Measuring Path

LB 379 and LB 3602 / 3603

Operating Manual
40437BA2

Rev. No.: 00, 12/2016

Contents

OPERATING MANUAL 1

40437BA2 1

REV. NO.: 00, 12/2016 1

1 OVERVIEW 6
1.1 The Principle of Measurement 6
1.2 The Measurement Device 8
1.3 Device Configuration (Operating Modes) 9
1.3.1 Setting the Detector Code 9
1.3.2 Measuring Path Dimension 9
1.4 Measuring Paths and Sources 10
1.4.1 Measuring Path LB 379 10
1.4.2 Measuring Paths LB 3602/3603 11
1.4.3 Radioactive Sources 12
1.5 Detector 12

2 INSTALLATION 13
2.1 Installation of the Measuring Path 13
2.1.1 Safety Instructions 13
2.1.2 Selection of Measuring Site 14
2.1.3 Installation Instructions for PTFE lined Measuring Paths (LB 379) 16
2.1.4 Installation of the Resistance Thermometer Pt 100 16

3 WATER COOLING IN THE MEASURING PATH LB 379 17
3.1 Cooling Water Requirement 17

4 ELECTRICAL CONNECTIONS 18
4.1 Detector 18

5 TECHNICAL DATA 19
5.1 Measuring Path LB 379 19
5.2 Measuring Path LB 3602/3603: 20
5.3 Pressure Equipment Directive 2014/68 / EU 21

6 RADIATION PROTECTION 22
6.1 Emergency Instructions 25
6.1.1 Checking the Crystal-Multiplier Assembly 26

7 APPENDIX 28
7.1 Table 1: Absorption Coefficients 28
7.1.1 Temperature Coefficients 29

8 DENSITY OF WATER AS A FUNCTION OF THE TEMPERATURE30

9 DIMENSIONAL DRAWINGS 31
9.1 Measuring Path LB 379 with DIN Flange 31
9.2 Measuring Path LB 379 with ASA Flange 32
9.3 Measuring Path LB 379 with Threaded Connector 33
9.4 Measuring Path LB 3602/03 34

10 ATEX CERTIFICATE 35

11 INDEX 42

Safety Summary

Electrical Shock Hazard
Disconnect power to ensure that contact with energized part is avoided during installation and servicing.

Specific Warnings
Never change the installation or the parameter settings without a full knowledge of the relevant part of this manual, the connected controller and the process, if it is controlled by this measuring device.

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

At least one screw on the access openings to the radioactive sources on the measuring path is sealed. Do not open any sealed screws. A damaged seal must be repaired immediately by a representative of the manufacturer.
Sources that are not in use must be kept in a secure place and protected against access by unauthorized persons.

1 Overview

The radiometric density measuring system 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. The measurement is independent of variations in pressure or viscosity, and on the flow rate of the product.

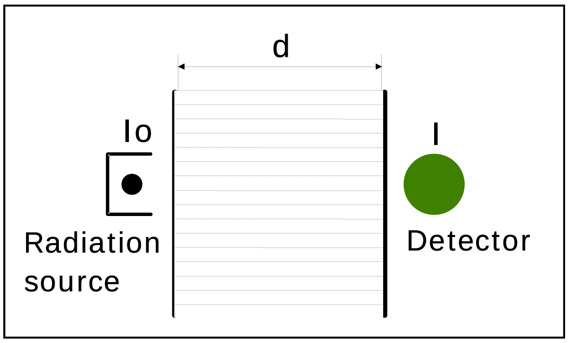
1.1The Principle of Measurement

The density measurement utilizes as a measuring effect the attenuation of gamma radiation passing through the product being measured. The residual radiation picked up by the detector (scintillator) is a measure of the density of the product being measured.

The attenuation of radiation takes place in accordance to the following law:

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

Figure 1: Principle of measurement



I	=	radiation picked up by the detector
Io	=	unattenuated radiation
µ	=	mass attenuation coefficient (absorption coefficient in cm^2/g
ρ	=	density of absorbing material in g/cm^3
d	=	thickness of absorbing material in cm

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 measuring paths LB 379 and LB LB3602/3603, source, measurement 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 completely excluded.

With the isotopes ^{241}Am and ^{244}Cm the absorption is dependent, in addition to the density, on the atomic number of the absorber. It increases with increasing atomic number (see Figure 2), so that with the substances occurring in practice we can almost always assume that a higher atomic number can also be equated with a higher absorption coefficient. 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.), with the measuring paths LB 379 and LB 3602/3603, which are equipped with one of these isotopes.

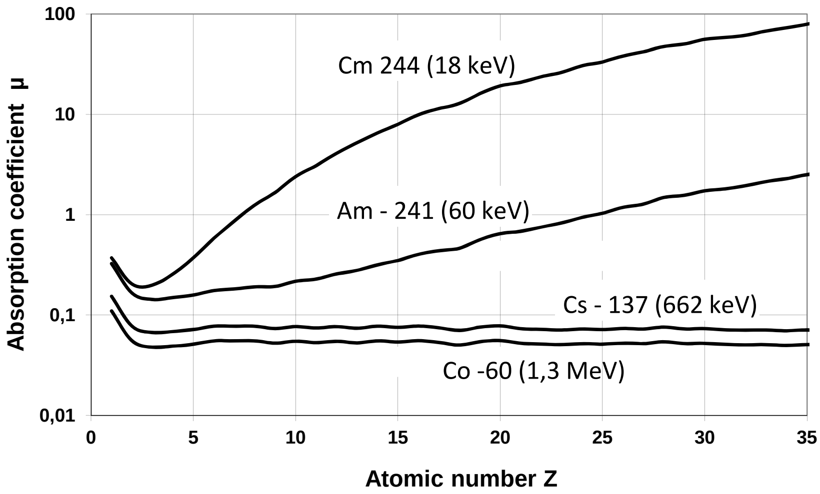


Figure 2: Absorption coefficients

With ^{244} cm, the atomic number has a significant influence on the absorption coefficient. This isotope is incorporated in the measuring paths LB 3602/3603. These measuring paths are used to measure materials with high atomic number at very low concentrations. **These measuring paths are not type approved.**

This dependence of the absorption coefficient on the atomic number has a positive effect if, for example, in a solution of sodium chloride in water, where the salt content is to be determined, contaminations by hydrocarbons may occur, for example by sugar or cellulose, in varying proportions. The lower absorption coefficient of the impurity results in a lower influence on the measurement result.

An adverse effect is obtained if, for example, the density of a hydrocarbon mixture is to be determined, which contain impurities by a substance having a high atomic number, such as chlorine. In this case we get significant changes in the absorption of the radiation even with low fluctuations in the chlorine content, so that a density change is simulated, which in reality does not exist.

1.2The Measurement Device

The radiometric density measuring system can be used to measure the density of

- liquids
- suspensions
- solids and
- bulk goods

The measurement can be performed directly on a product line and is independent of fluctuations in pressure and viscosity, as well as in the flow velocity.
Specific device configurations and calculations allow you to adapt the density measuring system to local conditions and the conditions of the product being measured.

The measuring device generally comprises the following components:

a) the measurement path with
- radioactive source
- through pipe for the product to be measured
- detector

b) the evaluation unit

c) the connection cable

d) the resistance thermometer Pt 100 (optional)

The detector's supply voltage and 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 evaluation unit via the connection cable between the detector and evaluation unit.

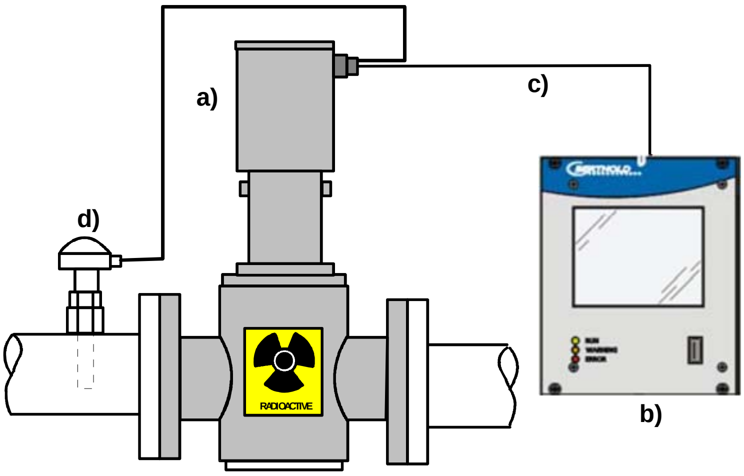


Figure 3: Measuring arrangement

1.3 Device Configuration (Operating Modes)

The evaluation unit can be used for different tasks.

- Density measurement without temperature compensation (TC)
- Density measurement with temperature compensation
  - via Pt100 or
  - density measurement with temperature compensation via current input

- Suspension measurement with any carrier liquid
  - solid density and liquid density are known
  - with or without TC

- Suspension measurement with water as the carrier liquid
  - solid density is known
  - with water temperature compensation, the density of the water and
  - the concentration of the solid material are taken into account for temperature compensation

- Mass flow measurement without TC (in connection with a volume flow meter)
- Mass flow measurement with TC via Pt 100 (in connection with a volume flow meter)
- Measurement modes
- Continuous measurement
- Discontinuous measurement
  - Batch operation via keyboard (press <**run**> button)
  - Batch operation via digital input

1.3.1 Setting the Detector Code

Internal device parameters are adjusted to suit the used scintillator size by setting the detector code. The correct detector code is set at the factory and a change is not normally required. A table with the detector codes to be used is found below:

Measuring Path	Detector Code
LB 379	2
LB 3602/3603	manual

For the measuring path LB 3602/3603 you must set the HV working point to manually fixed value. If the value is not known you must evaluate the value by a plateau measurement. The plateau measurement is descriped in the manual LB 474 respectively LB 444. The HV working point must be entered in the evaluation unit at the mid of the plateau curve.

1.3.2 Measuring Path Dimension

Input of the measuring path dimension in the evaluation unit:

Measuring Path	without Liner	with PTFE - Liner	With Rubber - Liner
LB 379	6.8	6.0	5.8
LB 3602/3603	5.1	-	-

Dimensions in cm

1.4 Measuring Paths and Sources

1.4.1 Measuring Path LB 379

The measuring path LB 379 includes the following components in a compact unit:

The radioactive source (1), isotope **Am-241**, with an activity of 1,110 MBq (30 mCi) and 3,700 MBq (100 mCi) or in exceptional cases 11,000 MBq (300 mCi).
The measuring path is no longer type approved for a source activity of 11,100 MBq (300 mCi).

Am-241 is particularly suitable for determining the concentration of components having a high atomic number (iron, nickel, HCl, etc.) in a carrier liquid having a low atomic number. The energy is 60keV, the half-life 433 years.
The radiation source is installed in a stainless steel coated lead shield (2). The collimator (3) allows the unattenuated exit of the useful radiation only in the direction of the product pipe.

The radiation is shielded by the lead shielding (2) and by the case even if the pipeline is empty, so that no additional protective measures are required.

In non-lined measuring paths, the product pipe DN 65/PN 10 (4) is made of stainless steel 1.4571 or 1.4401. The material number is stamped on the flange or on the pipe. Stainless steel 1.4301 is used for lined pipes. A lining made of PTFE (Teflon) can be supplied to protect the pipes against aggressive products. To protect the pipes from abrasive wear, we recommend using a lining made of soft rubber. For use in the food industry, a product pipe with threaded ends DN 65 according to DIN 11851 can be supplied instead of the flanged pipe. No lining is possible with this design. The detector (scintillation counter) LB 4451 (5) is located in the upper part of the measuring path. It is explosion-proof.

1.4.2 Measuring Paths LB 3602/3603

This measuring path is constructed similarly to the measuring path LB 379. It is comprised of the following components:

a) Radiation sources (1)
- Isotope ^{244}Cm
- Activity: max. 7400 MBq (200 mCi)
- Half-life: 17.8 years

- Energy of the emitted γ-radiation: about 18-22 keV

b) Product pipe (2): DN 50/PN 10
- Material: Polypropylene

c) Detector (3): Detector
in the measuring path LB 3602

LB 4491-05-0x-Gd-E
- Ex-protection: EEx de II CT6

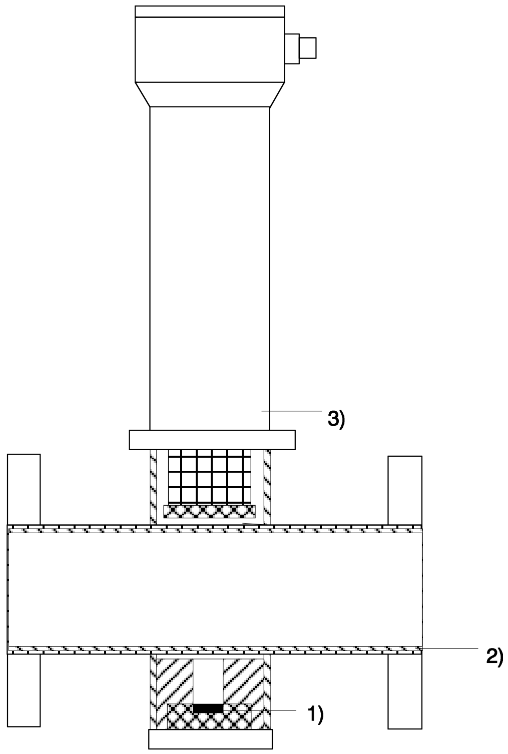


Figure 4: Measuring path LB 3602/3603

The measuring path LB 3602 can be used in potentially explosive areas

or

with the measuring path LB 3603 detector LB 5491-05-0x-2

Do NOT use the measuring path LB 3603 in potentially explosive areas.

The measuring paths LB 3602/3603 are not type approved.

IMPORTANT:
The measuring pipes and the lining should be checked at least once a year for damage and leaks. If damage is suspected, the Radiation Protection Officer and the manufacturer or the local agent must be informed immediately.

1.4.3 Radioactive Sources

Radioactive sources for industrial applications are generally "*enclosed radioactive materi-als*" which are tightly welded into a sturdy stainless steel capsule, so that the radioactive sub-stance 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 sources can be used for these measuring paths:

Radiation source	Measuring path	Energy of radiation	Half-life
Am-241	LB 379	60 keV	433 years
Cm-244	LB 3602/3603	about 18 keV	17.8 years

Please note the Radiation Protection Guidelines in Chapter 6.

1.5Detector

A scintillation counter is used as a detector.
The detector converts the gamma radiation picked up into electrical pulses. The count rate transmitted to the evaluation unit is proportional to the radiation intensity received.
The detector is equipped with an automatic drift compensation which automatically corrects component aging and temperature influences, ensuring a high long-term stability of the measuring system.
The power supply of the detector is carried out via the fail-safe connection circuit of the LB 444 evaluation unit.
The detector itself includes a fail-safe connection circuit to which a resistance thermometer Pt 100 can be connected for measurement of the product temperature.
The detector assembly in a sturdy stainless steel housing protects the instrument against normal ambient pollution in industrial applications.
The detector must not be subject to heavy mechanical stress or vibrations.
For more information on its function see chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**.
The ambient temperatures must not exceed 50°C; otherwise adequate cooling has to be provided.

2 Installation

The measuring path with the radioactive source is delivered in a box in compliance with the regulations concerning the transportation of radioactive substances.

Take the shielding out of the box just prior to installation. Until then, store it in a location that is guarded against unauthorized access.

Work is performed according to the instructions and under the supervision of the Radiation Safety Officer. It has to be ensured that the lock of the shielding is closed and secured, so that no unshielded radiation can exit. Make sure the shielding is not tampered with or damaged.

Very important: Please read the Radiation Protection Guidelines in chapter Radiation Protection and observe them strictly!

2.1 Installation of the Measuring Path

2.1.1 Safety Instructions

2.1.1.1 Measuring Path LB 379

1. The max. pressure in the measuring path must not exceed 10 bar.
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. The instructions and regulations of the type approval certificate must be observed.
4. Do not open the sealed screws.

CAUTION:

A damaged measuring path must be disassembled immediately.
Please inform immediately:

a) the manufacturer or their local agent
b) the competent supervisory authority.

2.1.1.2 Measuring Path LB 3601

1. The permissible operating pressure of the product pipe made of polypropylene decreases with increasing temperature. The following values must not be exceeded:

Temperature	max. pressure in kp/cm^2
20	10
30	10
40	6.2
50	5
60	3.6
70	2.2
80	1.2
90	0.8

2. You have to check whether the material of the product pipe is suitable for the intended application.

3. Do not open the sealed screws.

CAUTION:

A damaged measuring path must be disassembled immediately.
Please inform immediately:

a) the manufacturer or their local agent

b) the competent supervisory authority.

2.1.2 Selection of Measuring Site

When selecting the installation site, please keep in mind:

a) The pipeline must always be completely filled at the measuring site with the product to be measured during the operation.

b) Corrosion, abrasion or wall deposits must not occur at the pipeline walls. This hazard is least likely with installations on vertical pipes.

c) Gas bubbles in the product falsify the results. This risk can be avoided or at least reduced by:

- Performing measurements under fairly high pressure (see 2.1) (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 and gas bubbles (see Figure 50).

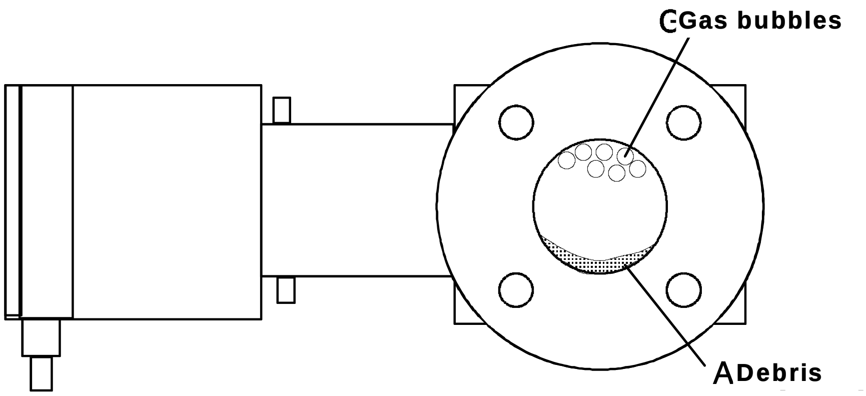


Figure 5: Installation on a horizontal pipeline with gas bubbles and debris

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 point 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, the product flows only in the center. However, the measurement covers the entire diameter of the product in the path or radiation. Therefore, the measurement result is not representative.
- no gas bubbles are present in the path of radiation.
- suspension measurements are not carried out directly behind a pipe-bend, for there the material will not be distributed homogeneously.
- The distance from the bend must be the larger
- the higher the flow rate
- the bigger the difference between liquid density and solid density

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

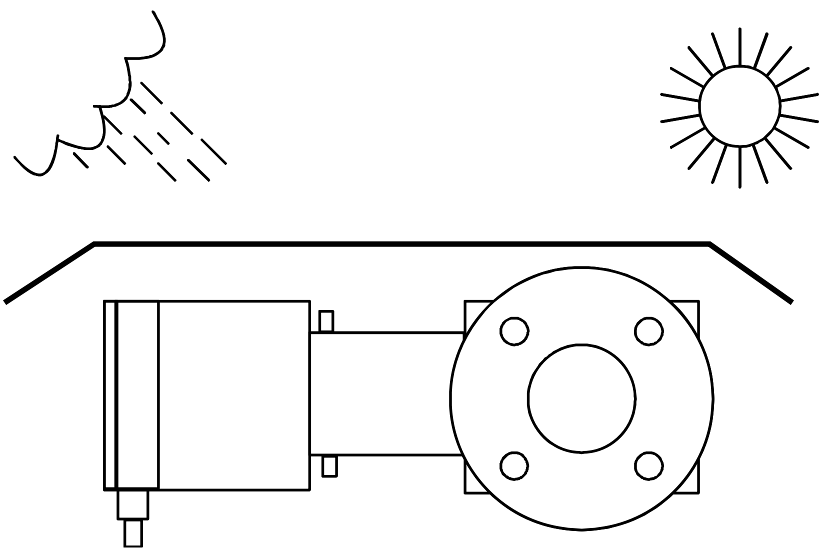


Figure 6: Canopy roof for protection against sun and rain in outdoor installations

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

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

2.1.3 Installation Instructions for PTFE lined Measuring Paths (LB 379)

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

The flanges of all parts are provided with protective plates, so that the sealing surfaces are not damaged during transport and storage. The protective plates should not be removed until immediately before installation. If plates are taken off for control purposes, they have to be attached again in any case.
No further seals are required between the sealing surfaces; however, possibly 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 5 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 line system the flange screws should be retightened once more to the specified torque after reaching the final temperature.

Pipeline parts may be disassembled only at max. 40°C so that the sealing surfaces are not damaged.

If a flange connection leaks, although all screws are tightened, NO LONGER TIGHTEN 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.

2.1.4 Installation of the Resistance Thermometer Pt 100

A temperature measurement must be carried out such that the measured temperature is fairly equal to the product temperature at the density measuring site. <u>The resistance thermometer must not obstruct the path of radiation.</u>

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 temperature insulation over a length of 1 - 2 m to ensure that the surface temperature of the pipeline at the temperature measuring point is fairly equal to the product temperature. Nevertheless, it may happen, especially with plastic pipes or lined pipelines that very rapid temperature changes occur in the product to be measured will lead to temperature-induced measurement errors. 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.

3 Water Cooling in the Measuring Path LB 379

The detector is allowed to reach a maximum temperature of 50°C. If significant heating may occur caused by the product to be measured and/or by a higher ambient temperature, the water cooling which is included in the measuring path LB 379 has to be used.

No water cooling is provided for the measuring path LB 3601.

3.1Cooling Water Requirement

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.

The minimum cooling water requirement Q_{min} can be calculated for the measuring path LB 379 using the following formula:

$$Q_{min} = \frac{(T_{Pr} - 323) * 5.5 + (T_U^{\ 4} - 323^4) * 9.75 * 10^{-11}}{313 - T_W}$$

Q_{min} = cooling water requirement in l/h
T_{Pr} = product temperature
T_U = ambient temperature
T_W = cooling water inlet temperature

Example:

Product temperature	T_{Pr}: 393 K (120° C)
Ambient temperature	T_U: 353 K (80° C)
Cooling water inlet temperature	T_W: 293 K (20° C)

$$Q_{min} = \frac{(393 - 323) * 5.55 + (353^4 - 323^4) * 9.75 * 10^{-11}}{313 - 293} = 19.3\, l/h$$

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!

If there is a risk that the cooling water can freeze, the water cooling system has to be emptied or antifreeze has to be added to the cooling water.

4 Electrical Connections

4.1Detector

Switch off the evaluation unit before connecting the detector.
Open the screws and remove the connection box cover to expose the connection area.
For intrinsically safe installations, connect the detector to the potential equalization bar of the installation. The detector is connected to the evaluation unit via a 2-wire cable with approx. 8...10 mm diameter and a cross-section of 1 mm². A screen cable may be used in installations with extremely strong electrical interferences. The screen may be placed only on one side of the detector.

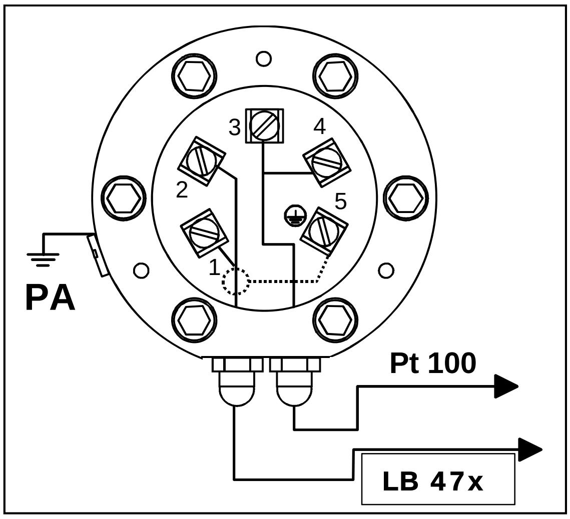


Figure 7: Cable connections to the detector

For intrinsically safe installations, the permissible inductivities and capacities of the connection cable have to be observed in accordance with the Ex test certificate.

Please observe the maximum cable lengths between evaluation unit and detector. They are listed in chapter 5.
When installing the connection cable, make sure that water cannot get into the connection box via the cable. At ambient temperatures >70°C, the installed cable has to be protected to prevent exceeding of the temperature limits of the cable. After connecting, make sure that the terminal compartment is carefully closed and the cable conduit properly sealed.
If a resistance thermometer is connected, pass the cable coming from the **Pt 100** through the second cable conduit to the terminals **3** and **4**.

For installations in hazardous areas, the special requirements of the cable and to the preparation of the lines have to be observed.

The detector LB 44... has to be used for installation in hazardous areas. Detector LB 54.. may only be used for non-hazardous applications.

The evaluation unit must always be installed outside the hazardous area.

A special transmission technique ensures interference suppression. Nevertheless, the cable should not be installed together with power cables.

5 Technical Data

5.1 Measuring Path LB 379

License no. BW/19/78

Detector LB 4450	Scintillation counter with NaI (Tl) crystal 44/5. With drift compensation.
Ex-protection:	II 2 G EEx de IIC T6 or II 2 G EEx ib d IIC T6
Temperature range:	Operating temperature: - 20 °C to + 50 °C (253 to 323 K). Water cooling for higher temperatures Storage temperature: - 40 °C to + 60 °C
Radioactive sources:	^{241}Am activity: 1110 to 3700 MBq (30 to 100 mCi) in the high-security version (special form)
Measuring pipe:	ND 65, NP 10, material: stainless steel 1.4571 or 1.4401, in lined pipes: 1.4301
Connections:	Flanges according to DIN 2576 or threaded connector SC 65 to DIN 11851. Measuring pipe with optional rubber or PTFE lining (only possible with flange version).
Product temperature:	Measuring pipe without lining: -190°C to +260°C (80 to 560 K). Measuring pipe with rubber lining: -30 to +80°C (243 to 353 K); Measuring pipe with PTFE lining: -190°C to + 260°C (80 to 560 K)
Housing:	Stainless steel, material 1.4301
Protection type:	IP 65
Weight:	approx. 18 kg
Connection cable:	2-wire, shielded, with 2 x 1.0 mm^2 Cable length detection - evaluation unit 1000 m.

5.2 Measuring Path LB 3602 / 3603:

Detector **LB 4491-05-0x-Gd-E (measuring path LB 3602)**

Ex-protection: II 2 G EEx de IIC T6
Scintillation counter with NaI(Tl) crystal 44/5

Detector **LB 5491-05-0x-2 (measuring path LB 3603)**

Ex-protection: **no**
Scintillation counter with NaI(Tl) crystal 44/5

Housing:	Stainless steel housing with integral junction box, material: 1.4301 Protection type IP 65
Temperature range:	Operating temperature for the detector: -20 to +50°C (253 to 323 K); Storage temperature: -40 to +65°C (233 to 338 K);

Measuring path LB 3602 / 3603:

Measuring pipe material:	Polypropylene
Flanges:	DN 50/PN 10 similar to DIN 2576
Radioactive sources:	^{244}Cm activity: 370 to 7400 MBq (10 to 200 mCi) in the high-security version (special form)
Connection cable:	2-wire, shielded, with 2 x 1.0 mm^2 Cable length detection - evaluation unit 1000 m.
Weight:	approx. 11 kg

5.3 Pressure Equipment Directive 2014/68 / EU

The LB 379 measuring path is manufactured and put on the market in accordance with the Pressure Equipment Directive 2014/68 / EU. Due to its design [DN 65 PN 10 (nominal diameter DN 65, nominal pressure 10)], the measuring path falls under Article 4 (3). The measuring path can only be used for measurements of liquids. The maximum operating pressure should not be higher than 10 bar. The maximum operating temperature is 120°C.

Since different liquids, such as acids, alkalis, aggressive and abrasive media, are to be measured, different linings (PVDF, rubber) are available to protect the measuring path. The responsibility of choosing the right lining lies with the operator.

The LB 379 measuring path 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 LB 379 measuring path 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.

For the measuring section LB 379 with the pipe dimensions DN 40 PN 16, the procedure is the same as before with DN 65.

6 Radiation Protection

Radioactive isotopes used for density measurements emit gamma radiation. Gamma radiation consists of high-energy electromagnetic waves, i.e. a type of radiation which resembles light, but has a much higher energy, so that it can pass through matter having a higher density. This high-energy radiation is hazardous to living beings; it can damage cells and cause mutations. To minimize this hazard, one must be extremely careful when handling radioactive substances.
Radioactive sources which are used for density measurements are enclosed radioactive materials, i.e. the actual radioactive substance is surrounded by at least one, often several sealed layers made of stainless steel, each of which is checked individually for leaks. Another check ensures that no radioactive particles are deposited on the surface of the capsule. The user will receive an official certificate specifying these features of the radioactive source.

Technical terms

In radiation measuring technique, just as in other fields, the units of measurement have been converted into SI units. The old units are also included in the following explanations.

1. Activity

Radiation is emitted as a result of nuclear disintegration. The higher the number of these nuclear transformations, the higher the activity. Unit of measure is the Becquerel (Bq), 1 Bq being equal to 1 decay per second. The old unit Curie (Ci) is sometimes still being used. The following correlation can be established between both units of measure:

$3.7 * 10^{10}$ Bq = 37 GBq = 1 Ci
$37 * 10^{6}$ Bq = 37 MBq = 1 mCi

2. Dose and dose rate

Various energies of individual isotopes have different effects on living beings. To allow a comparison, the so-called RBE-factor was introduced; it specifies the relative biological effects of radiation. This dose equivalent is measured in Sievert (Sv); it can be converted into the old unit rem as follows:

10^{-2} Sv = 1 rem
10 µSv = 1 mrem

Sv (or rem) specifies the dose incorporated over a period of undefined length. To get an indication of the intensity of the radiation, the dose rate is specified as dose per unit of time. It is measured in Sv/h or rem/h. More common are the smaller units mSv/h or mrem/h.

To calculate the dose rate generated by a source, you need to know the gamma radiation constant (k) in order to take into account the different energies of the various isotopes. The following table lists the constants for the radioactive sources most frequently used in industrial applications:

Isotope	k_{old} $\frac{mrem*m^2}{h*mCi}$	k_{new} $\frac{mSv*m^2}{h*Mbq}$
^{241}Am	0.0158	0.0043
244Cm	0.0064	0.00175

3. Half-value layer

Half-value layer (HVL) or half-value thickness (HVT) specifies the material thickness necessary to reduce the intensity of a certain type of radiation to half its original value. The following table lists the half-value thickness of some materials:

Half-value thickness layer in mm

Material	Isotope	
	241Am	244Cm
Water	40	12
Steel	0.9	0.05
Lead	0.125	--

The attenuation factor "s" can be calculated from the half-value thickness.
Example:

Activity: 3700 MBq (100 mCi) ^{241}Am

Shielding thickness: d = 5 mm steel

Distance: 0.2 m

$$s = e^{0.693*\frac{d}{HWS}} = e^{0.693*\frac{5}{0,9}} = 47$$

Determine the dose rate in a distance of 0.6 m using the following formula:

$$D = \frac{a*k*t}{a^2*s} = \frac{3700*0.0043*1}{(0.2)^2*47} = 8.46\mu Sv = 0.846 mrem$$

A = activity in MBq
k = radiation constant
t = time in hours
a = distance from the radiation source in m
s = attenuation factor

The result indicates that if you stay for one hour in a distance of 20 cm from the above mentioned radioactive source, which is shielded by 5 mm steel, you will incorporate a dose of 8.46 µSv/h or 0.846 mrem/h. If you stay for a longer (or shorter) time in the vicinity of the source, the dose increases (decreases) accordingly.
At ^{244}Cm, the gamma radiation is shielded almost completely by the housing wall of the measuring path. In addition, ^{244}Cm emits neutrons. The dose rate at an activity of 3700 MBq (100 mCi) in a distance of 1 m is about 0.14 mSv/h and 0.014 mrem/h.

Natural radiation exposure

For comparison's sake, it may be helpful to look at the average radiation exposure for the population in Germany. It is approx. 4000 μSv (400 mrem) per year. In addition, there is the medical radiation exposure, caused by X-rays, etc., which is about 500 μSv (50 mrem), and radiation exposure caused by other sources of about 100 μSv (10 mrem). Particularly the natural radiation exposure may vary significantly, depending on location, and may sometimes be more than 10 times above the value specified above.

Protective measures

The following protective measures will help reduce the radiation exposure of persons handling radioactive substances to a fairly low radiation dose:

1. **Shielding**
   Radioactive sources are usually delivered in a shielded container with lockable beam exit channel. DO NOT OPEN THIS BEAM EXIT CHANNEL BEFORE ASSEMBLY IS FULLY COMPLETED. The nuclide, the activity, the shielding thickness and the dose rate at a certain distance are indicated on the type plate. Based on these figures, the dose accumulated while working with the radioactive sources is calculated or at least estimated. To get more accurate results, we recommend using a dosimeter.

2. **Time**
   As the formula for the calculation of the absorbed dose shows, the dose is the greater the longer one is exposed to radiation. Therefore, it is especially important when working with radioactive sources to prepare work carefully and complete it quickly. This is especially true when the shielding thickness had to be kept low for technical reasons, or if one has to work with an unshielded source - which must be avoided as far as possible.

3. **Distance**
   Doubling the distance between the body and the radioactive source reduces the intensity of radiation to a quarter. This fact is especially important if you have to work with an unshielded source. In this case, the source of radiation should never be touched with the hands, because then the distance from the radiation source is almost 0. By using a pair of pliers, you can increase the distance from the radiation source to your hand from 1 to 20 cm; this means a reduction of the dose rate by a factor of 400!

Summary
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.

6.1Emergency Instructions

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 function of the shielding lock, 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, inform the Radiation Safety Officer 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 report to the competent authorities or the manufacturer or the supplier of the measuring system, so that all other measures are carried out under expert supervision.
If adequate know-how as well as suitable instruments are available, emergency measures may be taken immediately.

In this case, proceed as follows:

- Check the effectiveness of the shielding by measuring the radiation level.
- Secure and label radiation protection areas.
- Secure measuring path with the source.
- 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:

Avoid contamination.

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

IMPORTANT!
Unneeded or decayed radioactive sources must be delivered to the state repository for radioactive waste or to the manufacturer.

It is recommended to define these points in internal instructions or instructions tailored to the operation of the system.

Adjust current input Current input adjustment
Target value:/Actual value
Adjustment of input current. Feed current of 1.8 mA.
Confirm display with <**enter**>.
RUN appears on the display, the adjustment is running. Push <**more**> to stop the adjustment and continue with the next item.
Then feed 18 mA current and confirm with <**enter**> and push <**more**> to continue.

6.1.1 Checking the Crystal-Multiplier Assembly

A plateau that is too small or too steep indicates faults in the crystal-multiplier assembly.
Please proceed as follows to perform a visual inspection of crystal and multiplier:

Switch off the scintillation counter before opening the instrument.

Do not perform the check in bright daylight, as this may damage the photo cathode of the photomultiplier.

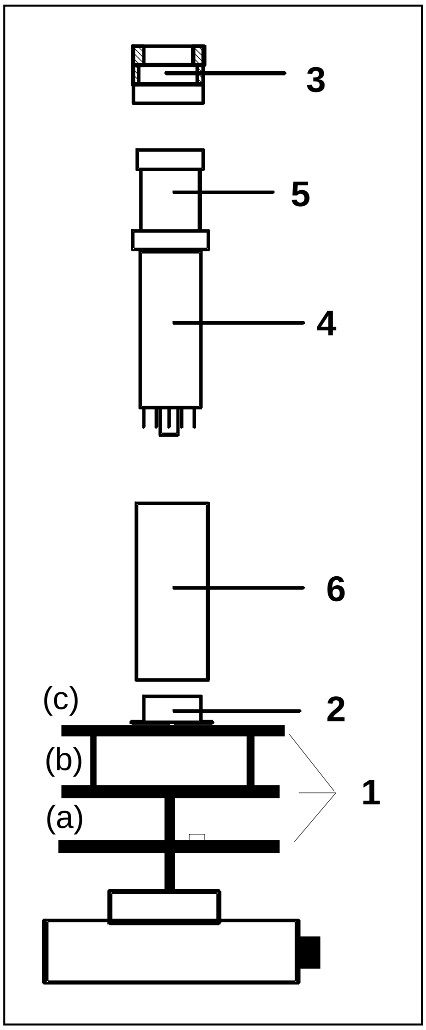


Figure 8: Assembly of the scintillation counter

1 = electronics part with (a) CPU, (b) HV, (c) voltage divider
2 = base
3 = ring nut
4 = photomultiplier
5 = crystal
6 = Mu-metal shielding

Open the scintillation counter by removing the cover of the connection box first and then the screws of the base. The entire electronics (1) with the crystal/multiplier combination can then be detached from the housing.

Remove photo multiplier combination from base (2) and unscrew ring nut (3) on front panel. The multiplier (4) including crystal (5) can now be detached from the Mu-metal shielding (6).
A thin layer of silicone oil between crystal and multiplier ensures optical coupling; silicone oil is rather viscous, particularly at low temperatures. Carefully detach the crystal from the multiplier window by gently sliding the crystal sideways.
Do not wipe off the silicone oil layer if no new silicon oil is available!

Check:
The ***crystal*** must be perfectly clear inside and not show any dull areas. Its typical color is white. A yellowish to brownish coloring is a sign of thermal overload and indicates that the crystal has to be replaced. The surrounding white reflecting layer must not be damaged. You can only check the photo multiplier for glass breakage or other mechanical damage. Other faults cannot be identified by visual checks alone. However, if the crystal does not show any faults, a bad plateau indicates that the photo multiplier is faulty.
The ***multiplier window*** is coated with a vapor-deposited layer acting as photocathode. This layer gives the window a brownish tint similar to smoked glass. If this layer is no longer present or if it is stained, then the photocathode has been destroyed (e.g. by over-heating, glass breakage, or incident light), and the multiplier must be replaced. Faults caused by damage to the dynode systems (e.g. by excessive vibration) cannot be identified by appearance. If in doubt, replace the multiplier.

The glass pane at the mating face to the photo multiplier must not show any cracks.
Before re-assembly, apply a drop of clean silicon oil between crystal and multiplier and distribute it evenly by gentle rubbing to ensure sound optical connection between both components. Attach the Mu-metal screen and fix it with screws, making sure that the Mu-metal screen is only under light tension.

Re-assembly:
Set the crystal again onto the front face of the photo multiplier and twist both components several times counter-clockwise. If a parts had to be replaced, apply 1 or 2 drops of silicone oil on the mating faces of the new and old component. It may also suffice to press the new component against the mating face of the old one and to turn it several times. Reassemble parts properly.
Just as after replacement of a complete detector, the calibration should be checked immediately.

After assembly of the scintillation counter, do not start the measurement in less than 12 hours.

7 Appendix

7.1Table 1: Absorption Coefficients

Absorption coefficients for ^{241}Am 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 cm^2/g

	Unit of measure		
	g/cm3	Conc. in g/l	Conc. in %
Whole milk	-0.163	-0.0000375	-0.00039
Skimmed milk	-0.163	-0.00006	-0.00065
Whey	-0.163	-0.000058	-0.00074
Starch - Water	-0.146	-0.0001	-0.001
Sugar solution	-0.131	-0.000048	-0.00064
Hydrochloric acid (HCl - H_2O)	-0.635	-0.00028	-0.0032
Sulfuric acid (H_2SO_4 - H_2O	-0.257	-0.00013	-0.00242
Nitric acid (HNO_3 - H_2O	-0.117	-0.000037	-0.00062
Phosphoric acid (H_3PO_4- H_2O	-0.235	-0.000140	-0.00261
Sodium hydroxide ($NaOH$ - H_2O)	-0.175	-0.000111	-0.00179
Lime ($Ca(OH)_2$ - H_2O)	-0.426	-0.00038	-0.00522
Saline ($NaCl$ - H_2O)	-0.377	-0.000238	-0.0029
Potassium chloride (KCl - H_2O)	-0.642	-0.00036	-0.0044
Magnesium sulfate solution ($MgSO_4$ - H_2O	-0.219	-0.00019	-0.00256
Sand - water (SiO_2 - H_2O)	-0.226	-0.00014	-0.00187
Titanium dioxide - water ($Ti\ O_2$- H_2O)	-0.556	-0.00042	-0.0048
Ethanol - water (C_2H_6O - H_2O)	-0.183	+0.000049	+0.00038
Methanol - water (CH_4O - H_2O	-0.177	+0.000047	+0.00037
Glycerin - water ($C_3H_5(OH)$§- H_2O	-0.125	-0.000027	-0.00033

7.1.1 Temperature Coefficients

Product	Concen-tration in Gew. %	Aver. temp. in °C	Input value at g/cm3	g/l	%	°Be
H2O - H2SO4	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

H2O - 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

H2O - 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 sol.	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

Water	Temp. in °C	Input value at g/cm3
	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

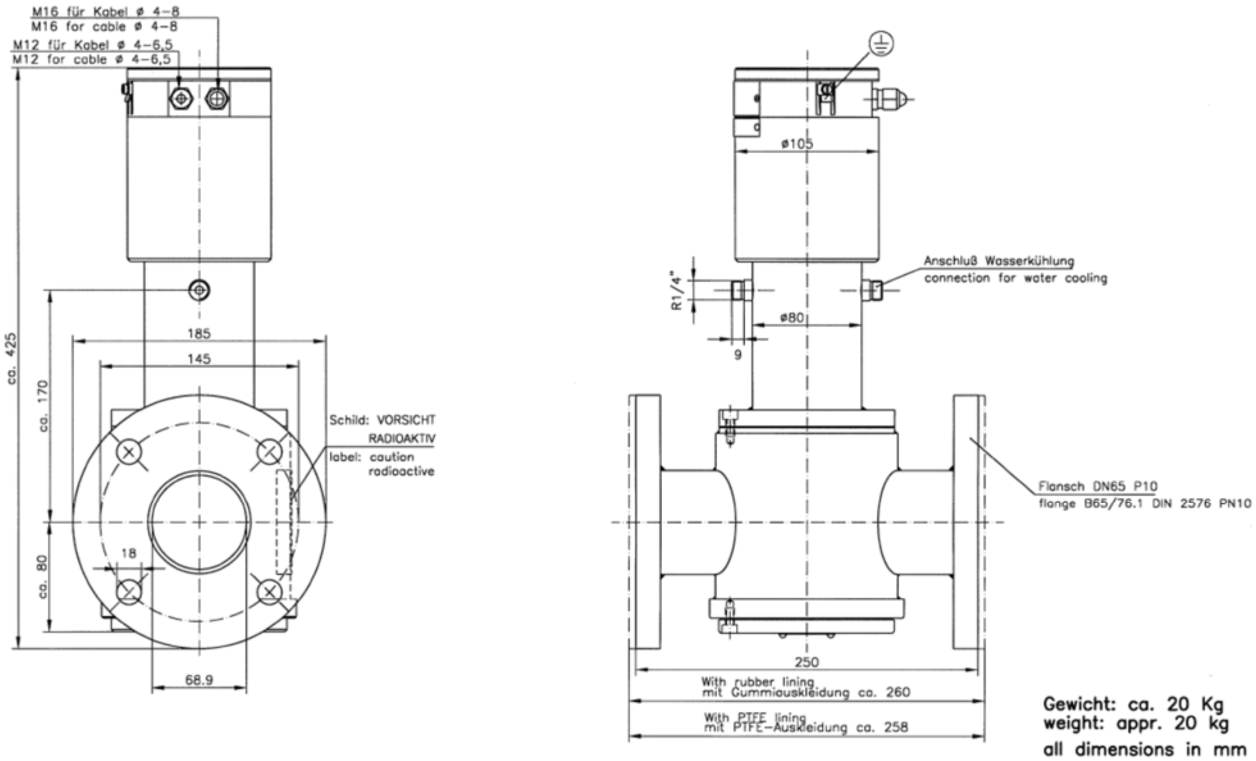
Note:
Water temperature coefficients can be used for many low concentration products, such as milk, beer, whey, starch suspension, etc. For upgraded milk, whey, cottage cheese, etc. the values given for sugar solution can be used with good approximation.

8 Density of Water as a Function of the Temperature

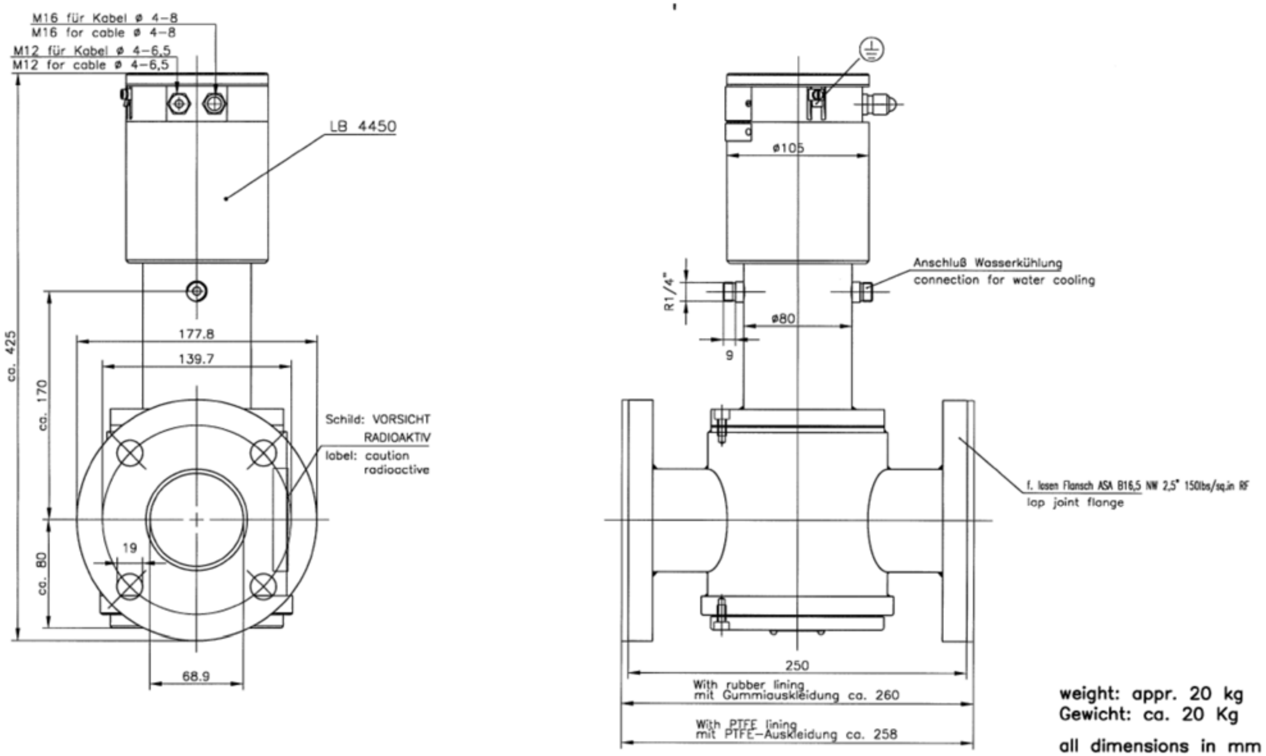
Temp. in °C	Density in g/cm^3	Temp. in °C	Density in g/cm^3	Temp. in °C	Density in g/cm^3
10	0.99973	40	0.99224	70	0.97781
11	0.99963	41	0.99185	71	0.97723
12	0.99951	42	0.99146	72	0.97665
13	0.99939	43	0.99106	73	0.97607
14	0.99926	44	0.99065	74	0.97548
15	0.99911	45	0.99024	75	0.97488
16	0.99896	46	0.98982	76	0.97428
17	0.99879	47	0.98939	77	0.97368
18	0.99861	48	0.98896	78	0.97307
19	0.99843	49	0.98852	79	0.97425
20	0.99823	50	0.98807	80	0.97183
21	0.99801	51	0.98761	81	0.97120
22	0.99779	52	0.98715	82	0.97057
23	0.99755	53	0.98668	83	0.96993
24	0.99731	54	0.98621	84	0.96929
25	0.99706	55	0.98673	85	0.96864
26	0.99680	56	0.98524	86	0.96799
27	0.99653	57	0.98475	87	0.96734
28	0.99625	58	0.98425	88	0.96668
29	0.99597	59	0.98375	89	0.96601
30	0.99567	60	0.98324	90	0.96534
31	0.99536	61	0.98272	91	0.96467
32	0.99504	62	0.98220	92	0.96399
33	0.99472	63	0.98167	93	0.96330
34	0.99439	64	0.98113	94	0.96261
35	0.99405	65	0.98059	95	0.96192
36	0.99370	66	0.98005	96	0.96122
37	0.99335	67	0.97950	97	0.96052
38	0.99299	68	0.97894	98	0.95981
39	0.99262	69	0.97838	99	0.95910

9 Dimensional Drawings

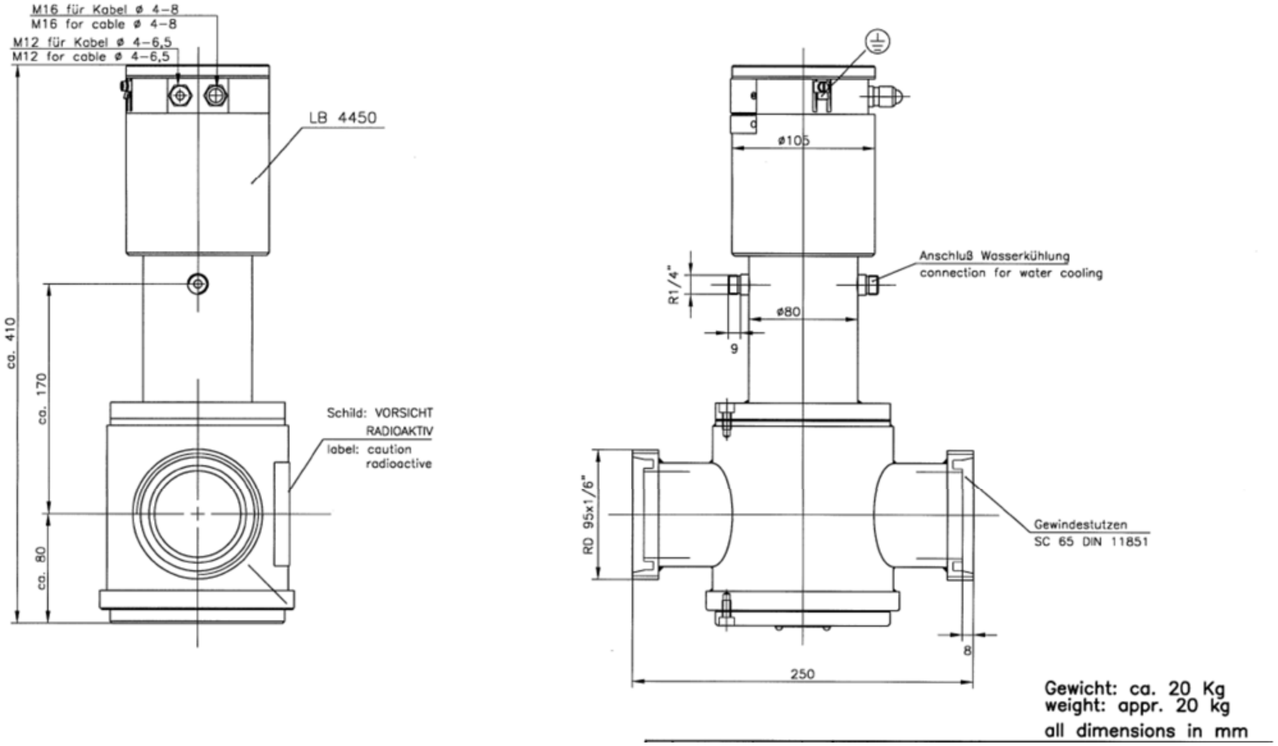
9.1 Measuring Path LB 379 with DIN Flange



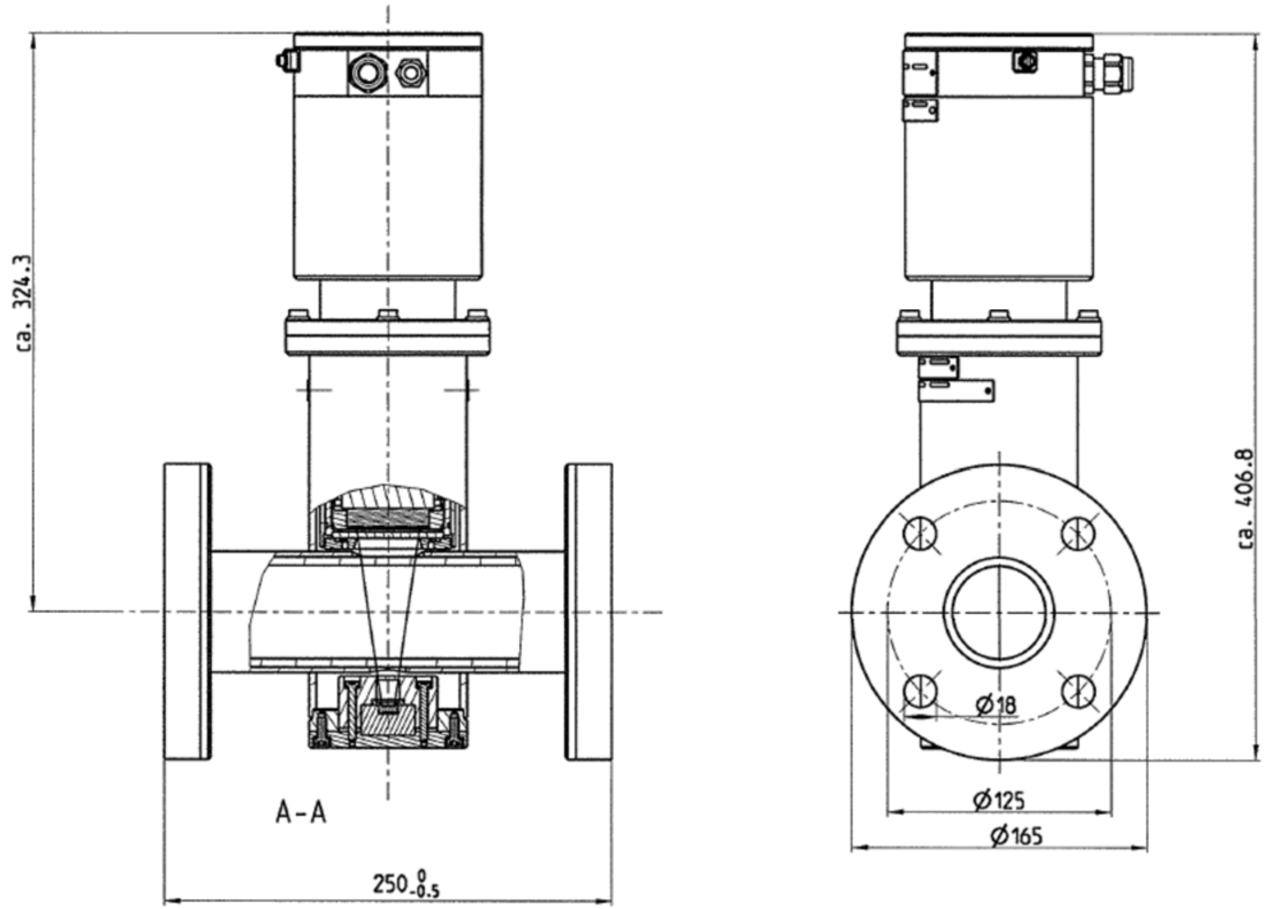
9.2 Measuring Path LB 379 with ASA Flange



9.3 Measuring Path LB 379 with Threaded Connector



9.4 Measuring Path LB 3602/03



10 ATEX Certificate

Physikalisch-Technische Bundesanstalt

Braunschweig und Berlin

PTB

(1) **EC-TYPE-EXAMINATION CERTIFICATE**

(Translation)

(2) Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres - **Directive 94/9/EC**

(3) EC-type-examination Certificate Number:

PTB 00 ATEX 2108

(4) Equipment: Scintillation counter / rod detector type LB44..F

(5) Manufacturer: Berthold GmbH & Co. KG

(6) Address: D-75323 Bad Wildbad

(7) This equipment and any acceptable variation thereto are specified in the schedule to this certificate and the documents therein referred to.

(8) The Physikalisch-Technische Bundesanstalt, notified body No. 0102 in accordance with Article 9 of the Council Directive 94/9/EC of 23 March 1994, certifies that this equipment has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of equipment and protective systems intended for use in potentially explosive atmospheres, given in Annex II to the Directive.

The examination and test results are recorded in the confidential report PTB Ex 00-20186.

(9) Compliance with the Essential Health and Safety Requirements has been assured by compliance with:

EN 50014:1997 EN 50018:1994 EN 50019:1994 EN 50020:1994

(10) If the sign "X" is placed after the certificate number, it indicates that the equipment is subject to special conditions for safe use specified in the schedule to this certificate.

(11) This EC-type-examination Certificate relates only to the design and construction of the specified equipment in accordance with Directive 94/9/EC. Further requirements of this Directive apply to the manufacture and supply of this equipment.

(12) The marking of the equipment shall include the following:

Ex II 2 G EEx ib d IIC T6 bzw. EEx d e IIC T6

Zertifizierungsstelle Explosionsschutz
By order:

Braunschweig, October 12, 2000

Dr.-Ing. U. Johannsmeyer
Regierungsdirektor

PHYSIKALISCH-TECHNISCHE BUNDESANSTALT 24

sheet 1/3

EC-type-examination Certificates without signature and official stamp shall not be valid. The certificates may be circulated only without alteration. Extracts or alterations are subject to approval by the Physikalisch-Technische Bundesanstalt.
In case of dispute, the German text shall prevail.

Physikalisch-Technische Bundesanstalt • Bundesallee 100 • D-38116 Braunschweig

Physikalisch-Technische Bundesanstalt

Braunschweig und Berlin

PTB

(13) # SCHEDULE

(14) **EC-TYPE-EXAMINATION CERTIFICATE PTB 00 ATEX 2108**

(15) Description of equipment

The scintillation counter / rod detector type LB44..F is used for the continuous measurement of levels in containers or bunkers with liquid, grainy, viscous or crust-forming contents as well as for the loading-measurement on conveyor belts.

The scintillation counter / rod detector is also used for the continuous measurement of the density of liquids, suspensions, pulps and bulk goods. It is also used for the continuous measurement of mass per unit area, ash, sulphur and for other special applications.

The maximum permissible range of the ambient temperature is: -40 °C until +50 °C.

Electical ratings

for the version EEx d e IIC T6 with PT100-output circuit

Signal- and supply circuit

Supply voltage max.	16,8 V
Supply power max.	2 W

PT100-circuit

Output voltage max.	16,8 V
Output current max.	34 mA
Output power max.	143 mW

for the version EEx d e IIC T6 without PT100-output circuit

Signal- and supply circuit

Supply voltage max.	30 V
Supply power max.	6 W

for the version EEx ib d IIC T6

Signal- and supply circuit (terminal 1 and 2)

type of protection Intrinsic Safety EEx ib IIC;
for connection to a certified intrinsically safe circuit only
Maximum values:
U_i = 16,8 V
P_i = 2 W
L_i negligibly small
C_i = 11 nF

sheet 2/3

EC-type-examination Certificates without signature and official stamp shall not be valid. The certificates may be circulated only without alteration. Extracts or alterations are subject to approval by the Physikalisch-Technische Bundesanstalt.
In case of dispute, the German text shall prevail.

Physikalisch-Technische Bundesanstalt

Braunschweig und Berlin

SCHEDULE TO EC-TYPE-EXAMINATION CERTIFICATE PTB 00 ATEX 2108

PT100-circuit (terminal 3 and 4)

type of protection Intrinsic Safety EEx ib IIC;
maximum values:
U_o = 16,8 V
I_o = 34 mA
P_o = 143 mW
linear characteristic
L_i negligibly small
C_i = 11 nF

	IIC	IIB
L_o	23 mH	87 mH
C_o	290 nF	1300 nF

The intrinsically safe signal and supply circuit and the PT100-circuit are operational earthed.

(16) Test report PTB Ex 00-20186

(17) Special conditions for safe use

none

(18) Essential health and safety requirements

Met by standards mentioned above.

Zertifizierungsstelle Explosionsschutz
By order:

Dr.-Ing. U. Johannsmeyer
Regierungsdirektor

Braunschweig, October 12, 2000

sheet 3/3

EC-type-examination Certificates without signature and official stamp shall not be valid. The certificates may be circulated only without alteration. Extracts or alterations are subject to approval by the Physikalisch-Technische Bundesanstalt.
In case of dispute, the German text shall prevail.

Physikalisch-Technische Bundesanstalt

Braunschweig und Berlin

1. SUPPLEMENT

according to Directive 94/9/EC Annex III.6

to EC-TYPE-EXAMINATION CERTIFICATE PTB 00 ATEX 2108

(Translation)

Equipment: Scintillation counter / rod detector type LB44..F

Marking: ⟨Ex⟩ **II 2 G EEx ib d IIC T6 resp. EEx d e IIC T6**

Manufacturer: Berthold Technologies GmbH & Co. KG

Address: Calmbacher Str. 22
75323 Bad Wildbad, Germany

Description of supplements and modifications

The Scintillation counter / rod detector type LB44..F in the version **EEx d e IIC T6 without PT100-output circuit** may also be operated in the ambient temperature range: -40°C to +60°C.

All other determinations and statements are valid without changes.

Test report: PTB Ex 01-21266

Zertifizierungsstelle Explosionsschutz
By order:

Dr.-Ing. U. Johannsmeyer
Regierungsdirektor

Braunschweig, July 24, 2001

Sheet 1/1

EC-type-examination Certificates without signature and official stamp shall not be valid. The certificates may be circulated only without alteration. Extracts or alterations are subject to approval by the Physikalisch-Technische Bundesanstalt.
In case of dispute, the German text shall prevail.

Physikalisch-Technische Bundesanstalt • Bundesallee 100 • D-38116 Braunschweig

Physikalisch-Technische Bundesanstalt

PTB

Braunschweig und Berlin

2. SUPPLEMENT

according to Directive 94/9/EC Annex III.6

to EC-TYPE-EXAMINATION CERTIFICATE PTB 00 ATEX 2108

(Translation)

Equipment: Scintillation counter / rod detector type LB44..F

Marking: ⟨Ex⟩ **II 2 G EEx ib d IIC T6 bzw. EEx d e IIC T6**

Manufacturer: Berthold Technologies GmbH & Co. KG

Address: 75323 Bad Wildbad, Germany

Description of supplements and modifications

The Scintillation counter / rod detector type LB44..F may alternatively be operated with the modified components electronic and case.
The Scintillation counter / rod detector type LB44..F is used for the continuous measurement of the level resp. density of pulps, bulk goods and it is also alternatively used for example in vessels or bunkers which are operated with combustible dust.
The maximum permissible range of ambient temperature is changed in this case. The maximum permissible range of ambient temperature in combustible dust atmospheres is:

in general	-20°C to +50°C
variant without PT100 Output	-20°C to +60°C

All other determinations and statements are valid without changes.
The marking of the equipment is amended and reads hereafter as follows:

Marking: ⟨Ex⟩ **II 2 G EEx ib d IIC T6 resp. EEx d e IIC T6**

⟨Ex⟩ **II 2 D IP65 T80°C resp. IP67 T80°C**

Test report: PTB Ex 02-22033

Certification body for explosion protection
By order:

Dr.-Ing. U. Klausmeyer
Regierungsdirektor

Braunschweig, April 10, 2002

Sheet 1/1

EC-type-examination Certificates without signature and official stamp shall not be valid. The certificates may be circulated only without alteration. Extracts or alterations are subject to approval by the Physikalisch-Technische Bundesanstalt.
In case of dispute, the German text shall prevail.

Physikalisch-Technische Bundesanstalt • Bundesallee 100 • D-38116 Braunschweig

Physikalisch-Technische Bundesanstalt

Braunschweig und Berlin

PTB

3rd SUPPLEMENT

according to Directive 94/9/EC Annex III.6

to EC-TYPE-EXAMINATION CERTIFICATE PTB 00 ATEX 2108

(Translation)

Equipment: Scintillation counter LB44..

Marking: Ⓔx **II 2 G EEx ib d IIC T6 or EEx de IIC T6**

Manufacturer: BERTHOLD TECHNOLOGIES GmbH & Co. KG

Address: Calmbacher Str. 22
75323 Bad Wildbad, Germany

Description of supplements and modifications

1. New design option with aluminium or beryllium disk.
2. An adhesive label may optionally be used for marking.
3. The operator marking is extended and will in future be as follows:

   Ⓔx **II 2 G EEx de IIC T6** or
   Ⓔx **II 2 G EEx ib d IIC T6** or
   Ⓔx **II 2 G D EEx de IIC T6 IP 65 T 80 °C or IP 67 T 80 °C** or
   Ⓔx **II 2 G D EEx ib d IIC T6 IP 65 T 80 °C or IP 67 T 80 °C**
4. Optional connection of commercial thread adapters to the EEx "e" terminal compartment for subsequent connection of a conduit as follows.

   M16*1.5 to ¾ " NPT
   M12*1.5 to ¾ " NPT
   M16*1.5 to ½ " NPT
   M12*1.5 to ½ " NPT
5. Variable wall thickness of the enclosure shoulder from 7 to 10 mm.
6. Extension of the operating temperature range to +73 °C for the EEx de IIC T6 version without PT100 output

Special conditions

The impact test made for the beryllium disk (scintillation counter LB44..) was only passed at the low impact energy of 4 J. For this design version, the operator marking must show an "X" symbol behind the certification number (as specified in EN 50014, section 27.2 i). In addition, a warning note shall be included in the operating instructions, which makes reference to the sensitivity to impact of the beryllium disk.

Sheet 1/2

EC-type-examination Certificates without signature and official stamp shall not be valid. The certificates may be circulated only without alteration. Extracts or alterations are subject to approval by the Physikalisch-Technische Bundesanstalt.
In case of dispute, the German text shall prevail.

Physikalisch-Technische Bundesanstalt • Bundesallee 100 • D-38116 Braunschweig

Physikalisch-Technische Bundesanstalt

PTB

Braunschweig und Berlin

3rd SUPPLEMENT TO EC-TYPE-EXAMINATION CERTIFICATE PTB 00 ATEX 2108

Additional notes for safe use

The version **EEx de IIC T6 without PT100 output** of the scintillation counter LB44.., may at a power input of 2 W also be operated up to a maximum ambient temperature of +73 °C. The maximum power input of 2 W shall in that case be safeguarded by adequate design features.

All the other specifications and details remain unaffected.

Test report: PTB Ex 03-13123

Zertifizierungsstelle Explosionsschutz
By order:

Dr.-Ing. M. Thedens

PHYSIKALISCH-TECHNISCHE BUNDESANSTALT 24

Braunschweig, May 19, 2003

Sheet 2/2

EC-type-examination Certificates without signature and official stamp shall not be valid. The certificates may be circulated only without alteration. Extracts or alterations are subject to approval by the Physikalisch-Technische Bundesanstalt.
In case of dispute, the German text shall prevail.

Physikalisch-Technische Bundesanstalt • Bundesallee 100 • D-38116 Braunschweig

11 Index

A

Adjust current input *26*
Adjustment of input current............... *26*
Assembly description........................ 13

C

Crystal *27*
Crystal-multiplier assembly *26*

D

Density of water (Table) 30
Device configuration........................... 8

E

Electrical connections 18
Emergency instructions..................... 25
Enclosed radioactive materials 12

M

Mu-metal shielding........................... *26*

P

Photocathode *27*
Photomultiplier *26*
Pt100.. 18

R

Radiation Protection Instructions.......... 5
Radiation Protection Officer 13
Radioactive source 12
Resistance thermometer 18

S

Safety summary 5
Scintillation counter *26*
Shielding 13
Silicon oil....................................... *26*
Sources... 12
Supply voltage 8

T

Technical Data 19
Temperature coefficients (Table)........ 29
Two-wire cable 8

W

Water inflow 17

BERTHOLD TECHNOLOGIES GmbH & Co. KG
Calmbacher Str. 22
D-75323 Bad Wildbad
Germany
www.Berthold.com