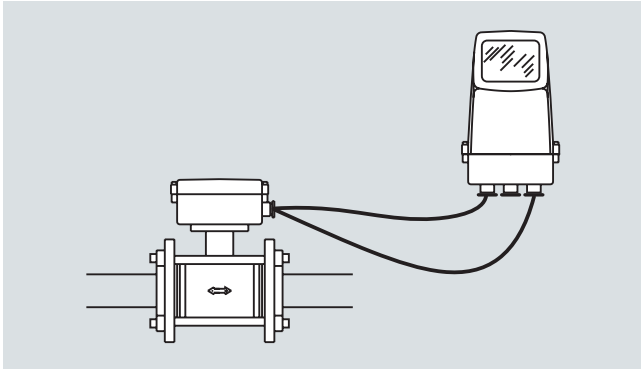
The transmitter can be installed either compact or remote.

With compact installation the temperature of medium must be according to the graph.

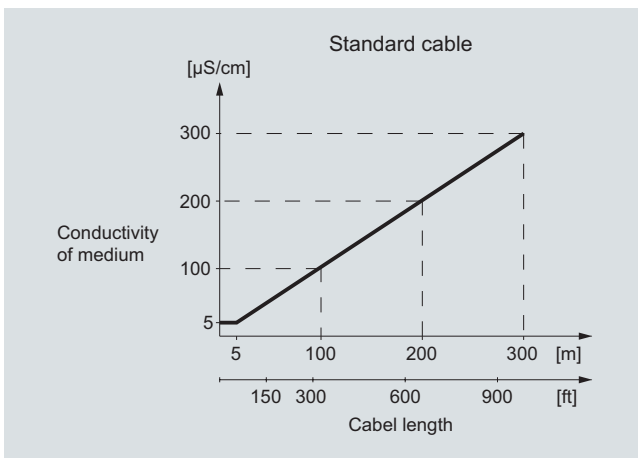
Sensor cables and conductivity of medium

Compact installation:

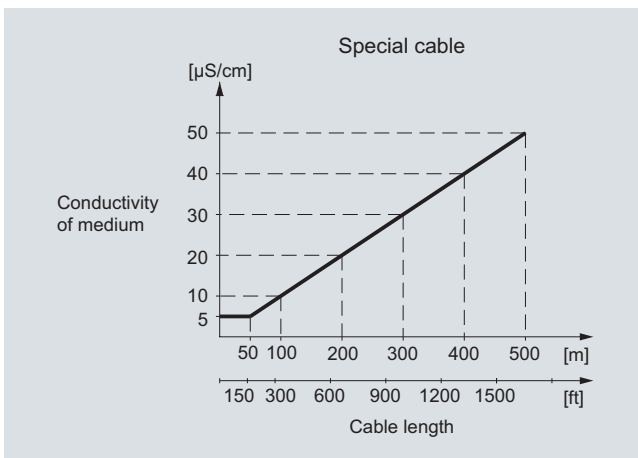
Liquids with an electrical conductivity $\geq 5 \mu\text{S/cm}$.



Remote installation



Minimum conductivity of medium (using standard electrode cable)



Minimum conductivity of medium (using special electrode cable)

Note

For detection of empty sensor the minimum sensor conductivity must always be $\geq 20 \mu\text{S/cm}$ and the maximum length of electrode cable when remotely mounted is 50 m (150 ft). Special shield cable must be used.

For **DN 2, DN 3** or for remote mounting in Ex applications special cable cannot be used, empty sensor cannot be detected and the conductivity must be $\geq 30 \mu\text{S/cm}$. For remote mounted CT installations the maximum cable length is 200 m (600 ft).