

Labom

MEASUREMENT TECHNOLOGY

Made to Measure. Since 1968.



DIAPHRAGM SEALS – SENSITIVE MESSENGERS

OPTIMUM SOLUTIONS FOR PRESSURE MEASUREMENTS

Function Models Applications

A microscopic image showing a dense field of cells, likely neurons, with various sized spherical structures and intricate internal patterns. The overall color palette is a range of greys and blues. The text 'SENSITIVE MESSENGERS' is overlaid in the upper left quadrant in a bold, white, sans-serif font.

SENSITIVE MESSENGERS

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QUALITY EXPERIENCE AND KNOWLEDGE

EXPERTS IN MEASUREMENT TECHNOLOGY

For over 40 years LABOM has been one of the leaders in quality for industrial measurement technology. The company, with headquarters in Hude, Germany, specialises in measuring and monitoring pressure and temperature as well as other derived values, such as fill levels and flow rates. In addition to a wide range of standard products, LABOM also realises purpose-built solutions at the customer's request.

LABOM devices are in service all over the world – mainly in the areas of food / pharmaceutical / biotechnology, chemicals, petrochemicals, energy, conservation and maritime shipping. Currently, the staff consists of some 170 employees, along with subsidiaries and representatives in over 40 countries.

Products from Labom are “Made in Germany”. In LABOM's own manufacturing facilities, the vast majority of the product range is produced directly on site. A high degree of in-house manufacturing depth, short distances and clever storage make high quality, great variety and short delivery times possible.



Pressure transmitters



Resistance thermometers



Diaphragm seals

HOW-HOW

TOPIC: DIAPHRAGM SEALS

Whether the media is problematic, stringent conditions of hygienic applications are given, or the gauges need to be especially robust to vibration, shock or extreme process temperatures – when the measurement task is unusually difficult, diaphragm seals are the perfect tools for the job.

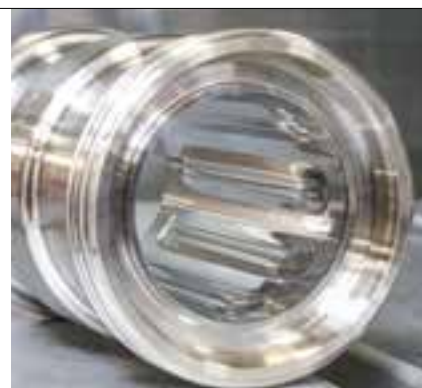
On the following pages we will explain what exactly diaphragm seals are, how different they can look and which components are particularly relevant, after which we will move on to specific areas of application. In the appendix we have provided some useful tables as a tool for specialists.



Different designs



Diaphragm seal filling



Inline diaphragm seal



INSTRUMENTS MADE TO MEASURE

THE EXCEPTION IS THE RULE

Working closely with our customers, innovative solutions are created day in and day out for specific projects. Often, technologies that have been developed in this way are used later in serial production.

EXAMPLES FOR CUSTOM SOLUTIONS

- ▣ Diaphragm seal made completely of titanium
- ▣ Flange diaphragm seal with rubber-coated diaphragm for use with highly abrasive media
- ▣ Inline diaphragm seals suitable for high-pressure cleaning up to 1000 bar
- ▣ Customised diaphragm seal for hydrogen applications up to 1500 bar
- ▣ Special combinations with tailor-made process connection as well as fill fluids



Quality must be crafted



Attention to detail

DEMANDING APPLICATIONS

HYGIENIC APPLICATION

Successful customised solutions for challenging use in hygienic and aseptic applications reflect LABOM's special expertise in this area: Designs with hygienic surfaces and a wide variety of aseptic connections without dead space are available.

LABOM uses clever techniques, for example extremely reduced volume pressure chambers, which reduce the temperature error to a large degree.

ABRASIVE MEDIA

For use in highly abrasive media, LABOM has developed screw-in diaphragm seals with rubber-coated diaphragms. The rubber coating ensures a long lifetime of the diaphragm for pressure measurements in areas where solids may be present in the media, such as in mining, or when measuring sludge or fly ash.

AGGRESSIVE MEDIA

For use in military technology, LABOM has developed a particularly robust diaphragm seal made entirely out of titanium, which can be used for the measurement of strongly oxidising or chloride-rich solutions or suspensions.

SINGLE-USE-SYSTEMS

For many other measurement tasks, the challenge lies not so much in extreme environmental conditions and measurement values, but rather in the details. For instance, in the pharmaceutical industry, in addition to process containers made of stainless steel, "single-use systems" are now also used. In these "disposable systems", the process pressure of flexible plastic bags is recorded, in which the media is prepared. For this demanding challenge, LABOM developed a flat diaphragm seal with special diaphragm geometry.

PATENTED PROCESSES

To realise special solutions, LABOM also develops new manufacturing processes, such as the patented fibre laser technology LABtec.

The advantage of LABtec is a full-surface diaphragm contact with special material without mix melting or additional soldering connections. This results in a high temperature resistance and stability of material properties (against corrosion, acids, etc.) of the special materials.

THE LABTEC PROCESS

- ▣ Full-surface welded diaphragm
- ▣ Excellent surface structure (hygiene)
- ▣ Meets highest hygiene requirements
- ▣ High temperature resistance
- ▣ No changes in material properties



Patented technology

SAFETY FOR YOUR APPLICATION

HYGIENIC AND ASEPTIC APPLICATIONS

Pressure gauges and diaphragm seals for hygienic applications must comply with the rules of hygienic design. The design and surface quality of the materials must exclude contamination-vulnerable arrangements and ensure proper cleanability in the scope of CIP/SIP processes. Hygienic diaphragm seals from LABOM are typically constructed and produced according to the relevant hygiene standards of the FDA (Food and Drug Administration) or the EHEDG (European Hygienic Engineering & Design Group).

In addition to off-the-shelf solutions according to relevant standards, LABOM also realises manufacturer specifications for individual customer solutions. According to the principles of hygienic design, the company guarantees good cleanability, a high level of reliability and no impact on the product.

LABOM achieves this high level of hygienic quality by consequently applying hygienic design principles. Important aspects include avoiding design dead space, gaps and edges, using suitable materials as well as the creation of defect-free surfaces with low roughness. With respect to the structural design, flush coupling of components and self-draining design are necessary or helpful. If requested by the customer, electropolishing can achieve even higher surface quality. (LABOM uses its own electropolishing facilities.)

Other sectors can also profit from these special designs. Having no gaps or dead space are also a prerequisite in the paint industry in order to minimise the cleaning cycles between colour changes.

HYGIENIC DESIGN REQUIRES

- ▣ Good cleanability of the components
- ▣ Exclusion of contamination of the product
- ▣ Assurance that bacteria cannot penetrate or propagate
- ▣ Prevention of sensory changes to the product
- ▣ Use of non-toxic and proven suitable materials
- ▣ Assurance of the stability of all materials used, during both operation and cleaning

VS



HYGIENIC CONNECTIONS

A series of LABOM diaphragm seals was also certified by the European Hygienic Engineering & Design Group (EHEDG) as suitable for SIP and CIP applications.

The certification includes the models according to DIN 11864 as flange, clamp or screw connection, Varivent®, NEUMO Biocontrol® and

the LABOM Hygienic Tubus series. In addition, for applications with less stringent requirements, a number of additional clamp connections or solutions with union nuts are available.

TRANSMISSION FLUIDS

As specialised producer of diaphragm seals for hygienic and aseptic processes, LABOM uses a stand-

ard pressure transmission fluid that complies with the internationally recognised hygiene standards of the FDA (Food and Drug Administration). For special applications, additional hygiene-compliant pressure fill fluids are available, including medical white oil, deionised water and a water-glycerol mixture.

EHEDG CERTIFICATION CLASSES

The respective system components are categorised in Classes I and II, with Class I relating to equipment that can be cleaned in its installed state (CIP cleaning) and Class II relating to components that can only be cleaned in their dismantled state. Furthermore, parts used in aseptic applications, can be certified as “EL Aseptic”, while certificate “ED” relates to components specifically intended for dry cleaning.

EL Class I	Applies to components that can be cleaned in their installed state (CIP= Cleaning in place).
EL Class II	Applies to components that can only be cleaned after they have been dismantled.
EL Aseptic Class I	Applies to components that can be cleaned in their installed state (CIP= Cleaning in place), sterilised (SIP = Sterilisation in place) and are impervious to bacteria.
EL Aseptic Class II	Components for closed processes, which are dismantled for cleaning, can be sterilised with steam and are impervious.
ED	Applies to components used in dry processes, which are cleaned dry. All the provisions of EHEDG documents 8, 22 and 26 have to be met.

DIAPHRAGM SEALS

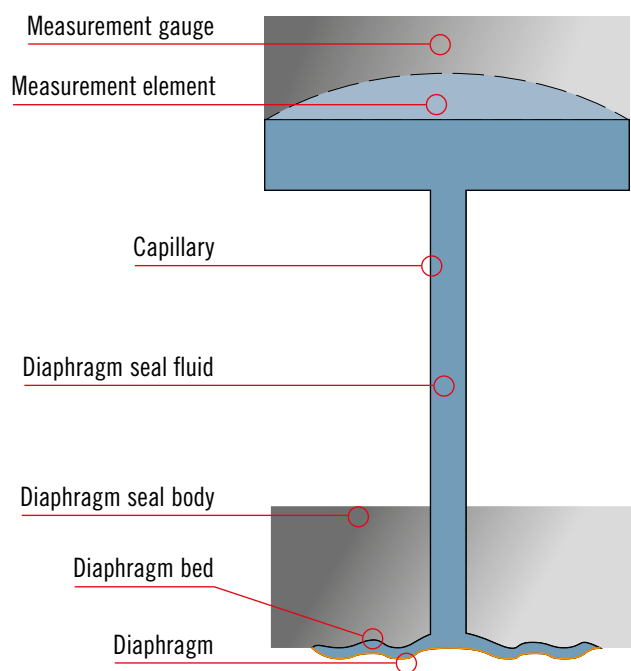
USE AND FUNCTION

Many pressure measurement tasks can be performed only with the help of diaphragm seals. Their use also improves the performance of processes and systems and contributes to an increased lifespan of the measurement equipment while reducing assembly and maintenance costs. The diaphragm seals from LABOM are perfectly suited for use with our pressure gauges, but they can also be used with gauges from other manufacturers.

FUNCTION

Diaphragm seals are partitions in pressure measuring instruments which prevent the measured media from entering the measuring system. This allows them to protect the gauges from aggressive, highly viscous or solidifying measurement media as well as from high media temperatures, enabling the connection of the instruments to hygienic processes and the reduction of measurement pressure fluctuations and pressure spikes. They also provide relief in case of an unfavourable location of the pressure measurement and enable the use of pressure gauges in potentially explosive areas of zone 0 as well as a measurement arrangement free of dead space.

The design of the diaphragm seals can vary greatly depending on the measurement task. Nonetheless, three basic components can be identified on any diaphragm seal. Particularly important for the protective function of the device is the diaphragm, a thin film that shields the gauge from the media in the process vessel or pipe. The diaphragm is held in place in the diaphragm seal body, which is called the diaphragm body. It must have a suitable process connection so that it can be integrated into the system to be measured. To transfer the process pressure “caught” by the diaphragm to the measurement element, a pressure transmission fluid (diaphragm seal fluid) is used.

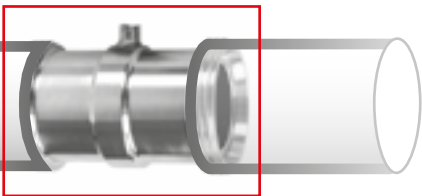


TASKS OF THE DIAPHRAGM SEAL

- Protects the measurement device from aggressive, corrosive, abrasive, viscous and solidifying media
- Protects the measurement device from extreme process temperatures or temperature fluctuations
- Protects the measurement device from strong vibrations and pressure spikes and pulses (with additional capillary)
- Protects the medium from contamination through the aid of the diaphragm seal avoiding difficult-to-clean dead spaces in the measurement device
- Spatial separation of measurement location and measurement device via capillaries

MODELS IN DETAIL

The wide range of applications for diaphragm seals requires a broad variety of solutions. Therefore, LABOM has more than 60 standard models in its programme. In general, a differentiation can be made between inline and flat diaphragm seals, which fulfil different types of requirements.



INLINE DIAPHRAGM SEALS

For inline diaphragm seals, a cylinder-shaped diaphragm is welded into a piece of piping. This ensures the avoidance of turbulence, flow restrictions, dead spaces and other hygienic risks. It must be taken into account, however, that the temperature error may be larger than for flat diaphragm seals. Inline diaphragm seals are offered with all standard pipe connections.

ADVANTAGES

- Easy to clean and self-draining. Particularly suited for dead-space free applications, frequent media change, for viscous media.

INLINE DIAPHRAGM SEALS FOR GENERAL APPLICATIONS



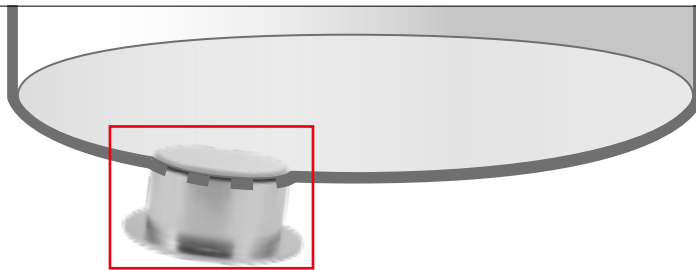
Flange connection



Aseptic version



Clamp connection



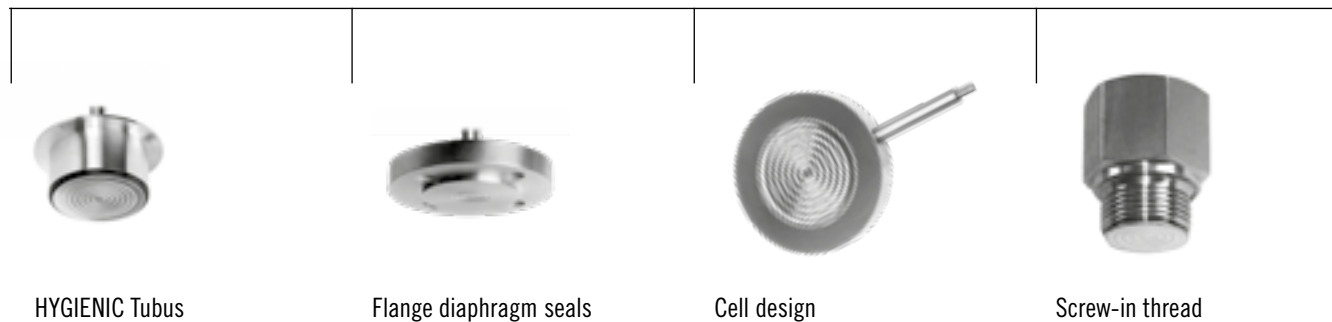
FLAT DIAPHRAGM SEALS

For flat diaphragm seals, the diaphragm lies plane and is usually circular. This facilitates the good spring properties of the diaphragm, thus maintaining low sensitivity of the diaphragm seal to temperature fluctuations. In addition, production is relatively simple. Flat diaphragm seals are available with a wide range of connection types.

ADVANTAGES

- ▣ Applications with high accuracy or low pressures, as the flat diaphragm shape has good spring properties. Wide range of assembly options. Can be removed, cleaned or calibrated easily.

FLAT DIAPHRAGM SEALS FOR GENERAL APPLICATIONS



THE HIGHLIGHT: CONCEPTION OF A DIAPHRAGM SEAL SYSTEM

The quality of a measurement system comprising of a pressure gauge and a diaphragm seal is influenced by the interaction of various parameters. In addition to the shape and material of the diaphragms and the design of the diaphragm seal, type and quality of fill fluid, as well as the temperature range, are of importance. With software that calculates the mutual influence of the parameters, LABOM supports its customers in the selection of the proper configuration from its modular system. In addition, the company realises new developments for the requirements of specific customer applications.

LABOM has decades of experience in the design and dimensioning of diaphragm seal-based systems. With in-house production, a wide range of adaptation can be made for specific measurement tasks, even for small quantities.

Even small changes, such as the replacement of the pressure transmission fluid, can have a significant effect. Additional potential is offered by changes in the diaphragm thickness or the material – in particular for small diaphragm seals with diaphragm diameters, for example, of 20mm in conjunction with small measurement ranges (0–250mbar). Depending on the measurement task, an optimal compromise can be made between measurement accuracy, temperature error, cost and durability.

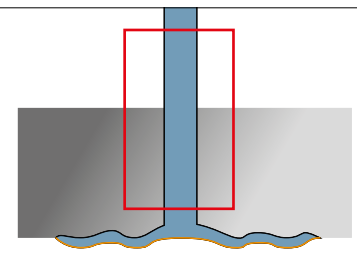
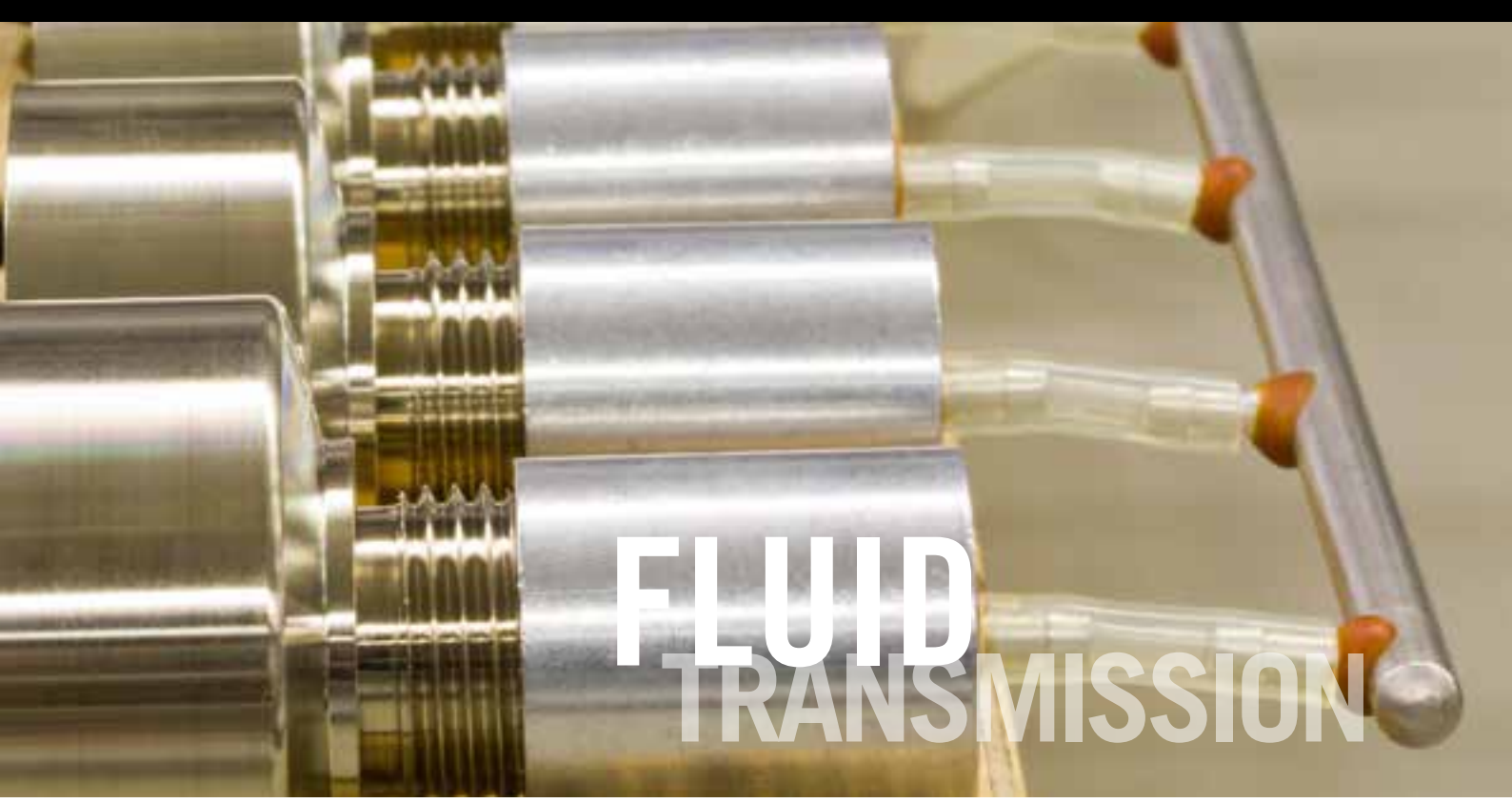
CONDITIONS

- ▣ Process temperature
- ▣ Ambient temperature
- ▣ Process medium
- ▣ Existing installation space
- ▣ Measurement device used

THE RIGHT DESIGN

WE DESIGN

- ▣ Diaphragm contour, material and thickness
- ▣ Type and quantity of the pressure transmission fluid used
- ▣ Additional coatings
- ▣ Welding processes and parameters
- ▣ Use of additional elements, such as temperature decouplers or capillaries



PRESSURE TRANSMISSION FLUIDS

The selection of the pressure transmission fluid has a great impact on the overall function of the diaphragm seal, particularly on the temperature error of the diaphragm seal. Notably in the pharmaceutical and foodstuff industry, LABOM uses fluids which have been approved exclusively for these applications.

Where necessary, LABOM can realise customised solutions. For example, the company developed a special diaphragm-seal filling for a manufacturer of paint systems that is not just absolutely free of silicone, but also completely excludes paint wetting disturbances while providing a wide operating temperature range.

FLUIDS IN DETAIL

In the appendix you will find a detailed table of a range of relevant pressure transmission fluids.

See page 26



DIAPHRAGM CONTOURS

BRIEF OVERVIEW OF CONTOURS

SINUS-SHAPED

Universal contour and material for all standard applications

SELF-COMPENSATING

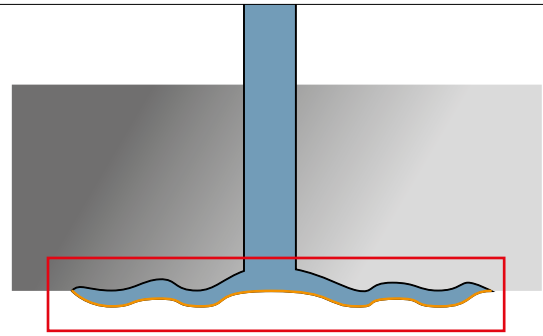
For special requirements for stability and accuracy in conjunction with special materials

LTC (Low Temperature Coefficient)

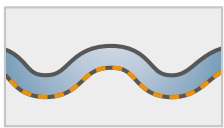
Lowest temperature sensitivity for use of stainless steel diaphragms

TEMPERATURE COMPENSATION

Diaphragm seals are used in very different temperature ranges. A key factor for exact measurement results is, therefore, the compensation of the temperature error. To achieve optimal temperature compensation for every application, LABOM offers three different diaphragm types depending on the process requirements: In addition to the sinus-shaped diaphragm, the compensation diaphragm and the LTC diaphragm are also available, both of which are based on a LABOM patent.

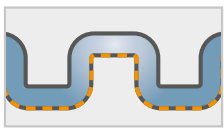


SINUS-SHAPED DIAPHRAGM



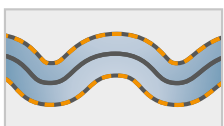
The standard diaphragm contour has a number of sinus-shaped waves. This universal contour can be used for all diaphragm materials, thickness and diameters. It is well-suited as a basis for additional coatings and can also be manufactured from diverse special materials such as monel, nickel or duplex steel. The sinus-shape design allows for a small temperature error and low manufacturing costs.

SELF-COMPENSATING DIAPHRAGM



For some media, diaphragms made of special materials such as Hastelloy or tantalum are needed to achieve the necessary resistance to the medium. Diaphragm seals with sinus-shaped diaphragms would however be characterised by a high temperature error due to the different thermal expansion of Hastelloy or tantalum and the stainless steel body. The patented contour of the compensation diaphragm prevents this disadvantage. The temperature error is reduced by 50% when compared to a stainless steel diaphragm with sinus-shaped contour. To achieve this goal, the properties of the diaphragm seal are matched so that a temperature-dependent volume increase of the fluid is compensated by the different thermal expansion of the materials. LABOM uses its compensation diaphragm as the standard for flange, tubus and cell-type compensation diaphragms with Hastelloy or tantalum diaphragms.

LTC DIAPHRAGM



In order to be in the position to offer a version with low temperature sensitivity for stainless steel diaphragms, the LTC diaphragm (Low Temperature Coefficient) was developed. Due to its special manufacturing process, it has two stable positions, the upper and lower zero position. As result of special manufacturing processes, the diaphragm operates in the middle position where the diaphragm rigidity is close to zero. The LTC diaphragm reduces the temperature error by up to 70% when compared to a stainless steel diaphragm with a sinus-shaped contour. It is highly insensitive to mechanical influences and also provides the option of using very thick diaphragms (up to 200 μm). The LTC diaphragms can be combined with all diaphragm seals with flat stainless steel diaphragms.

DIAPHRAGMS

THE MATERIALS

PURE METAL

Depending on the measurement media, different diaphragm materials can be used. If no special requirements exist, stainless steel 316L is used. Depending on the required resistance, a number of other materials can be selected.

STAINLESS STEEL 316L

Stainless steel (1.4404/1.4435) is characterised by its generally good resistance and media compatibility. It can even resist weak acids and alkalis, making it the standard material of the pharmaceutical industry.

DUPLEX STEEL

Duplex steel (1.4462) has a high resistance to corrosion cracking in media containing chloride such as pitting. It is well-suited for use in the chemical and petrochemical industry and particularly resistant to seawater.

TANTALUM

Tantalum is the metallic element with the highest general corrosion resistance. With only a few exceptions, tantalum is completely resistant to all pure acids.

TITANIUM

The good corrosion resistance of titanium is based on the formation of a dense and stable protective coating of titanium dioxide. Titanium is particularly well-suited for strongly oxidising and chloride-rich solutions and suspensions. Unlike almost all other common metallic materials, titanium is also resistant to chloride-saturated solutions.

HASTELLOY

The nickel-based alloy Hastelloy is very resistant to crevice and pitting corrosion and corrosion cracking and is resistant to chlorides, mid-concentrated sulphuric acids, acetic acids and phosphoric acids.

MONEL

Monel is a nickel-copper alloy with a good resistance to strong alkalis, most salt solutions, seawater as well as diluted and mid-concentrated inorganic acids.

NICKEL

Nickel is well-suited for application in strong alkalis such as sodium hydroxide or potassium hydroxide.



High quality stainless steel



COATINGS

Coatings on a stainless steel diaphragm provide properties that cannot be achieved with a homogeneous diaphragm. The most important coatings are described in the following.

GOLD

As a precious metal, gold has a very low reactivity. It is particularly suited for hydrogen applications, as a gold coating acts as a diffusion barrier.

PFA

This plastic is used in adhesive media because of its excellent anti-adhesive properties. It is also resistant to practically all chemicals and suited to a temperature range from -40 to +260 °C.

PTFE

In addition to excellent anti-adhesive properties, this plastic is characterised by its very good resistance to strong alkalis and acids. Special designs for vacuum applications up to 200 °C are available, in the overload pressure range PTFE can be used from -20 to +260 °C.

RUBBER COATING

A rubber coating protects the diaphragm from sharp objects and is consequently used in the cement industry, for instance.

ECTFE (HALAR)

Halar® is a thermoplastic material that is highly resistant to most known (and aggressive) chemicals as well as solvents. It also forms non-porous layers. The coating thickness is typically between 200 µm and 300 µm.



Sinus-shaped



Compensation diaphragm with special material

CONNECTIONS FOR EVERY NEED

Due to the wide range of applications, there is also a great variety of process connection variants. For tank or container installation welding sleeves and flanges are usually used to secure the diaphragm seal. In general, the connection types flange, clamp and threads can differ. However, the vast majority of diaphragm seals are installed in pipelines. The various pipe standards must be observed.



FLANGE CONNECTIONS

Flange connections provide a robust yet removable connection that is also suitable for high process pressures. For large-scale chemical, petrochemical and similar industries, this is the standard process connection.

For hygienic applications, special standardised flange connections are available (DIN 11864-2). Typically, however, clamping or screw connections are used for these applications.



CLAMP CONNECTIONS

Clamp connections are used almost exclusively in hygienic processes. The need for easily removable connections for the cleansing process led to the development of various clamping connections. Even today in SIP or CIP cleaned systems, the seals that come into contact with the media may need to be replaced regularly, making this requirement still relevant.

For the highest hygienic demands, clamping connections with metallic centring and stop as well as a practically dead-space free seal are available (DIN 11864-3). (Also see the appendix on page 28)



SCREW CONNECTIONS

Most widely used are threaded fasteners with a union nut, such as those specified in DIN 11851. This connection is also known as a dairy coupling. The disadvantage is the gap between process area and seal, which is difficult to clean. For aseptic applications, screw connections according to DIN 11864-1 are available.

Screw-in solutions for hygienic applications, such as tank measurements, often combine a standard thread with a process-oriented seal. An additional design combines a nozzle with a union nut. This prevents the O-ring from becoming twisted while it is being screwed in. A common example of this design is the so-called Ingold connection.

ASSEMBLY AND POSITION

- ▣ For assembly in vacuum applications, it is recommended that the pressure gauge is mounted if possible at the same height, and preferably, below the diaphragm seal to prevent the fluid column from tearing away due to great height differences. For a pure positive pressure measurement, the pressure gauge can also be mounted above the measurement point.



ACCESSORIES FOR EVERY NEED





CAPILLARY

A capillary is used to decouple the diaphragm seal from the measurement device, e. g. when there is not enough space at the measurement point for the measurement device. In addition, a capillary also protects the measurement device from vibrations and high temperatures. It must be taken into account, however, that a capillary, depending on its diameter and length, will increase the response time of the measurement device.

TEMPERATURE DECOUPLER

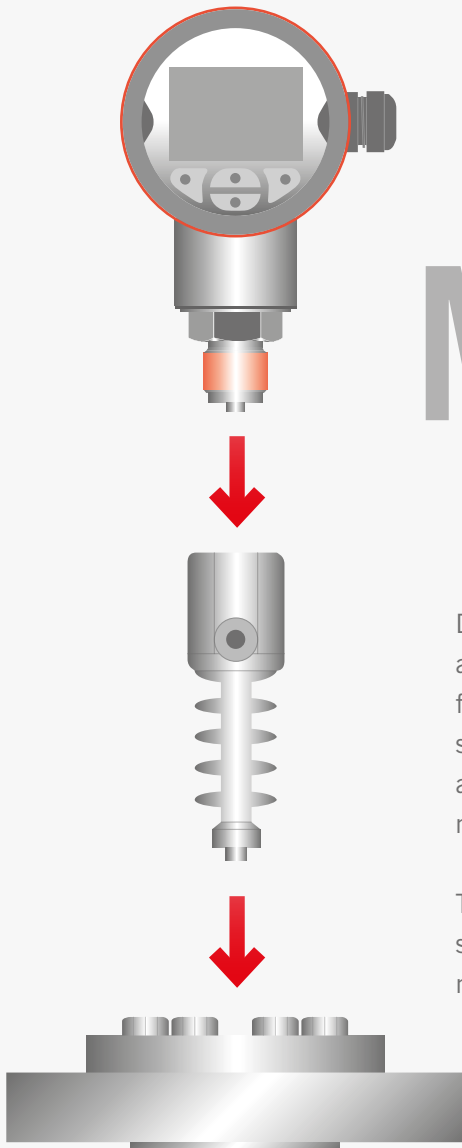
A temperature decoupler between the diaphragm seal and the measurement device protects the measurement device from high process temperatures.

FLUSHING RINGS

Flushing rings are clamped between the process flange and the diaphragm seal. Through the lateral flushing holes, the accumulated material can be flushed away in front of the diaphragm and the pressure chamber can be vented.

SEALING ELEMENTS

Sealing elements are not part of the standard scope of delivery due to the large dependency on the various process parameters. The seals must have different technical properties. For hygienic applications, additional requirements must be fulfilled.



MODULAR SYSTEM

Diaphragm seals on their own have no functionality. Only in combination with a measurement device does a pressure measurement system result that can fulfil a measurement task. With the LABOM modular system, the diaphragm seal and measurement device can be combined as desired. Depending on the application, additional elements such as a temperature decoupler or capillary may be used.

The modules of the system can be interchanged. In this way the diaphragm seals can be configured and provided exactly according to the customer's needs.

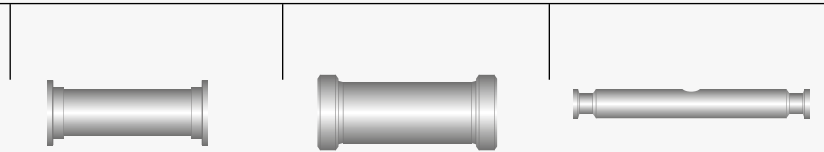
SPECIAL COMBINATIONS

- ▣ For special applications, a diaphragm seal can be equipped with two measurement devices. Typically, one mechanical and one electronic pressure gauge are combined. At one measurement point, an on-site display is available without auxiliary energy as well as a measurement signal for analysis in the control room. For redundant measurement, two electronic devices can also be used. Using a corresponding adapter, a wide range of variations can be realised.



THE COMPONENTS

INLINE DIAPHRAGM SEAL

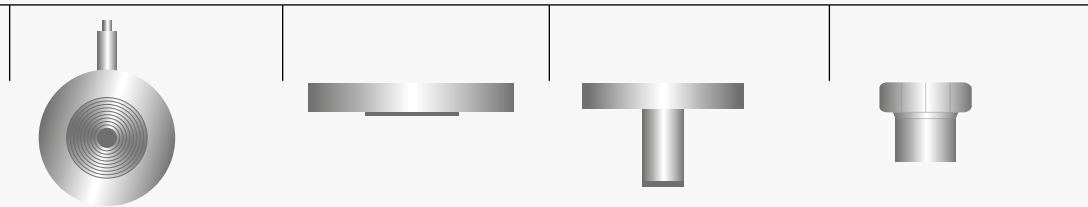


Standard version

Aseptic version

Clamp connection

DIAPHRAGM SEAL



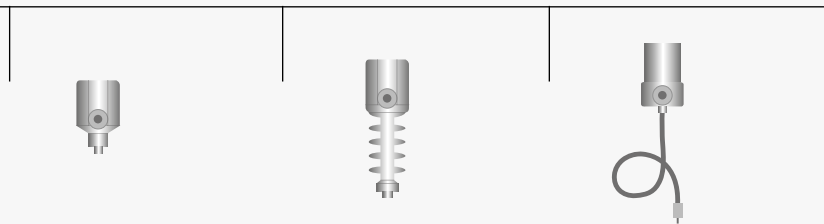
Cell design

Flange model

Tubus diaphragm seal

Screw-in thread

COUPLING ELEMENT

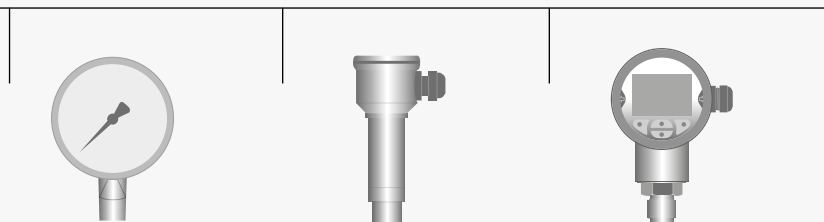


Via capillary

Directly welded

Via temperature decoupler

PRESSURE GAUGE



Mechanical pressure gauge

Electronic pressure transmitter

Pressure transmitter with display

PRESSURE TRANSMITTING LIQUIDS

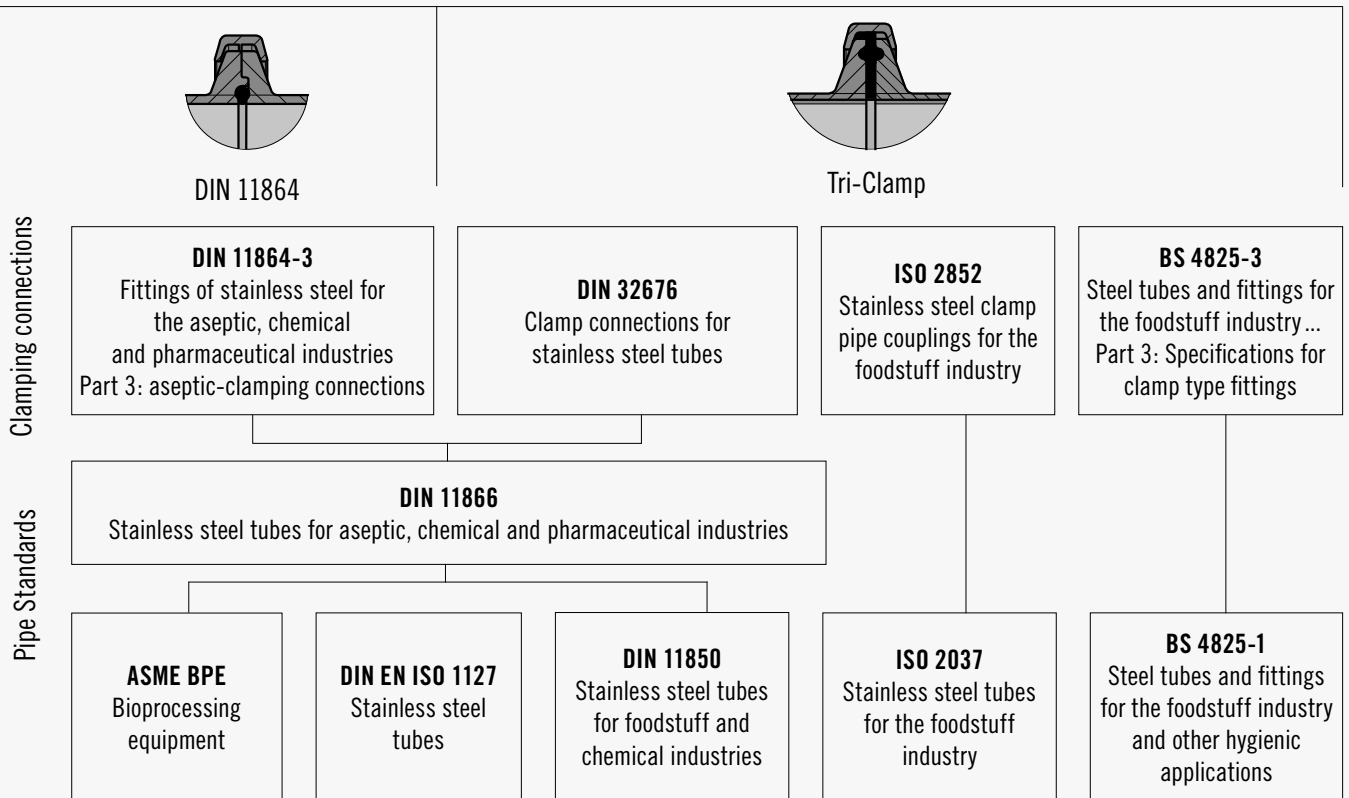
Code	Description/ Application	Type	t _{min} [°C]	t _{max} [°C]	density [g/cm ³]	kin. viscosity @ 40 °C [mm ² /s]	Tk [%/10 K]	compres- sibility [%/100 bar]
FD1	silicon-free oil suitable for food stuff applications	polyalphaolefine oil	-50	230	0,82	31	0,76	0,6
FV3H	vacuum and high temperature oil	highly refined mineral oil	-10	400	0,87	95	0,73	1
FC	Halocarbon oil for oxygen applictions	halogenated carbon chains	-30	190	1,92	56	0,9	0,73
FM50	silicone oil M50	high viscosity silicone oil	-50	300	0,96	40	1,0	1,02
FM5	low temperature silicone oil M5	low viscosity silicone oil	-90	160	0,92	4	1,1	1,2
FW	white oil for food stuff applications	low viscosity paraffin	-10	170	0,85	43	0,76	0,6
FGW	glycerine / water mixture	glycerine / water 70/30	-30	110	1,18	8	0,57	0,29
FAW	alcohol / water mixture for the paint industry	isopropanol / water 40/60	-20	75	0,95	1,9	0,52	0,81
FMH1	metal liquid for high temperatures or pressures	low melting alloy	0	350	6,44	1,4	0,126	0,02

CONVERSION TABLE OF PRESSURE UNITS

System of units		SI- units					Technical units					
		mbar	bar	Pa	kPa	MPa	mm WS	mWS	kp/cm ²	atm	Torr	psi
SI-units	1 mbar	1	10 ⁻³	100	0.1	0.1 · 10 ⁻³	10.197	10.197 · 10 ⁻³	1.0197 · 10 ⁻³	0.98692 · 10 ⁻³	0.75006	14.504 · 10 ⁻³
	1 bar	10 ³	1	10 ⁵	100	0.1	10.197 · 10 ³	10.197	1.0197	0.9869	750.06	14.504
	1 Pa	0.01	10 ⁻⁵	1	10 ³	10 ⁻⁶	0.10197	0.10197 · 10 ⁻³	10.197 · 10 ⁻⁶	9.8692 · 10 ⁻⁶	7.5006 · 10 ⁻³	0.14504 · 10 ⁻³
	1 kPa	10	0.01	10 ³	1	10 ⁻³	0.10197 · 10 ³	0.10197	10.197 · 10 ⁻³	9.8692 · 10 ⁻³	7.5006	0.14504
	1 MPa	10 · 10 ³	10	10 ⁶	10 ³	1	0.10197 · 10 ⁶	0.10197 · 10 ³	10.197	9.8692	7.5006 · 10 ³	0.14504 · 10 ³
Technical units	1 mm WS	98.067 · 10 ⁻³	98.067 · 10 ⁻⁶	9.8067	9.8067 · 10 ⁻³	9.8067 · 10 ⁻⁶	1	· 10 ⁻³	0.1 · 10 ⁻³	96.784 · 10 ⁻⁶	73.556 · 10 ⁻³	1.4223 · 10 ⁻³
	1 m WS	98.067	98.067 · 10 ⁻³	9.8067 · 10 ³	9.8067	9.8067 · 10 ⁻³	10 ³	1	0.1	96.784 · 10 ⁻³	73.556	1.4223
	1 kp/cm ²	0.98067 · 10 ³	0.98067	98.067 · 10 ³	98.067	98.067 · 10 ⁻³	10 · 10 ³	10	1	0.96784	735.56	14.224
	1 atm	1.0133 · 10 ³	1.0133	0.10133 · 10 ⁶	0.10133 · 10 ³	0.10133	10.332 · 10 ³	10.332	1.0332	1	760	14.693
	1 Torr	1.3332	1.3332 · 10 ⁻³	0.13332 · 10 ³	0.13332	0.13332 · 10 ⁻³	13.595	13.595 · 10 ⁻³	1.3595 · 10 ⁻³	1.3158 · 10 ⁻³	1	19.34 · 10 ⁻³
	1 psi	68.948	68.948 · 10 ⁻³	6.8948 · 10 ³	6.8948	6.8948 · 10 ⁻³	0.70307 · 10 ³	0.70307	70.307 · 10 ⁻³	68.046 · 10 ⁻³	51.715	1

Further designation: 1 Pa = 1 N/m², 1 hPa = 1 mbar, 1 mm HG = 1 Torr, 1kp/cm² = 1 at (atü)

CLAMPING CONNECTIONS



PIPE STANDARDS

Pipe Standard		DN	D external	D internal	wall thickness
inch tube	ASME BPE Table DT-1 (referred to in DIN 11866)	1/2"	12.70	9.40	1.65
		3/4"	19.05	15.75	1.65
		1"	25.40	22.10	1.65
		1 1/2"	38.10	34.80	1.65
		2"	50.80	47.50	1.65
		2 1/2"	63.50	60.20	1.65
		3"	76.20	72.90	1.65
		4"	101.60	97.38	2.11
	6"	152.40	146.86	2.77	
	BS 4825-1	12.7 (1/2")	12.70	10.30	1.2
		19.05 (3/4")	19.05	16.65	1.2
		25.4 (1")	25.40	22.20	1.6
		38.1 (1 1/2")	38.10	34.90	1.6
		50.8 (2")	50.80	47.60	1.6
		63.5 (2 1/2")	63.50	60.30	1.6
76.2 (3")		76.20	73.00	1.6	
101.6 (4")		101.60	97.60	2	
others up to DN 406.4 (16")					

	Pipe standard	DN	D external	D internal	wall thickness
metric tube	DIN 11850 Line 2 (referred to in DIN 11866)	6	8.00	6.00	1
		8	10.00	8.00	1
		10	13.00	10.00	1.5
		15	19.00	16.00	1.5
		20	23.00	20.00	1.5
		25	29.00	26.00	1.5
		32	35.00	32.00	1.5
		40	41.00	38.00	1.5
		50	53.00	50.00	1.5
		65	70.00	66.00	2
		80	85.00	81.00	2
		100	104.00	100.00	2
		125	129.00	125.00	2
		others, up to DN 200			
	ISO 1127 (referred to in DIN 11866)	10.2	10.20	7.00	1.6
		13.5	13.50	10.30	1.6
		17.2	17.20	14.00	1.6
		21.3	21.30	18.10	1.6
		26.9	26.90	23.70	1.6
		33.7	33.70	29.70	2
		42.4	42.40	38.40	2
		48.3	48.30	44.30	2
		60.3	60.30	56.30	2
		76.1	76.10	72.10	2
		88.9	88.90	84.30	2.3
		114.3	114.30	109.70	2.3
		114.3	114.30	109.70	2.3
		others, up to DN 219.1			
	ISO 2037	12	12.00	10.00	1
		12.7	12.70	10.70	1
		17.2	17.20	15.20	1
		21.3	21.30	19.30	1
		25	25.00	22.60	1.2
33.7		33.70	31.30	1.2	
38		38.00	35.60	1.2	
40		40.00	37.60	1.2	
51		51.00	48.60	1.2	
63.5		63.50	60.30	1.6	
70		70.00	66.80	1.6	
76.1		76.10	72.90	1.6	
88.9		88.90	84.90	2	
101.6		101.60	97.60	2	
114.3		114.30	110.30	2	
others, up to DN 406.4					



LABOM devices for hygienic application are manufactured according to GMP guidelines (Good Manufacturing Practice) and comply with the standards of the FDA (Food and Drug Administration) and the EHEDG (European Hygienic Engineering & Design Group). Our quality management system complies with DIN EN ISO 9001:2008, Pressure Equipment Directive 97/23/EC and ATEX 94/9/EC/IECEx.

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MEASUREMENT TECHNOLOGY



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