

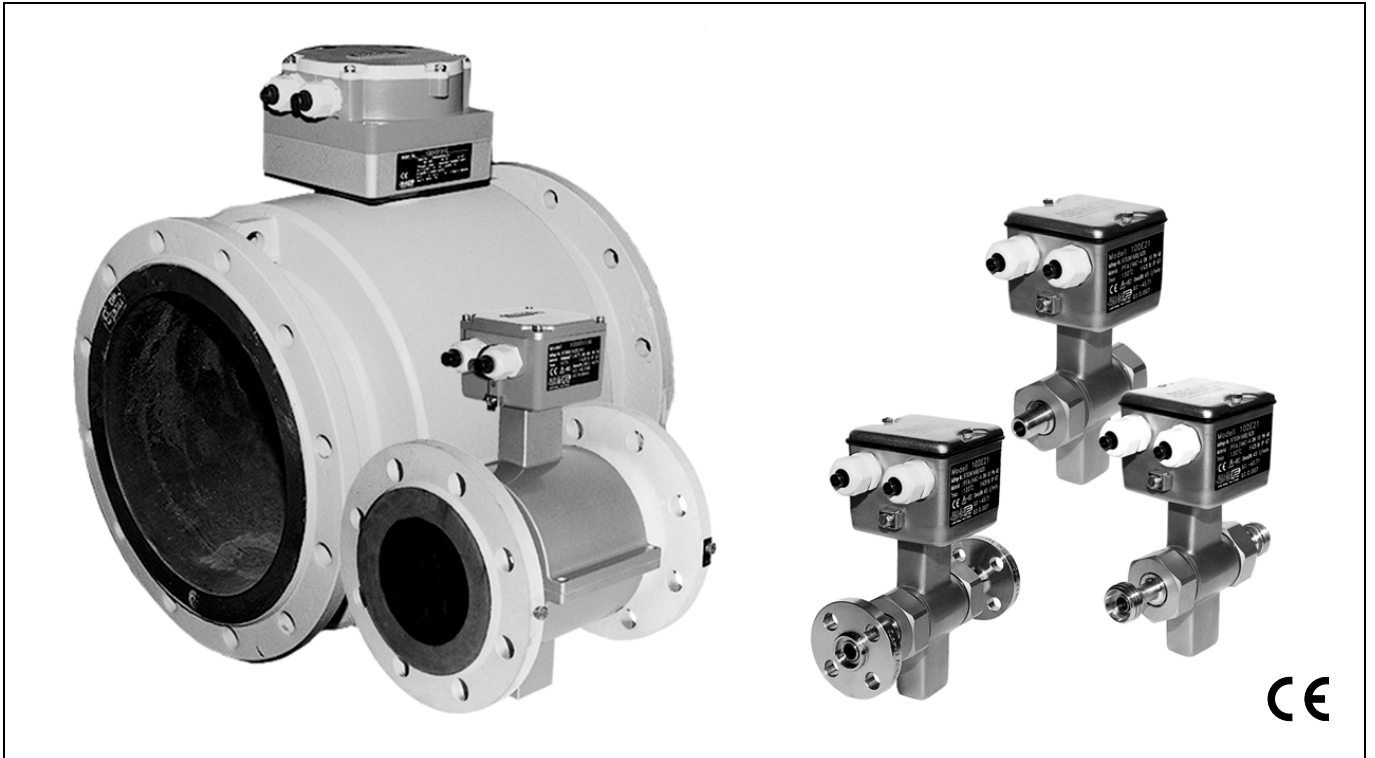
MAG-XM
MAG-CM

**Electromagnetic Flowmeter
Primary with
Pulsed DC Magnetic Field
Technology**

Models: DM2_/DM4_F/DC4_F/
10DX3_/10DX2_

D184B062U02 Rev. 01 / 03.2001

Instruction Bulletin



For Converters:

MAG-XM Model 50XM2000
MAG-CM Model 50XM2000

You have purchased a high quality, modern Electromagnetic Flowmeter Primary
from ABB Automation for use with a Remote Converter.

We appreciate your purchase and the confidence you have expressed in us.

This Instruction Bulletin contains information relating to the assembly and
installation of the instrument and the specifications as well the testing of this instrument design.

ABB Automation reserves the right to make hardware and software improvements
without prior notice. Any questions which may arise that are not specifically answered by
these instructions should be referred to our main plant in Göttingen, Germany,
or to one of our Technical Sales Bureaus.

The addresses, telephone and FAX numbers may be found on the back cover

The interference resistance of this converter complies with the
NAMUR-Recommendations "EMC-Guidelines for Manufacturers
and Users of Electrical Instruments and Systems"
Part 1, 5/93 and EMC-Guideline 89/336/EWG.

(EN 50081-1, EN 50081-2)

(EN 50082-1, EN 50082-2)

Introductory Safety Notes

Regulated Usage

The Electromagnetic Flowmeter System (EMF) is manufactured to state of the art designs and is safe to operate. The flowmeter is to be installed exclusively in applications which are in accord with the specifications.

Every usage which exceeds the specifications is considered to be non-specified. Any damages resulting therefrom are not the responsibility of the manufacturer. The user assumes all risk for such usage.

The applicable specifications include the installation, start-up and service requirements specified by the manufacturer.

Assembly, Start-Up and Operating Personnel

Please read this Instruction Bulletin and the safety notes before attempting installation, start-up or service.

Only qualified personnel should have access to the instrument.

The personnel should be familiar with the warnings and operating requirements contained in this Instruction Bulletin.

Assure that the interconnections are in accordance with the Interconnection Diagrams. Ground the flowmeter system.

Observe the warning notes designated in this document by the symbol:



Hazardous Material Information

If a repair is required.

In view of the Disposal Law of 27 Aug. 86 (AbfG. 11 Special Wastes) the owner of special wastes is responsible for its care and the employer also has, according to the Hazardous Material Law of 01 Oct. 86 (GefStoffV, 17 General Protection Responsibility), a responsibility to protect his employees, we must make note that

- a) all flowmeter primaries and/or flowmeter converters which are returned to ABB Automation for repair are to be free of any hazardous materials (acids, bases, solvents, etc.).
 - b) the flowmeter primaries must be flushed so that the hazardous materials are neutralized. There are cavities in the primaries between the metering tube and the housing. Therefore after metering hazardous materials, these cavities are to be neutralized (see Hazardous Material Law -GefStoffV). For two piece housings the housing screws are loosened. For flowmeter primaries $\geq 14''/DN 350$ the drain plug at the bottom of the housing is to be removed in order to neutralize any hazardous material in the magnet coil and electrode areas.
 - c) for service and repairs **written confirmation** is required that the measures listed in a) and b) have been carried out.
 - d) any costs incurred to remove the hazardous materials during a repair will be billed to the owner of the equipment.
-



EG-Konformitätserklärung EC-Certificate of Compliance



Hiermit bestätigen wir die Übereinstimmung der aufgeführten Geräte mit den Richtlinien des Rates der Europäischen Gemeinschaft. Die Sicherheits- und Installationshinweise der Produktdokumentation sind zu beachten.

Herewith we confirm that the listed instruments are in compliance with the council directives of the European Community. The safety and installation requirements of the product documentation must be observed.

Modell: 50XM2000 10DX2... DM2_
Model: 50CM2000 10DX3... DM4_F DC4_F

Richtlinie: EMV Richtlinie 89/336/EWG *
Directive: EMC directive 89/336/EEC *

Europäische Norm: EN 50081-1, 3/93 *
European Standard: EN 50082-2, 2/96 *

Richtlinie: Niederspannungsrichtlinie 73/23/EWG *
Directive: Low voltage directive 73/23/EEC *

Europäische Norm: EN 61010-1, 3/94 *
European Standard:

* einschließlich Nachträge
including alterations

Göttingen, 22.06.2000


.....
Unterschrift / Signature

BZ-13-5110, Rev.1, 917

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BLZ: 500 400 00

Contents

Page

1.	Flowmeter Primary and Converter Coordination	1
1.1	Applicability	1
1.2	Model Number Coordination	1
1.3	Instruction Bulletins	1
1.4	Specification Sheet	1
1.5	Overview, Flowmeter Primary Designs	2
1.6	Functional Description	3
2.	Assembly and Installation	4
2.1	Inspection	4
2.2	Installation Requirements Flowmeter Primary	4
2.2.1	Installation of the Flowmeter Primary	5
2.2.1.1	Installations for Protection Class IP 68	7
2.2.2	Installation of the High Temperature Design	8
2.2.3	Installation in Larger Size Pipelines	8
3.	Replaceable Parts, Flowmeter Primary	10
3.1	Replaceable Parts List, Connection Box Model 10DX3121/3122	11
3.2	Replaceable Parts List, Connection Box, Aluminum ≤ 12":DN 300	12
4.	Safety Relevant Section of the Instruction Bulletin	13
4.1	Grounding	13
4.1.1	Installation and Grounding in Pipelines with Cathodic Corrosion Protection (CCP)	16
4.1.1.1	Interior Insulated Pipelines with Cathodic Corrosion Protection Potentials	16
4.1.1.2	Mixed System, Pipeline at both CCP and Ground Potentials	16
4.1.2	Supply Power Connections	17
4.1.2.1	Supply and Signal Cable Connections	17
4.1.2.2	Signal Cable Construction	17
4.1.3	Interconnection Diagram	17
4.1.4	Connection Area	18
5.	Start-Up	20
5.1	Preliminary Checks, Flowmeter Primary	20
5.2	Maintenance	20
6.	Testing and Error Search for the Flowmeter Primary Using the Converter	21

1. Flowmeter Primary and Converter Coordination

Note


- You are using a pulsed DC flowmeter system. In order to assure trouble-free operation assure that coordination between the flowmeter primary and the converter listed below is observed. The Model Numbers are listed on the Instrument Tag.

Flowmeter System with Pulsed DC Magnetic Field Technology

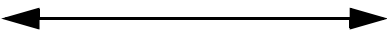
1.1 Applicability

The Electromagnetic Flowmeter is an economical and precise means for measuring the flowrate of liquids, slurries and sludges with electrical conductivities above 5 $\mu\text{S/cm}$ (MAG-CM above 0.05 $\mu\text{S/cm}$).

1.2 Model Number Coordination

Flowmeter Primary		Converter
Stainless Steel Housing Series 2000 10DX2111/10DX2112, DM21_	MAG-XM	50XM2000
Aluminum Housing Series 3000/4000 10DX3111/10DX3112/10DX3121/ DM41F/DC44F	MAG-XM MAG-CM	50XM2000 50XM2000

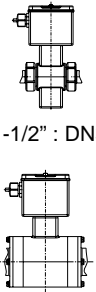
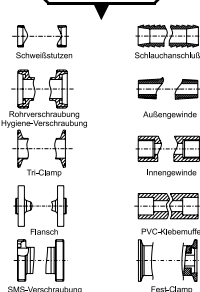
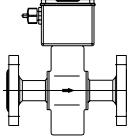
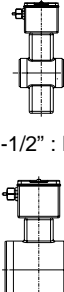

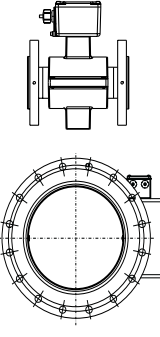
1.3 Instruction Bulletins

Flowmeter Primary		Converter
ABB Part No.: D184B062U01 Rev.01	MAG-XM/MAG-CM	ABB Part No. D184B059U01 Rev. 01
	Primary Simulator	D184B049U01
	COPA-XM/MAG-XM COPA-CM/MAG-CM	ABB Part No.: D184S031U01 Rev. 01 D184S007U01 Rev. 00

1.4 Specification Sheet

Electromagnetic Flowmeter

1.5 Overview, Flowmeter Primary Designs

Variable Connections	Connection Types	Fixed Flange	Wafer Design	Fixed Flange							
 <p>1/10"-1-1/2" : DN3 - 40</p> <p>2" - 4" : DN50 - 100</p>	 <p>See also Process Conn's, Others upon request</p>		 <p>1/10"-1-1/2" : DN3 - 40</p>  <p>2" - 4" : DN50 - 100</p>								
Accuracy	0.4% of rate, Option 0.2% of rate										
Flowmeter primary housing mat'l	Stainless Steel Housing for Series 2000			Alum. Series 4000							
Flowmeter Primary											
Model Number	DM21*		DM21F	DM21W	DM41F						
Process Connections	Inch	DN	PN	*	Meter Size	PN	Inch	DN	PN	Inch : DN	PN
Wafer Design				W			1/10-4	3-100	10-40		
Flanges DIN 2501				F	3-100	10-40				3-2000	10-40
Flanges ANSI B16.5	1/10-4	3-100	10	F	1/10"-4"	CL150-300				1/10"-78"	CL150-300
Flanges FAB1B DIN 11864-2B	1/10-4	3-100	16	L							
Aseptic connection. DIN 11864-1B	1/10-4	3-100	10-40	A							
Food Industry fitting. DIN 11851	1-4	25-100	16	S							
Threaded connection. SMS 1145	1-4	25-100	16	D							
Weld stubs DIN 11850	1/10-4	3-100	10	R							
Weld stubs DIN 2463	1/10-4	3-100	10	Q							
Weld stubs ISO 2037	1-4	25-100	40	P							
Tri-Clamp DIN 32676	1-4	25-100	10	T							
Tri-Clamp ISO 2852	1/10-4	3-100	10-40	U							
Fixed clamp	3/8-1-1/2	10-40	10	C							
External threads ISO 228	1/10-1	3-25	10	E							
Internal threads ISO 228	1/10-1	3-25	10	I							
PVC-Cement sleeve	1/10-1	3-25	10	G							
Hose connector	1/10-1/2	3-15	10	H							
1/8" Sanitary connector	1/25-3/32	1-2	10	B							
Liner	PEEK, Torton (<1/10" : DN3) PFA (>3/32" : DN2)				PFA		PFA			Hard/soft rubber, PTFE, PFA, others	
Conductivity	≥ 5 µS/cm										
Electrodes	SS 316Ti/1.4571, SS 1.4539, Hastelloy B-2/C-4, Platinum-Iridium, Tantalum, Titanium										
Process connection material	SS316L/1.4404, 304/1.4301,		SS 316Ti/1.4571		-		Steel, SS 316Ti/1.4571				
Protection Class	IP 67 / IP 68		IP 67 / IP 68		IP 67 / IP 68		IP 67 / IP 68		IP 67/IP68		
Fluid temperature	-25 to 130 °C		-40 to 130 °C		-25 to 130 °C		-25 to 130 °C		-25 to 130 °C/180°C		
Approvals											
Hygienic and sterile requirements	CIP/SIP-capable FML, 3A, EHEDG (Cleanability)						CIP-capable				

Note:

MAG-XM	MAG-CM
The electromagnetic flow measurement system includes contacting electrodes and has a minimum conductivity limit of 5 µS/cm. The maximum signal cable length between the flowmeter primary and converter is 200 m.	The electromagnetic flow measurement system includes capacitively coupled electrodes and has a minimum conductivity limit of 0.05 µS/cm. The maximum signal cable length between the flowmeter primary and converter is 200 m. For lower conductivities, < 1 µS/cm the max. flow velocity must be reduced when ϵ_r (e.g. demineralized water has an ϵ_r of 78) is high.

Note:

Check to assure that the coordination between the flowmeter primary and converter is correct. The instruments which are to be connected together have the same end characters listed on the Instrument Tag, e.g. A1 and B1, X001 and Y001, A2 and B2 or X002 and Y002. For the specified coordination (flow range, pulse, etc. are preset) and the external EEPROM (with the stored calibration data) was installed prior to shipment. The end characters A1 and B1 or X001 and Y001 thereby constitute a single entity. Observe the note in the converter Instruction Bulletin and check to assure that the order number on the external EEPROM tag is identical to the order number on the Instrument Tag of the flowmeter primary.

1.6 Functional Description

ABB Automation Electromagnetic Flowmeters »EMF« are the ideal flow metering instruments for liquids, slurries and sludges which have a specific minimum electrical conductivity. The instruments measure accurately, add no additional pressure drop, have no moving or protruding parts, are wear free and chemically resistant. The flowmeters can be readily installed in existing pipelines.

EMFs have been proven over many years and are the preferred flowmeters in the Chemical Industry, Municipal Water and Waste Water treatment facilities and in the Food and Beverage Industry as well as in the Pulp and Paper Industry.

Principle of Operation

The basis for the operation of electromagnetic flowmeters are Faraday's Laws of Induction. A voltage is induced in a conductor as it moves through a magnetic field.

This measurement principle is applied to a conductive fluid which flows in a pipe through which a magnetic field is generated perpendicular to the flow direction, see Schematic.

$$U_E \sim B \cdot D \cdot v$$

The voltage which is induced in the fluid is measured at two electrodes located diametrically opposite to each other. This flow signal voltage U_E is proportional to the magnetic induction B , the electrode spacing D and the average fluid velocity v .

Noting that the magnetic induction B and the electrode spacing D are constant values indicates that a proportionality exists between the signal voltage U_E and the average flow velocity v . The equation for calculating the volume flowrate shows that the signal voltage U_E is linear and proportional to the volume flowrate.

$$U_E \sim q_v$$

Design

An electromagnetic flowmeter system includes a flowmeter primary and a converter. The flowmeter primary is installed in the pipeline while the converter which processes the flow signals can be mounted locally or in a central control room.

Note:

- Please observe the specified coordination between the flowmeter primaries and the converters shown on Page 1.

Principle of Operation MAG-CM

The basis for the operation of electromagnetic flowmeters are Faraday's Laws of Induction. A voltage is induced in a conductor as it moves through a magnetic field.

This measurement principle is applied to a conductive fluid which flows in a pipe through which a magnetic field is generated perpendicular to the flow direction (see Schematic).

$$U_E \sim B \cdot D \cdot v$$

The voltage which is induced in the fluid is measured at two electrodes located diametrically opposite to each other. The voltage is measured capacitively, i.e., the electrodes do not come in contact with the fluid.

Each electrode forms a coupling capacitor with the inside wall of the lined meter tube on which the signal potential exists whose dielectric is the liner material. The flowrate proportional measurement signal is fed to the input of an integrated preamplifier over this coupling capacitor.

This signal voltage U_E is proportional to the magnetic induction B , the electrode spacing D and the average fluid velocity v .

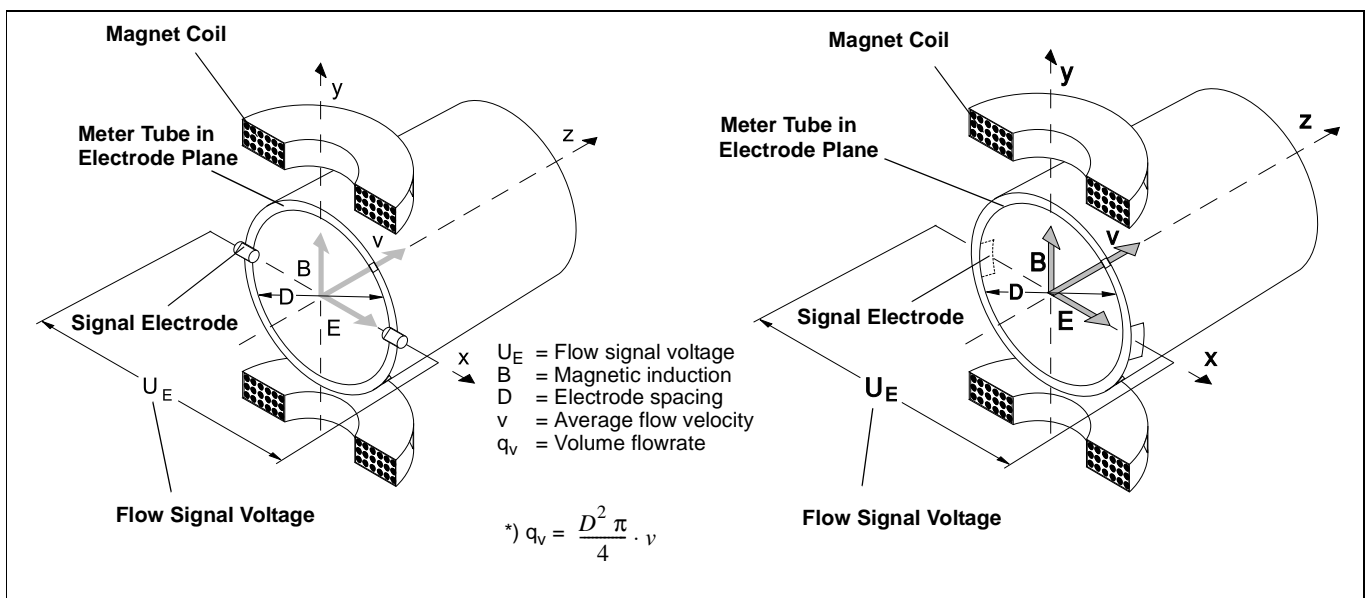


Fig. 1 Electromagnetic Flowmeter Schematic

Electromagnetic Flowmeter

2. Assembly and Installation

2.1 Inspection

Before installing the electromagnetic flowmeter primary check for mechanical damage due to possible mishandling during shipping. All claims for damage are to be made promptly to the shipper before installation.

2.2 Installation Requirements Flowmeter Primary

The flowmeter primary and the signal cables should not be installed in close proximity to strong electromagnetic fields.

The flowmeter primary must be installed so that the meter tube is always completely filled with fluid. Valves or other shut off devices should be installed downstream from the EMF so that the flowmeter primary cannot drain. A slight upward slope of approx. 3% is desirable to prevent gas build up within the flowmeter (Fig. 2).

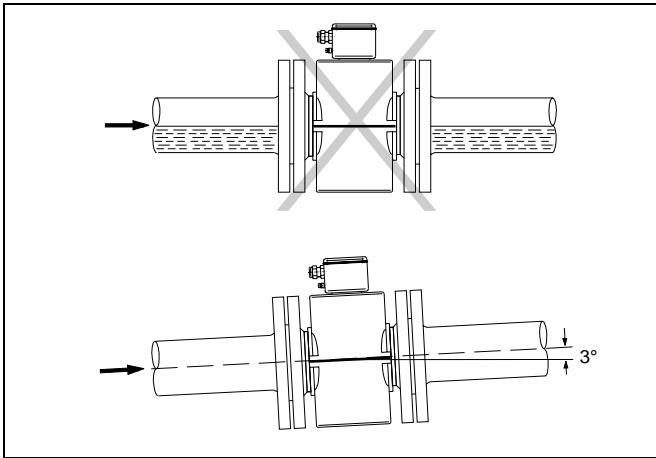


Fig. 2

Vertical installations (Fig. 3) are ideal when the fluid flows in an upward direction. Installations in drop lines, i.e., the fluid flows from the top to the bottom are to be avoided because experience has shown that it is not possible to guarantee that the pipeline will continuously remain 100% full and that an equilibrium condition between the upward flowing gas and the downward flowing fluid will not occur

Generally, the flowmeter primary should be installed in the pipeline with the cable connectors pointing downward. If the flow direction with this arrangement does not agree with the flow direction indicated by the arrow on the flowmeter primary, see "Preliminary Checks, Flowmeter Primary" on Page 20 for corrective measures.

Note

- The figures for the EMF flanged designs shown in Section 2.2 also apply to the other process connection types e.g. Wafer Design, aseptic connections, 1/8" sanitary connections, hose connectors, Tri-Clamp, screwed flanges and others.

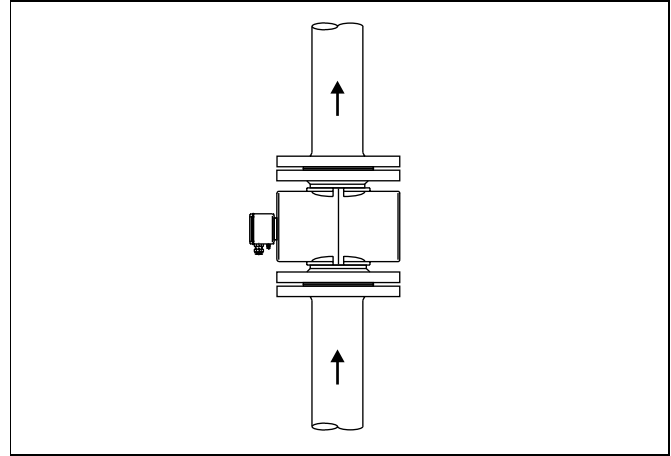


Fig. 3

In horizontal installations the imaginary line connecting the electrodes should be horizontal so that air or gas bubbles cannot affect the flow signal voltage. The electrode orientation is shown in Fig. 4.

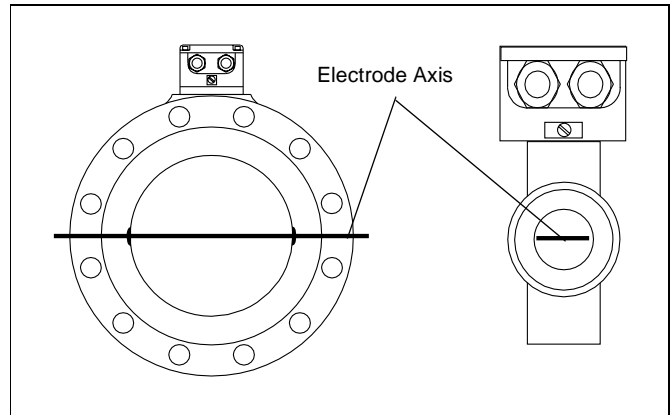


Fig. 4

For a free flow in- or outlet an invert should be provided to assure that the flowmeter primary is always filled with fluid (Fig. 5).

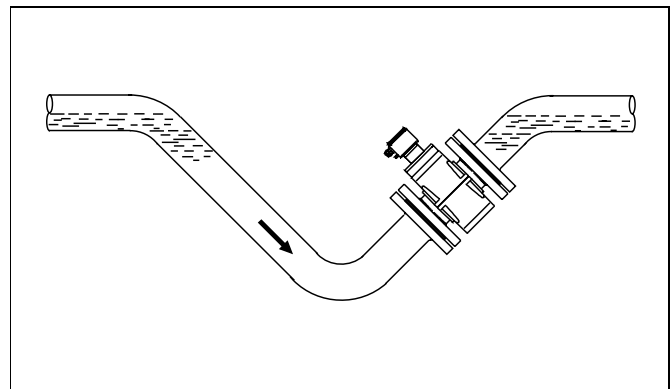


Fig. 5

Electromagnetic Flowmeter

In a free flow outlet (drop line) the flowmeter primary should not be installed at the highest point or in the discharge of the pipeline (meter tube could drain, air bubbles Fig. 6).

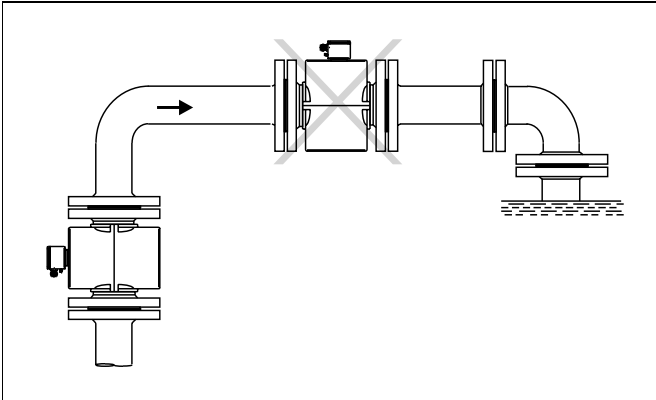


Fig. 6

The measurement principle is independent of flow profile as long as standing eddies do not extend into the measurement section (e.g. after double elbows, tangential inflows or half open valves upstream of the flowmeter primary). In such situations, measures to condition the flow are required. Experience indicates that in most cases a straight upstream section with a length of $3 \times D$ and a downstream section of $2 \times D$ is sufficient (D = flowmeter primary size Fig. 7).

The reference conditions for test stands, per DIN 19200, require a straight upstream length of $10 \times D$ and a $5 \times D$ straight length downstream. For Volume Flow Integrators additional installation requirements are mandatory, see "Installation Requirements for Volume Flow Integrators" on Page 9.

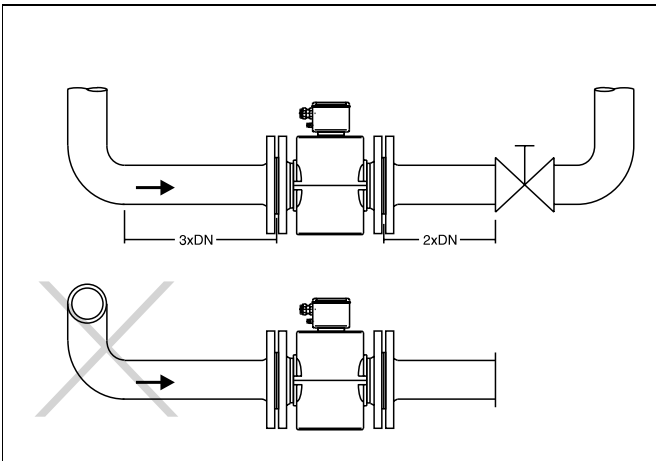


Fig. 7

Wafer valves are to be installed in such a manner that the wafer, when open, does not extend into the flowmeter. Valves or other shut off devices should be installed downstream from the EMF so that the flowmeter primary cannot drain.

An automatic empty pipe detector option is available in the μ P-Converter which uses the existing electrodes for its input.

For heavily contaminated fluids a bypass line as shown in Fig. 8 is recommended so that the flowmeter may be mechanically cleaned without shutting down the process.

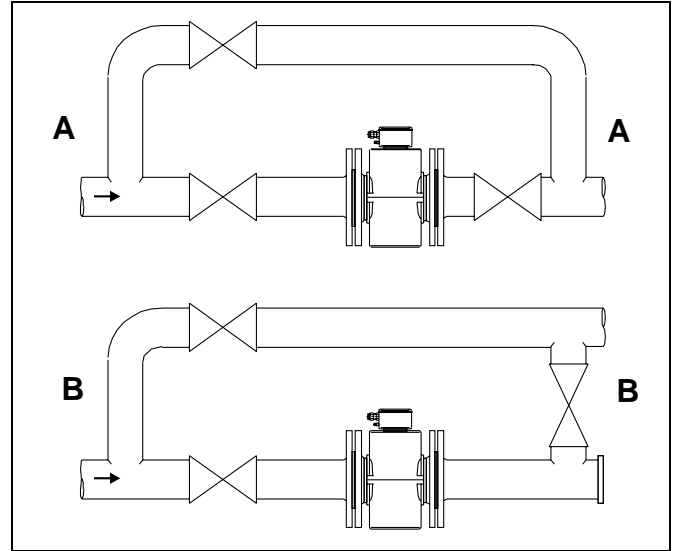


Fig. 8

When it is anticipated that the electrodes may be coated with an insulating layer, a bypass line as shown in Fig. 8 Option B should be installed to facilitate the cleaning operation.

For flowmeter primaries installed in the vicinity of pumps or other vibrating equipment the utilization of mechanical dampers is advantageous (Fig. 9).

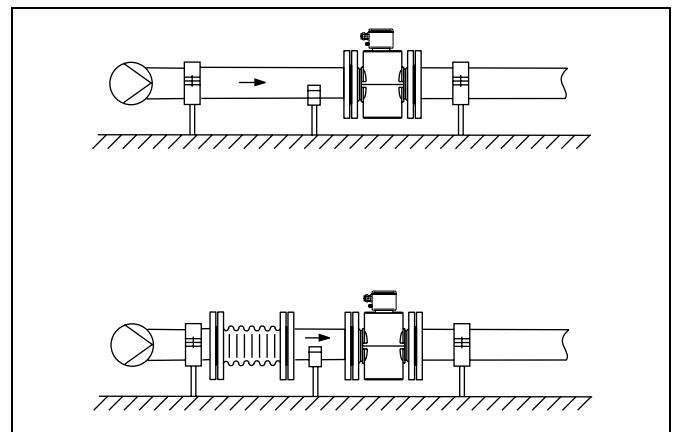


Fig. 9

In mixing and injection systems the flowmeter primary should be installed at a location where the fluids have been completely mixed. A nonhomogeneous distribution of one fluid in the other in the meter tube is to be avoided. Injection locations should always be installed downstream from the flowmeter primary.

Electromagnetic Flowmeter

2.2.1 Installation of the Flowmeter Primary

The electromagnetic flowmeter can be installed at any arbitrary location in the pipeline as long as the installation requirements (see "Installation Requirements Flowmeter Primary" on Page 4) are satisfied. The Wafer Design flowmeter primaries can be installed between DIN, ANSI, BS or JIS flanges. Included with the shipment are the required gaskets, bolts, nuts and centering sleeves.

The flowmeter primary should only be installed between flanges which are axisymmetric and parallel to each other, see Fig. 10.

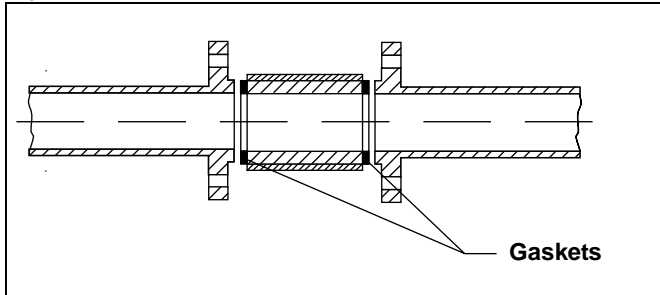


Fig. 10

Improper installation between flanges which are not parallel can result in permanent damage to the flowmeter primary and therefore should be avoided (Fig. 11).

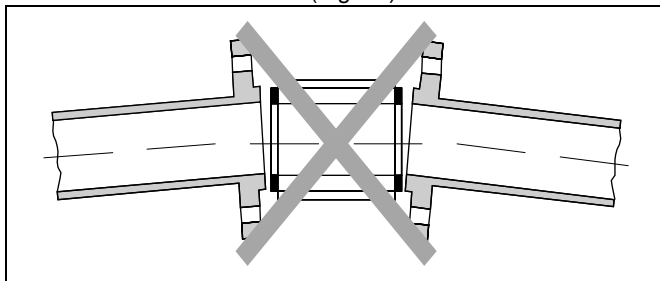


Fig. 11

At the same time, care should be exercised when selecting the installation site to assure that moisture cannot seep into the connection area. Be certain to carefully seat the housing cover gaskets when installing the covers after the installation and start-up have been completed.

Gaskets

It is essential to use the gaskets which accompanied the flowmeter primary shipment. Only when these gaskets are used and the flowmeter primary has been installed correctly are leaks avoided. Observe the information in Table 1.

Wafer Design flowmeter primaries with PTFE/PFA liners are shipped **without gaskets**. The installation (axisymmetric and parallel) is made directly into the pipeline without gaskets. Only when a grounding plate is installed is an additional gasket required (grounding plate / pipeline flange). See Table 3 for torque specifications.

For all other flanged flowmeter primary designs commercially available gaskets are to be used made of materials compatible with the fluid being metered and suitable for the operating temperatures (rubber, It, PFA).

Note:

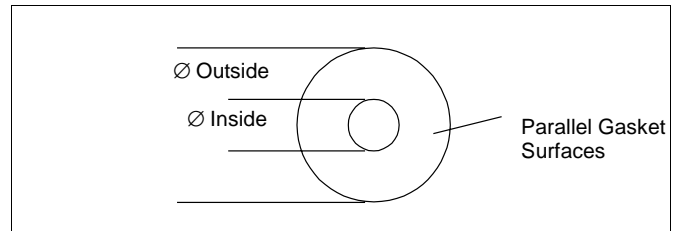
- Graphite should not be used to lubricate the flange or process connection gaskets because, under certain conditions, an electrically conductive coating may form on the inside surface of the meter tube adversely affecting operation.

The flowmeter primary should not be installed in close proximity to strong electromagnetic fields. During installation, steel parts (e.g. steel mounting brackets should be spaced at least 100 mm distant from the flowmeter primary). Vacuum shocks should be avoided to prevent damage to the liner.

Comment: A vacuum shock resistant liner design is included in the flowmeter program.

Gasket Surfaces on the Mating Flanges

In every installation parallel mating flange surfaces should be provided and gaskets made from materials suitable for the fluid and the temperature should be used. Only then can leaks be avoided. The flange gaskets for the flowmeter primary must be installed concentrically to achieve optimum measurement results. The parallel gasket surface requirements for the mating flanges are:



Flowmeter Primary Inch	DN	Required Parallel Gasket Surface	
		Ø Inside mm	Ø Outside mm
1/10 – 1/4	3 – 6	8	21.5
3/8	10	14	35
1/2	15	18	35
3/4	20	22	44
1	25	29	52
1-1/4	32	37	61
1-1/2	40	43	71
2	50	52	91
2-1/2	65	71	107
3	80	81	124
4	100	100	149

Protection Plates

The protection plates for the PTFE/PFA/ETFE lined flowmeter primaries have been installed to prevent damage to the liner during shipment. Remove these protection plates only when ready to install the meter in the pipeline. Be careful not to cut or otherwise damage the liner in order to prevent leakage. The Dimension Drawings for your instrument design may be found in the Specification Sheet.

Torque Specifications for Flanged and Wafer Design Flowmeter Primaries

The mounting bolts are to be tightened equally in the usual manner without excessive one-sided tightening. We recommend that the bolts be greased prior to tightening and that they be tightened using a wrench with a normal length, in a crisscross pattern as shown in Fig. 12. Tighten the bolts during the first pass to approx. 50%, during the second pass to approx. 80% and only during the third pass to 100% of the max. torque value. The max. torque values should not be exceeded, see the following tables.

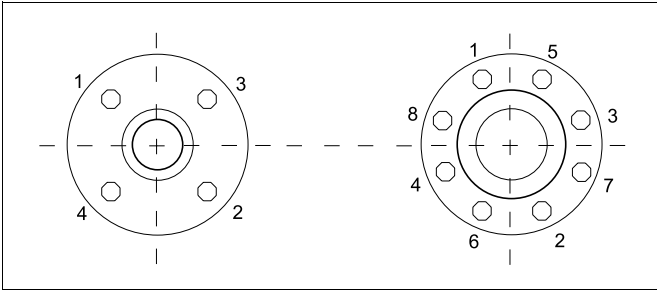


Fig. 12

Torque Specifications

Liner	Meter Size Inch DN	Process Connection	Bolts	Torque Max. NM	PN bar	
PFA/ PTFE/ Hard Rubber	1/10-3/8 3-10 1/2 15 3/4 20 1 25	Flanges, Wafer Design	4 x M12	8	40	
(≥ 1/2": DN 15)	1-1/4 32 1-1/2 40		4 x M12	10	40	
ETFE	2 50		4 x M12	16	40	
(≥ 1": DN 25)	2-1/2 65 3 80		4 x M16	21	40	
			4 x M16	34	40	
			4 x M16	43	40	
			4 x M16	56	40	
			8 x M16	39	40	
			8 x M16	49	40	
PFA	4 100	Wafer Design, Flanges	8 x M16	47	16	
≥ 10":	5 125		8 x M16	62	16	
DN 250	6 150		8 x M20	83	16	
PTFE/ Hard Rbr	8 200		12 x M20	81	16	
ETFE	10 250		12 x M24	120	16	
≤ 12":	12 300		12 x M24	160	16	
DN 300	14 350		16 x M24	195	16	
	16 400		16 x M27	250	16	
			Flanges	20 x M24	200	10
				20 x M27	260	10
		24 x M27		300	10	
		24 x M30		390	10	
		28 x M30		385	10	
		28 x M33		480	10	
		32 x M36		640	10	
		36 x M39		750	10	
		Flanges	40 x M45	1050	10	
			44 x M45	1100	10	
			48 x M45	1200	10	
			32 x M30	365	6	
			36 x M33	480	6	
			40 x M33	500	6	
		44 x M36	620	6		
		48 x M39	725	6		

Table 2

Torque Specifications for Wafer Design Flowmeters

Liner	Meter Size Inch DN	Process Connection	Bolts	Torque Max. NM	PN bar
PFA	1/10-5/16 3-8	Wafer Design	4 x M12	2.3	40
PFA	3/8 10	Wafer Design	4 x M12	7.0	40
	1/2 15		4 x M12	7.0	40
	3/4 20		4 x M12	11.0	40
	1 25		4 x M12	15.0	40
	1-1/4 32		4 x M16	26.0	40
	1-1/2 40		4 x M16	33.0	40
	2 50		4 x M16	46.0	40
	2-1/2 65		8 x M16	30.0	40
	3 80		8 x M16	40.0	40
	4 100		8 x M20	67.0	40

Table 3

2.2.1.1 Installations for Protection Class IP 68

For flowmeter primaries for **Protection Class IP 68** the maximum permanent submerged depth is 5 m. In place of the standard cable connectors hose enclosed cable connectors are utilized. The cable is installed inside a 1/2" hose from connection box to the maximum water surface height. Above this level the cable is installed in a watertight cable connector included with the shipment. The 1/2" hose is then sealed and secured to the hose connectors using threaded hose clamps. After the installation has been completed the connection box cover **must** be carefully reinstalled.

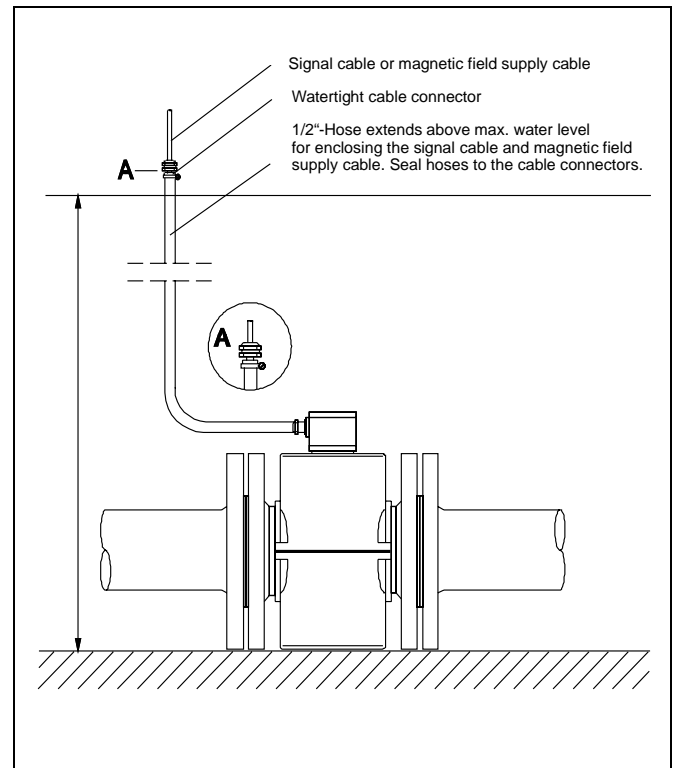


Fig. 13 Installation IP 68 (Hose Connections)

Electromagnetic Flowmeter

2.2.2 Installation of the High Temperature Design

Please see the Installation Notes in Section 2.2.1.

The connection box in the high temperature design for fluid temperatures $<180\text{ }^{\circ}\text{C}$, is spaced away from the lower section of the flowmeter primary by a pipe nipple. This provides thermal insulation between the connection box and the lower section of the flowmeter primary. The insulation for the pipeline and the flowmeter primary should be installed as shown in Fig. 14.

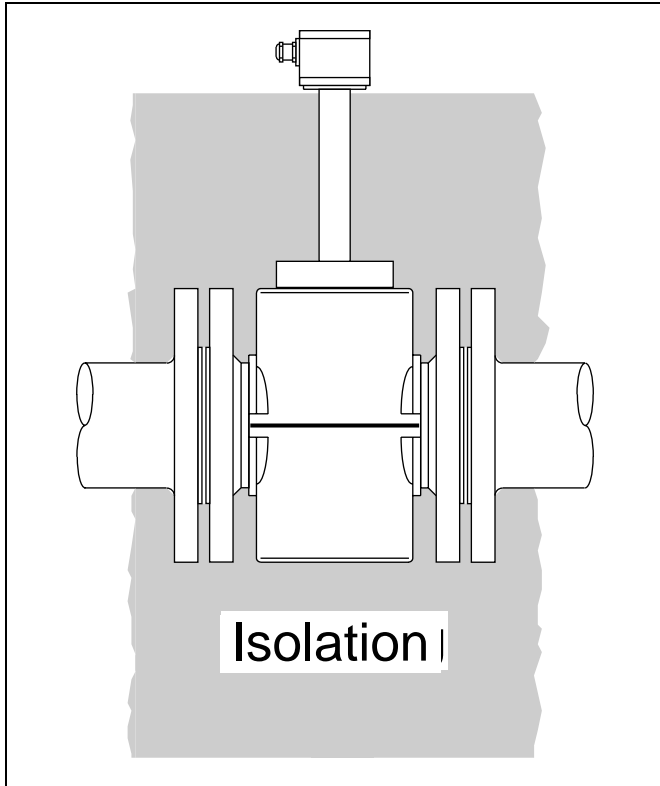


Fig. 14

2.2.3 Installation in Larger Size Pipelines

The flowmeter can readily be installed in larger size pipelines through utilization of flanged transition sections (e.g. Flanged Reducers per DIN 28545). The pressure drop resulting from the reduction can be determined from Diagram Fig. 15 using the following procedure:

1. Calculate the diameter ratio d/D .
2. Calculate the flow velocity as a function of the meter size and the flowrate:

$$v = \frac{Q \text{ (Instantaneous Flowrate)}}{\text{Primary Constant}}$$

The flow velocity can also be determined from the Flow Rate Nomograph in the Specification Sheet D184S031U01 Rev. 01.

3. The pressure drop can be read on the -Y- axis at the intersection of the flow velocity value and the "Diameter Ratio d/D " value on -X- axis in Fig. 15.

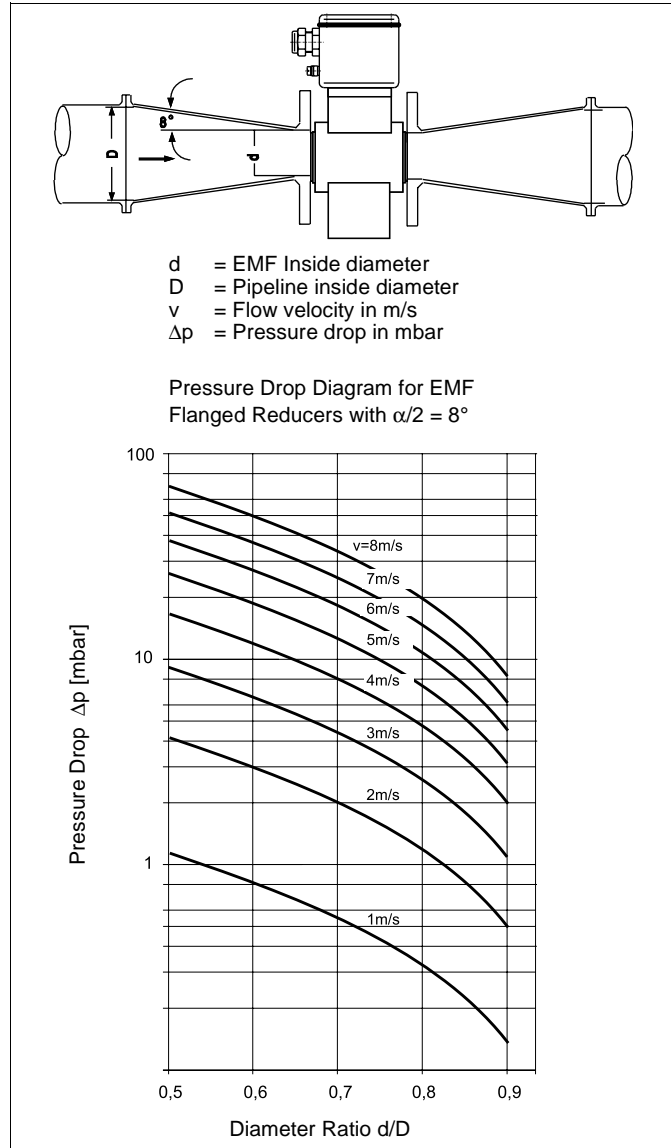


Fig. 15 Pressure Drop Nomograph

Electromagnetic Flowmeter

Approvals

The instrument design "Electromagnetic Volume Flow Integrator with Electrical Counter" has been approved by the Physikalisch-Technischen Bundesanstalt [National Institute of Science and Technology] in Braunschweig, Germany for intrastate custody transfer. For the Volume Flow Integrator MAG-XM, consisting of a flowmeter primary and a converter, the following approvals have been granted:

6.221 Electromagnetic Volume Flow Integrator
87.12 with Electrical Counter in Class B for
Cold Water and Waste Water.

5.721 Electromagnetic Volume Flow Integrator
87.05 with Electrical Counter for **Liquids, other than Water** (Milk, Beverage Concentrates or Syrups, Beer, Wort, Brine). The approval also applies to chemical liquids.

For the Electromagnetic Volume Flow Integrators with Electrical Counters, Appendix 6 (EO6) and Appendix 5 (EO5) of the Certification Regulation of 1988 also apply.

Certification

The electromagnetic flowmeters are calibrated on the ABB flow test stands in Göttingen, Germany approved for certification calibrations. After the calibration, the parameters which affect the certification can only be changed in the presence of a Certification Official.

Approved Flowmeter Sizes for "Cold Water and Waste Water"

Meter Size		Minimum Approved Flow Range (approx. 2 m/s)		Maximum Approved Flow Range (approx. 10 m/s)	
Inch	DN				
1	25	0 to 2.4	m ³ /h	0 to 16	m ³ /h
1-1/4	32	0 to 5	m ³ /h	0 to 26	m ³ /h
1-1/2	40	0 to 9	m ³ /h	0 to 46	m ³ /h
2	50	0 to 14	m ³ /h	0 to 70	m ³ /h
2-1/2	65	0 to 20	m ³ /h	0 to 120	m ³ /h
3	80	0 to 40	m ³ /h	0 to 180	m ³ /h
4	100	0 to 60	m ³ /h	0 to 280	m ³ /h
5	125	0 to 80	m ³ /h	0 to 420	m ³ /h
6	150	0 to 120	m ³ /h	0 to 640	m ³ /h
8	200	0 to 220	m ³ /h	0 to 1100	m ³ /h
10	250	0 to 360	m ³ /h	0 to 1800	m ³ /h
12	300	0 to 500	m ³ /h	0 to 2600	m ³ /h
14	350	0 to 700	m ³ /h	0 to 3600	m ³ /h
16	400	0 to 900	m ³ /h	0 to 4600	m ³ /h
20	500	0 to 1400	m ³ /h	0 to 7200	m ³ /h
24	600	0 to 2000	m ³ /h	0 to 10000	m ³ /h
28	700	0 to 2800	m ³ /h	0 to 14000	m ³ /h
32	800	0 to 3600	m ³ /h	0 to 18000	m ³ /h
36	900	0 to 4600	m ³ /h	0 to 24000	m ³ /h
40	1000	0 to 5600	m ³ /h	0 to 28000	m ³ /h
42	1100	0 to 6200	m ³ /h	0 to 32000	m ³ /h
48	1200	0 to 8200	m ³ /h	0 to 84000	m ³ /h
54	1400	0 to 11000	m ³ /h	0 to 96000	m ³ /h
64	1600	0 to 14400	m ³ /h	0 to 144000	m ³ /h
72	1800	0 to 18400	m ³ /h	0 to 184000	m ³ /h
78	2000	0 to 22000	m ³ /h	0 to 220000	m ³ /h

Approved Flowmeter Sizes for "Liquids other than Water"

Flowmeter Sizes and Maximum Approved Flowrates						
Inch	DN	Q _{max} Liter/min				
1	25	selectable from	50 to 200	in steps of	10	
1-1/4	32	selectable from	100 to 400	in steps of	20	
1-1/2	40	selectable from	150 to 750	in steps of	50	
2	50	selectable from	250 to 1000	in steps of	50	
2-1/2	65	selectable from	400 to 2000	in steps of	100	
3	80	selectable from	700 to 3000	in steps of	100	
4	100	selectable from	900 to 4500	in steps of	100	
6	150	selectable from	2000 to 10000	in steps of	500	

Meter Size		Minimum Metered Flowrates	Fluids
Inch	DN	Liter/min	Liquids other than Water, also Chemical Liquids - Examples:
1	25	8	Beverage Concentrate
		20	Beer
1-1/4	32	20	Beer
1-1/2	40	20	Beer, Milk
2	50	200	Beer, Wort
2-1/2	65	500	Beer, Wort, Milk
3	80	500	Beer, Wort, Milk
4	100	2000	Wort, Brine
6	150	2000	Brine

Velocity at min. flowrate approx. 2.5 m/s.

Velocity at max. flowrate approx. 10 m/s.

The prescribed flow ranges correspond to those listed in the tables above. Subsequent flow range changes require a new calibration on a certified test stand.

Installation Requirements for Volume Flow Integrators

Up- and downstream of the flowmeter primary straight pipe sections are to be installed with the same inside diameter as the inlet opening of the flowmeter. Upstream of the flowmeter primary the length must be at least 10 times the diameter of the flowmeter primary and the downstream length must be at least 5 times the diameter of the flowmeter primary, see Fig. 16.

The flowmeter primary must always be completely filled with fluid.

The distance (signal cable length) between the flowmeter primary and the converter may not exceed 50 m.

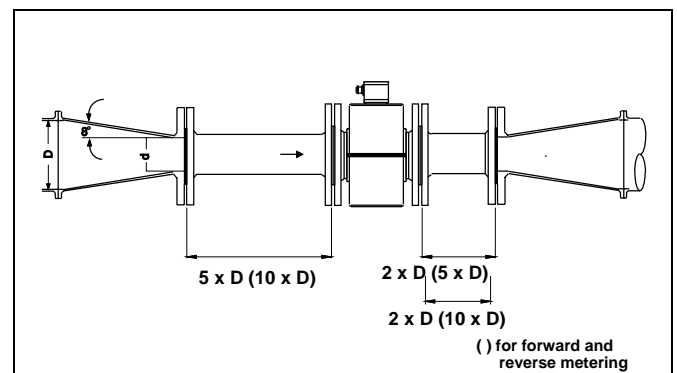


Fig. 16 Pipeline Installation, Reductions when Required

Electromagnetic Flowmeter

Accessories

Additional instruments such as volume flowrate indicators, recorders or controllers as well as approved printers, flow controllers or remote totalizers may be connected to the Volume Flow Integrator.

Printers, flow controllers and remote totalizers, when required, must be connected to the Volume Flow Integrator during its calibration.

3. Replaceable Parts, Flowmeter Primary

When repairs to the liner, electrodes or magnet coils are required, the flowmeter primary must be returned to the factory in Göttingen, Germany. Please note the information in the "Introductory Safety Notes" section (Hazardous Material Information).

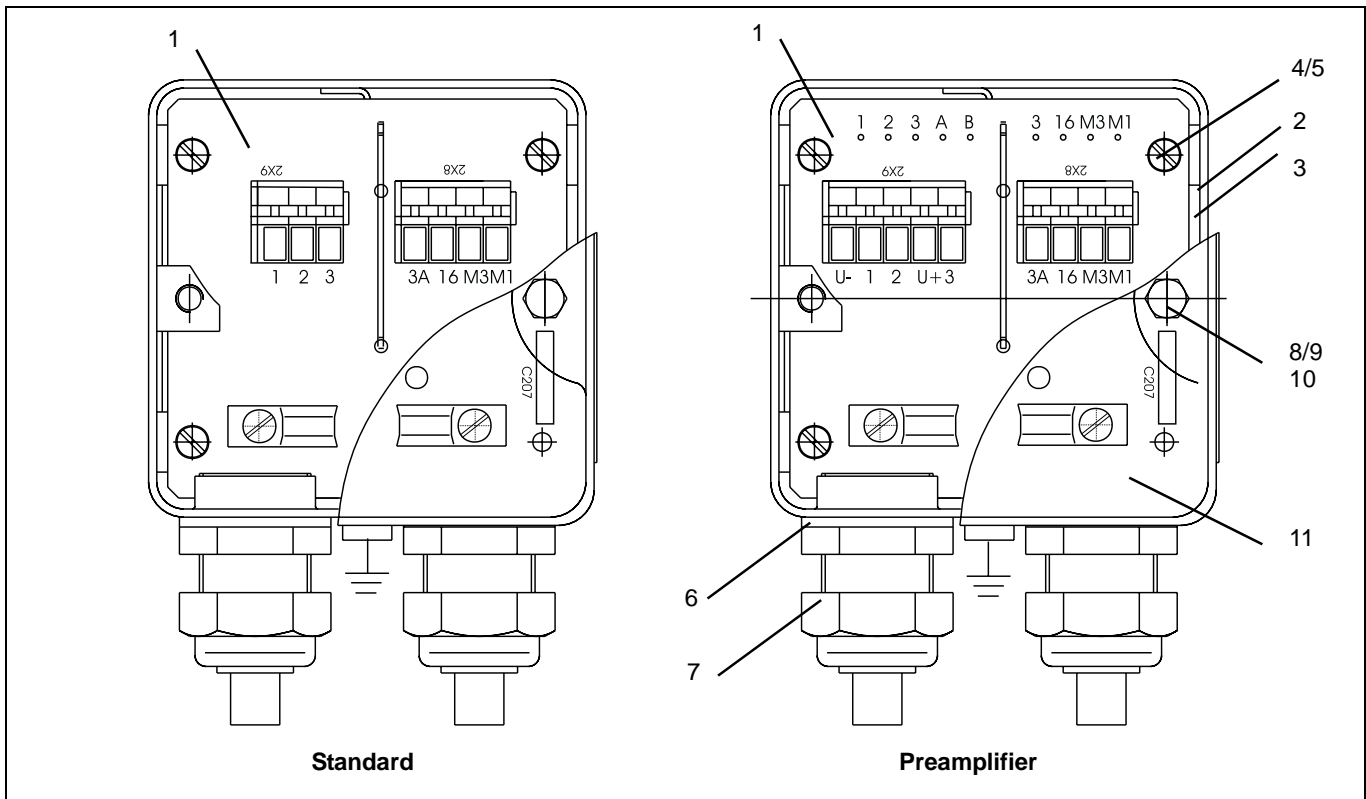


Fig. 17 Flowmeter Primary

Replaceable Parts List, Stainless Steel Connection Box

Item No.	Designation	Part No.
1	Connection board standard	D685A813U01
1	Connection board with preamplifier	D685A614U01
2	Lower section complete, SS 304/1.4301 Series 4000	D612A128U05
2	Lower section complete, SS 304/1.4301 Series 2000	D612A128U01
3	Gasket	D333F016U01
4	Phillister head screw M3 x 6 DIN 7985	D004F106AU20
5	Serrated washer A3.2 DIN 6798	D085G017AU32
6	Cable connector gasket PE Pg 13.5	D150Z007U06
7	Cable connector Pg 13.5 plastic gray (6 - 12mm)	D150A008U02
8	Hex head screw M4 x 14 DIN 7964 Stn Stl	D024G110AU20
9	Washer "Nyltite-Siegel" F.M4	D115B004U01
10	Spacer	D375A018U01
11	Cover SS 304/1.4301	D612A127U01

IP 68 design upon request

3.1 Replaceable Parts List, Connection Box Model 10DX3121/3122

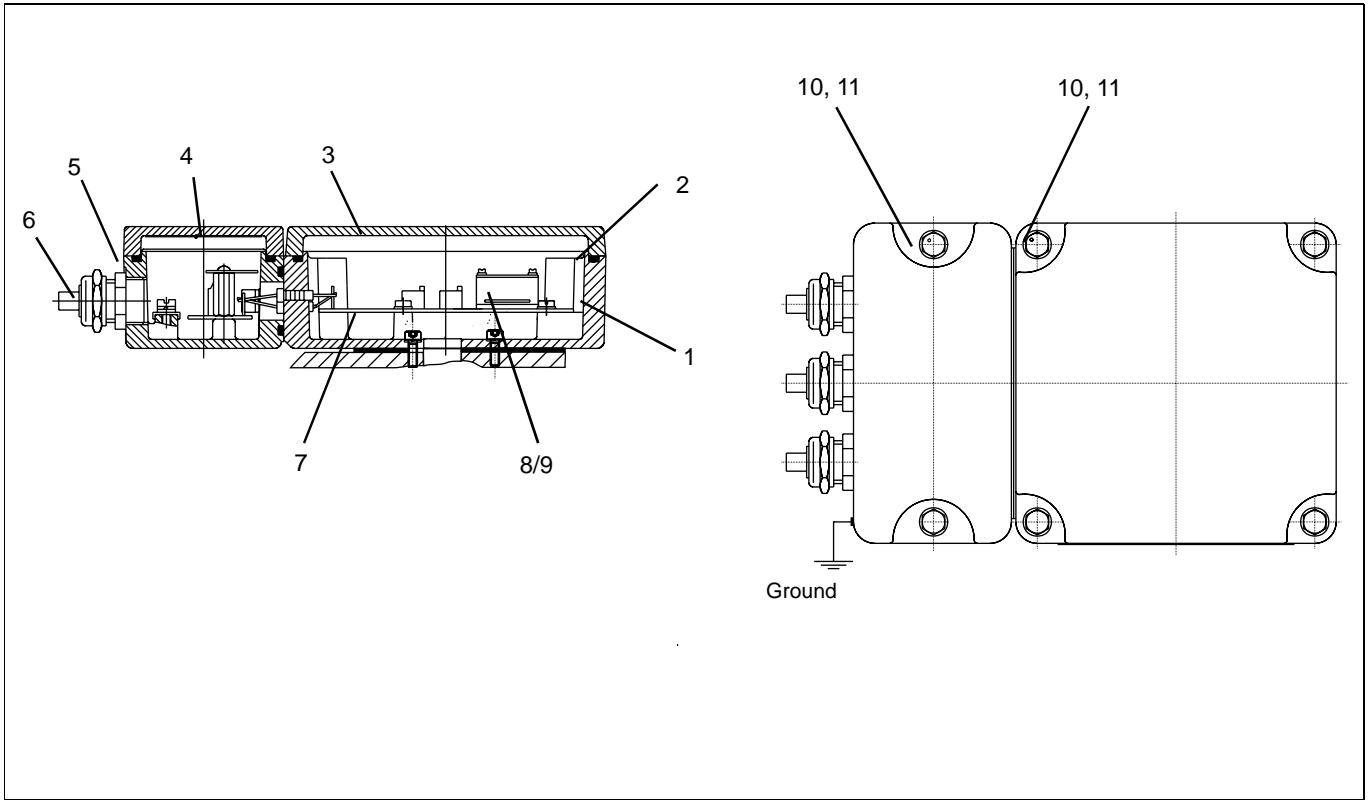


Fig. 18 Connection and Electronic Area

Replaceable Parts

Item No.	Designation	Part No.
1	Lower section with connection box	D612A111U01
2	O-Ring	D101A009U01
3	Cover, large	D612A182U01
4	Cover, small	D379D024U02
5	Gasket	D333F004U01
6	Cable connector M20 x 1.5	D150A008U15
7	Preamplifier board	D685A442U02
8	Preamplifier input	D685A859U03
9	Cover	D379B037U01
10	Hex head screw M6 x 16 DIN 33 Stn Stl	D022J112AU20
11	Spring washer DIN 137 Stn Stl	D085D026AU20

Electromagnetic Flowmeter

3.2 Replaceable Parts List, Connection Box, Aluminum ≤ 12":DN 300

Replaceable Parts List, Connection Box, Aluminum

Item No.	Designation	Part No.
1	Connection board, standard 3/4" - 12" : DN 20 - 300	D685 A861U01
1.1	Connection board, preamplifier 3/4" - 12" : DN 20 - 300	D685 A860U03
2	Sheet metal screw 2.9 x 6.5 DIN 7981	D055E106CZ01
2.1	Serrated washer A 3.2 DIN 6798	D085G017AU32
3	Slotted cheese head screw M \S x 8 DIN 84	D002F107AU20
4	Lower section with cable connector M20 x 1.5	D612A153U01
4.1	Lower section with cable connector Pg 13.5	D612A153U02
4.2	Lower section with cable connector, hose Pg 13.5 and IP 68	D612A153U018
5	Cover complete.	D612A152U01
6	Cap screw, hex socket head M 4 x 18 DIN 912	D009G113AU20
6.1	Flat washer B 4.3 DIN 125	D085A021BU20
6.2	Security ring	D160A001U25
7	Cover gasket	D333F022U01
8	Ground accessories	D614L607U01
9	Cable connector M20 x 1.5	D150A008U15
9.1	Cable connector Pg 13.5	D150A008U02
9.2	Cable connector, hose Pg 13.5 and IP 68	D150A006U02
9.2.1	Hose nipple IP 68 Stn Stl	D365A027U01
9.2.2	Screw hose clamp SGL 12 - 20 Stn Stl	1D108D1016
9.2.3	PE - hose 5/8" 16 x 13 mm, black UV-resistant	D109A001U07
9.2.4	Hose nipple IP 68 Stn Stl for the Pg at the end of the cable	D365A020U01

4. Safety Relevant Section of the Instruction Bulletin

4.1 Grounding

The grounding procedure described is to be observed. According to VDE 0100, Part 540 a Cu-wire with a cross section of at least 4 mm² is to be connected between the ground screw on the flowmeter primary (on the flange and the connection box, only on the connection box for flowmeter designs in which there is metallic contact to the fluid) and ground. For measurement reasons the ground potential should be identical to the pipeline potential if possible. An additional ground connection at the terminals is not required.

When installed in plastic or lined insulating pipelines the connections to ground are made from a grounding plate or grounding electrode. Grounding electrodes are used in sizes 6" : DN 150 and up with hard and soft rubber liners. When there are stray potentials in the fluid the installation of a grounding plate on both sides of the flowmeter primary is recommended.

Three grounding procedures are described below. In cases a) and b) the fluid is in electrical contact with the pipeline.

Note:

- The ground screw for Models 10DX2112 is located on the lower section of the connection box, see Dimensions in the Specification Sheet. For instrument designs with aseptic connectors, Tri-Clamp and hose connectors the meter tube is in electrical contact with the fluid. It is only necessary to connect the ground connection on the flowmeter primary to ground, see Fig. 20 and Fig. 21.

a) Metal pipe with fixed flanges

- 1) Drill blind holes in the flanges on the pipeline (18 mm deep).
- 2) Thread holes, (M6, 12 mm deep).
- 3) Attach the ground strap to the flange using a screw (M6), spring washer and flat washer and connect to the ground connection on the flowmeter primary.
- 4) Connect a 4 mm² CU wire between the ground connection on the flowmeter primary and the potential equalization (PA).

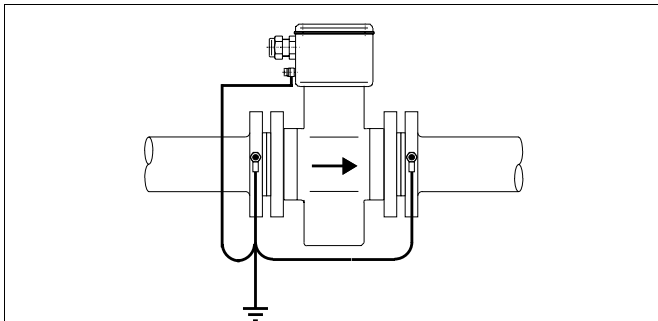


Fig. 19 Flowmeter Primary 1/10" – 1-1/2" : DN 3 – 40, Screwed Flanges

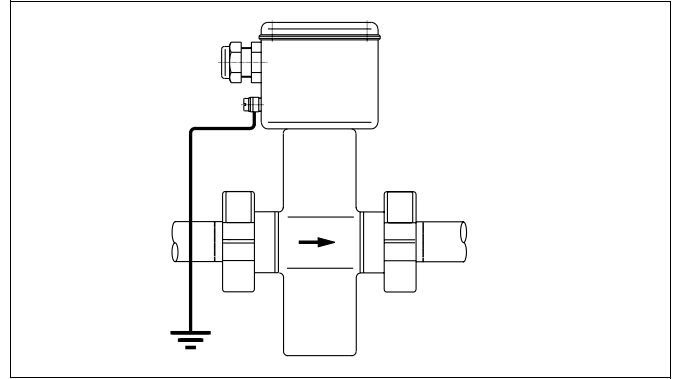


Fig. 20 Flowmeter Primary 1/10" - 4 : DN 3 - 100, Aseptic Connections

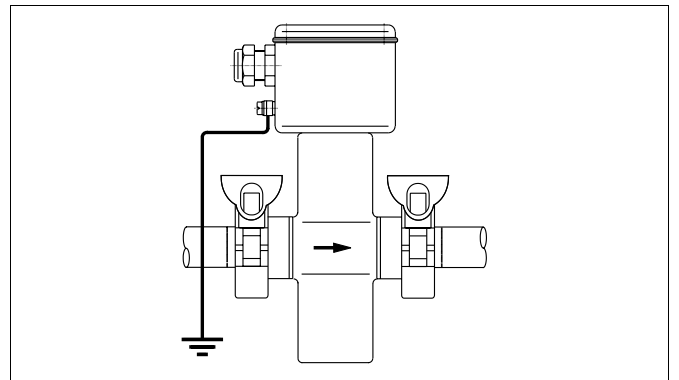


Fig. 21 Flowmeter Primary 1/10" – 2-1/2" : DN 3 – 65, Tri-Clamp Connections

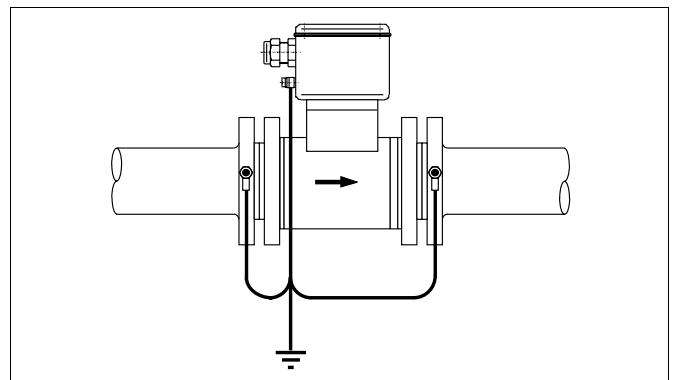


Fig. 22 Flowmeter Primary 2" – 4" : DN 50 – 100, Wafer Design

Electromagnetic Flowmeter

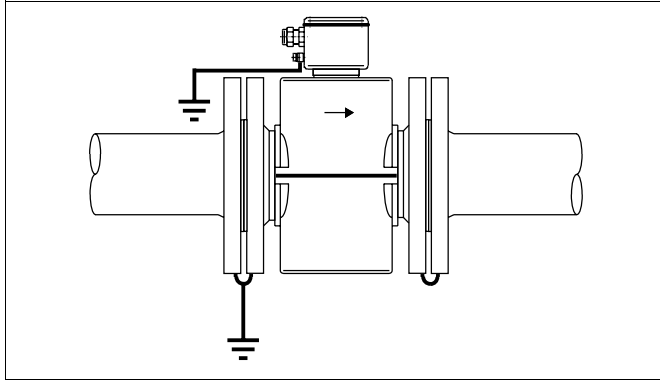


Fig. 23 Flowmeter Primary 3/8" – 12" : DN 10 – 300, Two Piece Housing and Flanges

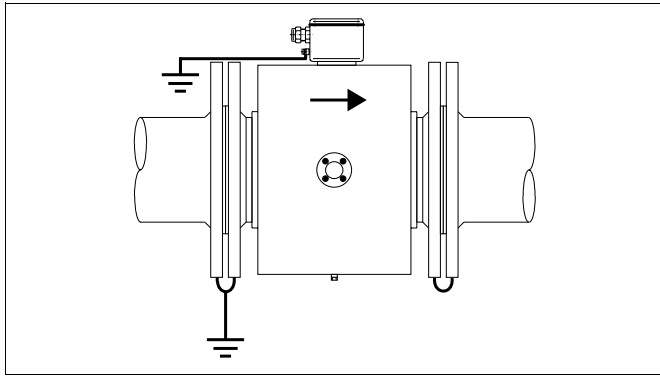


Fig. 24 Flowmeter Primary from 14" : DN 350 and up, Welded Steel Construction

b) Metal Pipe with Loose Flanges

- 1) In order to assure a trouble free ground connection to the fluid and the flowmeter primary in a pipeline with loose flanges, M6 threaded studs should be welded to the pipeline.
- 2) Attach the ground strap to the flange using a nut, spring washer and flat washer and connect to the ground connection on the flowmeter primary.
- 3) Connect a 4.0 mm² CU wire between the ground connection on the flowmeter primary and the potential equalization (PA).

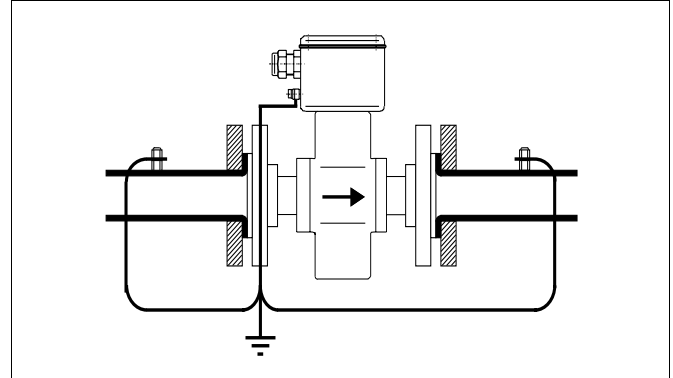


Fig. 25 Flowmeter Primary 1/10" – 1-1/2" : DN 3 – 40, Screwed Flanges

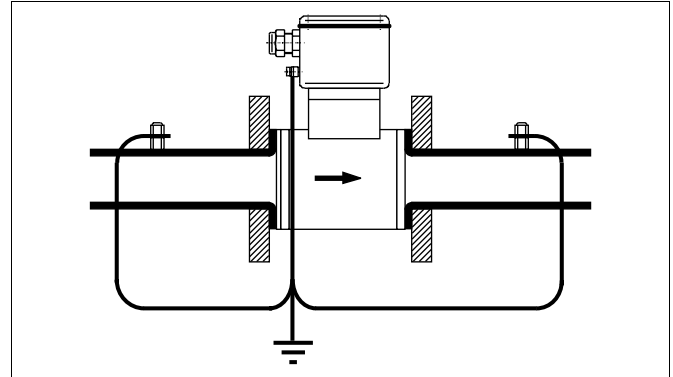


Fig. 26 Flowmeter Primary 2" – 4" : DN 50 – 100, Wafer Design

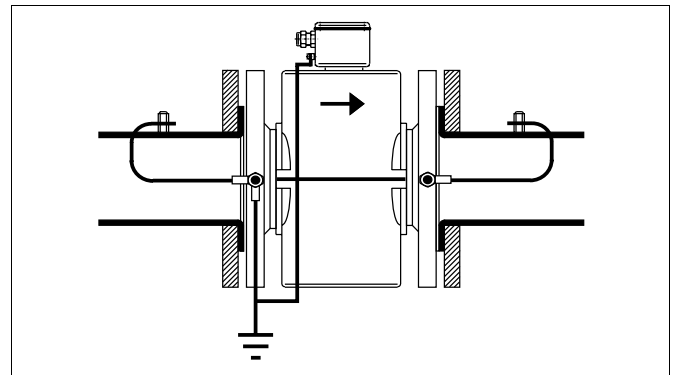


Fig. 27 Flowmeter Primary 3/8" – 12" : DN 10 – 300, Two Piece Housing and Flanges

c) Plastic, Concrete or Pipelines with Insulating Liners

- 1) Install EMF in pipeline with a grounding plate.
- 2) Connect the connection tab on the grounding plate to the ground connection on the flowmeter primary with the ground strap.
- 3) Connect a 4.0 mm² CU wire between the ground connection on the flowmeter primary and a good ground.

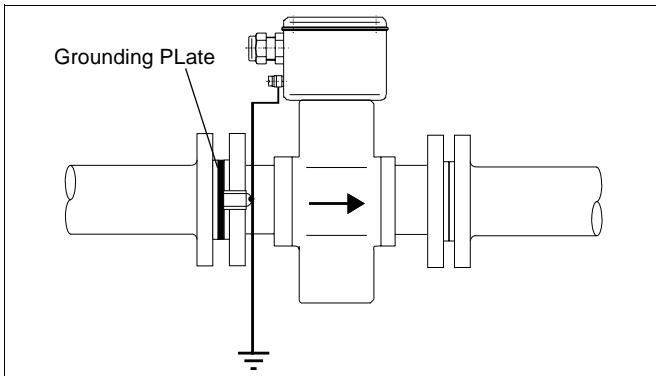


Fig. 28 Flowmeter Primary 1/10" – 1-1/2" :DN 3 – 40,
Screwed Flange

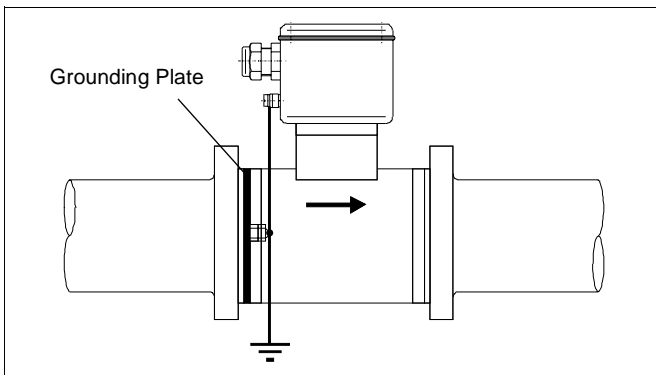


Fig. 29 Flowmeter Primary 2" – 4" : DN 50 – 100,
Wafer Design

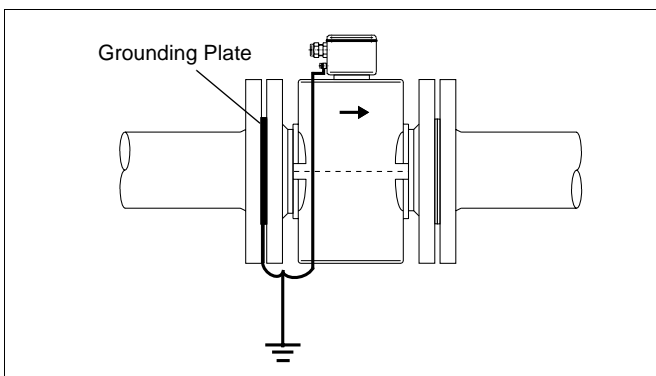


Fig. 30 Flowmeter Primary 3/8" – 12" : DN 10 – 300,
Two Piece Housing and Flanges

Electromagnetic Flowmeter

4.1.1 Installation and Grounding in Pipelines with Cathodic Corrosion Protection (CCP)

The installation of electromagnetic flowmeters in pipelines with cathodic protection must take into account the specific system conditions. In these installations the following factors are critical:

- a) Is pipeline interior electrically conductive or insulating?
 - b) Is the pipeline extensively and universally at CCS potential or is it a mixed system with regions at CCP potential and some at PE potential.
- For pipelines with interior insulating liners and without stray currents, the EMF should be installed with grounding plates up- and downstream of the flowmeter which are insulated from the pipeline in order to provide a shunt path for the CCP potential. The grounding plates up- and downstream of the EMF are at the ground potential (Fig. 32/Fig. 33).
 - For pipelines with interior insulating liners in which stray currents are expected (e.g. long pipeline runs in close proximity to supply power equipment) a section of uninsulated pipe 1/4D long should be installed up- and downstream of the flowmeter primary in order to shunt the stray currents (Fig. 33).

4.1.1.1 Interior Insulated Pipelines with Cathodic Corrosion Protection Potentials

Bolt View

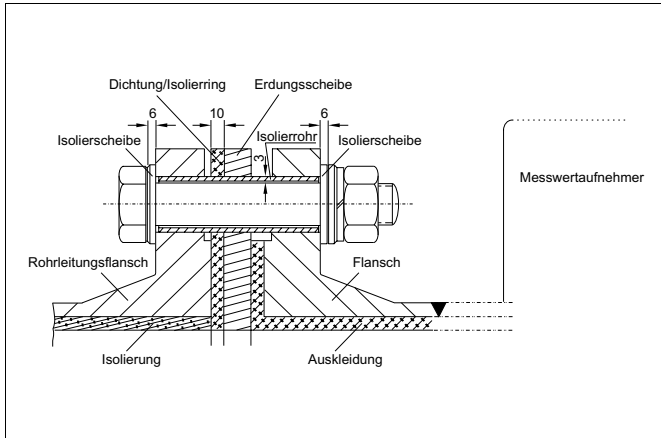


Fig. 31 Bolts

Grounding plates are to be installed up- and downstream of the flowmeter primary. They must be insulated from the flanges and connected to ground together with the flowmeter primary. The flange bolts are to be installed **insulated**. Insulation plates and insulating sleeves are not included with the shipment, they are to be provided by the user. The CCP potential must be shunted around the insulated flowmeter primary using a shunt.

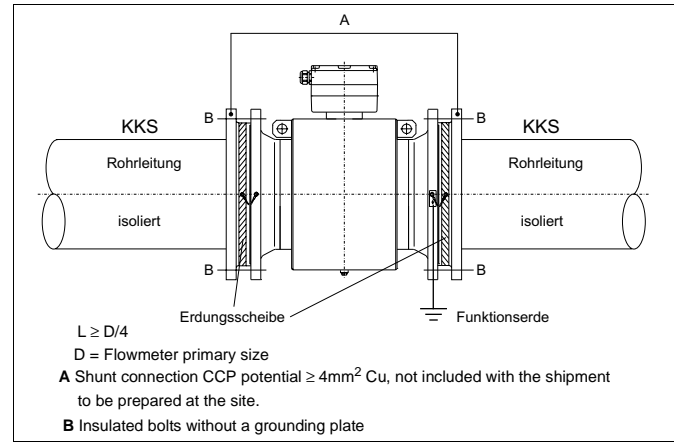


Fig. 32 Flowmeter Primary with Grounding Plates and Ground

4.1.1.2 Mixed System, Pipeline at both CCP and Ground Potentials

In a mixed system, the insulated pipeline is at the CCP potential and the unlined metal pipe sections ($L = \frac{1}{4} \times$ flowmeter primary size) up- and downstream of the flowmeter primary at ground potential.

Fig. 33 shows the preferred installation for systems with cathodic corrosion protection.

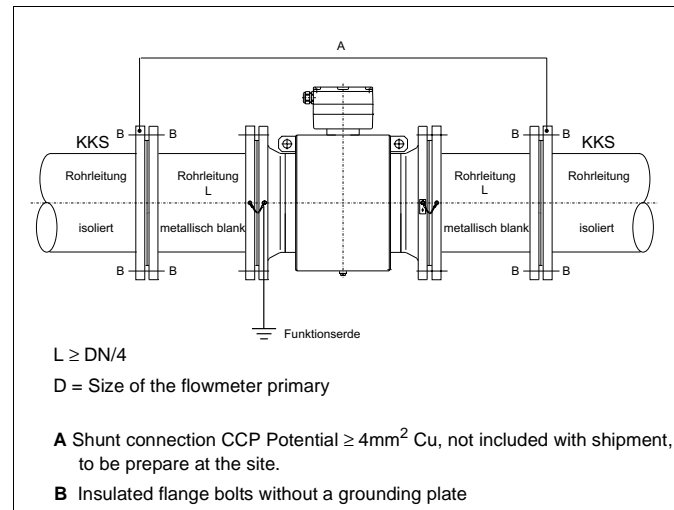


Fig. 33 Flowmeter Primary with Ground

4.1.2 Supply Power Connections

The supply power is connected in accord with the specifications on the Instrument Tag to terminals L (phase) and N (Neutral), L+ and L-, or 1L1 and 1L2 at the flowmeter converter over a main fuse and a main switch.

The Electromagnetic Flowmeter Primary is connected to the converter using the signal/reference voltage and the magnet supply cables. For detailed interconnection cabling information see the appropriate Instruction Bulletin for the converter.

4.1.2.1 Supply and Signal Cable Connections

The magnet coils in the flowmeter primary are supplied from the remote mounted converter at terminals M1/M3 (supply cable e.g. shielded 2 x 1.5 mm²). The signal/reference voltage cable is connected to terminals 1, 2, 3, 3a, 16 and SE at the flowmeter primary. The terminal designations are described in Fig. 37. The shield 3 is connected to common of the flowmeter primary, which in turn is connected to ground or PA.

Note:

- The shields of the signal leads may not contact each other or the outer shield (signal short circuit).

In older flowmeter primaries the flow signal lead shields were connected to 1S and 2S.

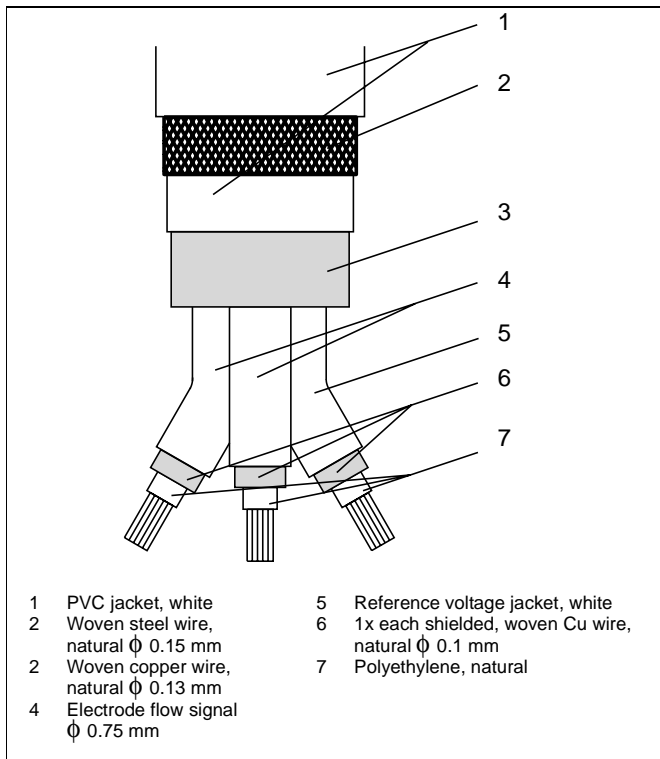


Fig. 34 Signal Cable Construction D173D018U02

4.1.2.2 Signal Cable Construction

The signal cable conducts signals of only a few millivolts and should therefore be routed in the shortest manner. The cables should not be routed in the vicinity of large electrical machinery or switch gear equipment which could induce stray fields, pulses and voltages. The signal cable should not be fed through branch fittings or terminals strips.

The maximum allowable signal cable length is 50 m for designs without a preamplifier, Ex-Instruments and certified Volume Flow Integrators. If a preamplifier is installed in the flowmeter primary for low conductivity metering, the maximum signal cable length limit is increased to 200m. A shielded excitation cable is located parallel to the signal leads in the cable assembly so that only two cables (signal/reference voltage cable and supply cable for the magnet coils) are required between the flowmeter primary and the converter. The signal cable is designed with an individual copper shield (common potential) which surrounds the individually shielded signal leads and for the shielded reference voltage lead. The signal lead shields serve as "Driven Shields" for the flow signal transmission.

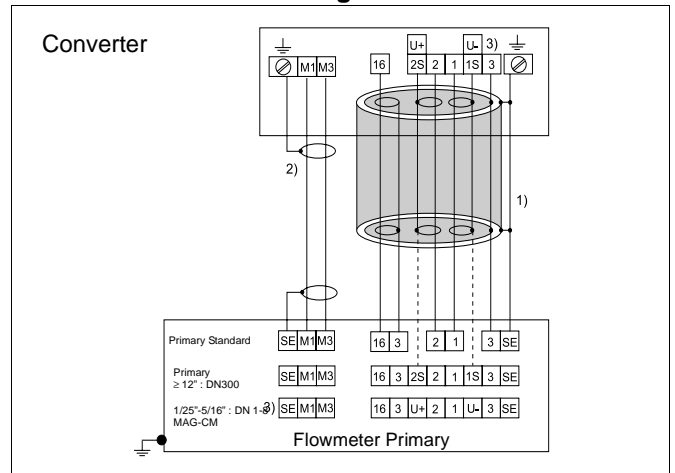
To shield against magnetic pickup the cable incorporates an outer steel shield which is to be connected to the SE Terminals.

Note:

- If plant conditions make it impossible to avoid proximity to electrical machinery or switch gear equipment, it is advisable to route the signal/excitation cable in metallic conduits.

The preamplifiers in the flowmeter primaries which include this option are supplied with a DC voltage at terminals U- and U+.

4.1.3 Interconnection Diagram



- Shielded signal cable
Part No. D173D018U02
- Magnet excitation current cable e.g. shielded 2 x 1.5 mm², terminals M1, M3
- Voltage supply for preamplifier
Standard for 1/25"-5/16": DN1 - 8 and MAG-CM, optional for $\geq 3/8''$: DN 10

Electromagnetic Flowmeter

4.1.4 Connection Area

The signal cable leads should be routed in the shortest manner to the connection terminals. Loops are to be avoided, (see Fig. 37 and Fig. 38).

Connection Box with Screwless Spring Loaded Terminals

Operation: Lead (2), with the insulation stripped, can be inserted into the terminal when spring (1) is depressed. Then release the pressure (3) on the spring (Fig. 35).

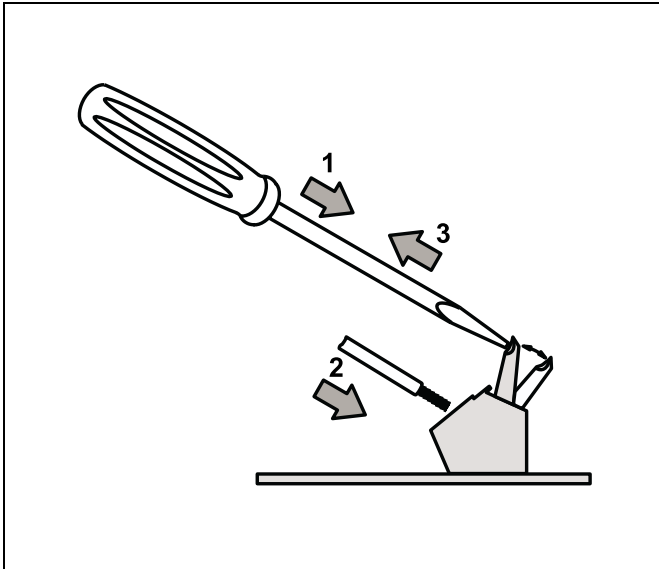


Fig. 35 Cable Insertion in the Screwless Spring Loaded Terminals

When installing and screwing the cover care should be exercised. Check that the gasket is properly seated. Only then will Protection Class IP 67 be assured.

Note:

- When installing the signal/excitation cable to the flowmeter primary a water trap should be provided, (Fig. 36).

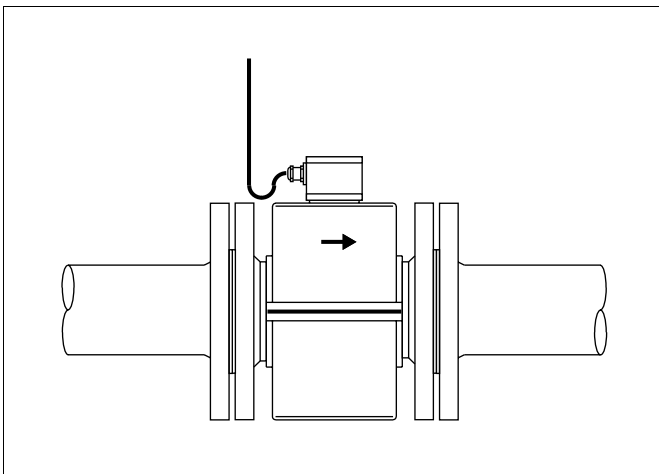


Fig. 36 Cable Routing

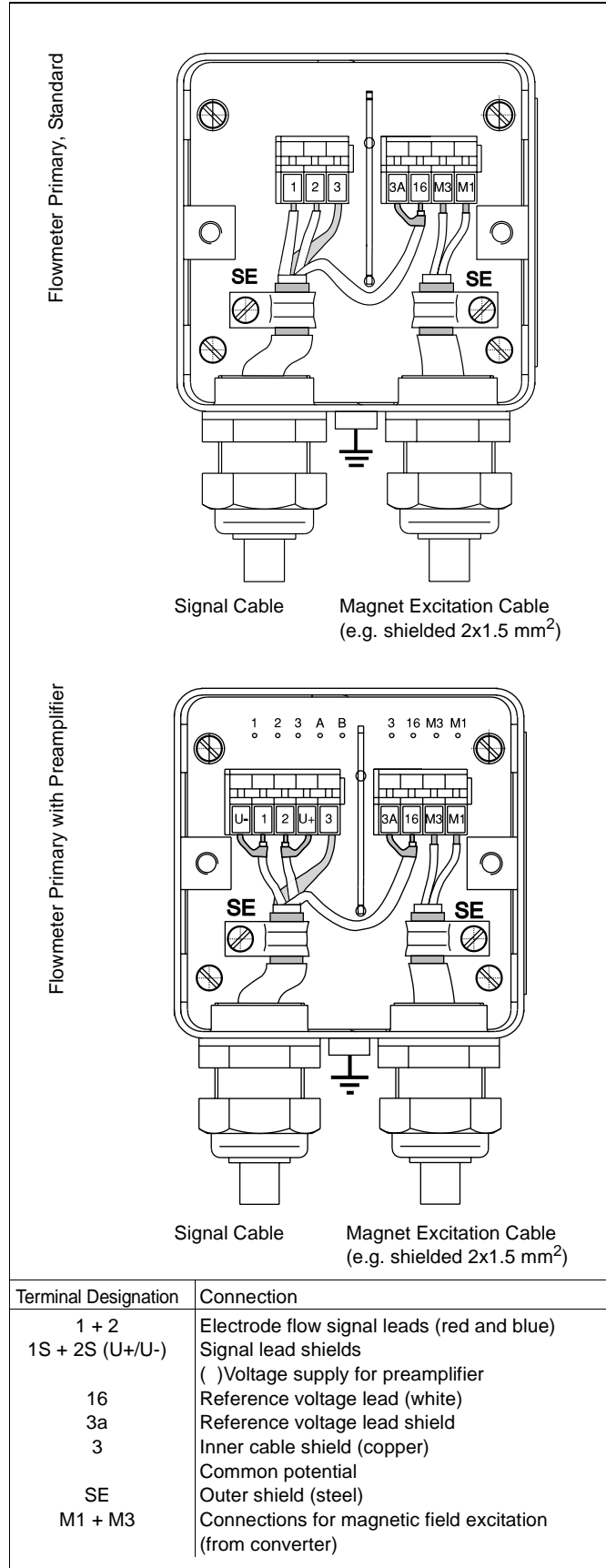


Fig. 37 Connection Area for Flowmeter Primaries $\leq 12''$:DN 300

Electromagnetic Flowmeter

Connection Box Flowmeter Primary and Ex-Connection Box

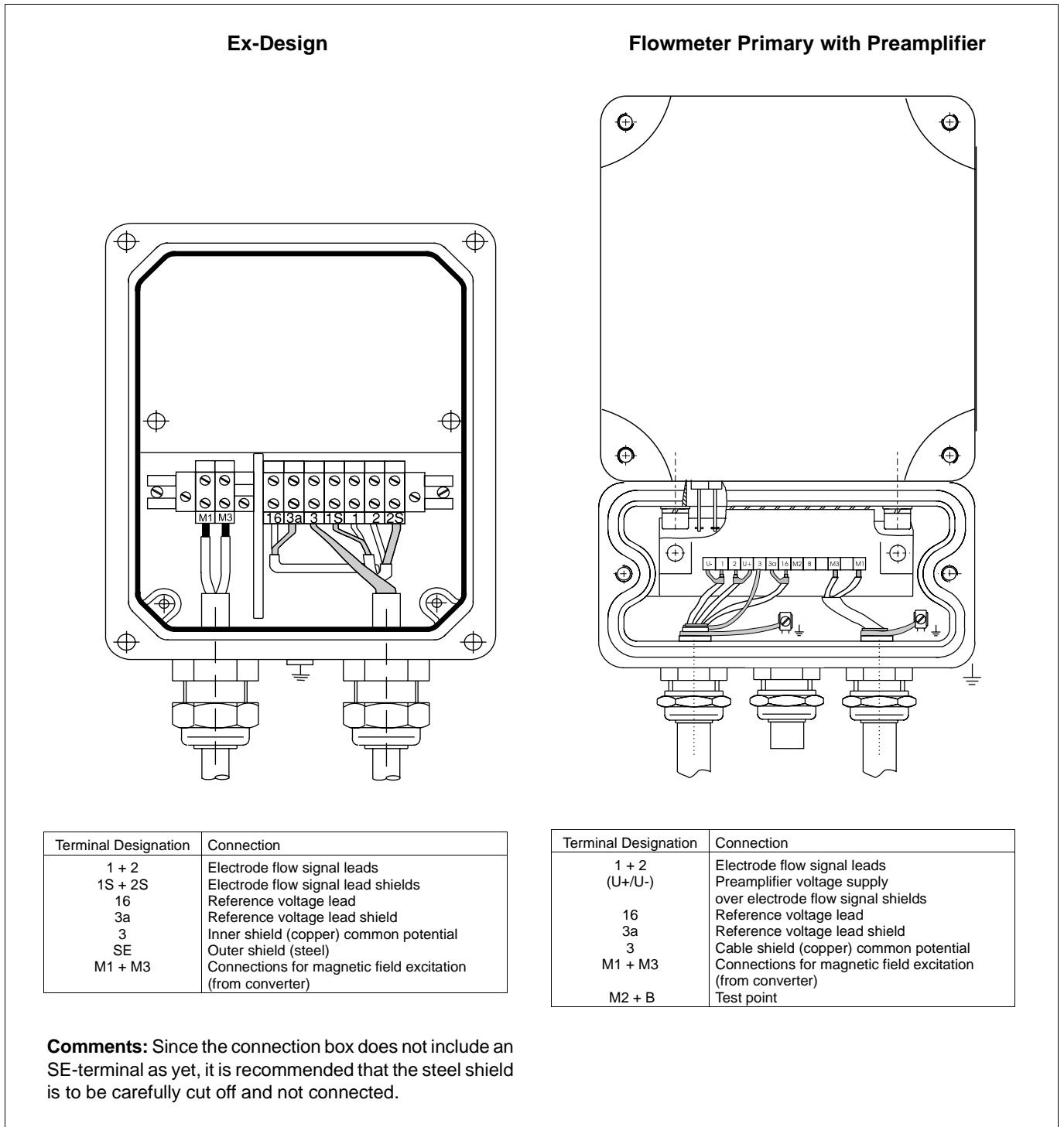


Fig. 38 Connection Box Flowmeter Primaries Ex 1/10" – 78" : DN 3 – DN 2000 and MAG-CM

Electromagnetic Flowmeter

5. Start-Up

The start-up procedure of the EMF system follows after the installation of the flowmeter primary and converter have been completed. A preliminary check of the flowmeter primary should be made. Checking of the flowmeter primary with the converter is described in Section 6.

5.1 Preliminary Checks, Flowmeter Primary

Check to assure that

- the flow direction of the fluid agrees with the direction indicators in the display.
- the installation requirements in Sect. 2.2 have been considered.
- the cable connections agree with the Interconnection diagram.
- the ambient conditions do not exceed the specified limits.

Turn on the power.

- Check that the parameter settings correspond to the operating conditions.
- Check the system zero. See description in the Instruction Bulletin for the converter.

General Note:

- If the flow direction indicators in the display do not agree with the actual flow directions it may be because the signal lead connections were interchanged. Interchange the connections 1 with 2 and 1S with 2S at the flowmeter primary.

For the designs with a preamplifier only connections 1 and 2 should be interchanged.

The coordination between the flow direction and the direction indicators in the display can also be changed in the parameter "Flow Direction" by selecting "Normal or Inverse".

5.2 Maintenance

The flowmeter primary is essentially maintenance free. The ambient conditions (air circulation, humidity), seal integrity of the process connections, cable connectors and cover screws, functional reliability of the supply voltage, lightning protection and the grounds should be checked annually. The electrodes should be cleaned if the flow indicated by the converter changes even though the flowrate has not. Higher flow indications are due to insulating coatings while decreases in the indications are due to conductive coatings.

Note:

- Repairs or maintenance tasks should only be performed by qualified personnel.

See the note (Hazardous Material Information), if the flowmeter primary is to be returned to the ABB Factory in Göttingen, Germany!

6. Testing and Error Search for the Flowmeter Primary Using the Converter



Warning

When the housing cover is removed the EMC and Personnel Contact protection is voided.

Connections agree with the Interconnection Diagram? Was the total measurement system checked?

no

Check the complete measurement system. See the Instruction Bulletin for the converter under "Error Search".

yes

Connect an oscilloscope from 16 to 3. Is a pulsing DC voltage of approx. $70\text{mV}_{\text{rms}} \pm 10\%$ observed? Using a digital voltmeter on the DC range across terminals 16 and 3s and with the converter switched to continuous positive excitation is the reading approx. $70\text{mV}_{\text{dc}} \pm 10\%$? Check if the voltage supply for the magnet coils at terminals M1/M3. Is the measured DC voltage $< 40\text{ V DC}$?

no

Check signal cable. Check converter with primary simulator. Check the converter, see the Instruction Bulletin for the converter and the primary simulator.

yes

Measure the electrode resistance with an ac bridge under a full pipe condition (does not apply to MAG-CM and flowmeter primaries with preamplifiers). Are the measured values from electrode 1 to 3 and from electrode 2 to 3 the same $\pm 5\%$? Remove the signal cable at the flowmeter primary. (Turn off supply power).

no

Electrodes are contaminated, conduct a CIP-Cleaning or clean with normal cleaning fluids and water. Electrodes leak. Flowmeter primary must be returned to the factory for repair.

yes

Flowmeter primary operational.



Warning

For flowmeter primaries in the Ex-Design the housing may not be opened and no external voltages (e.g. measurement instruments with test voltages) may be applied to terminals 1 and 2 in order to prevent damage to the integrated barriers.



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