

# Determination of density and concentration

LB 444



# Determining density and concentration using the LB 444



Arrangement for 45° irradiation

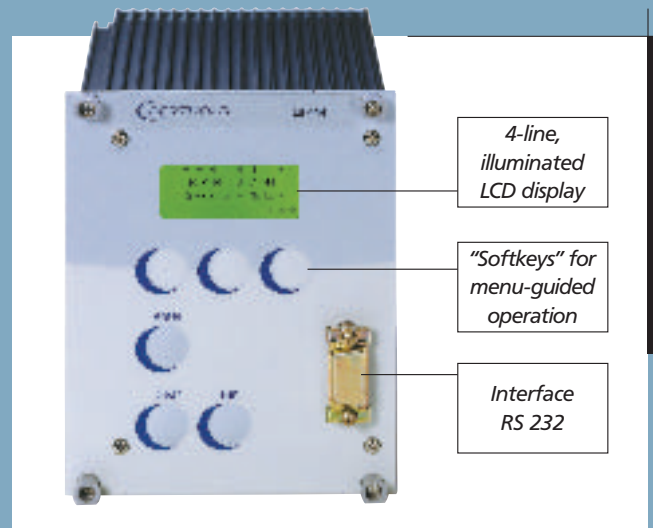
The measuring system LB 444 is used for contactless, continuous density measurements of liquids or bulk materials in pipes and vessels. It is easily installed on existing pipelines without process down time. The measurement is repeatable and unaffected by colour, temperature, pressure or chemical properties of the measured product. The LB444 system provides high levels of operational safety and requires virtually no maintenance, even under extreme environmental conditions.

## Applications

- Concentration measurements of acids, alkalis, saline solutions and suspensions.
- Crystallisation and polymerisation monitoring.
- Measurement of the solid matter content in slurries, in sewage mud, in pulp and paper production, in flue gas desulphurisation suspensions, in aluminium production, in mining, on dredgers
- Determination of the bulk density in washing powder and clinker.

**Evaluation unit The LB 444** evaluation unit incorporates a 32 Bit processor for high computing speed and precision in all applications. The design is compact, housed in a module type 3 HE; 21 TE. Installation is in a wall-housing or up to 4 units installed in a 19" rack. It features:

- An illuminated 4 line LCD Display.
- Interactive multilingual user guidance via soft keys.
- Continuous self-monitoring of the measurement process.
- Storage of all calibration data in a Flash-memory.
- 6 membrane keys for ease of operation



4-line, illuminated LCD display

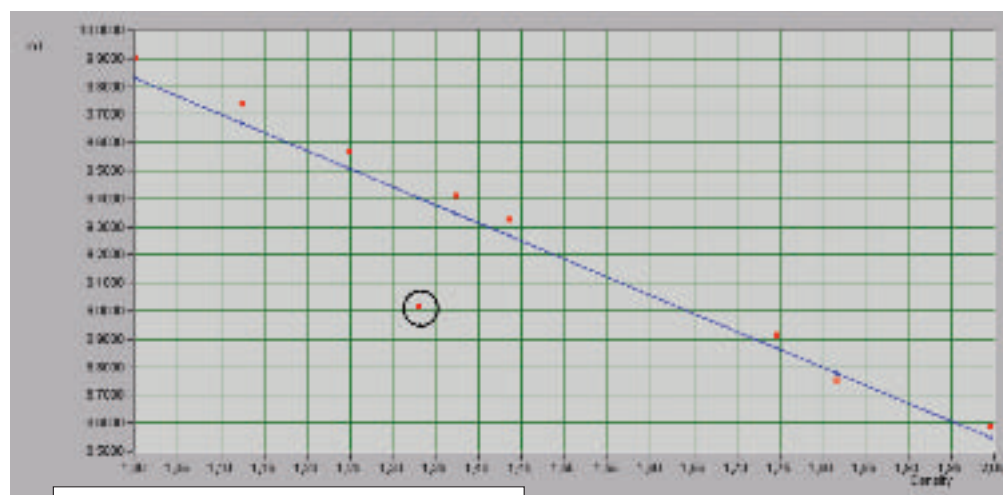
"Softkeys" for menu-guided operation

Interface RS 232

### Calibration

The user-friendly calibration software makes start-ups easy. The properties of the product and the conditions at the measuring point are processed automatically. Simple Start up with input of only ONE calibration point. For more precise calibrations, up to 10 calibration points may be entered. Temperature fluctuations of the product during calibration are compensated automatically. Up to four calibration curves can be stored for different products and accessed externally.

With our unique calibration software **UNIBERT™** a very concise calibration is possible using a PC connected to the RS 232 interface. By using a display of the calibration curve errors can be corrected.



Calibration Curve using UNIBERT™ Software

## Detector

A scintillation counter with a NaI crystal is used as a detector. Photoflashes are produced in the crystal by gamma radiation. The number of flashes is proportional to the intensity of the radiation field. The crystal is optically coupled to a photo multiplier which, together with the electronics, converts the photoflashes into electrical impulses. In comparison with other detector technologies (such as ionisation chambers), the advantages are:

- high sensitivity to gamma radiation,
- therefore lower source activity,
- higher temperature stability
- longer service life.

The compact shape of the sensitive part of the detector – the crystal – combined with lead shielding reduces measurement errors due to fluctuations of background radiation.

## LB 4430/LB 5430: The detector for special applications

Measurements on large pipelines i. e. on dredgers or in mining, often required high source activity. Ultra sensitive Detector types LB 4430/LB 5430 were especially developed for these applications, drastically reducing source activities.

Both detector models are equipped with lead shielding to effectively reduce the influence of background radiation. This results in high measurement accuracy using low source activity.

## Radiation sources and shielding

All radioactive sources in industrial applications are encapsulated in stainless steel, keeping the radioactive substance separate and isolated from the material being measured. In most cases, a  $^{137}\text{Cs}$  radiation source is used, although  $^{60}\text{Co}$  and  $^{241}\text{Am}$  sources are used in special applications. The shielding container consists of a cast-iron or stainless-steel casing filled with lead and has a lockable shutter for the exit channel of the useful beam. Many other types of shieldings are available from Berthold Technologies™ for measurements in tanks or vessels and for most industrial processes.

### Engineering data

To prepare our quotation we need from you, following technical data:

■  
density range

■  
product temperature range

■  
for suspensions: solid matter density,  
liquid density, min./max. density

■  
for liquids: measuring range in  
 $\text{kg/m}^3$ , min./max. concentration,  
chemical formula (if possible)

■  
required accuracy

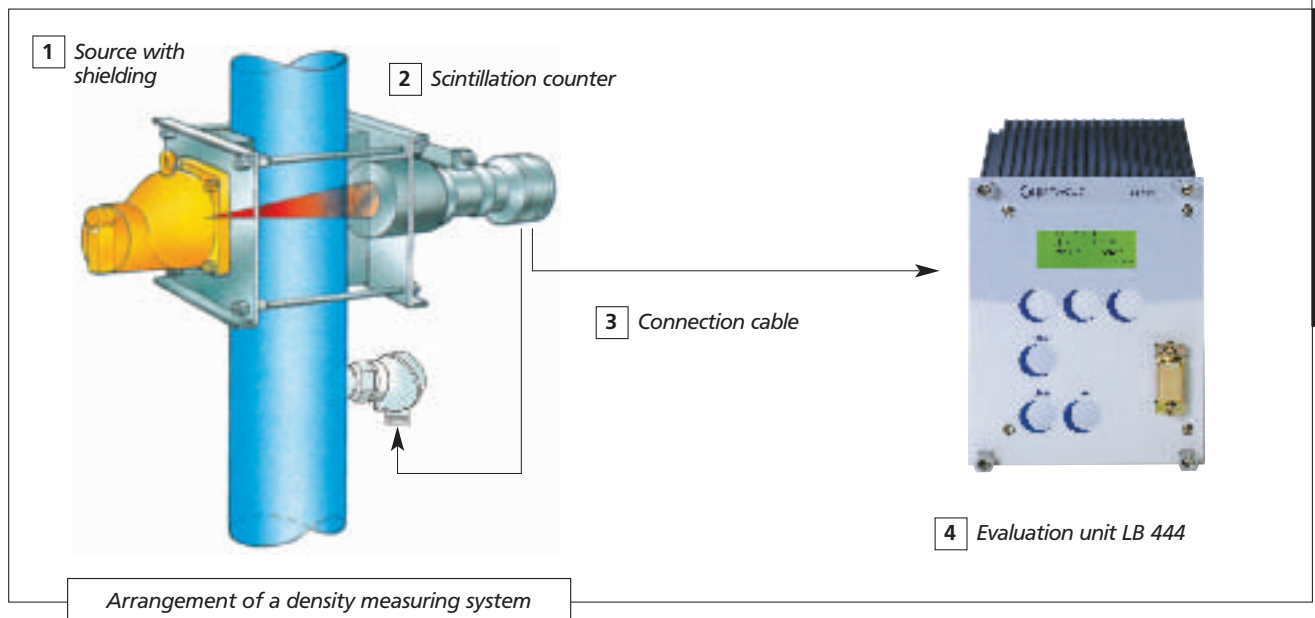
■  
external diameter of the pipe, wall  
and material thickness, lining (if any)

■  
reference to possible gas bubbles at  
the measuring point.

## Measurement principle

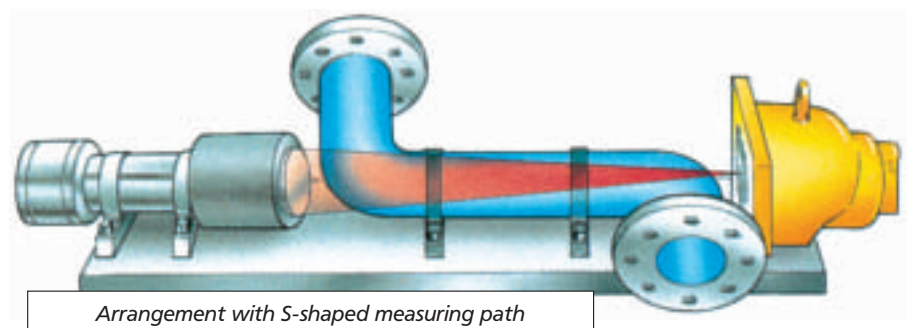
Gamma radiation emitted by a source is attenuated when it passes through matter. The extent to which it is attenuated depends on the length of the measuring path and on the density of the product. Given a

constant distance of the measuring path, radiation absorption is a function of the density of the material being measured.



The figure above shows a typical arrangement of a complete measurement system. It consists of the source with shielding [1], a scintillation counter [2] and the connection cable [3] from the detector to the LB 444 evaluation unit [4]. Installation is achieved without pipeline modification or production downtime. Both the shielding and the detector can be mounted on the outside of the pipe using our clamping devices with 90°, 45°, and 30° irradiation angles.

When there is sufficient absorption by the product, the measurement is arranged at an angle of 90° to the pipe axis. In the case of smaller pipe diameters or lower densities, the measuring system can be fitted at an angle of 30° or 45° in order to increase the measuring path in the product. For more precise measurements with small pipe diameters, an s- or u-shaped measuring path is used to place two pipe diameters into the measurement path.



# Technical Data LB 444

## Evaluation unit LB 444

|                        |   |
|------------------------|---|
| Design                 | 19" module 3 HE, 21 TE,<br>protection class IP 20   |
| Weight                 | approx. 2 kg  |
| Power supply           | 230/115 V AC +/- 10 %,<br>18 to 32 V DC   |
| Power consumption      | approx. 30 VA (AC), 30 W (DC)   |
| Operation temperature: | 0 to + 50 °C<br>(273 to 323 K) no condensation  |
| Storage temperature    | - 40 to + 70 °C (233 to 343 K)<br>no condensation   |
| Mounting               | in a panel<br>in a 19" rack 21 HE, 84 TE (max. 4 units)<br>wall mounted cabinet (IP 65/NEMA 4)<br>(max. 2 units)  |
| Detector connection    | [EEx ib] IIB<br>[EEx ib] IIC (option)   |
| Temperature signal     | Pt 100 connected at the detector<br>[EEx ib IICT6]<br>measuring range: - 20 to + 200°C (253 to<br>473 K) or input for temperature signal<br>0/4 to 20 mA, isolated, impedance 50 Ω  |
| Digital inputs         | DI1/DI2: for external selection of a<br>calibration curve<br>DI3: for external start/stop of measurement  |
| Outputs                | 0/4 to 20 mA isolated, max. 500 Ω<br>Digital outputs:<br>1 relay for collective failure message<br>2 relays for thresholds<br>max load:<br>AC: max. 250 V AC, max. 1 A, max. 200 VA<br>DC: max. 300 V; max. 1 A, max. 60 W not<br>inductive   |
| Display                | LCD-display with 4 x 20 characters,<br>illuminated, data input via membrane keys,<br>user guided dialog with "soft keys", dialog:<br>German, English, French, Spanish, data<br>protection by user-selectable password.  |
| Interfaces             | RS 232 and RS 485   |
| Program                | Time constant 0.5 to 9999 s with automatic<br>reduction of 1/10 of the value in case<br>of rapid changes of measuring value.<br>Automatic decay compensation for<br><sup>137</sup> Cs, <sup>60</sup> Co, <sup>241</sup> Am, <sup>244</sup> Cm, <sup>90</sup> Sr and <sup>85</sup> Kr. |

Design modifications may occur without notice.

## Detectors

|                   |  |                     |
|-------------------|--|---------------------|
| Detectors         | Scintillation counter, stainless steel<br>housing, IP 65/NEMA 4<br>Connection for RTD Pt 100 |                     |
| Cable glands      | M16  | M12                 |
| Cable diameter    | 5 to 10 mm   | 4 to 7 mm           |
| Connection cable  | LiYCY 2 x 1 mm <sup>2</sup>  |                     |
| Max. cable length | with cable Id Nr. 32024  |                     |
|                   | EEx ib IIB<br>1000 m   | EEx ib IIC<br>250 m |

## Protection class

|               |   |
|---------------|---|
| ATEX          | ⊕ II 2 G EEx de IIC T6 or<br>⊕ II 2 G EEx ib d IIC T6   |
| Options: ATEX | ⊕ II 2 D IP65 T 80 °C   |
| FM            | Class I Division 1 Group A, B, C, D<br>Class II Division 1 Group E, F, G<br>Temperature class: T6 (85 °C) |

## Detectors with NaI (TI) Crystal

| Type       | Crystal size | approval | weight approx. kg |
|------------|--------------|----------|-------------------|
| LB 4441-01 | 25/25        | ATEX     | 18                |
| LB 4441-02 | 40/35        | ATEX     | 18                |
| LB 4441-03 | 50/50        | ATEX     | 18                |
| LB 4451    | 44/5         | ATEX     | 6                 |
| LB 5441-01 | 25/25        |          | 18                |
| LB 5441-02 | 40/35        |          | 18                |
| LB 5441-03 | 50/50        |          | 18                |
| LB 5481    | 44/5         |          | 6                 |

Long term stability: +/- 0,1 %

Operation temperature: - 40 to + 50 °C, (233 to 323 K)

For higher op. temp. a water cooling can be supplied.

Storage temperature: - 40 to + 70 °C, (243 to 343 K)

## Detectors with plastic scintillators

| Type    | Approval | Weight ca. kg |
|---------|----------|---------------|
| LB 4430 | ATEX/FM  | 54            |
| LB 5430 |          | 52            |

Operation temperature: - 40 to + 50 °C, (233 to 323 K)

Storage temperature: - 40 to + 55 °C, (243 to 328 K)

Source and shielding see separate brochure.

