

# Density, Concentration and Solids Content

Non-contacting measurement



# Non-contacting measurement technology by Berthold

The density measurement systems by Berthold are used for the continuous process monitoring on pipelines and in vessels. The density, concentration and solids content are determined in a non-contacting manner without affecting the flow properties of the measured material.

Successful applications can be found in a wide variety of industries and in particular when facing extreme measurement conditions:

- Extreme temperatures
- High pressure
- Dust
- Acid or abrasive media

The measurement can be carried out on all kinds of liquids and mixtures, including acids, lyes, solutions, emulsions and suspensions. Determining the bulk density of solid matters such as granulates or powders is also possible.



## Non-contacting perfection

- Easy mounting, on the outside of the pipeline
- No contact with measured material
- Free of wear and maintenance
- Subsequent installation on existing systems possible without process downtime
- High availability and therefore high operational safety

## Measuring principle & function

Gamma radiation is attenuated when it passes through a pipeline. This attenuation is measured by a detector. The extent to which the radiation is attenuated is dependent on the density of the medium in the pipe. The higher the density the less radiation reaches the detector. This way, the density, concentration and solids content can be reliably determined in a non-contacting manner – irrespective of pressure, temperature, colour, conductivity and other chemical properties.

Consequently, this results in the high reliability and low maintenance requirements of the radiometric measurement systems, even under harsh operating and environmental conditions.

# Density measurement

## Flexible adjustment to measurement geometry and task

Customized solutions which ideally comply with the existing requirements may be achieved by using various detectors and sources. They can be combined in various ways and may also be inserted in dip pipes.

All systems can compensate fluctuating temperatures independent of the measuring arrangement, which ensures the highest level of accuracy.

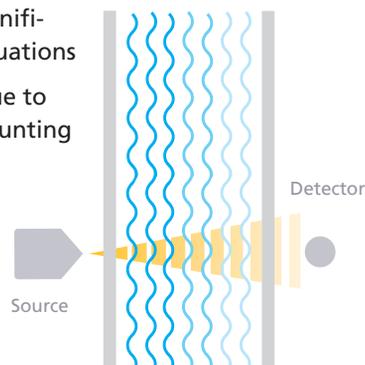
Which of these possibilities is selected depends on the:

- Measurement geometry
- Accuracy requirements
- Economic aspects

Our experienced sales and application engineers will support you to find the optimum system configuration.

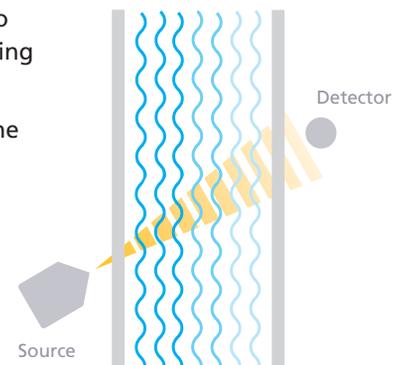
### 90° - irradiation

- Standard solution
- Ideal for large pipe diameters and significant density fluctuations
- Easy mounting due to preassembled mounting device



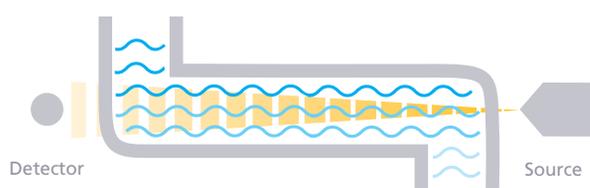
### 30° or 45° - irradiation

- Highest accuracy for small measuring ranges
- Easy mounting due to preassembled mounting device
- No modification of the pipes required



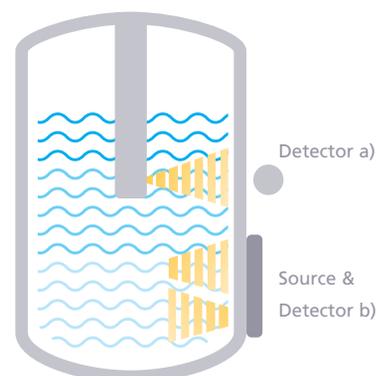
### S- or U-shaped measuring path

- For the smallest pipe diameters
- For the smallest changes in density
- Measuring path can optimally be adjusted to the measurement task



### Vessel measurement

- Transmission measurement with source in dip pipe (a) or backscattering measurement (b)
- Density profile measurement
- Optimal adjustment to measurement task possible



# Using variety and experience to achieve a custom-made solution

Due to its unique and comprehensive range of "modular systems", Berthold is unparalleled when it comes to developing custom-made solutions that exactly meet the requirements of your measurement task. The Berthold experts can choose from a variety of proven components in order to provide you with the optimum system configuration that best fulfills your requirements and offer even further benefits that are not listed in your specifications.

By using different isotopes, we are able to install even non-standard systems that are perfectly tailored to your application and operating conditions. In combination with the highly sensitive detectors, extremely precise measurements are achieved while source activities are kept to a minimum.

The great variety of communication standards and certificates or the availability of 2-wire systems with separate evaluation units and compact probes complete the "Berthold offer of modular systems".

Excellent application engineers, a development department that has invested more than 800 man-years into the development of our systems and more than 30 patents

ensure the function and precision that you have come to expect. The more than 20,000 measurement systems reliably operating worldwide are a proof of that every day.

**No matter which measurement task you are facing – we can offer you the right solution.**

## Varied technological leadership

- Large selection of detectors
- 2-wire systems with separate evaluation unit or compact probes
- Flexible mounting possibilities and a large selection of standard mounting devices
- In-house production of various source types with different isotopes
- Communication via HART, 4-20 mA, Profibus PA, Foundation Fieldbus
- Comprehensive safety features
- Robust design
- Comfortable software solutions
- Regular quality and stress tests



# The detectors offer the following benefits

## Highest sensitivity

The high sensitivity offers many advantages:

- Increased accuracy and faster reaction times
- Longer service life despite reduced source activity and less effort (radiation protection)
- Use of smaller shieldings resulting in lower acquisition and transportation costs for source and shielding
- Dose rate of less than 1  $\mu\text{Sv/h}$

## Very good long-term stability

A patented procedure for automatic drift compensation compensates temperature influences and ensures a high sensitivity as well as a constant measurement accuracy over the entire lifetime of the system.

The stability of the CrystalSENS is  $\leq 0.002\%$  per  $^{\circ}\text{C}$ , tested over a temperature range of  $-40\dots+60^{\circ}\text{C}$ .



## CrystalSENS

Point detector with high-quality scintillation crystal made of sodium iodide which achieves a particularly high sensitivity despite its small volume. Due to its compact design, it is ideally suited for applications with limited space requirements.

## SuperSENS

Point detector with extraordinarily high sensitivity and measurement accuracy. Ideally suited for applications that could only be solved by using very high source activities until now. It is perfect for thick-walled pipes and vessels or for large vessel diameters because measurements can be carried out using smallest source activities. The extremely large scintillation volume is many times bigger than that of traditional detectors resulting in a threefold to fourfold increase of the sensitivity. By using the SuperSENS, an imminent source replacement can be delayed by several years.

## Inline density meter LB 379

The measuring unit LB 379 combines the radioactive source and the detector in one unit. The compelling advantage of the LB 379 is the use of low-energy isotopes such as Am-241. For measurements with only minor density changes, the LB 379 provides the highest accuracy. Due to the low energy (comparable to that of x-rays), the measuring unit can be operated on a license-free basis in several countries. The system is flanged to the pipeline and is completely made from stainless steel.

# LB 444

Proven in thousands of applications

## Using proven 2-wire technology

- The most commonly used radiometric detector worldwide
- Ideal for standard and special applications such as concentration measurement and product analysis
- Proven 2-wire technology with separate evaluation unit and intrinsically safe power supply
- Very easy to use
- Ideally suited for applications with limited space requirements due to its compact design
- Highest reliability

Lead collimator provides protection from background radiation and ensures high reliability and measurement accuracy

Full Ex-i  
(intrinsically safe power supply)

Detector and terminal connection room offer increased safety

Slim and light design, also ideally suited for applications in dip pipes



Stainless steel housing

In order to ensure an optimal adjustment to the measurement task, various scintillator crystals are available

## Proven in thousands of applications – LB 444

The LB 444 offers proven 2-wire technology with a separate evaluation unit of the best quality. During the decades of its successful use, it has received many system optimisations. The more than 15,000 systems that are in operation today are an impressive proof of its high industrial standard. LB 444 has successful applications in SIL2 plants as well. The detector is slim and light, easy to mount and can be used for dip pipes. It is a system that provides unique versatility and reliability.

## Separate evaluation unit with display



## LB 379 measuring unit for special applications

Due to the use of the low-energy isotope AM-241, elements can be detected depending on their atomic number using the LB 379. This way, the concentration of one or several elements in a solution can be calculated. These measurements can even be carried out if the density does not or only slightly changes when the material composition varies.

Application examples: %HCl, %H<sub>2</sub>SO<sub>4</sub> and %Zn in aqueous solution.

## Calibration using UNIBERT

UNIBERT makes calibrating very convenient. All calibrating functions can be activated using a PC or laptop connected to the RS 232 interface. The results can be graphically displayed.

## LB 444

Evaluation unit	
Power supply	115/230 VAC, ±10 %, 50 ... 60 Hz, 30 VA 24 VDC (18 ... 32 VDC), 30 W; 24 VAC, +10 %/-15 %, 50 ... 60 Hz, 30 VA
Ambient temperature	Operation: 0 ... +50 °C (-40 ... +122 °F), no condensation Storage: 0 ... +70 °C (-40 ... +158 °F), no condensation
Design	19" module 3 HE, 21 TE, protection class IP 20
Installation	19" frame (max. 4 modules), wall housing (max. 2 modules) or switchboard

Detector operating data	
Power supply	Supplied by AWE via a 2-wire signal cable
Cable connections	1x M16 for cable 4 ... 9 mm 1x M12 for cable 3 ... 6 mm
Maximum cable length	for Berthold cable id. no. 32024, LiYCY-OZ 2 x 1 mm <sup>2</sup> : 1000 m other cables: max. 40 Ω, for intrinsically safe installations: L & C to be considered according to certificate.
Wire cross-section	0.5 ... 1.5 mm <sup>2</sup>
Housing material	Stainless steel ISO 1.4301 / AISI 304
Water cooling	Option (can also be retrofitted), max. 6 bar

	Scintillator size Ø x length [mm]	Weight [kg]	Weight with cooling system [kg]	Collimator
CrystalsENS (point detectors)	44 x 5 NaI(Tl)	6	8	N.A. (LB 379)
	25 x 25 NaI(Tl)	6	8	Option
	40 x 35 NaI(Tl)	6	8	Option
	50 x 50 NaI(Tl)	18	20	Standard
SuperSENS	150 x 150 polymer	45	54	Standard
Ambient temperature (Operation and storage)	-40 ... +60 °C (-40 ... +140 °F) for NaI(Tl) and/or -40 ... +55 °C (-40 ... +131 °F) for polymer Observe possible temp. restrictions for Ex-protection!			
Temperature stability	≤0.002 %/°C (-20 ... +50 °C) for NaI(Tl) and/or ≤0.01 %/°C (-20 ... +50 °C) for polymer			

Measuring unit LB 379	
Material	Stainless steel 1.4571, 1.4401 or 1.4301 (for pipes with linings)
Measurement pipe	DN 65, 10 bar, optional soft rubber or PTFE lining Flange in accordance with DIN 2576 or ASA, threaded connection pipe SC 65 in accordance with DIN 11851
Product temperature	with PTFE coating / without lining: -190 ... +260 °C (-310 ... +500 °F) with soft rubber: -30 ... +80 °C (-22 ... +176 °F)

Detector certificates & tests	
IP protection	IP65
Explosion protection	ATEX: II 2 G EEx de IIC T6 II 2 D EEx de IIC T6 IP65 T80 II 2 G EEx ib IIC T6 FM/CSA: Class I Division 1 Group A, B, C, D FM: Class II Division 1 Group E, F, G
Other certificates	Nepsi, TIIS, Kosha, others upon request

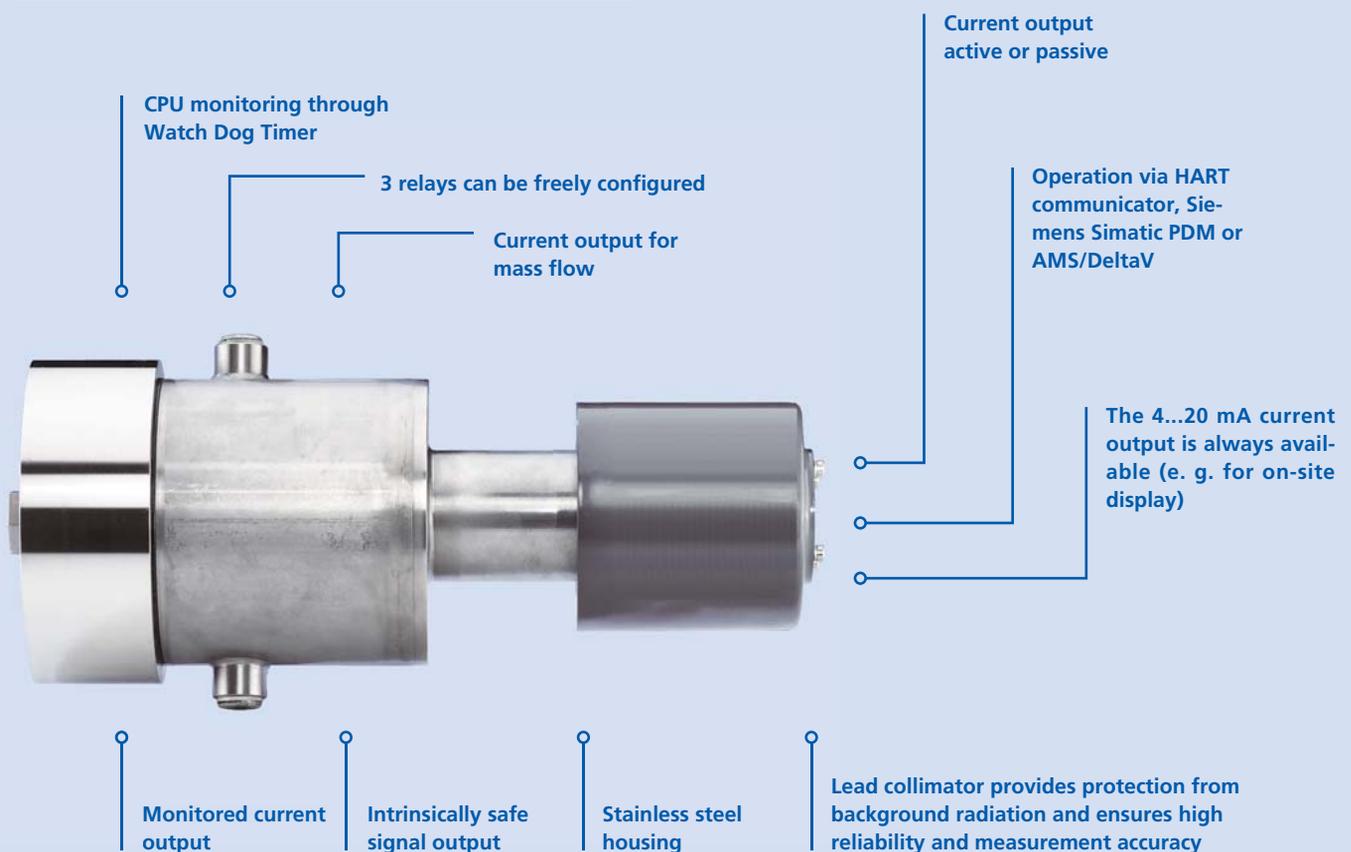
Signal inputs and outputs	
Signal output	0/4 ... 20 mA potential-free / max. impedance 500 Ω
Digital input	Hold input
Analogue input	Pt100 for temperature compensation (directly at the detector)
Digital outputs	1 relay for collective fault message 2 relays for min. / max. alarm or detector temperature Permissible load at ohmic load: AC: max. 250 V, max. 1 A, max. 200 VA DC: max. 300 V, max. 1 A, max. 60 W
Interfaces	RS 232 for parameter export or PC operation using UNIBERT
Data backup	in non-volatile memory
Menu languages	English, German, French

# Uni-Probe LB 491

A universal field device for various applications

## A versatile compact device

- Versatile detector for various applications
- Compact field device with integrated evaluation unit
- Communication via HART, Foundation Fieldbus or Profibus PA
- Communication can be switched from Bus to HART at any time
- Inexpensive and solid system for standard applications



## Robust compact device for high demands

The density measurement system Uni-Probe LB 491 is a proven compact device provided with a robust stainless steel housing. It is inexpensive, reliable, precise and

requires very little source activity. It features all common communication capabilities such as HART, Profibus PA and Foundation Fieldbus.



## Monitored current output

A monitored current output provides you with a high level of safety. It ensures that the correct measurement values are displayed. The device constantly compares the actually flowing current with the target value. In the event of deviations, a failure current is generated. A Watch Dog Timer monitors the functioning of the CPU simultaneously.

## Mass flow

In combination with a flow rate measurement, the Uni-Probe LB 491 can also be used for determining the mass flow (t/h). The signal of the flow rate is directly transferred to the Uni-Probe as a 4-20 mA current signal before being internally offset against the density. The result is a reliable and precise mass flow measurement which combines all of the non-contacting measurement technology's benefits.

## LB 491

### Detector operating data

Power supply	100 ... 240 VAC, $\pm 10\%$ , 50 ... 60 Hz, 15 VA 24 VDC (18 ... 32 VDC), 15 W; 24 VAC $+10\%$ / $-15\%$ , 50 ... 60 Hz, 15 VA
Cable connections	4 cable entries, 3/4 inch, NPT, closed with blind plug Option: metric adapters and cable glands upon request
Maximum cable length	3300 m (120 $\Omega$ ), 1600 m (250 $\Omega$ ), 800 m (500 $\Omega$ )
Wire cross-section	0.5 ... 1.5 mm <sup>2</sup>
Housing material	Stainless steel ISO 1.4301 / AISI 304
Water cooling	Option, max. 6 bar

	Scintillator size $\varnothing$ x length [mm]	Weight [kg]	Weight with cooling system [kg]	Collimator
CrystalsSENS (point detectors)	50 x 50 NaI(Tl)	22,5	24	Standard
SuperSENS	150 x 150 polymer	52	62	Standard
Ambient temperature (Operation and storage)	-40 ... +60 °C (-40 ... +140 °F) for NaI(Tl) and/or -40 ... +55 °C (-40 ... +131 °F) for polymer Observe possible temp. restrictions for Ex-protection! for 100...240 VAC version, operation only up to max. 50 °C			
Temperature stability	$\leq 0.002\%$ /°C (-40 ... +50 °C) for NaI(Tl) and/or $\leq 0.01\%$ /°C (-40 ... +50 °C) for polymer			

### Detector certificates & tests

IP protection	IP65 / IP66 + Nema 4X		
Explosion protection	ATEX:	II 2 GD EEx d IIB T5 IP66 T80 °C II 2 GD EEx d IIC T6 IP66 T80 °C (...+50 °C for LB 490 TowerSENS and SuperSENS)	-40 ... +80 °C -40 ... +60 °C
	FM/CSA:	II 2 GD EEx d [Ia] IIC T6 IP66 T80 °C Class I Division 1 Group A, B, C, D Class II Division 1, Group E, F, G	-20 ... +50 °C -40 ... +50 °C
Other certificates	Nepsi, IECEx, Kosha, CCOE, others upon request		

### Signal inputs and outputs

Signal output	HART 4 ... 20 mA potential-free, active or passive max. impedance: 500 $\Omega$ (active) Power supply: 12 V ... 24 V (passive) max. impedance at 12 V: 250 $\Omega$ and/or 24 V: 500 $\Omega$ (passive) Option: intrinsically safe HART current output 4 ... 20 mA, potential-free, passive Power supply: 12 ... 30 V, voltage drop <3.5 V, 20 m signal cable (blue), pre-assembled Exi IIB: Lo=14.78 mH; Co=679 nF / Exi IIC: Lo=2.18 mH; Co=84 nF
Bus output - option	Bus interface: Profibus PA or Foundation Fieldbus Bus powered, typical 13 mA with 2xAI function blocks Option: intrinsically safe Bus interface, 20 m signal cable (blue), pre-assembled Approval according to ATEX and FISCO
Digital inputs	Dig In 1: Hold input, Dig In 2: Empty adjustment
Analogue input	Pt100 for temperature compensation
Digital outputs	1 relay (SPDT) for collective fault message 3 relays (SPDT) alternatively for: Hold signal, min. / max. alarm, Detector temperature, radiation interference detection Permissible load at ohmic load: max. 5 A at 250 VAC or 30 VDC
Interfaces	RS 232 for software update
Data backup	in non-volatile memory

# SENSseries LB 480

The best choice for high demands

## The best choice for high demands

- Compact field device with integrated evaluation unit
- Process connection via HART
- SILready developed according to IEC 61508 and FMEDA with SFF 96 %
- Quick Start menu for effective and fast start-up
- Continuous self-monitoring
- High interference immunity (SIL standard)



## SENSseries LB 480 for critical processes

The SENSseries LB 480 measurement system is especially suited for challenging applications. It was developed according to IEC 61508 and features many maintenance-oriented diagnosis functions. For instance, the performance of the detector is continuously monitored by using cosmic radiation for an additional reference measurement. SENSseries LB 480 is SILready. The system offers an excellent operational safety and system stability as well as a high interference immunity that complies with the SIL standard. In short: It is the best choice for your critical processes.

### Quick Start - for a fast and easy start-up

The user-friendly Quick Start menu guides you to an effective start-up in only a few steps. Once the most important measurement parameters (isotope and one calibration point) have been entered, the measurement is available within a very short time. Special functions and supplementary parameters can be added at a later time if required.

## LB 480

### Detector operating data

Power supply	100 ... 240 VAC, $\pm 10\%$ , 50 ... 60 Hz, 8 VA 24 VDC (18 ... 32 VDC), 8 W
Cable connections	4 cable entries M20 closed with blind plug Option: Cable glands M20
Maximum cable length	3300 m (120 $\Omega$ ), 1600 m (250 $\Omega$ ), 800 m (500 $\Omega$ )
Wire cross-section	0.5 ... 1.5 mm <sup>2</sup> (up to 2.5 mm <sup>2</sup> without wire-end sleeve)
Housing material	Stainless steel ISO 1.4301 / AISI 304 (others upon request)
Water cooling	Option (can also be retrofitted), max. 6 bar

	Scintillator size $\varnothing \times \text{length [mm]}$	Weight [kg]	Weight with cooling system [kg]	Collimator
CrystalSENS (point detectors)	50 x 50 NaI(Tl)	11	14,5	Option
Ambient temperature (Operation and storage)	-40 ... +60 °C (-40 ... +140 °F) for NaI(Tl), observe possible temp. restrictions for Ex-protection!			
Temperature stability	$\leq 0.002\%$ / °C (-40 ... +60 °C) for NaI(Tl)			

### Detector certificates & tests

IP protection	IP65 / IP66 / IP67 / IP68 / IP69K		
Explosion protection	ATEX: II 2 G Ex db eb IIC T5 / Ex tb IIIC T95 °C II 2 G Ex db eb IIC T6 / Ex tb IIIC T80 °C		-40 °C ... 80 °C -40 °C ... 60 °C
Vibration / Shock	Vibration: 1.9 g / mechanical Shock: 30 g according to DIN EN 60068-6 and 60068-2-27		

### Signal inputs and outputs

Signal output	HART 4 ... 20 mA potential-free, active or passive max. impedance: 500 $\Omega$ (active) Resolution better than 0.006 mA Stability $\pm 0.001\%$ / °C (-40 ... 60 °C) Power supply: 12 V ... 24 V (passive) max. impedance at 12 V: 250 $\Omega$ (passive) max. impedance at 24 V: 500 $\Omega$ (passive)
Analogue input	Pt100 for temperature compensation
Digital outputs	Open Collector alternatively for: Max. alarm, min. alarm, warning messages + error messages, hold signal, radiation interference detection, detector temperature Permissible load at ohmic load: max. 100 mA at 5 ... 36 VDC
Interfaces	RS 485 for software update
Data backup	in non-volatile memory

# Unique technology

Making special solutions the new standard

The long-established company Berthold Technologies is the only radiometry supplier worldwide with an in-house source production. This opens up unique possibilities for our customers. The sources are manufactured according to customer-specific specifications and can therefore be optimally adjusted to the respective application requirements. Our standard range includes:

- Point and rod sources
- Dip pipe sources for installation in a vessel
- Various isotopes such as Cs-137, Am-241, Co-60 or Cm-244
- Various shielding materials such as lead, wolfram or stainless steel

This variety enables us to always select the isotopes and shieldings that represent the most cost-efficient solution for the respective application while ensuring the best measurement result at minimum radiation exposure. We will be happy to develop special solutions for special applications as well. **Please contact us.**



## Maximum safety

The SSC source capsules made by Berthold have been tested according to ISO 2919 and exceed even the highest classification C66646. They are extremely robust and can withstand temperatures of up to 1200 °C. The three-fold encapsulation of the isotope ensures maximum safety even in extreme measurement environments. Our shieldings comply with the following international standards:

- ANSI 43.8
- ISO 7205
- IEC 62598

## Tailor-made – the best solution for you

For every measurement, our project engineers recalculate the required source activity while strictly adhering to the ALARA principle (As Low As Reasonably Achievable). This means that the sources are designed in such a way that only the absolutely necessary source activity is used. Thanks to the high sensitivity of our detectors, the source activity in systems made by Berthold is the lowest of all systems currently available on the market. A dose rate of less than 0.001 mSv/h is typically sufficient in order to realise a reliable density measurement. In order to provide you with a short overview of the radiations you may typically be exposed to, we have listed some examples in the table „How high is the radiation?“.

## How high is the radiation?

Radiation	
Flight over the Atlantic	0.06 mSv
Chest x-ray	0.1 mSv
Living at 1600 metres above sea level	1.2 mSv/a
Berthold measurement (pipe is empty)	0.001 mSv/h

## Competence in radiation protection

Whoever conducts radiometric measurements automatically has to deal with the issue of radiation protection. So it is good to have a team of in-house experts on this matter. In the radiation protection business unit, experts are dealing with the tasks related to dose rate measurement. The transfer of knowledge is direct and synergies are to your advantage. Berthold takes a special responsibility when it comes to the training of its customers. We offer trainings and workshops for radiation protection officers.

Project-specific design of the source activity according to the ALARA principle

Small in size and with best shielding effect

Use of various isotopes:  
Cs-137, Am-241,  
Co-60, Cm-244

Various versions available

Maximum safety due to the use of extremely temperature and corrosion resistant source capsules

Use of various shielding materials such as lead, wolfram or stainless steel



In-house production plant for sources enables customer-specific production and individual designs

## Other applications



Our measurement systems are also ideally suited for the following applications:

- **Continuous level**
- **Level switch**
- **Bulk flow / mass flow**
- **Weight per unit area**
- **Coating thickness**

For more detailed information, please contact us!

### Technical support – a matter of course

Our sales engineers and application experts will gladly assist you in choosing the detector that is best suited for your measurement task. They will determine the right solution according to your needs and specifications and provide you with individual advice.

**LB 444****Uni-Probe LB 491****SENSseries LB 480****Communication standards**

4-20 mA	•	•	•
HART		•	•
Foundation Fieldbus		•	
Profibus PA		•	

**Explosion protection**

ATEX	•	•	•
Intrinsically safe signal output	•	•	•
Intrinsically safe power supply	•		
FM	•	•	
CSA	•	•	
IECEX		•	

**Versions**

CrystalSENS	•	•	•
SuperSENS	•	•	
Measuring unit LB 379	•		

**Temperature compensation**

Pt100 input	•	•	•
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**Software**

Quick Start			•
Mass flow measurement		•	
Monitored current output		•	•

**Operation and parameter settings**

Separate evaluation unit	•		
HART communicator		•	•
DeltaV AMS / Simatic PDM		•	•
FDT/DTM		•	



## We are there for you! Worldwide.

Our sales engineers are looking forward to your request. Regardless of what you want to measure and no matter where. We will provide you with the right system for each measurement task and we do know how to configure it so that it perfectly suits your needs. From a wide variety of possible variants, our application engineers will choose the right one for you.

We provide our customers with individual solutions and consider complex tasks to be a challenge that we will gladly face for you with a high degree of motivation and dedication.

All of our products are being developed and manufactured in Germany. At Berthold, you will always receive "made in Germany" quality products.

**BERTHOLD TECHNOLOGIES perfect solutions from a single source.**

The engineers and service technicians of Berthold Technologies are always there when they are needed. Thanks to our worldwide network of branch offices we are able to provide you with quick and most of all competent support if necessary. Our qualified personnel will be at your site in no time at all!

**You can take our word for it.**



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