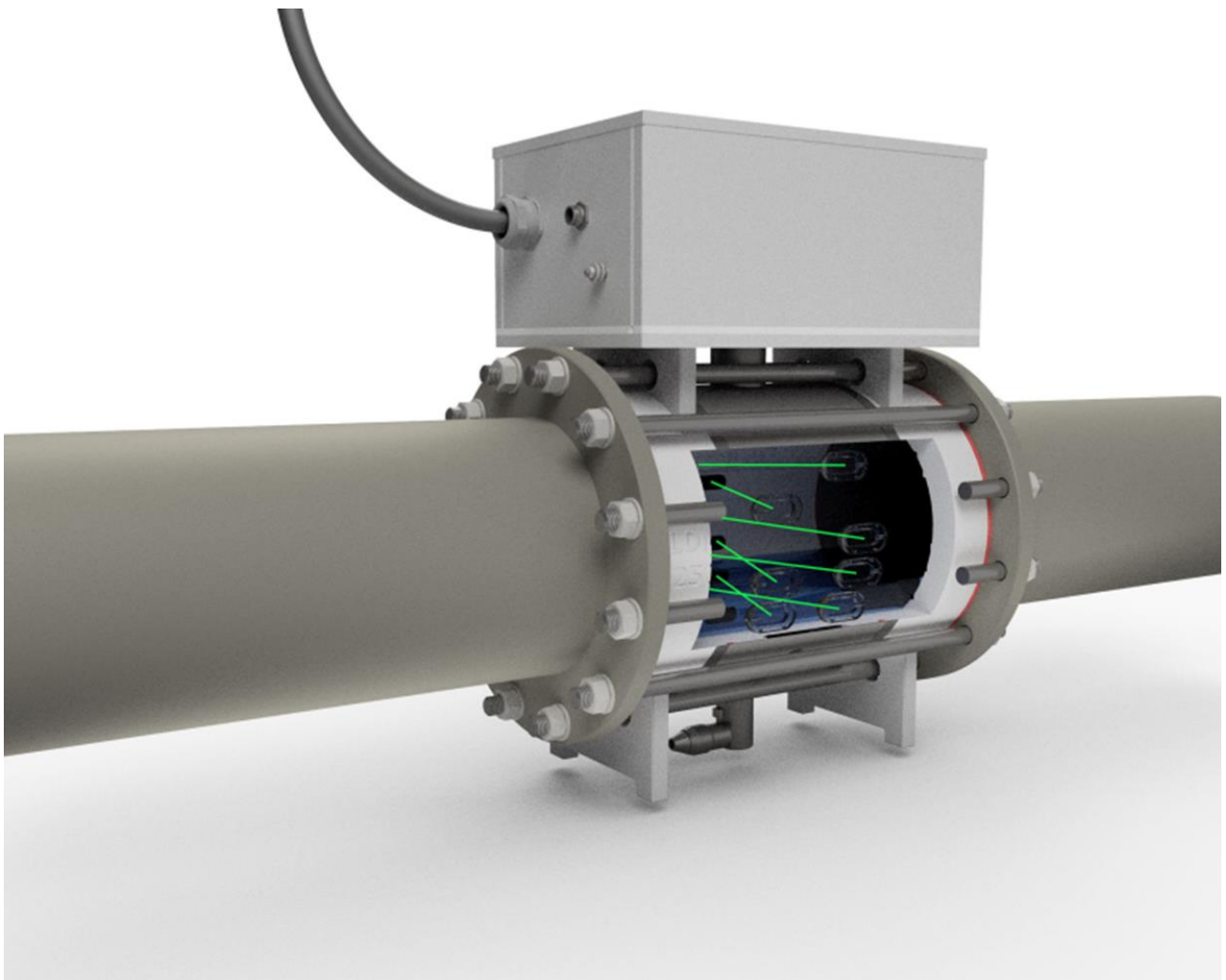


Technical information

Partially filled LDM (transit time difference - flow measurement)

Intermediate flange flowmeter for partially filled pipelines according to the ultrasonic transit time difference measuring method for water and wastewater applications



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List of changes

Date	Version	Description	Author
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1 Introduction



Attention

This technical information is no substitute for the operating instructions. In particular, the warning and safety instructions required in accordance with DIN EN 82079-1 (preparation of information for use (instructions for use) of products), which are necessary for installation, maintenance and troubleshooting on site, are missing.

This technical information is an abridged version of the operating instructions for the partially filled LDM and the transmitter. Contact STEBATEC if you wish to obtain the detailed operating instructions, which contain the necessary warnings and safety instructions as well as further information.

2 Product features

2.1 Short description

The LDM is a calibrated meter for backwater-free flow measurement of wastewater in open channel or gravity pipes. It has ten integrated, redundantly arranged and bidirectionally functioning ultrasonic transit time differential measuring sections and provides accurate flow measurements in partially or fully filled pipes. The system is suitable for water, wastewater and raw sewage and measures reliably even at the smallest levels. The level measurement is integrated in the device housing. The system is manufactured without flanges and is clamped between two pipes with bolts or threaded rods.

The LDM has the following features:

- Can be used in partially filled pipes in the water and wastewater industry
- can be supplied for nominal diameters of the measuring pipe of the LDM from DN 150 to DN 1200
- Has a high resistance to abrasion and chemicals
- Measures from 26.1mm filling height for a nominal width of DN 150
- does not need to be calibrated on site, as this is done at the factory

The LDM can be used for flow measurement of the following liquids:

- Water
- Rainwater
- Wastewater
- Raw sewage
- Biologically and chemically contaminated wastewater

2.2 Areas of application

The need for source-based cost accounting is also increasing in the wastewater sector. In view of increasing demands on precise measuring and control systems, the STEBATEC measuring system of stationary, partially filled flow measurement offers significant advantages in:

- Quantity recording in municipal wastewater associations
- Wastewater discharge control for industrial plants
- Measuring drainage water
- Mining and process water measurements in mining and tunnel construction
- Cost accounting measurement
- Measurement of extraneous water
- Rainwater measurement

2.3 Structure

The illustration below shows an example of an assembled LDM together with the transmitter.

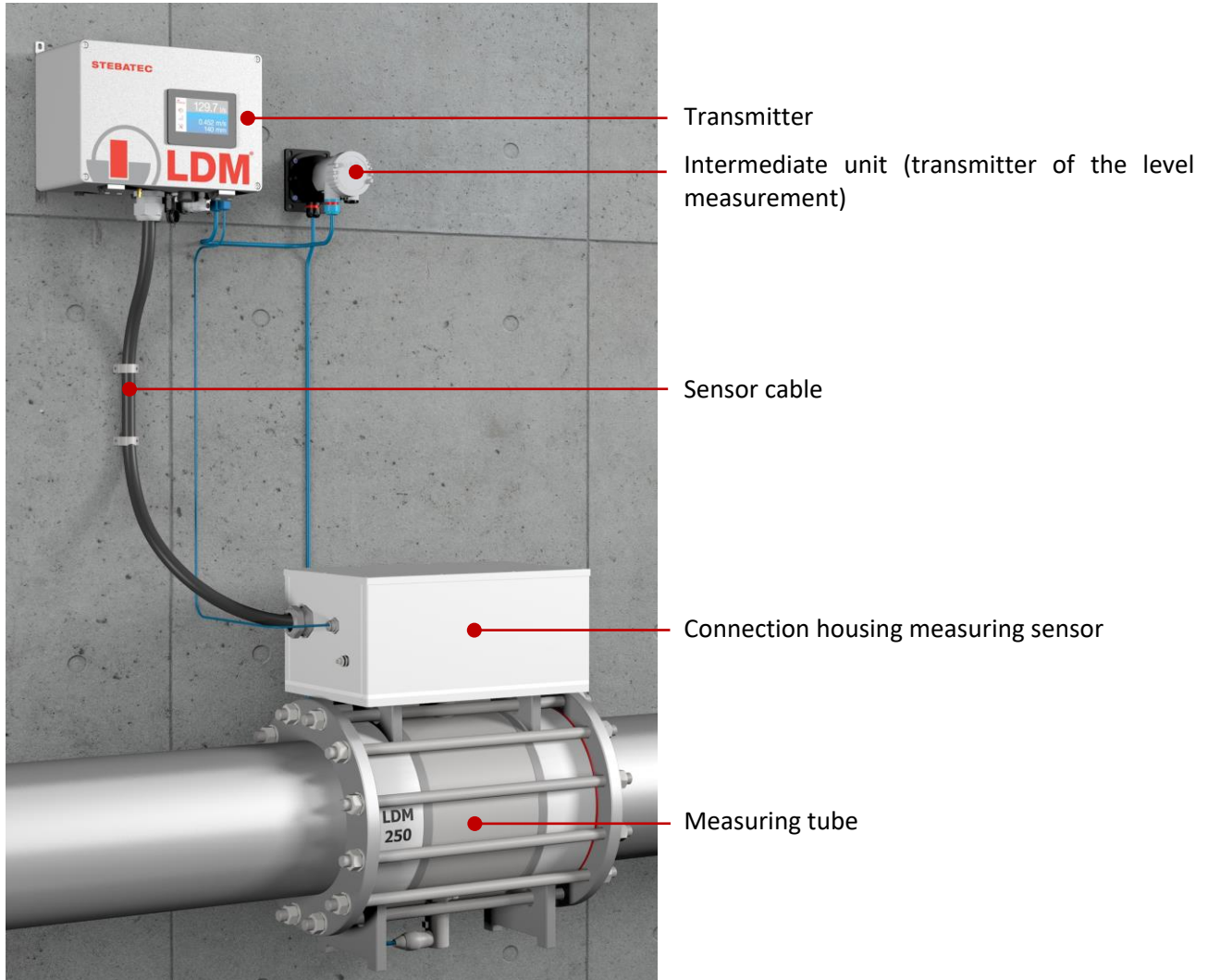


Figure 1: Mounted LDM with transmitter

The transmitter is documented in a separate operating manual. The following illustrations show the basic structure of the LDM:

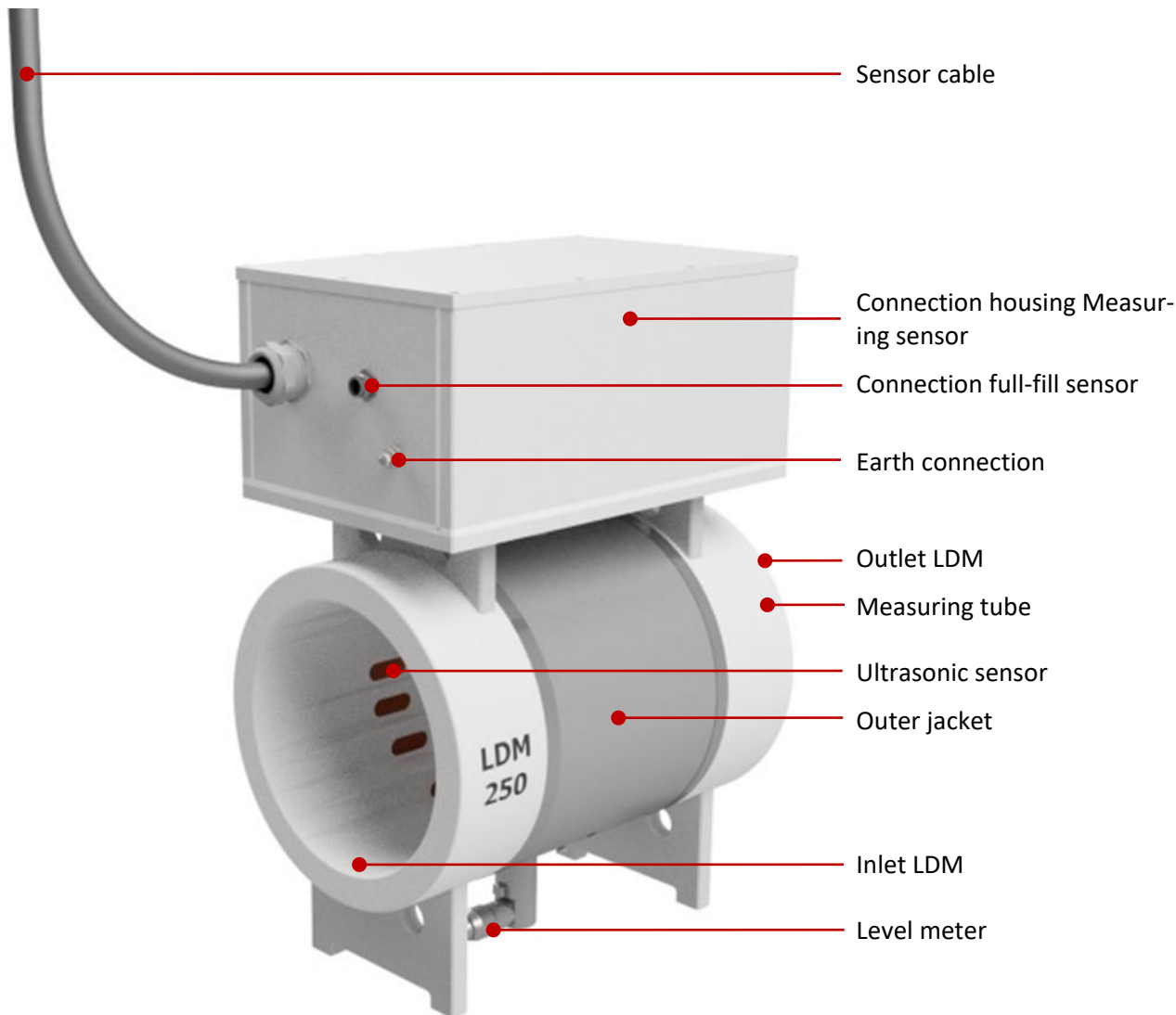


Figure 2: LDM basic design (without full-fill sensor)

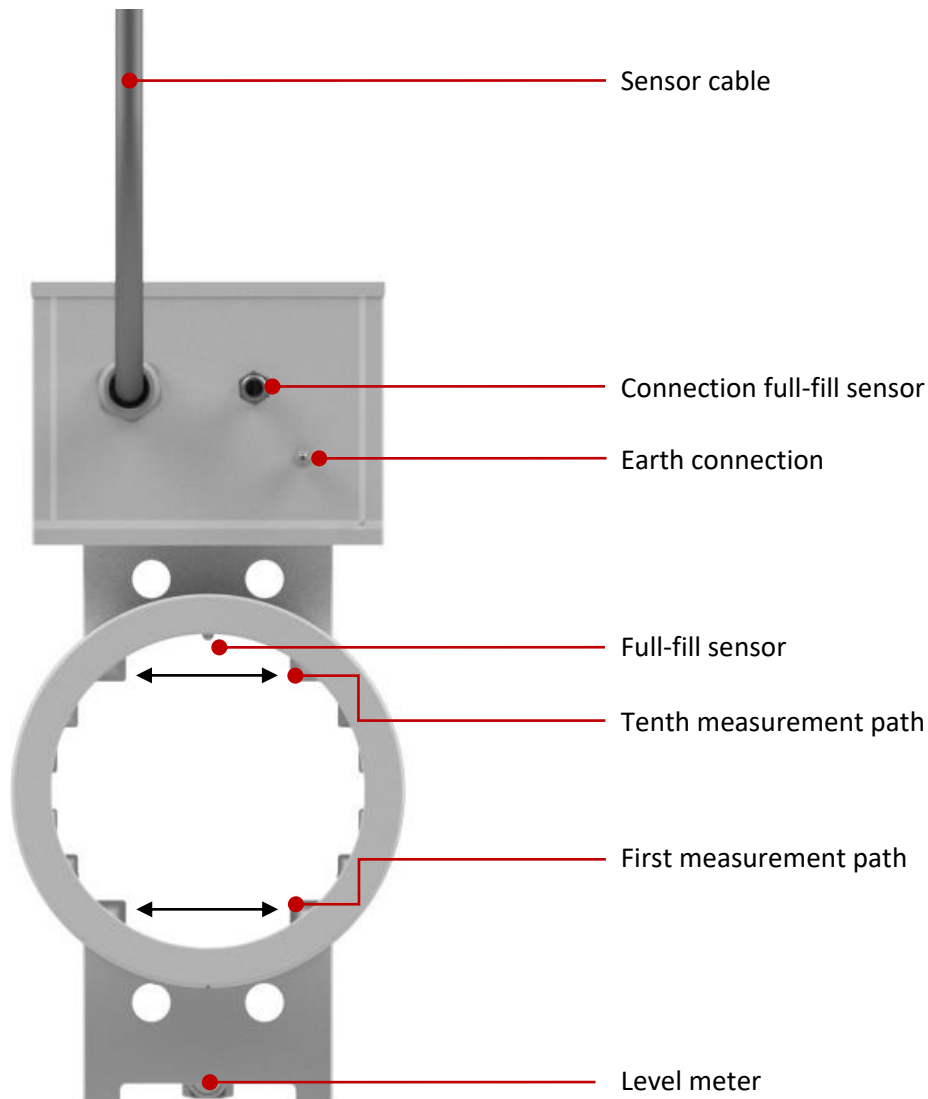


Figure 3: Principle of LDM design with full-fill sensor

2.4 Properties

The partially filled LDM consists of an intermediate flange for a transducer with the following characteristics:

- Robust construction
- IP 66 (IP 67 in preparation)
- ATEX Zone 1
- Power supply 24 VDC

2.5 Device variants

The LDM has the following unit variants, whereby the individual features can be combined:

- Various nominal diameters
- As a component of a PNA (STEBATEC pneumatic discharge control) or as a measuring point without connection to a PNA

3 Scope of delivery

Included in the scope of delivery:

- Transducer with integrated level measurement
- Transmitter level measurement
- Sensor cable Ultrasonic sensors
 - Diameter 22.5mm
 - Length project-specific (maximum 25m)
- Sensor cable Level measurement (using a pressure probe)
 - Diameter 8mm
 - Length of sensor cable from pressure probe to transmitter 7.5m
 - Length of sensor cable from transducer of pressure probe to transducer of LDM project-specific
- Full-fill sensor
- Sensor cable Full-fill sensor
 - Diameter 4.8mm
 - Length project-specific
- Mounted transmitter

Optionally can be supplied:

- Threaded bolts for mounting the LDM together with corresponding nuts and washers
- Sealing between the measuring pipe, LDM and the flanges of the connecting pipes
- Maintenance opening for cleaning the measuring tube
- Remote transmitter panel for longer distances (>25m) between sensor and transmitter

4 Technical data transducer

Temperature	
Ambient temperature (use in ATEX zone 1)	0 ... +30°C
Ambient temperature (no use in ATEX zone 1)	-20 ... +50°C
Fluid velocity	
Measuring range	-5 ... +5m/s
Liquid pressure	
Maximum permissible pressure (PN) of the LDM	1 Bar
Geometry of the bolt circle for the connecting flange	According to PN 10 (pressure stage)
Requirements Medium	
Vented medium	There must be no turbulence or air pockets in the immediate inlet area.
Electrical conductivity	Non-conductive liquids (<50pS/m) are prohibited for reasons of explosion hazard Note: Seawater and river water are sufficiently conductive
Permissible solids content (volume)	≤ 10% For process liquid sludge and flakes: Density < 0.5kg/dm ³

Table 1: Technical data

4.1 Installation conditions

Description	Conditions
Installation	Detailed information can be found in chapter 7 "Installation".
Flow direction	Forward and backward See installation conditions, chapter 6.1.2 "Inlet and outlet side of the measuring tube".
Entry route	≥ 5 x DN with calm flow ≥ 10 x DN with turbulent flow
Outfeed section	≥ 3 x DN
Dimensions and weights	Detailed information can be found in chapter 5.1 "Dimensions and weights".

Table 2: Installation conditions

4.2 Materials

Description	Material
Measuring tube	LLDPE (Linear Low-Density Polyethylene)
Junction box inside LDM	V4A (Stainless steel)
Connection housing transmitter	Polypropylene white Seal EPDM (Ethylen-Propylen diene Rubber)
Ultrasonic sensors	PEEK (Polyetheretherketon)

Table 3: Materials

4.3 Approvals and certificates

Explosion hazard zone	
ATEX	Zone 1
IP	
IP protection class	IP 66 (IP 67 in preparation)

Table 4: Approvals and certifications

4.4 Dimensions and weights

Detailed 2D and 3D drawings are available on request. The dimensional drawing, the table of available sizes and their approximate weights are described below:

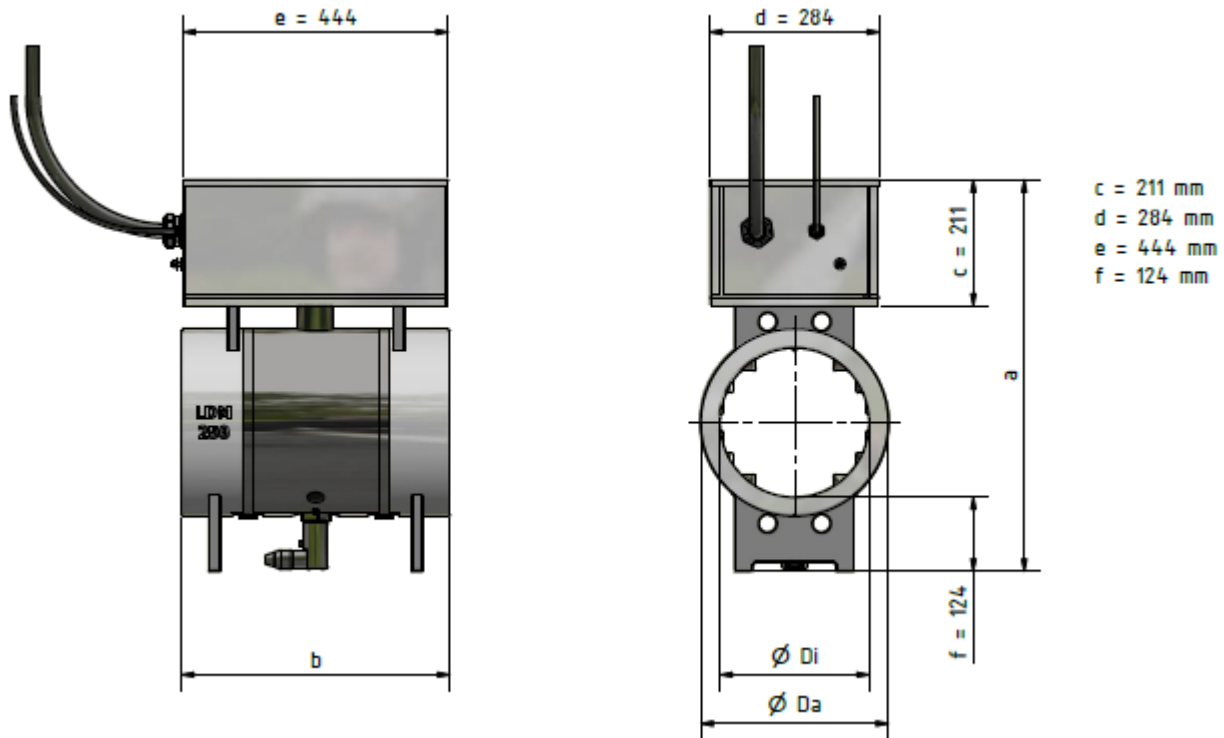


Figure 4: Dimensions

Nominal size DN	Dimensions [mm]				Approximate weight [kg]
	a	b	ØDi	ØDa	
150	553	300	150	218	23
200	603	350	200	264	28
250	653	450	250	314	33
300	703	500	300	364	40
350	753	550	350	414	47
400	803	600	400	464	55
500	906	650	500	564	69
600	1010	780	600	664	94
700	1117	910	700	766	130
800	1224	1040	800	868	174
900	1324	1170	900	970	229
1000	1430	1300	1000	1080	362
1100	1536	1380	1100	1185	473
1200	1642	1560	1200	1290	648

Table 5: Dimensions and approximate weights depending on the nominal diameter of the LDM

The geometry of the bolt circle for the connecting flange is based on the standard for PN10 (pressure rating).

4.5 Measurement accuracy

If the LDM is serviced at least once every six months, or more frequently in the case of extreme contamination, the following measuring accuracy of the LDM can be assumed:

4.5.1 Measuring accuracy of the LDM with full and partial filling

If the flow velocity of the liquid is greater than or equal to 0.01m/s, the measurement uncertainty of the measured flow is a maximum of 2% of the measured value and 0.5% of the final value of the measuring range.

4.6 Minimum levels and flows

The theoretical minimum measuring ranges at different pipe gradients (Q) were calculated. From the following table it can be read at which minimum discharge quantities Q, depending on the pipe gradient (measured in percent), the smallest measurable level (smallest h) is undercut. A free, backwater-free, partially filled discharge was used as the basis for the calculation.

DN [mm]	Minimum h [mm]	Q (0.5%) [l/s]	Q (0.6%) [l/s]	Q (0.7%) [l/s]	Q (0.8%) [l/s]	Q (0.9%) [l/s]	Q (1%) [l/s]	Q (2%) [l/s]
150	26.1	0.95	1.01	1.09	1.17	1.24	1.31	1.85
200	26.8	1.16	1.27	1.37	1.47	1.56	1.64	2.32
250	28.0	1.45	1.59	1.71	1.83	1.94	2.05	2.89
300	31.7	2.08	2.28	2.47	2.64	2.80	2.95	4.17
350	33.4	2.54	2.78	3.00	3.21	3.40	3.59	5.07
400	34.8	2.98	3.27	3.53	3.77	4.00	4.22	5.96
500	37.9	4.04	4.42	4.78	5.11	5.42	5.71	8.08
600	40.7	5.19	5.68	6.14	6.56	6.96	7.34	10.38
700	43.4	6.47	7.08	7.65	8.18	8.68	9.14	12.93
800	46.0	7.86	8.61	9.31	9.95	10.55	11.12	15.73
900	48.5	9.38	10.27	11.09	11.86	12.58	13.26	18.75
1000	50.9	10.99	12.04	13.01	13.91	14.75	15.55	21.99
1100	53.3	12.76	13.98	15.10	16.14	17.12	18.05	25.52
1200	55.6	14.63	16.02	17.31	18.50	19.62	20.68	29.25

Table 6: Minimum filling levels and flow rates [Q]

For the correct dimensioning of the required nominal widths, please observe the above table during project planning.

5 Technical data transmitter

The transmitter is mounted remotely from the sensor.



Figure 5: Transducer of the partially filled LDM

5.1 Dimensions and weights

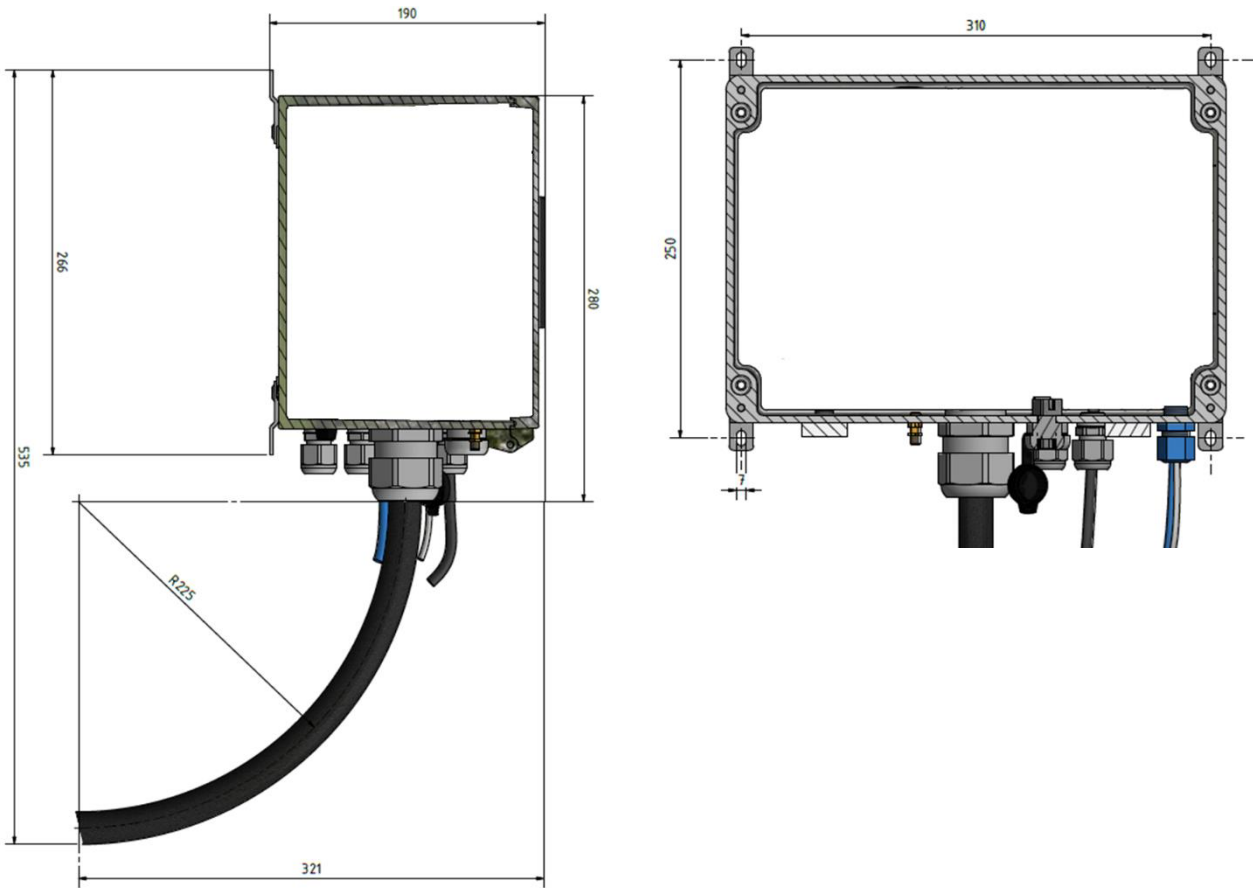


Figure 6: Dimensions of the transmitter

Dimensions	
Total width	330mm
Height (incl. cable connections)	280mm
Height (including top mounting bracket and minimum bending radius of transducer cable)	535mm
Depth	190mm
Weight	Approx. 9 kg

Table 7: Dimensions transmitter

5.2 Materials and electrical connections

5.2.1 Materials

Description	Material
Transmitter	Aluminium

Table 8: Materials

5.2.2 Electrical connection values

Description	Value
Power supply	24 VDC (-15% / +10%)
Power consumption	25 W
Fuse protection	2.5 A Inert

Table 9: Electrical connection values

5.2.3 Communication interfaces

Designation	Description
Ethernet (Modbus TCP)	With the Modbus TCP protocol, all available data points can be read out and values of writeable data points can be changed
Optional I/O interfaces	See tables below
Maximum cable length (sensor ← → transmitter)	25 m (remote panel available, should the transmitter be installed in an intermediate shaft)
Connecting cable (cores)	24 x 2 x 0.22mm ² 22.5mm

Table 10: Communication interfaces

The following two optional I/O variants can be installed:

5.2.3.1 Option I/O Output

Designation	Description
Number of analogue outputs	4
Data points analogue	<p>Up to four freely selectable data points, which are recorded in the transmitter, can be communicated. Examples are:</p> <ul style="list-style-type: none"> • Q (flow rate) • v_m (velocity of the liquid) • $v_1 - v_{10}$ (speed of measurement paths 1 to 10) • h (filling height of the measuring tube)
Number of digital outputs	4, optionally configurable as transistor or relay output
Data points digital	<p>Up to four freely selectable data points, which are recorded in the transmitter, can be communicated. Examples are:</p> <ul style="list-style-type: none"> • Operating message • Malfunction • Quantity of liquid, communicated as pulses

Table 11: I/O Output

5.2.3.2 Option I/O Input

Designation	Description
Number of analogue outputs	2
Data points analogue	<p>Up to two analogue inputs can be configured for the acquisition of external level measurements</p>

Table 12: I/O Input

5.3 Operating conditions

The following conditions must be fulfilled so that the transmitter of the partially filled LDM can be operated properly:

5.3.1 Approvals and certificates

Explosion hazard zone	
ATEX	The transmitter is not approved for operation in an explosive environment.
IP	
IP protection class	IP 54

Table 13: Approvals and certifications

5.3.2 Operating temperature

Temperature	
Ambient temperature	0 ... +40°C

Table 14: Operating temperature

6 Installation conditions

The partially filled LDM can only be operated as intended if the points listed in chapter 4 "Technical data sensor" and the installation conditions listed below are met.

6.1.1 Pipe cross-sections

The inner diameter of the pipe must match that of the flow meter.

6.1.2 Inlet and outlet side of the measuring tube

The inlet of the measuring tube is set as follows:

- The inlet is on the side where the sensor cables exit the connection housing of the LDM.
- Forward direction is defined as when the liquid flows from the inlet towards the outlet. The reverse direction of flow is called the backward direction and is correspondingly output as a negative measurement result.

6.1.3 Inlet and outlet section

To avoid turbulence in the measuring range and to ensure a smooth flow, the dimensions of the following minimum dimensions for the inlet and outlet sections must be strictly observed during installation.

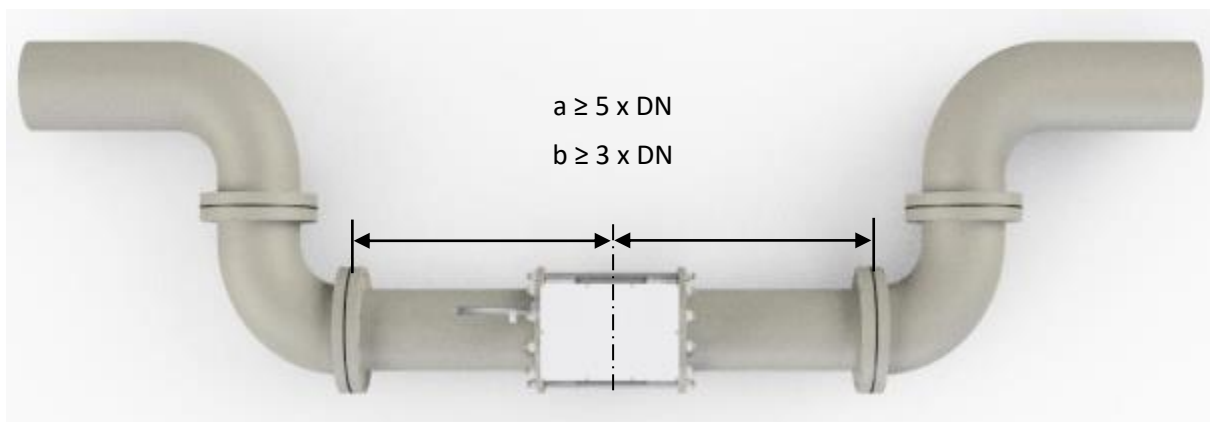


Figure 7: Recommended inlet and outlet distances, side view

Example:

If DN = 250mm, then the distances a and b must have at least the following lengths:

$$a \geq 5 \times 250\text{mm} = 1250\text{mm}$$

$$b \geq 3 \times 250\text{mm} = 750\text{mm}$$

If the flow is turbulent, then $a \geq 10 \times DN$ must apply. For the length b, the condition $b \geq 3 \times DN$ can still be used.

6.1.4 Installation before control valve

To avoid turbulence around the measurement paths, do not install a control valve immediately upstream of the LDM. When measuring in both flow directions, no control valve must be installed before and after the LDM. If a control valve is installed, it must be installed after the LDM.

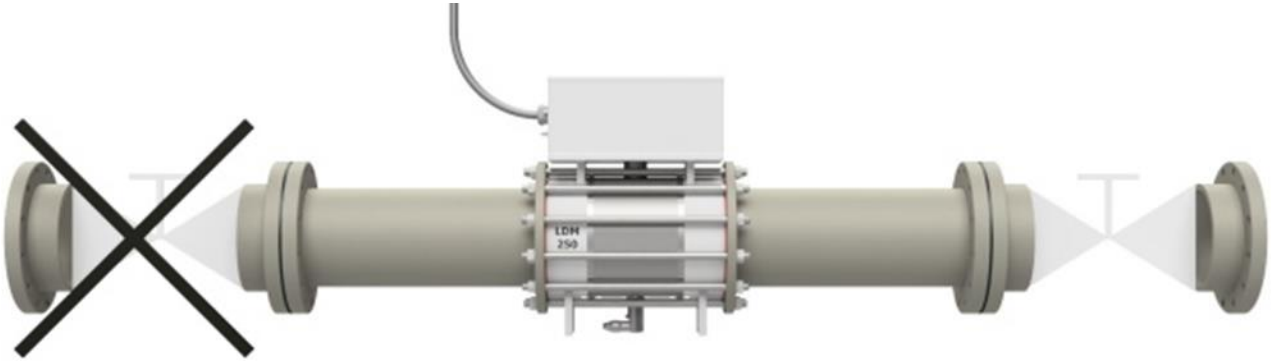


Figure 8: Installation of control valve after partially filled LDM

If you install a control valve, then consider the recommended minimum distances, which are described in the previous chapters.

6.1.5 Pipe gradient

The measuring accuracy of the measured flows can be influenced by the pipe gradient. For this reason, the gradient must be within 0% to +2%. If the gradient is known, the project-specific calibration of the measuring device is carried out at the factory.

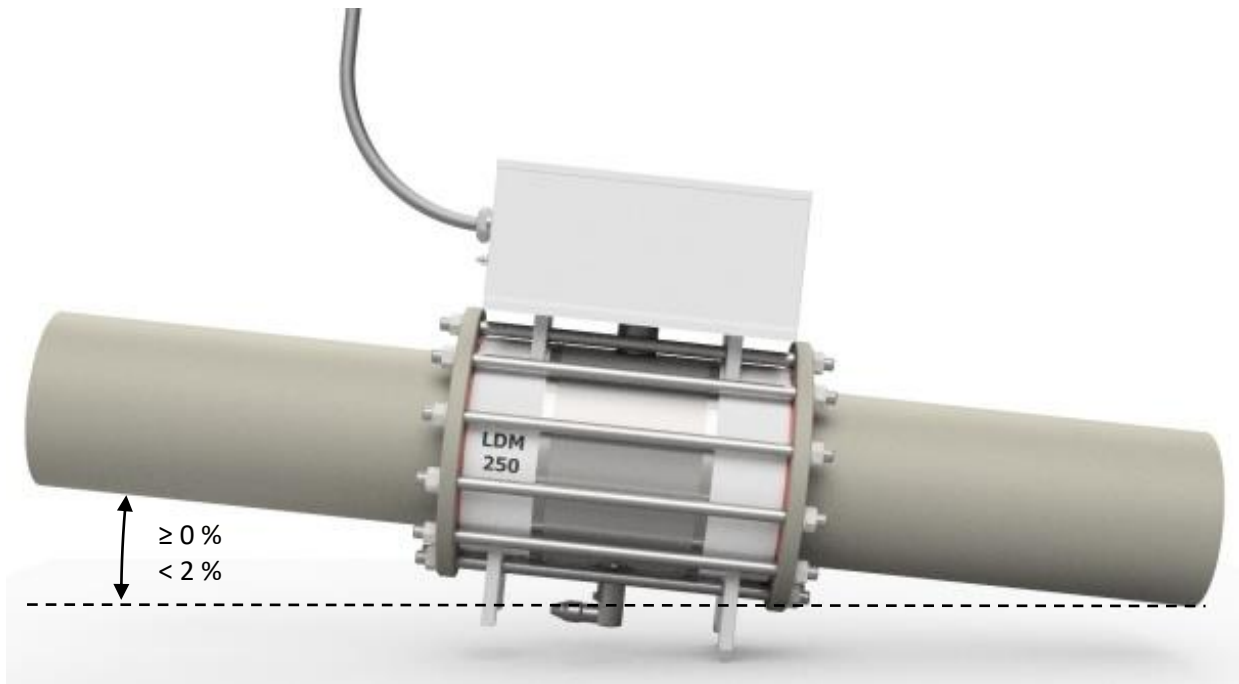


Figure 9: Recommended pipe gradient of the LDM

6.1.6 Free run

If no control damper or control valve is connected downstream, a pipe with a free outlet must always be used. This prevents backflow to the sensor.

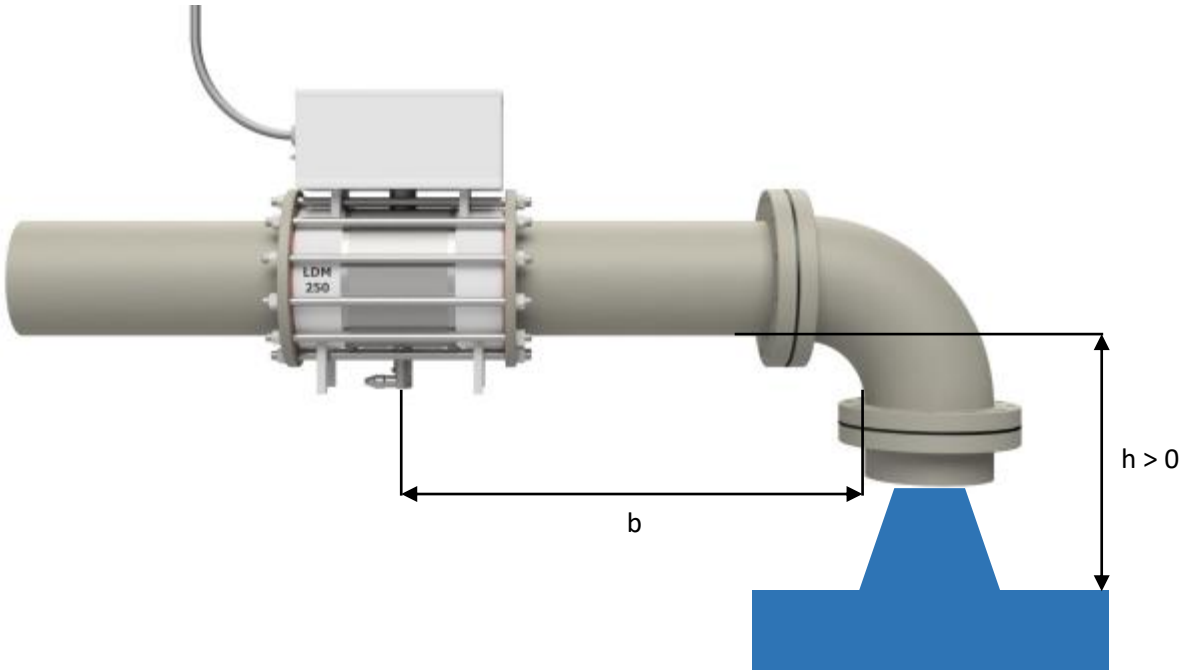


Figure 10: Free outlet after partially filled LDM

Designation	Description
b	<p>This length must be greater than or equal to 3 times the nominal width ($\geq 3 \times \text{DN}$).</p> <p>Example</p> <p>DN = 250mm</p> <p>$b \geq 3 \times \text{DN} \geq 3 \times 250\text{mm} = 750\text{mm}$</p>
h > 0	Make sure that the water level below the pipe outlet cannot back up into it.

Table 15: Definitions for free run

6.1.7 Free height of the LDM above ground

Easy removal of the pressure sensor requires that when installing the LDM, the free height under the installed pressure sensor to the surrounding base surface must be at least 40mm. If this free height is not considered when installing the LDM, the measuring sensor must be dismantled before removing the pressure sensor.

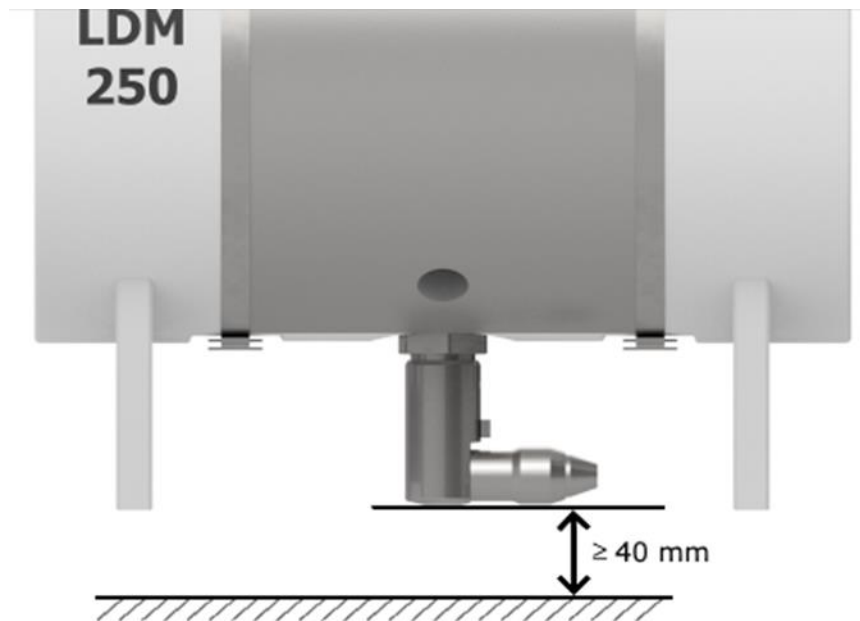


Figure 11: Minimum free height of LDM above base area

6.1.8 Minimum bending radius sensor cable

The sensor cable that is connected to the transducer must have a minimum bending radius of 225mm. This radius must not be undercut, otherwise a cable break could occur.

Cable \varnothing 22.5mm

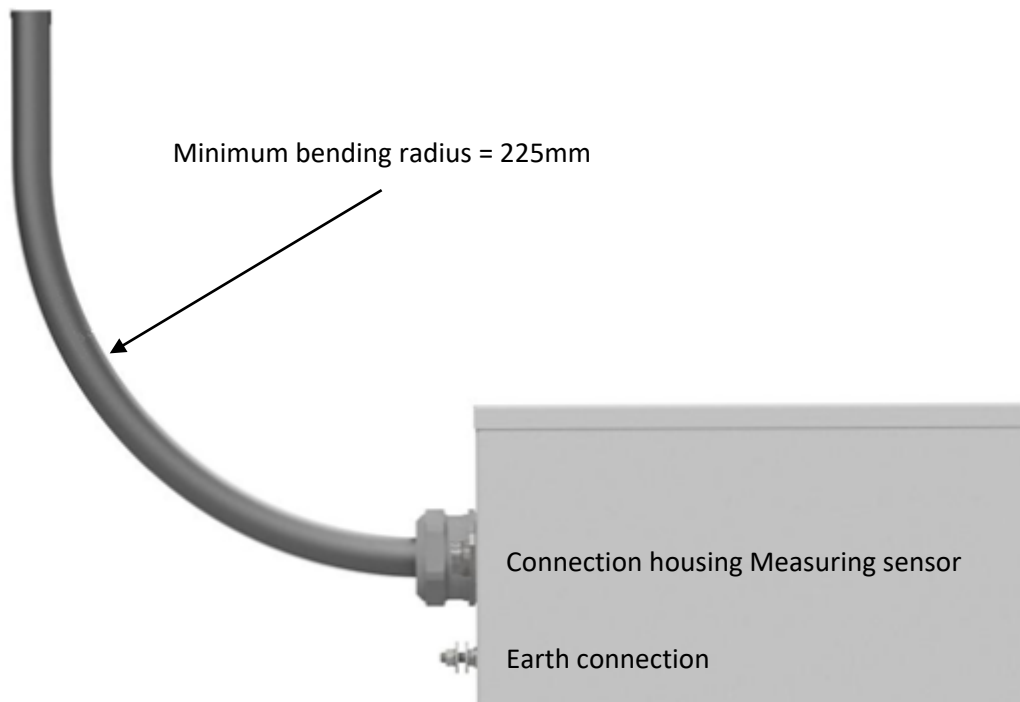


Figure 12: Minimum bending radius sensor cable

6.1.9 Connection to the transmitter

The transmitter is connected to the measuring sensor of the LDM with the sensor cable. It should be noted that the transmitter is not designed for use in potentially explosive atmospheres. The maximum cable length of the sensor cable is 25m.

6.1.10 Grounding

The LDM must be connected to earth via the connection provided on the housing of the measuring sensor. The liquids to be measured and the pipelines must also be earthed. Whether this is done via the potential equalisation, or the earth connection is left to the installation personnel. Under no circumstances may the earthing be connected to external potentials.

6.1.11 Vibrations

Neither the connections nor the LDM must vibrate during operation.

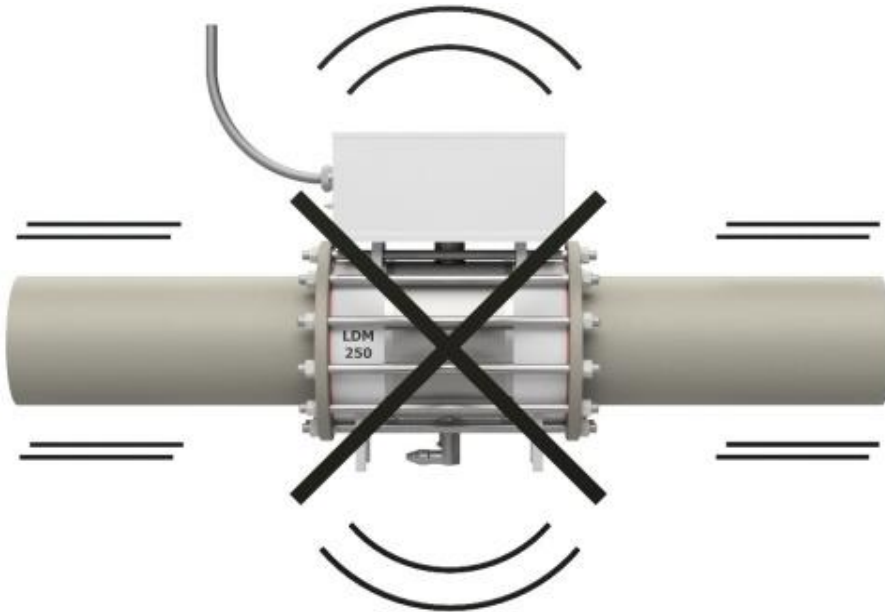


Figure 13: No vibrations allowed

This condition must be checked especially during commissioning and maintenance.

6.1.12 Flange offset of the axles of the pipes

The maximum flange offset can be understood as a measure of the axle offset after installation is complete. The maximum offset of the flange surfaces after installation must not exceed 0.5mm.

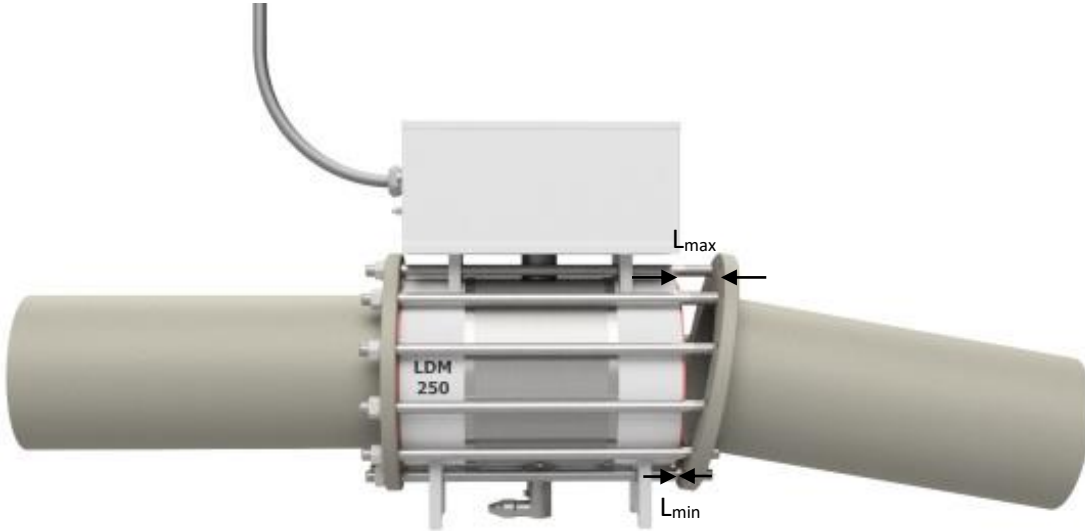


Figure 14: Maximum permissible flange offset

Designation	Description
L_{min}	Minimum distance of the flange from the edge of the measuring tube of the LDM
L_{max}	Maximum distance of the flange from the edge of the measuring tube of the LDM

Table 16: Definitions flange offset

Maximum flange offset of the LDM after installation has been completed

$$L_{max} - L_{min} \leq 0.5\text{mm or } L_{max} - L_{min} \leq 0.02'' \text{ respectively}$$

6.1.13 Lateral offset of the pipes

The mounted pipes must have as small a lateral offset as possible. Otherwise, turbulence of the measured liquids is possible, which considerably deteriorates the quality of the measured flows. The simplest method to check the offset and its strength is to scan the grooves of the pipe transitions by hand after assembly - if this is possible.

6.1.14 Mounting position

The transmitter must be mounted perpendicular to the connection housing. A maximum deviation of $\pm 2^\circ$ (rotation) is permitted. If the angle is exceeded, the measuring paths will not be evenly covered by liquid and the measuring accuracy will decrease considerably.

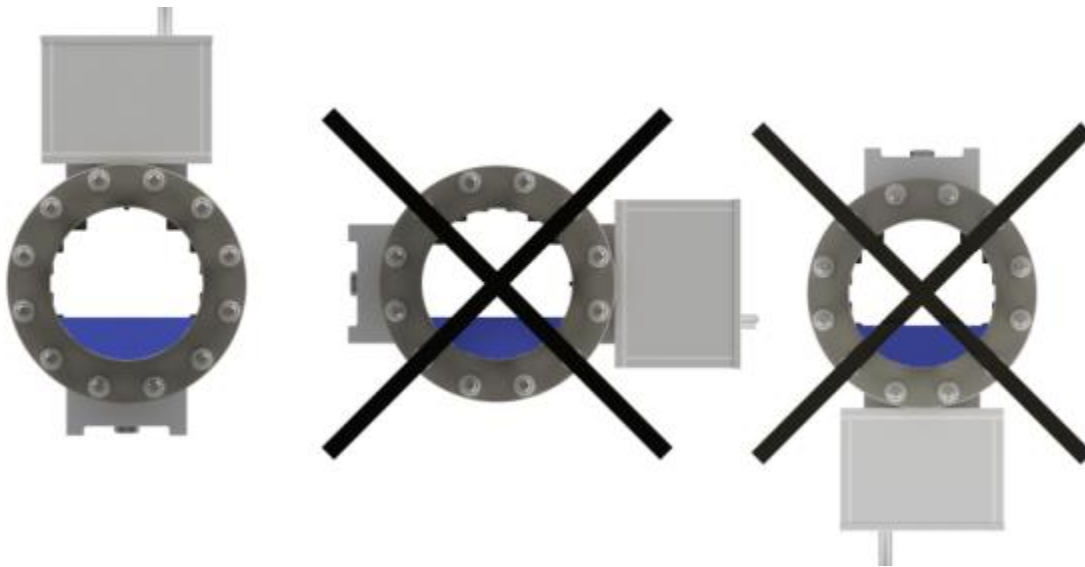


Figure 15: Mounting position of the LDM

6.1.15 Cleaning opening

The transducer is very resistant to dirt. If the LDM is serviced at least once every six months, or more frequently if it is extremely exposed to dirt, the measurement will not be falsified by possible contamination. However, it is recommended to order the "cleaning opening" option, as this will eliminate the need for tedious dismantling of the LDM for cleaning.

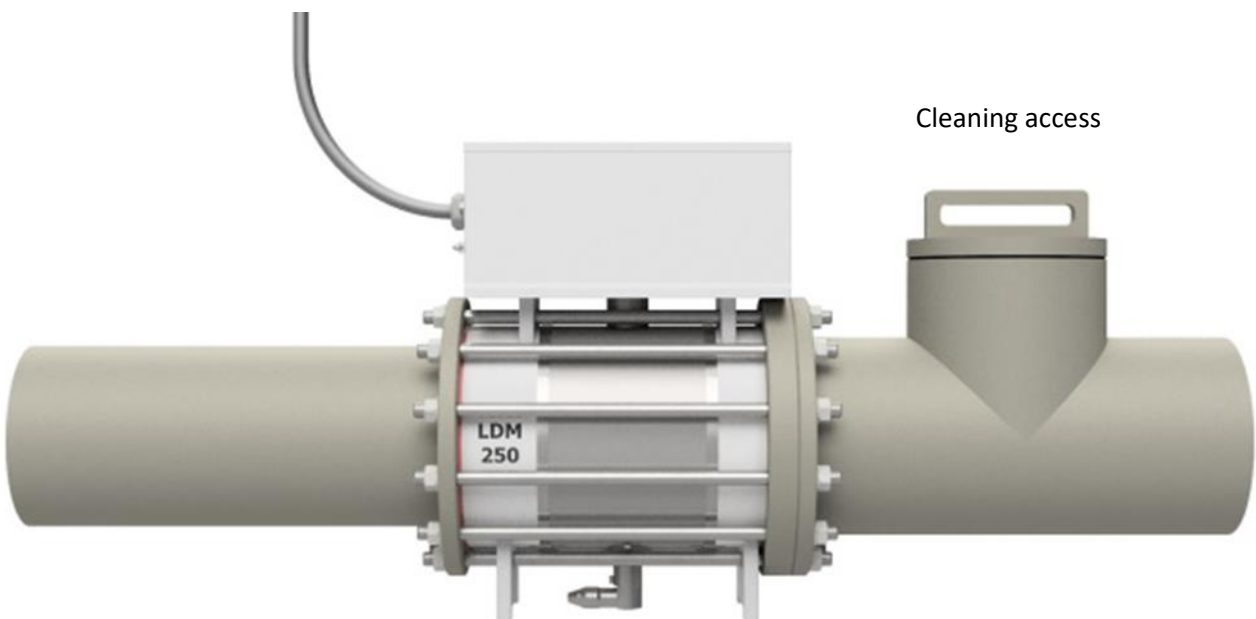


Figure 16: Option for cleaning the LDM

6.1.16 Mounting under difficult installation conditions

Contact your STEBATEC customer advisor for alternative solutions if the installation conditions listed above cannot be met. For example, in this case the LDM can be installed between two tanks. The inlet of the LDM must be higher than the outlet of the following tank. This guarantees a smooth inlet to the flow meter and thus enables highly accurate measurements. The size of the containers must be adapted to the dimension of the LDM.

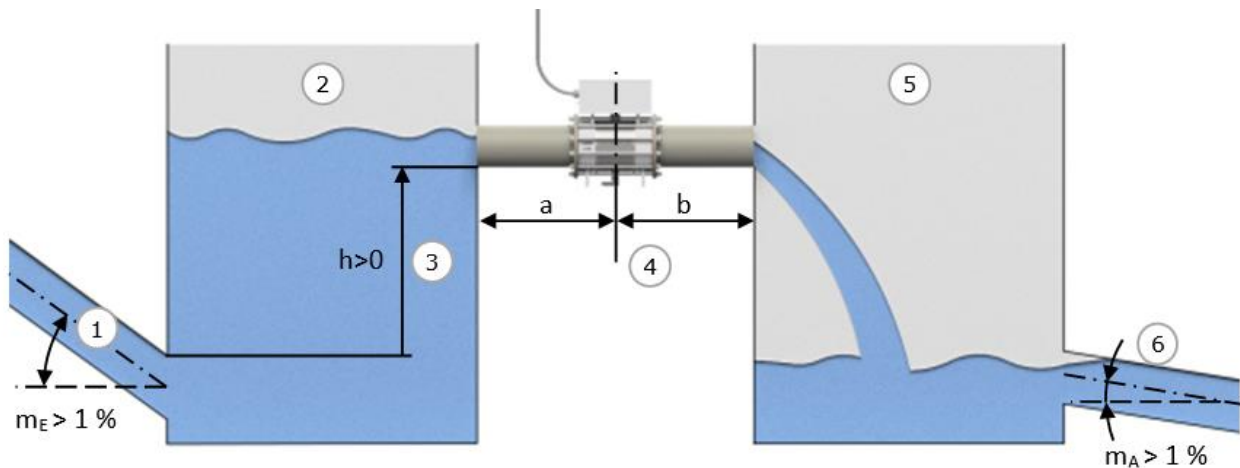


Figure 17: Mounting under difficult conditions

Number	Designation	Description
①	$m_E > 1\%$	Use an inlet tank in advance of the LDM if the inlet pipe has a gradient of $m_E > 1\%$.
②	Inlet container	Inlet tank to be installed if the inlet pipe slope is greater than 1%.
③	$h > 0$	If an inlet tank is used, ensure that the outlet of the inlet pipe is lower than the inlet of the LDM.
④	a, b	If an inlet container is used, the following applies $a \geq 10 \times DN$ $b \geq 5 \times DN$ Example If $DN = 250\text{mm}$, then $a \geq 10 \times DN = 10 \times 250\text{mm} = 2500\text{mm}$ $b \geq 5 \times DN = 5 \times 250\text{mm} = 1250\text{mm}$
⑤	Outlet container	Outlet tank, which must be installed if the slope of the outlet pipe is greater than 1%.
⑥	$m_A > 1\%$	Use an outlet tank after the LDM if the outlet pipe has a gradient of $m_A > 1\%$.

Table 17: Installation under difficult installation conditions

7 Installation

7.1 Fastening

Procedure for tightening the bolts/threaded rods

- Always tighten the bolts evenly and crosswise
- Be careful not to exceed the maximum torque value
- Step 1: approx. 50% of the max. torque indicated in the table
- Step 2: approx. 80% of the max. torque indicated in the table
- Step 3: 100% of the max. torque indicated in the table

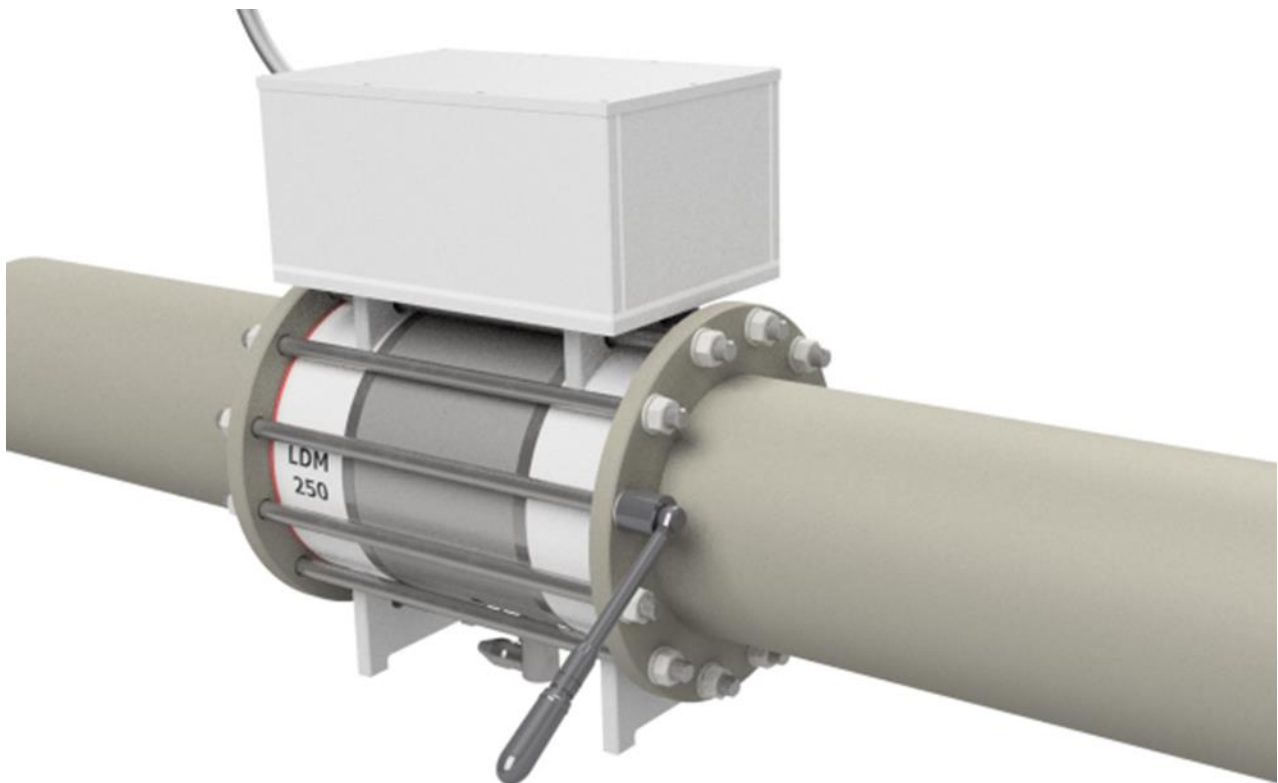


Figure 18: Tightening the threaded rods

The following tightening torques must be observed for the fastening:

Nominal width DN [mm]	Pressure stage connection	Threaded rods	50% Max. Torque [Nm]	80% Max. Torque [Nm]	Max. Torque [Nm]
150	PN 10	8 x M20	8	13	16
200	PN 10	8 x M20	10	15	19
250	PN 10	12 x M20	8	12	15
300	PN 10	12 x M20	9	14	18
350	PN 10	16 x M20	8	13	16
400	PN 10	16 x M24	10	15	19
500	PN 10	20 x M24	9	14	18
600	PN 10	20 x M27	13	20	25
700	PN 10	24 x M27	13	20	25
800	PN 10	24 x M30	19	30	38
900	PN 10	28 x M30	18	29	36
1000	PN 10	28 x M33	25	40	50
1200	PN 10	32 x M36	33	52	65

Table 18: Tightening torques

7.2 Parameterisation

No special parameterisation is required for the LDM. However, the transmitter of the LDM must be parameterised.

8 Maintenance

STEBATEC products are designed in such a way that they do not require special tools for installation and removal during maintenance work.

8.1 Cleaning

To enable cleaning of the LDM, the inside of the measuring tube must be accessible. For cleaning, proceed as follows:

- The measuring tube is cleaned with a high-pressure cleaner by inserting its lance into the measuring tube and spraying the inner walls of the measuring tube of the LDM at a shallow angle.
- The membrane of the pressure probe (which is used as a level gauge) should not be cleaned with a high-pressure water jet over a longer period.
- Check whether the LDM shows plausible flow values again

8.2 Removal and installation

For safe installation in shafts and channels, a lifting device is recommended (e.g. cable winch, pulley block or crane). This enables the operating personnel to manoeuvre the unit safely in the channel or manhole.

Avoid touching or bumping the unit too hard, this may cause damage to the system.

Cables and hoses must be secured against pulling or kinking. Damage must be documented photographically and sent immediately to STEBATEC together with a description.

Sharp edges or other pointed objects that protrude into the channel must be removed beforehand.

When using a suspension adapter, the unit is precisely aligned during the first installation. Any further installation and removal for maintenance can be done without tools. Re-alignment is normally not necessary, but the alignment must be checked.

8.3 Recommissioning and function check

Functional checks or recommissioning become necessary after a major event. This may be necessary, for example, after:

- a flood
- a power failure
- Conversions
- Refurbishments

8.4 Value preservation

If the maintenance and servicing work is not carried out as specified during the warranty period, or if it can be determined that system parts have been severely neglected, services for restoration will be invoiced. Electronic components are consumable parts and are not subject to warranty.

The following activities are to be carried out by the maintenance staff:

How often?	What measures?
When reporting pollution	The LDM's transducer sends a binary signal indicating whether there is contamination. If this binary signal is present, the LDM must be cleaned thoroughly.
Half-yearly	The LDM must be inspected for damage. It must be checked whether the LDM starts to oscillate during operation. This would result in a falsification of the measurement results and must be prevented.
Annual	The screw connections of the LDM must be checked and tightened if necessary.

Table 19: Maintenance

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