InlineSENS - Density Measuring Unit

Duo SERIES LB 4700-5x

Operating Manual
56926-5BA2
Rev. No.: 00, 04/2021
Embedded Software as of vers. XX.00.00

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Table of Contents

1 General Information

1.1 Applicable Documents

This manual of the density measuring device InlineSENS contains the following document:

- Technical Information, Mat. No. 56926-5TI

This manual applys as an addition to the following documents:

- Safety Manual / Explosion Protection Manual LB 4700, Mat. No. 56926BA26
- Operating Manual LB 4700, Mat. No. 56926BA2
- Technical Information LB 4700, Mat. No. 56926TI

1.2 Conformity and Certificates

For the original declaration of conformity and the certificates of the detector, please refer to the technical information Mat. No. 56926TI and safety manual / explosion protection manual Mat. No. 56926BA26.

1.3 Symbols Used on the Device

Observe the operating manual

Please observe the instructions in this operating manual.

Electrostatic discharge

Please note the handling instructions. Electrostatically endangered components. Please observe the instructions in this operating manual.

Protective earth connection

At this position, connect the protective earth conductor (PE).

Equipotential bonding connection

At this position, connect the equipotential bonding conductor.

No domestic waste

The electric product must not be disposed of in domestic waste.

Ionising radiation

The shield is equipped with a radioactive source. Please note the handling instructions. Please observe the transport instructions in this operating manual.

1.4 About this Operating Manual

The product is handed over to you by the manufacturer BERTHOLD TECHNOLOGIES GmbH & Co. KG (hereinafter referred to as Berthold) in a complete and functionally reliable condition.

This operating manual illustrates how to:

- set up/install the product
- establish the connections to the power supply
- perform measurements
- apply software settings
- carry out maintenance on the product
- fix errors
- disassemble the product
- dispose of the product

Read these instructions thoroughly and completely before working with the product. We have tried to compile all information for safe and proper operation for you.

However, should questions arise which are not answered in this operating manual, please contact Berthold.

Store the instructions where they are accessible for all users at all times.

Validity of the Operating Manual

The operating manual is valid from the delivery of the Berthold product to the user until its disposal. Version and release date of this operating manual can be found in the bottom of each page. Modification service is not performed by the manufacturer Berthold.

The manufacturer reserves the right to make changes to this operating manual at any time without stating reasons.

NOTICE

The current revision of this operating manual replaces all previous versions.

Target Group

This operating manual is directed at qualified specialist personnel who are familiar with handling electrical and electronic assemblies as well as with communication and measuring techniques.

Specialist personnel refers to those who can assess the work assigned to them and recognise possible dangers through their specialist training, knowledge and experience as well as knowledge of the relevant regulations.

Storage Place

This operating manual as well as all product-related documentation relevant to the respective application must be accessible at all times near the device.

Copyright

1.4.1 Structure of the Operating Manual

This operating manual has been divided into chapters. The order of the chapters should help you to quickly and properly familiarise yourself with the operation.

Symbols Used

NOTICE

If this information is not observed, deterioration in the operation and/or property damage may occur.

IMPORTANT

Sections marked with this symbol point out important information on the product or on handling the product.

Tip

Provides tips on application and other useful information.

General warning symbol

Warning symbol electrical shock

Warning symbol suspended load

Warning of radioactive substances

Wear protective helmet

Wear safety shoes

1.4.2 Structure of Warnings

Signal Word

Source and consequence
Explanation, if required
- Prevention

In case of emergency

- **Warning symbols:** (warning triangle) draws attention to the hazard.
- **Signal word:** indicates the severity of danger.
- **Source:** specifies the type or source of danger.
- **Consequence:** describes the consequences of non-compliance.
- **Prevention:** states how one can avoid the hazard.
- **In case of emergency:** specifies which actions are required in the event of the occurrence of risk.

In this manual, warning instructions before instructions for action refer to risks of injury or damage to property. The hazard-prevention measures described must be observed.

DANGER

Indicates an **imminent**, major hazard, which will certainly result in serious injuries or even death if the hazard is not avoided.

WARNING

Indicates a **potential** hazard, which can result in serious injuries or even death if the hazard is not avoided.

CAUTION

Refers to a **potentially dangerous** situation, which can result in medium or minor physical injuries or damages to property, if it is not avoided.

2 Safety

2.1 Dangers and safety measures

- Read these instructions and all applicable documents thoroughly and completely before working with the product.
- Store the instructions where they are accessible for all users at all times.

2.2 Proper Use

The InlineSENS is used along with an appropriate transmitter of Berthold to measure the radiation intensity as part of a radiometric measurement.

The system was developed for the measurement of the density of liquids, suspensions, turbidity and bulk solids and may be used exclusively for this purpose.

The measuring system InlineSENS contains a radioactive source. The notes on radiation protection contained in the present manual as well as any statutory requirements in this respect are to be strictly adhered to.

The following constitutes proper use:

- Strictly adhering to the instructions and procedural sequences and perform no unauthorised third-party actions that endanger your safety and the functional efficiency of the measuring system!
- Observing the provided safety instructions!
- Carrying out the prescribed maintenance measures or having them carried out for you!

Improper Use

- Failing to observe the specified safety instructions and instructions for the operation, maintenance and disposal in the manual.
- Any non-compliance with the present manual for the supplied products.
- Applying conditions and requirements which do not conform to those stated in the technical documents, data sheets, operation and assembly instructions and other specific guidelines of the manufacturer.
- Using the product in a damaged or corroded condition.
- Restructuring or changing the system components.
- Using the product with
  - open or not properly closed cover,
  - improperly closed entries,
  - insufficiently tightened or damaged screw connections i.e. cable glands, adapters or blind plugs[1].
- Operation without the safety precautions provided by the manufacturer.

[1] blanking elements acc. to IEC 60079

- Manipulation or avoidance of existing safety equipment.

Berthold shall only accept liability for/guarantee the conformity of the device to its published specifications.

If the product is used in a way which is not described in the present manual, the device's protection is compromised, and the warranty claim becomes invalMat.

2.3 Ambient Conditions during Operation and Storage

The compliance with the operating conditions specified contributes to guaranteeing the permanent functionality of the measuring system and the prevention of damage (see document “Technical Information”).

Measuring systems containing radioactive substances and sources are to be stored in a lockable storage room complying with the national requirements as regards the storage of radioactive substances.

Highly combustible or explosive substances must not be kept in the vicinity of measuring system in order to prevent a fire from spreading to the radioactive substances.

The measuring system must be stored dry (no condensation), dark (no direct sunlight) in a clean, lockable room. Furthermore, the ambient conditions in the document “Technical Information” Mat. No. 56926-5TI (see appendix) are to be observed.

2.4 Qualification of the Personnel

NOTICE

A minimum requirement for all work on or with the product would be employees with general knowledge who are instructed by an expert or authorised person.

At different parts in this operating manual, reference is made to groups of people with certain qualifications who can be entrusted with different tasks during installation, operation and maintenance.

These three groups of people are:

- Employees with General Knowledge
- Experts
- Authorised Persons.

Employees with General Knowledge

NOTICE

Employees with general knowledge must always be guided by an expert at the very least. When dealing with radioactive substances, a radiation safety officer must also be consulted.

Employees with general knowledge are e.g. technicians or welders, who can undertake different tasks during the transportation, assembly and installation of the product under the guidance of an authorised person. This can also refer to construction site personnel. The persons in question must have experience in handling the product.

Experts

Experts are persons who have sufficient knowledge in the required area due to their specialist training and who are familiar with the relevant national health and safety regulations, accident prevention regulations, guidelines and recognised technical rules.

Expert personnel must be capable of safely assessing the results of their work and they must be familiar with the content of this operating manual.

Authorised Persons

Authorised persons are those who are either designated for the corresponding task due to legal regulations or those who have been authorised by Berthold for particular tasks. When dealing with radioactive materials, a radiation safety officer must also be consulted.

Radiation Safety Officer

In order to ensure proper handling and compliance with the statutory requirements, the company has to appoint a radiation safety officer in accordance with the applicable national law (in Germany: Strahlenschutzverordnung [German radiation protection regulation]). The radiation safety officer must implement the statutory radiation protection requirements in order to protect employees against damage to their health caused by handling radioactive materials.

NOTICE

Dangerous goods officers must not perform any activities as radiation protection officers!

Radiation protection officers must have a special training with attendance of an officially recognized course and appropriate professional experience.

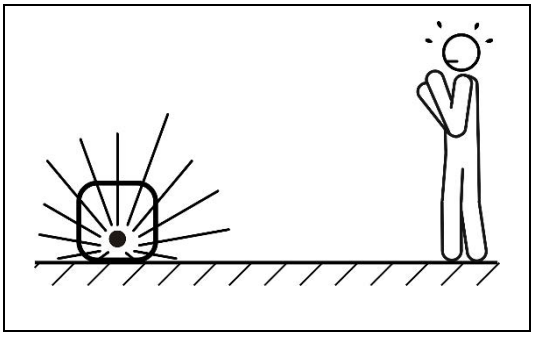
2.5 Radiation Protection

This measuring system uses radioactive sources. The radiation protection information in this operating manual and the relevant statutory provisions must be strictly observed.

Basic Principles and Regulations

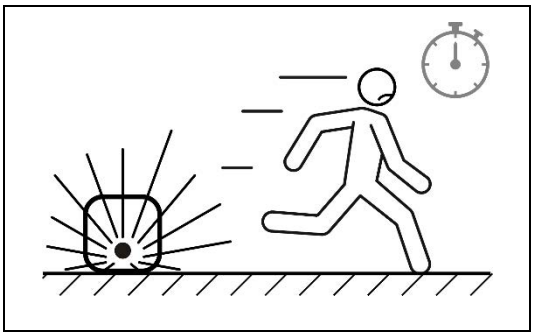
The amount of radiation absorbed by the body (exposure to radiation) is determined by three parameters from which the basic radiation protection regulations can be derived:

Distance



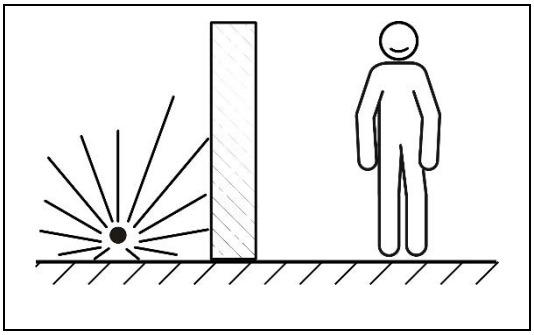
If work close to equipment containing radioactive substances is required, the largest distance possible is to be kept. In particular, this shall apply for employees which do not immediately participate in such work.

Time



Any work required in the vicinity of radiometric measuring systems is to be prepared carefully and to be organised in a way that the work can be executed as quickly as possible. Here, providing the correct tools and aids is particularly important.

Shield



When mounting and dismounting the shield, it is to be ensured in advance that the radiation beam outlet is closed.

Exposure of Employees to Radiation

Work may only be executed according to the instructions and under the supervision of the radiation safety officer, who furthermore has to calculate or estimate the exposure of the employees to radiation in order to ensure that the statutory dose rate limits are not exceeded.

If a radiometric measuring system is used as intended, the dose rate is so low that it usually lies below the detection limit of dosimeters. Even if one has to work with an unshielded source for a short time, the radiation dose can be limited through good preparation of the work and by keeping a fairly large distance between body and source, so that the body is exposed to a dose that is only a fraction of the natural radiation exposure. Nevertheless, one should heed the legislator's requirement:

THE RADIATION EXPOSURE WHEN HANDLING RADIOACTIVE MATERIALS MUST BE KEPT AS LOW AS POSSIBLE.

Theft Protection

Radioactive substances or equipment containing radioactive substances must be secured in a way that they are protected against access by unauthorized persons. In the case of firmly installed equipment containing radioactive substances, the protection against unauthorized access is generally provided by the firmly attached installation.

Measuring systems with radioactive sources which are decommissioned for a certain period of time must be dismounted and securely stored in a storage room complying with the national regulations as regards the storage of radioactive substances.

Portable measuring systems must never be left unsupervised. When this equipment is out of use, it is to be protected against access by unauthorised persons.

In the Case of Fire

The shield material can melt and leak from the shield if exposed to very high temperatures for an extended period of time. During and after a fire, there is a risk of major long-time consequences for your health due to the incorporation of lead as well as a risk of increased radiation exposure.

When planning the use of radiometric measuring systems, constructional measures ensuring fire prevention are to be provided.

- In the case of fire, these measures limit the access to this area.
- Avoid the incorporation by keeping sufficient distance.
- Notify Berthold of the situation; you will promptly receive information on immediate measures.

2.6 Emergency Procedure

In case of serious operational trouble, such as fire or explosion, which could adversely affect the radiometric measuring facility, it cannot be ruled out that the shielding efficiency or the stability of the source capsule have been impaired. In this case, it is possible that persons in the vicinity of the shielding have been exposed to higher levels of radiation.

If you suspect such a severe malfunction, the Radiation Safety Officer has to be notified immediately. He will then investigate the situation immediately and take all necessary provisions to prevent further damage and to avoid more exposure of the operating staff to radiation.

The Radiation Safety Officer has to make sure that the measuring system is no longer in operation and then take appropriate steps. He may have to inform the authorities or contact the manufacturer or supplier of the measuring system.

If adequate know-how as well as suitable instruments are available, emergency measures may be taken immediately. In this case, proceed as follows:

1. Locate the measuring system.
2. Check the function of the measuring system.
3. Check the efficiency of the measuring system by measuring the dose rate.
4. Secure and label radiation protection areas.
5. Secure the measuring system with source.
6. Document the event and estimate the possible radiation level to which the persons involved were exposed.

If you suspect any damage to the source capsule, the following points have to be observed as well:

1. Avoid contamination.
2. Take hold of source using a tool (a pair of pliers or a pair of tweezers) and put both (source and tool) into a plastic bag.
3. Secure them behind an auxiliary shielding (concrete wall, steel or lead plate).
4. Check if the environment is free of contamination.
5. Make sure the radioactive waste is secured and disposed off in compliance with the pertinent regulatory requirements.

2.7 Operator's Obligations

The operator of the product must regularly train his personnel in the following topics:

- Observation and use of the operating manual and the legal provisions.
- Intended operation of the product.
- Observation of the plant security instructions and the operating instructions of the operator.
- Regular monitoring/maintenance of the product.

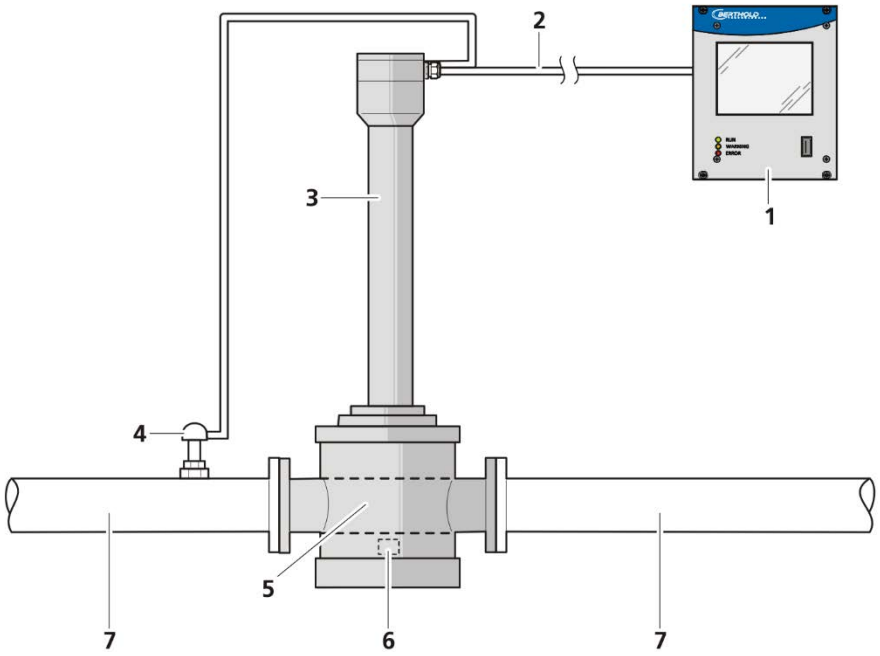
3 System Description

3.1 Overview

The radiometric density measuring system InlineSENS offers the possibility to measure the density of

- liquids,
- suspensions,
- slurries and
- bulk goods.

The measurement can be carried out directly in a product line (Fig. 1, Pos.7). The measurement is independent of variations in pressure or viscosity, and on the flow rate of the product.



1	Transmitter LB 474	4	Resistance thermometer Pt 100 (optional)
2	Connection cable	5	Implemented measuring pipe
3	Scintillation detector	6	Radioactive source
		7	Product line

Fig. 1 Exemplary measuring arrangement

Specific device configurations and calculations allow you to adapt the InlineSENS to local conditions and the conditions of the product being measured.

The measuring device comprises the following components:

- the InlineSENS with
  - radioactive source
  - pipe for the product to be measured
  - detector
- the transmitter
- the connection cable
- the resistance thermometer Pt 100 (optional)

The detector's supply voltage, the measurement signal and important information (high voltage setting, detector temperature, product temperature with connected Pt 100, etc.) are transmitted from the detector to the transmitter via connection cable.

3.2 Pressure Equipment Directive

Pressure Equipment Directive 2014/68/EU

The InlineSENS is manufactured and put on the market in accordance with the Pressure Equipment Directive 2014/68 / EU. Due to its design (DN 65, DN 50 and DN 40) the InlineSENS falls under Article 4 (3) of the Pressure Equipment Directive. The device can only be used for measurements of liquids.

- The maximum operating pressure is 10 bar
- The maximum operating temperature is 100°C
- The maximum product temperature for the version without lining is 120°C
- For the version with polypropylene lining, observe the temperature / pressure table (see document “Technical Information”)

Since different liquids, such as acids, alkalis, aggressive and abrasive media, are to be measured, different linings (PTFE, rubber) are available to protect the implemented product pipe. Observe the lower max. product temperatures in the document "Technical Information". The responsibility of choosing the right lining lies with the operator.

The InlineSENS is pressurized twice. The leak test is carried out with 2 bar air. To improve the detectability of leaks and to protect personnel, the test is carried out under water. The actual pressure test is carried out with 15.3 bar water.

As standard, the InlineSENS is equipped with water cooling. The connection of the water cooling has the size R ¼". The maximum operating pressure is 6 bar. Only clean cooling water may be used so that blockage or obstruction of the water cooling can be excluded.

On request, material certificates according to EN 10204 3.1 and pressure test certificates can be issued.

3.3 Measuring Principle

The density measurement utilizes as a measuring effect the attenuation of gamma radiation passing through the product being measured. The remaining radiation detected by the scintillation detector is a measure of the density of the respective product.

The attenuation of radiation is described as follows:

$$I = I_0 * e^{-\mu * \rho * d}$$

I = radiation detected by the detector
I_o = unattenuated radiation
μ = mass attenuation coefficient in cm^2/g
ρ = density of absorbing material in g/cm^3
d = measurement path through product in cm

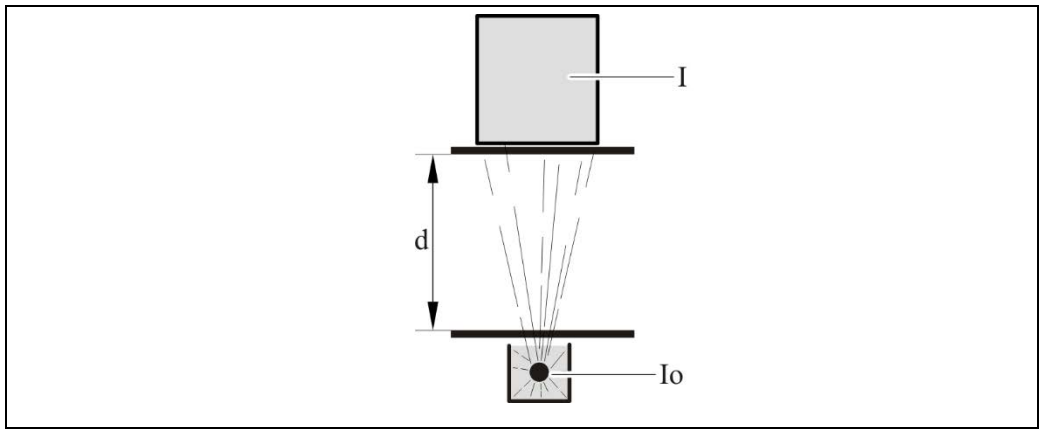


Fig. 2 Principle of measurement

The intensity of the radiation arriving at the detector is also dependent on the distance between source and detector. As in the case of light, the function involved is a square function, i.e. doubling the distance reduces the radiation intensity to ¼ if all other conditions remain unchanged.

In the InlineSENS, source, measuring pipe and detector are combined into one unit. This ensures a fixed geometry and a constant distance. Under these conditions, the radiation arriving at the detector is only dependent on the density of the material to be measured.

An activation of the product being measured, or of the pipe used for the measurement by the gamma radiation is excluded.

Using the isotopes ^{241}Am and ^{244}Cm as radioactive sources, the absorption of the radiation is not only dependent on the product density, but also very strongly on the atomic number of the elements contained therein. In comparison, ^{244}Cm shows the strongest dependence. The absorption increases with increasing atomic number. Due to this relationship, very high measurement accuracies can be achieved for products containing substances with a high atomic number (e.g. hydrochloric acid, milk of lime, sulfuric acid, etc.).

This dependence of the absorption coefficient on the atomic number has a positive effect if, for example, the sodium chloride concentration is to be determined in a saline solution and hydrocarbon impurities, such as sugar or cellulose, occur in varying proportions. The lower absorption coefficient of the impurities results in a correspondingly lower influence on the measured result.

An adverse effect is obtained if, for example, the density of a hydrocarbon mixture is to be determined, which contains impurities by a substance having a high atomic number, such as chlorine. This case results in significant changes in the absorption of the radiation even with low fluctuations in the chlorine content, so that a real density change of the product is only pretended.

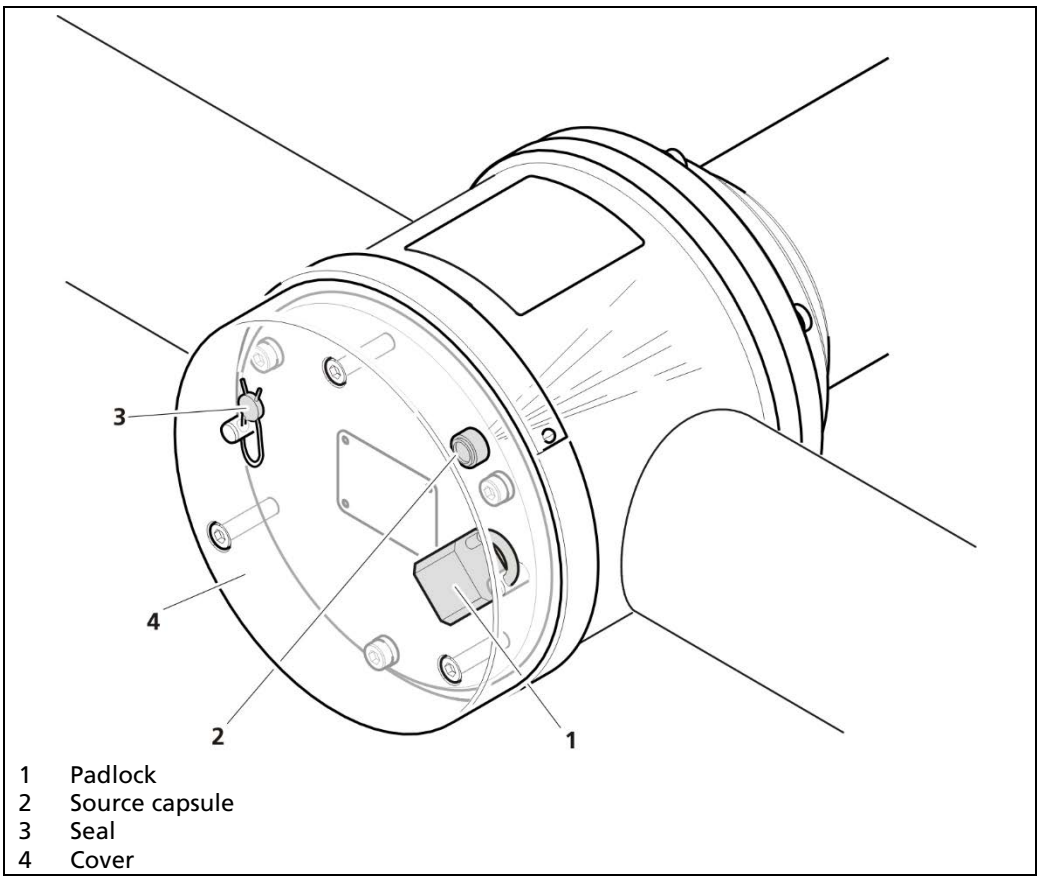
3.4 Radioactive Source

The radioactive substance is contained in a leak-proof welded source capsule (Fig. 3, Pos. 2) and installed in the housing, which connects the different components of the InlineSENS.

The screwed locking plate behind the cover (Fig. 3, Pos. 4) of the housing ensures that the source cannot be removed by unauthorized persons. The locking plate is secured on one side by a padlock (Fig. 3, Pos. 1).

The seal (Fig. 3, Pos. 3) is used to determine whether the locking plate has been opened without authorization. The locking plate must not be opened. A damaged seal must be repaired immediately by a representative of the manufacturer.

In the delivery state, the flanges are provided with protective discs, which serve to protect against reaching into and against damaging the sealing surfaces. The protective discs may only be removed right before assembly.



1 Padlock
2 Source capsule
3 Seal
4 Cover

Fig. 3 Installation location of the radioactive source

⚠ CAUTION

Danger caused by ionising radiation!

The InlineSENS contains a radioactive source. An increased exposure to radiation may lead to damage to health.

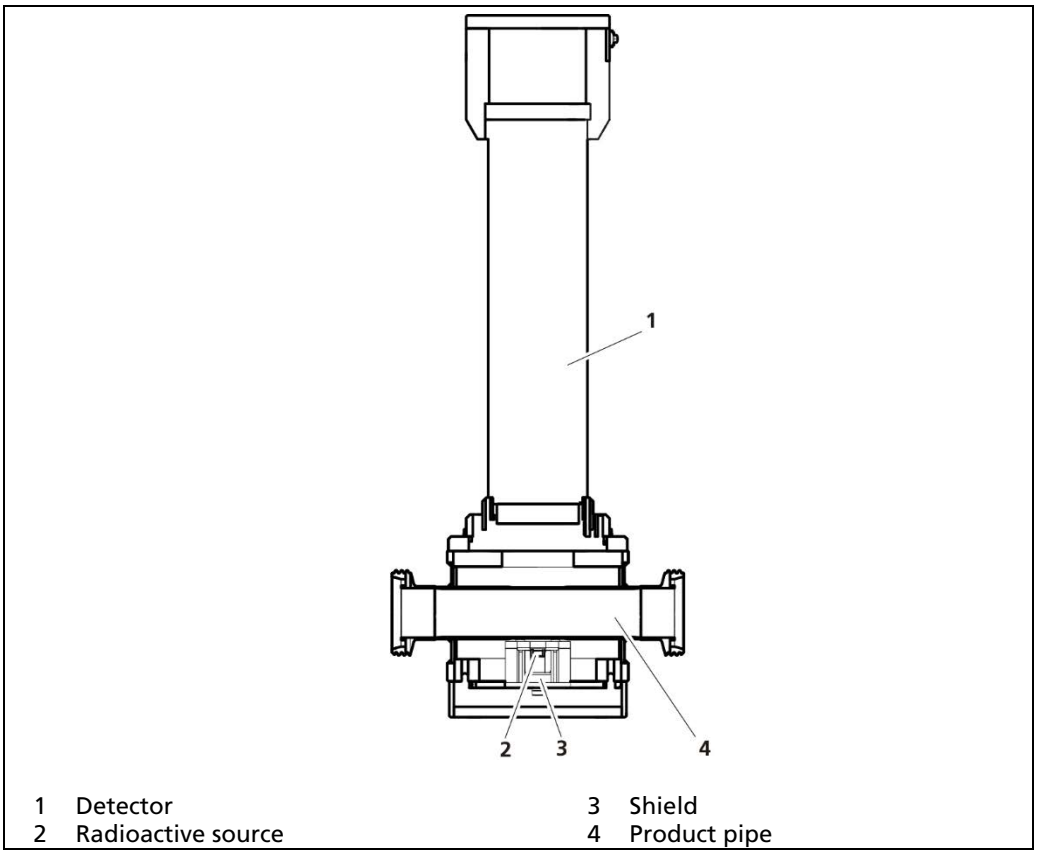
- The cover and the padlock at the locking plate must not be removed.
- Coordinate the handling of the measuring system with the radiation protection officer responsible for the operation.
- Observe the information in Chapter 2.5 Radiation Protection.

Radioactive sources for industrial applications are generally "enclosed radioactive materials" which are tightly welded into a sturdy stainless steel capsule, so that the radioactive substance cannot leak out. Contamination is therefore excluded. Moreover, for physical reasons, any activation of the product being measured by the emitted gamma radiation is not possible. The following isotopes as radiation sources can be used:

Source	Energy in keV	Half-life in years
^{241}Am	60	433
^{244}Cm	ca. 18	17,8

3.5 System Components InlineSENS with ^{241}Am

In the InlineSENS with ^{241}Am, the listed components are combined into a compact unit.



1 Detector
2 Radioactive source
3 Shield
4 Product pipe

Fig. 4 System components InlineSENS with ^{241}Am (section view)

Detector (scintillation counter)

The detector is located in the upper part of the InlineSENS.

Radioactive sources

Isotope ^{241}Am with the following activities:

- 1110 MBq (30 mCi)
- 3700 MBq (100 mCi)

The energy of the radiation emitted by ^{241}Am is 60 keV and the half-life is 433 years.

Shield

The radioactivity is shielded by the shield of brass and stainless steel and by the housing of stainless steel to such an extent that no additional protective measures are required, even when the product pipe is empty.

Product pipe

The product pipe is available in the following versions:

Pipe diameter and type of connection	Inlining		
	Without	PTFE	Rubber*
DN65 DIN flange	x	x	x
DN65 ASA flange	x	x	x
DN65 threaded coupling	x	-	-
DN40 threaded coupling	x	-	-
DN40 DIN flange	x	-	-

* Soft rubber

For protection against aggressive or sticking products, a version of the InlineSENS with a product pipe lined with PTFE (Teflon) is recommended. To protect the pipes from abrasive wear, a lining made of soft rubber is recommended. For the use e.g. in the food industry, the InlineSENS can be supplied with a product pipe with threaded connections according to DIN 11851-SC (DN65 and DN40). No lining is possible with this design.

The material properties of the product pipes and linings are listed in the document “Technical Information”.

3.6 System Components InlineSENS with ^{244}Cm

This InlineSENS version has a similar design as the one with ^{241}Am. It consists of the listed components.

Detector (scintillation counter)

The detector is located in the upper part of the InlineSENS.

Radioactive Sources

Isotope ^{244}Cm with an activity of 3700 MBq (100 mCi).

The energy of the radiation emitted by ^{244}Cm is 18–22 keV and the half-life is 17.8 years.

Shield

The radioactivity is shielded by the shield of brass and stainless steel and by the housing of stainless steel to such an extent that no additional protective measures are required, even when the product pipe is empty.

Product pipe

The product pipe is available exclusively with DIN flanges in DN40 and DN50 including a polypropylene liner.

4 Installation

4.1 Safety Instructions

⚠ WARNING

Danger of injury by falling loads!

- Never stand underneath a lifted or suspended load, keep a safe distance.
- Only use tested sling gear components appropriate for the transport weight.
- Observe the marking for the centre of gravity on the outer packaging, if applicable.
- Wear head protection and safety shoes.

IMPORTANT

The applicable national regulations of the country of use have to be observed!

4.2 General Instructions

⚠ WARNING

Danger from impermissible process conditions!

The InlineSENS can be damaged by excessive pressure, vibrations and / or inadmissible ambient conditions.

- The max. pressure in the measuring pipe must not exceed 10 bar resp. 1000 kPa.
- The permissible ambient conditions must be guaranteed.
- Take device out of service immediately if damaged.

NOTE

The intended use of the InlineSENS is specified in the project planning phase and determined by means of drawings, sketches or written notes. During installation, these specifications must be strictly observed since deviations may lead to malfunction of the measuring system.

The device with the radioactive source is delivered in a box in compliance with the regulations concerning the transportation of radioactive substances. Take the InlineSENS out of the box just prior to installation. Until then, store it in a location that is guarded against unauthorized access.

The flanges of all parts are provided with protective discs to prevent reaching into and to prevent damaging the sealing surfaces during transport and storage. The protective discs may only be removed right before assembly. If the discs are removed for inspection, they must be reattached in any case.

Work is performed according to the instructions and under the supervision of the Radiation Safety Officer.

NOTE

If the device is damaged, it must be taken out of service and must be removed immediately.

- In case of damage notify the manufacturer or its local representative.
- Also notify the competent supervisory authority.

4.3 Preparing the Installation

To avoid an unnecessary exposure to radiation, the handling period of the InlineSENS must be kept as short as possible during installation. It is therefore recommended to perform the following steps prior to delivery of the device:

- Installation planning (incl. estimation of radiation exposure).
- Instruction of the employees.
- Organising and cleaning the installation site.
- Preparing the required tools and hoisting devices.
- Removing all obstacles which might hinder the installation of the InlineSENS.

4.4 Unpacking / Scope of Delivery

The product will be delivered completely configured according to the purchase order. Check your delivery for completeness and damage according to your order. Please report missing, defective or incorrect parts immediately.

4.5 Selection of Measuring Site

When selecting the installation site, please keep in mind:

- During operation at the measuring site, the pipeline must always be completely filled with the product to be measured.
- Corrosion, abrasion or wall deposits must not occur at the pipeline walls. This risk is least likely with installations on vertical pipes.
- Gas bubbles (Fig. 5, Pos. 1) in the product falsify the results. This risk can be avoided or at least reduced by:
  - Performing measurements under fairly high pressure (installation in pressure pipes, at the foot of a standpipe).
  - If no air bubbles are to be expected in the product, the suction side of the pump should preferably be used for installation to exclude air bubbles which might occur as a result of damaged pump seals.
  - Measurements on horizontal pipelines should be performed using horizontal irradiation to reduce errors caused by deposit formation (Fig. 5, Pos. 2) and gas bubbles (Fig. 5, Pos. 1).

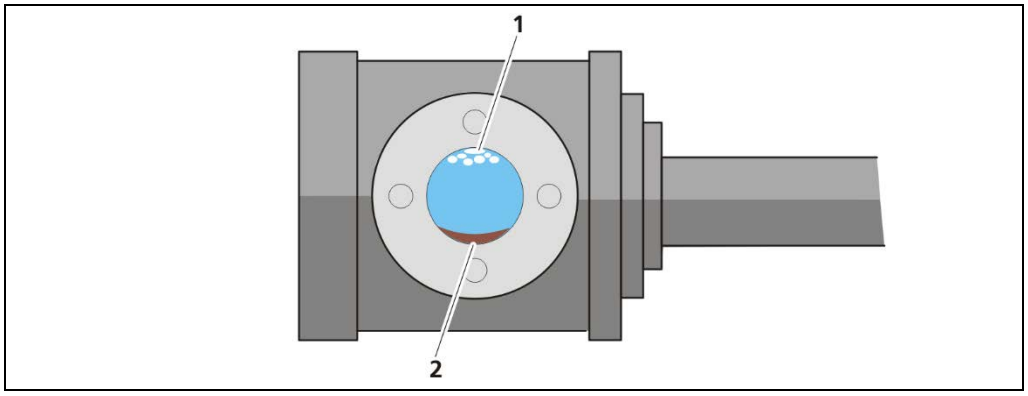


Fig. 5 Gas bubbles and debris in the product pipe

Extensions of the pipeline should be avoided. If they are unavoidable, they should always be performed only on vertical lines. Pipe extensions may be made at the measurement location only if

- a continuous flow of product is ensured over the entire pipe cross section. Particularly with highly viscous products this will not always be the case. Usually, for highly viscous products the product flows only in the center. However, by the measurement, the product in the radiation path is detected over the entire diameter. Therefore, the measurement result is not representative.
- no gas bubbles are present in the radiation path.

Suspension measurements must not be carried out directly behind a pipe bend, since the material will not be distributed homogeneously at this location. The distance from the pipe bend must be the larger

- the higher the flow rate
- the bigger the difference between liquid density and solid density

Measuring system installed outdoors have to be protected from rain and direct sunshine by a canopy.

The pipeline must not be subject to heavy vibrations as this could damage the detector. Vibration dampers have to be installed, if necessary.

Samples have to be taken for calibration of the measurement. A sampling location has to be provided in the direct vicinity of the measuring site.

4.6 Installation instructions for InlineSENS versions with PTFE lining

Lined parts must not be welded, soldered or burned as this can destroy the plastic material.

When connecting flanges plane parallel, no further seals are required between the sealing surfaces. However a further seal is possibly required, when attaching a sealing surface to a flange made of metal, glass, carbon or ceramic, if that flange is not plane parallel. This PTFE seal, which should be about 4 mm thick, can then absorb tensions and inhomogeneities as a resilient sealing element.

The screws should be tightened to a torque of 45 Nm. The sealing surface may get deformed if the screws are tightened too much during installation of pipe parts. During commissioning of a pipeline system the flange screws should be retightened once more to the specified torque after reaching the final temperature.

NOTE

If a flange connection leaks, although all screws are tight, DO NOT RETIGHTEN but loosen the screws on the side opposite the leak and tighten the other side. If the leak persists, examine the sealing surfaces for grooves or chips, which may be the cause of the leak. If the impressions or damage are no deeper than about 15% of the flange thickness, these can be removed with fine emery cloth.

4.7 Installation of the InlineSENS with ^{241}Am

1. Make sure that the maximum permissible pressure in the product pipe is not exceeded. Note the values in the document “Technical Information”.
2. You have to check whether the resistance of the pipe material and the liner is suitable for the intended application. The exact material name is stamped on the flange or on the pipe.
3. No covers or housing parts may be removed. Do not open screws.
4. Assemble the InlineSENS according to the plant operator's instructions.

4.8 Installation of the InlineSENS with ^{244}Cm

1. The permissible operating pressure of the product pipe made of polypropylene decreases with increasing temperature. Corresponding values can be found in the table in chapter "Permissible operating pressure of the ^{244}Cm InlineSENS in the document "Technical Information".
2. You have to check whether the material of the product pipe is suitable for the intended application.
3. No covers or housing parts may be removed. Do not open screws.
4. Assemble the InlineSENS according to the plant operator's instructions.

4.9 Installation of the Resistance Thermometer Pt 100

A temperature measurement must be carried out in such a way that the measured temperature is as close as possible to the product temperature at the density measuring site. The resistance thermometer must not obstruct the radiation path.

If the resistance thermometer cannot be installed in the pipeline, it may also be mounted on the outside of the pipeline.

The pipeline with the mounted resistance thermometer must be provided with thermal insulation over a length of 1-2 m to ensure that the surface temperature of the pipeline at the temperature measuring location is as close as possible to the product temperature.

Nevertheless, especially with plastic lines or lined pipelines, temperature-related measuring errors may occur in the case of very rapid temperature changes in the measured material. The change in density is detected by the measurement without time delay, however, the necessary temperature correction is delayed due to the inertia of the temperature measurement. This influence can be reduced by operating the measuring device with the greatest possible time constant.

4.10 Water Cooling

The detector must not exceed the maximum operating temperature (see values in the document "Technical Information" Mat. No. 56926-5TI). The temperature of the product to be measured, the ambient temperature, solar radiation, radiant heat from hot components and heat transfer through mounting materials must be taken into account. If significant heating may occur, the InlineSENS version with water cooling has to be used. Retrofitting a water cooling system to a model without water cooling is technically not possible.

Coolant

Water should preferably be used as cooling medium, because air does not ensure adequate cooling at high temperatures. The water must be clean to avoid the buildup of dirt particles in the cooling jacket, which would have an adverse effect on the cooling efficiency.

Cooling Water Flow

Water must enter from below and exit at the top. Thus, the cooling jacket is always filled with water, ensuring good thermal insulation. The connection cables used have to be able to withstand higher ambient temperatures.

Cooling Water Demand

For the minimum cooling water demand, please refer to the information "Cooling Water Demand point detector" in the document "Technical Information" of LB 4700, Mat. No. 56926TI.

NOTE

When operating in areas with danger of explosion, observe the specific ambient temperature limits, which are specified in the safety manual and in the document "Technical Information" of LB 4700, Mat. No. 56926TI.

NOTE

If water remains in the water cooling systems at ambient temperatures below the frost point, the cooling water system can be damaged.

- If there is a risk of frost, empty the water cooling system.

NOTE

If there is a risk that the maximum operating temperature is exceeded, the cooling water circuit must remain in operation even if the detector is switched off.

NOTE

A failure of the cooling water system or an insufficient flow can overheat the detector and thereby cause damage. For cooling, exclusively use water of drinking water quality.

5 Electric Installation

For correct electric installation, observe the operating manual for the LB 4700 detectors, Mat. No. 56926BA2.

6 Operation

6.1 Operating Concept

For operation, different user interfaces are available

1. transmitter LB 474
2. transmitter LB 444
3. PC software (via detector service modem)

The detector internal diagnostic functions and diagnostic data are not available when operating the detector with the transmitter LB 444.

The operation and parameterisation are described solely by the example of the PC software. For information on the operation of the detector with the transmitter LB 474 and LB 444, please refer to the respective operating manual of the transmitter.

6.2 Detector Code

The correct detector code is set at the factory and a change is normally not required. A table with the detector codes to be used is found below:

LB Number	Nuclide	Detector Code
LB 4700-51…5-… and LB 4700-5A…E-…	^{241}Am	2
LB 4700-56/7-… and LB 4700-5F/G-…	^{244}Cm	3* 4**

* for ambient temperatures of 0...60°C

** if negative ambient temperatures can also occur (-40...60°C)

6.3 Measuring Path

To perform a correct measurement, the measuring path in the product must be entered in the transmitter (LB 444 or LB 474). The measuring path depends on the pipe diameter and its lining (for dimensions see "Technical Information").

LB 474

The measuring path is entered in the transmitter LB 474 in the menu Device Settings | Setup | Calibration | Calibration Settings: Parameters | Enviroment. Enter the measuring path in the "Measuring distance" input field in mm.

LB 444

The measuring path is entered in the transmitter under ect. | Parameters | Product data | Measuring path. Enter the measuring path in **cm**.

7 Maintenance and Repair

⚠ CAUTION

Danger from unauthorized repair work!

The InlineSENS contains a radioactive source. Unauthorized repairs can lead to increased radiation exposure and / or contamination.

- Tests and repairs may only be carried out by a service technician authorized by Berthold.
- Do not carry out any repair work on the shield / source.

IMPORTANT

Both the measuring pipe and the detector electronics can be exchanged if necessary. However, this must be done by a service technician authorized by Berthold.

7.1 Visual Inspection

The visual inspection must be carried out by persons who are at least employees with general knowledge at the following intervals:

- before initial commissioning
- with every repair that may be required
- regularly at least every six months
- before dispatch

When determining the intervals for the visual inspection, the following conditions are to be considered:

- ambient conditions (outdoors, rain, sunlight, wind)
- operating conditions (degree of utilisation of the plant, misuse)

Performing the Visual Inspection:

1. Check the InlineSENS for obvious damage (dents, cracks, holes etc.) and corrosion.
2. Only before dispatch: Check whether the protective discs are mounted on the flanges.
3. If any defects are identified during visual inspection, inform the radiation safety officer who will initiate the measures required for repairing the defects.

For further information, please contact the manufacturer.

7.2 Leak Test Source Container

Depending on the supervisory authority responsible for the area where the source is used, regular leak tests must be carried out. These tests are to be carried out at the discretion of the competent supervisory authority either by an authorized expert or by the manufacturer. For this test, the corresponding source documentation must be made available.

Required documents

- Inventory list of the sources to be tested including indication of previous leak tests.
- **Source certificate containing the following information:** Nuclide, activity, procurement date, physical/chemical form, description of the enclosure and type of sealing, resistance against mechanical and thermal influences or classification of the source design. The source certificate is provided together with the source.
- Information on the location, application as well as on the maximum customary mechanical and thermal strains.
- If the source is installed in a device, a drawing is to be provided. In the drawing, the position of the source and of all parts intended to protect the source against external influences must be clearly indicated. Recommendations regarding the most appropriate test method should be given, e.g. by indicating alternative test areas. If required, recommendations should be given on how the necessary test can be conducted without affecting the functionality of the system or device.

Alternative Test Areas

Substitute test areas are those areas on the InlineSENS where contamination is most likely to occur if the radiator is not tight.

As an alternative test surface, the upper side of the firmly screwed locking plate, which is located under the cover (Fig. 3, Pos. 4) is recommended.

7.3 Checking the Pipe

The pipes and the lining should be checked for intactness and leaks at least once a year. If damage is suspected, the radiation protection officer and the manufacturer or local representative must be informed immediately.

7.4 Repair

The repair of the detector is described in the operating manual for the detector, Mat. No. 56926BA2.

8 Decommissioning

⚠ DANGER

Danger to life from electric shock!

- The decomissioning may only be carried out by a qualified electrician.
- Please adhere to the relevant safety regulations.
- Only open the device when free of voltage.

In case of an electric shock, carry out first aid measures and immediately call an emergency service.

⚠ WARNING

Danger of injury by falling loads!

- Never stand underneath a lifted or suspended load, keep at a safe distance.
- Only use tested sling gear components appropriate for the transport weight.
- Observe the marking for the centre of gravity on the outer packaging, if applicable.
- Wear head protection and safety shoes.

⚠ CAUTION!

Danger caused by ionising radiation!

The InlineSENS contains a radioactive source. An increased exposure to radiation may lead to damage to health.

- Consult the radiation safety officer responsible for your company.

Follow this sequence for decommissioning:

1. Remove all cables from the detector and if necessary from the Pt 100.
2. Remove the InlineSENS off the product pipe as specified by the plant operator.

8.1 Disposal of radioactive Substances

NOTICE

Should you have any questions regarding the transportation or disposal of radioactive substances, please contact the manufacturer.

Generally, each country has a depot where radioactive material is accepted and can be disposed of.

8.2 Shipment of radioactive Substances

If you wish to dispatch radioactive material, you must observe the international regulations for the transport of dangerous goods and for radiation protection as well as any applicable national regulations. It is the full responsibility of the sender to comply with these regulations.

The general rules:

- It must be checked whether the product may be shipped as an excepted package.
- The dose rate on the surface of the packaging must be less than 2000 µSv/h.
- The dose rate at a distance of 1m from the surface of the packaging must be less than 100 µSv/h.
- The packaging must be marked with a reference for dangerous goods in accordance with the applicable regulations with the UN number.
- Furthermore, transport documents with the correct description of the content as well as an accident procedures sheet according to the ADR regulations are required.
    - With regard to transport by air, the IATA DGR.
    - IAEA as the basis for all regulations.
- Packaging must comply with the current ADR regulations (for example European Agreement concerning the International Carriage of Dangerous Goods by Road).
- The cargo must be secured in the transport vehicle according to the applicable national and international regulations.
- Before dispatch, every product that contains a source must be subjected to a visual inspection by the user. The product may only be dispatched if the test requirements are met.
- At the time of dispatch, a valid certificate concerning the leak proofness of the source must be available.

IMPORTANT

Under special circumstances, the density measuring unit can be sent as an exempt package.

Preconditions for returns to BERTHOLD TECHNOLOGIES GmbH & Co. KG

- Radioactive substances and their shields must not be damaged in any way and a respective, valid seal test certificate must be provided. The seal test certificate must have a remaining validity of at least 6 months before the arrival of the radioactive material in Germany.
- If radioactive sources with isotope ^{241}Am or ^{244}Cm are returned, the special form certificate must be attached.
- At all times, any radioactive material sent to us must be sufficiently labelled with your name and address. If we have sent you a quotation in advance, our quotation number must be indicated, as well.
- Radioactive substances may only be returned after the respective approval by Berthold. We are pleased to send you a quotation regarding the costs.
- Radioactive substances must be sent to Bad Wildbad, Germany, carriage paMat. Berthold will not assume any costs for customs clearance or transportation.
- Berthold is to be informed about any return transport in advance. Berthold will reject any radioactive substances sent to Berthold without prior notice. Any storage costs accrued in such case shall be borne by the sender.
- A notification of the radioactive sources you wish to send to Berthold. We will be pleased to send you the current version of the message form.
- Berthold is to be informed about any return transport in advance. Berthold will reject any radioactive substances sent to Berthold without prior notice. Any storage costs accrued in such case shall be borne by the sender.

NOTICE

Observe the observance of the current regulations when taking them out of operation and disposal.

Modifications due to technical advancement reserved.

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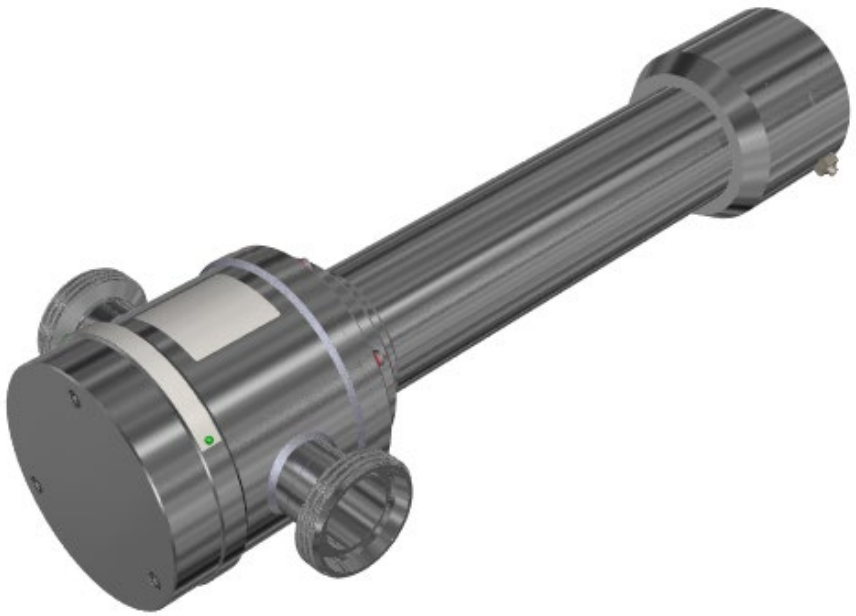
Mat. No. 56926-5BA2

BERTHOLD



InlineSENS LB 4700-5x

InlienSENS LB 4700-5x

Duo SERIES

Technical Information

Technische Information

56926-5TI
Rev. No.: 00, 04/2021

detect and identify

2 Wire Technology

The LB 4700 InlineSENS combines radioactive source and detector into one. A separate transmitter is used for display and operation.

The transmitter is a state-of-the-art control unit with robust 3.5" TFT touch panel, powerful Dual Core CPU and diverse operator interfaces. Advanced self diagnostics and monitoring features ensure a safe function of the system. Furthermore, the data logging functionality allows operators to analyze their processes in depth, e.g. develop trends, track process changes etc.

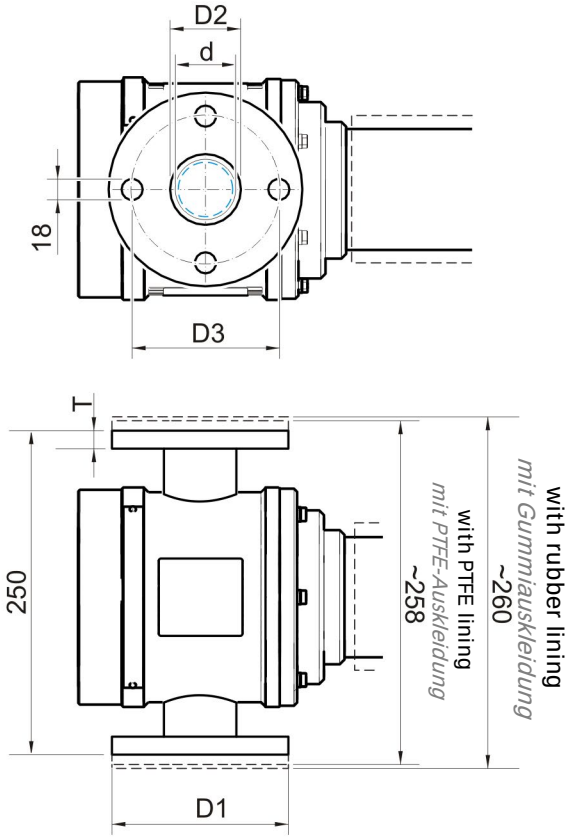
2-Leiter Technologie

Die LB4700 InlineSENS Dichtemessstrecke fasst Strahlenquelle und Detektor in einer Messeinheit zusammen. Eine separate Auswerteeinheit dient zur Anzeige und Bedienung.

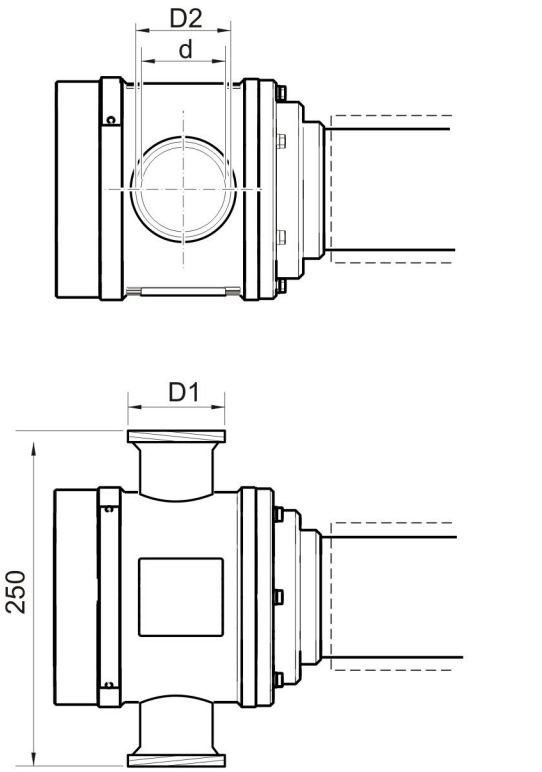
Die moderne Auswerteeinheit verfügt über ein 3,5" Touch Panel, eine starke Dual Core CPU und verschiedenen Bedien-Optionen. Erweiterte Funktionen zur Selbstdiagnose und Überwachung sorgen zudem für höchste funktionale Sicherheit der Messung im Betrieb. Darüber hinaus können die Betreiber die Daten-Log Funktionen für eine detaillierte Prozessanalyse nutzen und so zum Beispiel Trends entwickeln oder Prozessänderungen nachvollziehen.

InlineSENS LB 4700-5x

DIN & ASA Flange Version
DIN & ASA Flansch-Ausführung



Version with threaded connector
Ausführung mit Gewindestutzen



Dimensions in mm
Abmessungen in mm

Flange *Flansch*	D1	D2	D3	T	d1	d2 Rubber	d2 PTFE[3]	d2 PP[2]	Weight *Gewicht*	Weight with WC *Gewicht mit WC*
DN65 DIN	185	76.1	145	18	68.9	ca. 58.9	ca. 60.9	-	on request / *auf Anfrage*	
DN65 ASA	177.8	76.1	139.7	22	68.9	ca. 58.9	ca. 60.9	-		
DN65 threaded connector	95x1/6"	76.1	-	8	68.9	-	-	-		
DN40 threaded connector	65x1/6"	40	-	7	37	-	-	-		
DN40 DIN	150	48.3	110	18	43.1	-	-	-		
DN40 DIN (PP)	on request / *auf Anfrage*									
DN50 DIN (PP)	165	68	125	18	-	-	-	51		

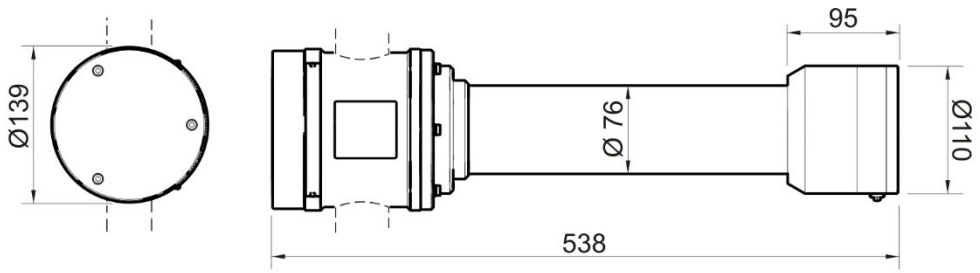
[1] Water Cooling
Wasserkühlung

[2] Polypropylene
Polypropylene

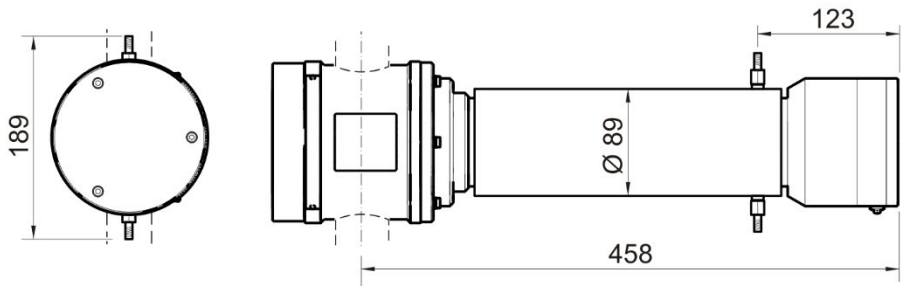
[3] Polytetrafluoroethylene
Polytetrafluoroethylene

InlineSENS LB 4700-5x

Without water-cooling
Ohne Wasserkühlung



With water cooling
Mit Wasserkühlung



Dimensions in mm
Abmessungen in mm

Fitting Connection *Anschluss-Stutzen*	Mat. No. (material) *Mat. Nr. (Werkstoff)*
R ¼" pipe connection, male European standard Whitworth pipe thread *R ¼" Außengewinde für Rohrverschraubung europäisches Standard Whitworth-Rohrgewinde*	included in standard water cooling *enthalten bei Standard-Wasserkühlung*
10 mm hose connection for water hose connection ID 10 mm *Schlauchstutzen für Schlauch-Innendurchmesser 10 mm*	
fitting adaptor ½" NPT female *Adapter mit ½" NPT Innengewinde*	47189 (304/1.4301)
fitting adaptor ¼" NPT female *Adapter mit ¼" NPT Innengewinde*	46743 (304/1.4301)
fitting adaptor ½" NPT male *Adapter mit ½" NPT Außengewinde*	6352 (304/1.4301)
fitting adaptor ¼" NPT male *Adapter mit ¼" NPT Außengewinde*	6349 (304/1.4301)

Permissible operating pressure of the Cm-244 measuring unit
Zulässiger Betriebsdruck der Cm-244 Messstrecke

Temperature in °C *Temperatur in °C*	max. pressure in bar resp. in x10^5 Pa *max. Druck in bar bzw. in x10^5 Pa*
20	9.8
30	9.8
40	6
50	4.9
60	3.5
70	2.1
80	1.1
90	0.8

Absorption Coefficients
Absorptionskoeffizienten

Absorption coefficients for Am-241 for one-point calibration. The absorption coefficients were calculated for average concentrations. Depending on the resolution behavior, these values may differ with other concentrations. Absorption coefficients in cm²/g

Absorptionskoeffizienten für Am-241 bei Einpunktkalibrierung. Die Absorptionskoeffizienten wurden für mittlere Konzentrationen berechnet. Aufgrund des Lösungsverhaltens können sich bei anderen Konzentrationen Abweichungen ergeben. Absorptionskoeffizienten in cm²/g.

Product *Produkt*	**Unit of measure** *Messgröße*		
	g/cm³	**Concenctration** *Konzentration* **in g/l**	**Concenctration** *Konzentration* **in %**
Whole milk *Vollmilch*	-0.163	-0.0000375	-0.00039
Skimmed milk *Magermilch*	-0.163	-0.00006	-0.00065
Whey *Molke*	-0.163	-0.000058	-0.00074
Starch – Water *Stärke – Wasser*	-0.146	-0.0001	-0.001
Sugar solution *Zuckerlösung*	-0.131	-0.000048	-0.00064
Hydrochloric acid ($HCl - H_2O$) *Salzsäure ($HCl - H_2O$)*	-0.635	-0.00028	-0.0032
Sulfuric acid ($H_2SO_4 - H_2O$) *Schwefelsäure ($H_2SO4 - H_2O$)*	-0.257	-0.00013	-0.00242
Nitric acid ($HNO_3 - H_2O$) *Salpetersäure ($HNO_3 - H_2O$)*	-0.117	-0.000037	-0.00062
Phosphoric acid ($H_3PO_4 - H_2O$) *Phosphorsäure ($H_3PO_4 - H_2O$)*	-0.235	-0.000140	-0.00261
Sodium hydroxide ($NaOH - H_2O$) *Natronlauge ($NaOH - H_2O$)*	-0.175	-0.000111	-0.00179
Lime ($Ca(OH)_2 - H_2O$) *Kalkmilch ($Ca(OH)_2 - H_2O$)*	-0.426	-0.00038	-0.00522
Saline ($NaCl - H_2O$) Kochsalzlösung ($NaCl - H_2O$)	-0.377	-0.000238	-0.0029
Potassium chloride ($KCl - H_2O$) Kaliumchloridlösung ($KCl - H_2O$)	-0.642	-0.00036	-0.0044
Magnesium sulfate solution ($MgSO_4 - H_2O$) *Magnesiumsulfatlösung ($MgSO_4 - H_2O$)*	-0.219	-0.00019	-0.00256
Sand - water ($SiO_2 - H_2O$) *Sand - Wasser ($SiO_2 - H_2O$)*	-0.226	-0.00014	-0.00187
Titanium dioxide - water ($TiO_2 - H_2O$) *Titandioxid - Wasser ($TiO_2 - H_2O$)*	-0.556	-0.00042	-0.0048
Ethanol - water ($C_2H_6O - H_2O$) *Äthanol - Wasser ($C_2H_6O - H_2O$)*	-0.183	+0.000049	+0.00038
Methanol - water ($CH_4O - H_2O$) *Methanol - Wasser ($CH_4O - H_2O$)*	-0.177	+0.000047	+0.00037
Glycerin - water ($C_3H_5(OH)_3 - H_2O$) *Glyzerin - Wasser ($C_3H_5(OH)_3 - H_2O$)*	-0.125	-0.000027	-0.00033

Temperature Coefficients
Temperatur Koeffizienten

Product *Produkt*	*Concentration* *Konzentration* in Gew. %	Aver. Temp. *Mittlere Temp. in °C*	Input value at *Eingabewert bei*			
			g/cm³	g/l	%	°Be
H_2O - H_2SO_4	20	30	5.9500E-04	1.0220E+00	8.0000E-02	5.3100E-03
	50	30	6.9500E-04	1.9320E+00	1.0300E-01	7.7300E-03
	80	30	1.0150E-03	2.5190E+00	1.0000E-01	4.9900E-03
	20	60	6.3500E-04	1.1070E+00	8.8000E-02	1.2920E-02
H_2O - NaOH	10	30	0.00047	0.528	0.04315	0.00436
	30	30	0.00062	0.974	0.05964	0.00308
	50	30	0.00072	1.44	0.0759	0.00684
	10	60	0.00055	0.628	0.0521	0.0064
	30	60	0.00065	1.02	0.0634	0.00353
	50	60	0.0007	1.404	0.075	0.00681
H_2O - HCl	10	25	3.3000E-04	7.3600E-01	6.7200E-02	2.9300E-03
	30	25	6.0000E-04	1.5720E+00	1.2150E-01	8.0000E-03
	10	75	5.3800E-04	1.1960E+00	1.1160E-01	4.1450E-02
	30	75	5.7600E-04	1.6610E+00	1.3330E-01	4.4380E-02
Sugar solution *Zuckerlösung*	10	20	0.0002377	0.621	0.05748	0.000823
	30	20	0.000341	0.908	0.07144	0.001245
	50	20	0.000436	1.196	0.0794	0.001488
	70	20	0.000518	1.457	0.0855	0.00355
	10	50	0.000472	1.247	0.1167	0.00339
	30	50	0.000582	1.395	0.1111	0.00302
	50	50	0.000559	1.536	0.1033	0.00254
	70	50	0.000588	1.654	0.0983	0.00475
	10	70	0.000582	1.538	0.145	0.00531
	30	70	0.000608	1.631	0.131	0.00426
	50	70	0.000627	1.718	0.117	0.00328
	70	70	0.000632	1.768	0.106	0.00561
	10	80	0.000632	1.665	0.1583	0.00636
	30	80	0.000649	1.173	0.1401	0.00491
	50	80	0.000658	1.794	0.1223	0.00365
	70	80	0.000641	1.785	0.1072	0.00582

Temperature Coefficients
Temperatur Koeffizienten

	Temperature *Temperature* in °C	Input value *Eingabewert* g/cm³
Water *Wasser*	10	1.5000E-04
	20	2.0300E-04
	30	2.9900E-04
	40	3.8000E-04
	50	4.5700E-04
	60	5.1300E-04
	70	5.7100E-04
	80	6.2350E-04
	90	6.7000E-04

NOTICE HINWEIS

Water temperature coefficients can be used for many low concentration products, such as milk, beer, whey, starch suspension, etc. For concentrated milk, whey, cottage cheese, etc. the values given for sugar solution can be used with good approximation.

Die Temperaturkoeffizienten von Wasser können für viele Produkte mit niedriger Konzentration benutzt werden, z.B. Milch, Bier, Molke, Stärkesuspensionen, usw. Für konzentrierte Milch, Molke, Quark, usw. können die für die Zuckerlösung angegebenen Werte mit guter Näherung verwendet werden.

Density of Water as a Function of the Temperature

Dichte von Wasser in Abhängigkeit von der Temperatur

Temperature *Temperature* in °C	Density *Dichte* g/cm³
10	0.99973
11	0.99963
12	0.99951
13	0.99939
14	0.99926
15	0.99911
16	0.99896
17	0.99879
18	0.99861
19	0.99843
20	0.99823
21	0.99801
22	0.99779
23	0.99755
24	0.99731
25	0.99706
26	0.99680
27	0.99653
28	0.99625
29	0.99597
30	0.99567
31	0.99536
32	0.99504
33	0.99472
34	0.99439
35	0.99405
36	0.99370
37	0.99335
38	0.99299
39	0.99262

Temperature *Temperature* in °C	Density *Dichte* g/cm³
40	0.99224
41	0.99185
42	0.99146
43	0.99106
44	0.99065
45	0.99024
46	0.98982
47	0.98939
48	0.98896
49	0.98852
50	0.98807
51	0.98761
52	0.98715
53	0.98668
54	0.98621
55	0.98673
56	0.98524
57	0.98475
58	0.98425
59	0.98375
60	0.98324
61	0.98272
62	0.98220
63	0.98167
64	0.98113
65	0.98059
66	0.98005
67	0.97950
68	0.97894
69	0.97838

Temperature *Temperature* in °C	Density *Dichte* g/cm³
70	0.97781
71	0.97723
72	0.97665
73	0.97607
74	0.97548
75	0.97488
76	0.97428
77	0.97368
78	0.97307
79	0.97425
80	0.97183
81	0.97120
82	0.97057
83	0.96993
84	0.96929
85	0.96864
86	0.96799
87	0.96734
88	0.96668
89	0.96601
90	0.96534
91	0.96467
92	0.96399
93	0.96330
94	0.96261
95	0.96192
96	0.96122
97	0.96052
98	0.95981
99	0.95910

Technical Data
Technische Daten

Operating Temperature (Detector) *Betriebstemperatur (Detektor)*	**<u>extended temperature range with metallic cable glands:</u>** **-40 ... +60 °C (-40 ... +140 °F)** **<u>extended temperature range with water cooling system:</u>** **-40 ... 100 °C (-40 ... +212 °F)** **Observe the max. permissible ambient and surface temperatures for explosion protection (see Safety Manual / Explosion Protection Manual).** *<u>erweiterter Temperaturbereich mit metallische Kabelverschraubungen:</u>* *-40 ... +60 °C (-40 ... +140 °F)* *<u>erweiterter Temperaturbereich mit zusätzlicher Wasserkühlung:</u>* *-40 ... 100 °C (-40 ... +212 °F)* *Beachten Sie die max. zulässigen Umgebungs-und Oberflächentemperaturen für den Explosionsschutz (siehe Sicherheitshandbuch / Explosionsschutzhandbuch).*
Storage Temperatur *Lagertemperatur*	-40 ... +60 °C (-40 ... +140 °F)
Product Temperature *Produkttemperatur*	without lining: 0… +120 °C (32 … +248 °F) with rubber lining: 0… +80 °C (32 … +176 °F) with PTFE lining: 0… +120 °C (32 … +248 °F) with PP lining: 0 … +90 °C (32 … +194 °F) **Temperature-pressure dependency: see table on previous page "Permissible operating pressure of the Cm-244 measuring unit"** The given temperatures are based on both the operating temperature of the detector and the temperature resistance of the lining. Regarding the product temperature, it must be ensured that sufficient flowability is guaranteed at low temperatures and that gas formation can be excluded at all temperatures. *ohne Auskleidung: 0 … +120 °C (32 … +248 °F)* *mit Gummiauskleidung: 0 … +80 °C (32 … +176 °F)* *mit PTFE Auskleidung: 0 … +120 °C (32 … +248 °F)* *mit PP Auskleidung: 0 … +90 °C (32 … +194 °F)* ***Temperatur-Druckabhängigkeit: siehe Tabelle vorherige Seite "Zulässiger Betriebsdruck der Cm-244 Messtrecke"*** *Die angegebenen Temperaturen richten sich sowohl nach der Betriebstemperatur des Detektors als auch nach der Temperaturbeständigkeit der Auskleidung. Bei der Produkttemperatur ist darauf zu achten, dass bei tiefen Temperaturen eine ausreichende Fließfähigkeit gewährleistet wird und bei allen Temperaturen eine Gasbildung ausgeschlossen werden kann.*
Housing material detector *Gehäusematerial detector*	Stainless steel ISO 1.4301 / AISI 304 (other materials on request) *Edelstahl ISO 1.4301 / AISI 304 (andere Materialien auf Anfrage)*
Housing Material Connection Piece *Gehäusematerial Verbindungsstück*	Stainless steel ISO 1.4301 / AISI 304 (other materials on request) *Edelstahl ISO 1.4301 / AISI 304 (andere Materialien auf Anfrage)*
Material and possible diameters of product pipe *Material und mögliche Durchmesser des Produktrohrs*	Stainless Steel ISO 1.4571 or 1.4404 / AISI 316 DN 65, DN 50, DN 40 *Edelstahl ISO 1.4571 oder 1.4404 / AISI 316* *DN 65, DN 50, DN 40*
Flange and threaded connection *Flansch- & Gewindeanschluss*	Flanges DIN EN 1092-1 (DN 65, DN 50, DN 40); Stainless Steel ISO 1.4571 or 1.4404 / AISI 316; Flanges ASME B16.5 DN 65; Stainless Steel ISO 1.4571 or 1.4404 / AISI 316; Threaded connections DIN 11851-SC (DN 65, DN 40) Stainless Steel ISO 1.4571 or 1.4404 / AISI 316 *Flansche DIN EN 1092-1 (DN 65, DN 50, DN 40); Edelstahl ISO 1.4571 oder 1.4404 / AISI 316;* *Flansche ASME B16.5 DN 65; Edelstahl ISO 1.4571 oder 1.4404 / AISI 316;* *Gewindestutzen DIN 11851-SC (DN 65, DN 40) Edelstahl ISO 1.4571 oder 1.4404 / AISI 316*

Lining *Auskleidung*	InlineSENS Am-241: optional lining of rubber or PTFE (only for flange version possible) InlineSENS Cm-244: Polypropylene *InlineSENS Am-241: optionale Auskleidung aus Weichgummi oder PTFE (nur bei Flanschausführung möglich)* *InlineSENS Cm-244: Polypropylen*
Environmental Testing *Umweltprüfungen*	IEC 60068-2-27: mechanical shock (30 g) IEC 60068-2-6: Vibration (1.9 g at resonance, sinusoidal) IEC 60068-2-38: Climate testing (-10 ... +65 °C; relative humidity >90%) IEC 60068-2-14 NA: Temperature shock (-45 °C ... 65 °C in 10 s) *IEC 60068-2-27: mechanischer Schock (30 g)* *IEC 60068-2-6: Vibration (1,9 g bei Resonanz, sinusförmig)* *IEC 60068-2-38: Klimalagerung (-10 … +65 °C; rel. Luftdeuchte >90%)* *IEC 60068-2-14 NA: Temperatur-Schock (-45 °C ... 65 °C in 10 s)*
Water cooling system *Wasserkühlung*	Optional, stainless steel ISO 1.4301/AISI 304 Water pressure up to 6 bar Tube connection R1/4", d=10 mm Weight approx. 3 kg *Optional, Edelstahl ISO 1.4301 / AISI 304* *Wasserdruck bis 6 bar* *Schlauchanschluss R1/4" bzw. d = 10 mm* *Gewicht ca. 3 kg*
Maximum operaring pressure *Maximaler Betriebsdruck*	10 bar for InlineSENS with Am-241. For InlineSENS with Cm-244: Temperature-pressure dependency: see table on previous page "Permissible operating pressure of the Cm-244 measuring unit" *10 bar für InlineSENS mit Am-241. Für InlineSENS mit Cm-244: Temperatur-Druckabhängigkeit: siehe Tabelle vorherige Seite "Zulässiger Betriebsdruck der Cm-244 Messstrecke"*
Radioactive Source *Radioaktiver Strahler*	Am-241; Activity: 1110 or 3700 MBq (30 or 100 mCi) Cm-244; Activity: 3700 MBq (100 mCi) *Am-241; Aktivität: 1110 oder 3700 MBq (30 oder 100 mCi)* *Cm-244; Aktivität: 3700 MBq (100 mCi)*
Detector Scintillator *Detektor Szintillator*	Point Detector NaI(Tl) crystal 44x5 mm *Punktdetektor NaI(Tl) Kristall 44x5 mm*
Temperature stabilty *Temperaturstabilität*	+/- 0.00625%/°C (-20 … +60°C) +/- 0.01000%/°C (-40 … +60°C) *+/- 0,00625%/°C (-20 … +60°C)* *+/- 0,01000%/°C (-40 … +60°C)*

NOTICE HINWEIS

Note the electrical data in the technical information and certificates for the LB 4700 detector: Mat. No. 56926TI

Beachten Sie die elektrische Daten und Zertifikate in der Technische Information des LB 4700 Detektors:
Mat.-Nr. 56926TI

Number Key LB 4700-5x Detectors
Nummernschlüssel LB 4700-5x Detektoren

NOTICE HINWEIS

Only by the LB Number Key, the detector can be uniquely identified (Scintillator, size, certification, ect.).
Nur durch den LB-Nummernschlüssel kann der Detektor eindeutig identifiziert werden (Szintillator Größe, Zertifikate, ect.).

L B 4 7 0 0 – 5 1 – 0 0 – 8 0 – 0 1 – 1 0 0

Device family / *Gerätefamilie*	
4700	DuoSeries

Flange		
5	1	DN65 DIN
5	2	DN65 ASA
5	3	DN65 Threaded connector
5	4	DN40 Threaded connector
5	5	DN40 DIN
5	6	DN40 DIN PP
5	7	DN50 DIN PP
5	A	DN65 DIN with water cooling
5	B	DN65 ASA with water cooling
5	C	DN65 Threaded connector with wc
5	D	DN40 Threaded connector with wc
5	E	DN40 DIN with wc
5	F	DN40 DIN PP with wc
5	G	DN50 DIN PP with wc

Certification: class: signal	Ex-Version (A,B,... Y)	
0	0	No explosion certificate
1		Ex-d/e (ATEX / IECEx)
I		Intrinsically safe: Ex-d/i (ATEX / IECEx)

Signal	
8	FSK

Voltage supply	
0	No separate power supply

Collimator	
0	none

Housing Material	
1	1.4301 Standard

Temperature range	
1	Extended

Lining	
0	none
1	PTFE
2	Rubber
3	Polypropylene

Openings	
0	1x M12x1.5; 1xM16; radial