Level Gauge

LB 440

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Soft. V.3.0
# Table of Contents

**Operating Manual Level Gauge LB 440**

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.</strong></td>
<td>Overview</td>
<td>1</td>
</tr>
<tr>
<td><strong>2.</strong></td>
<td>System Description</td>
<td>2</td>
</tr>
<tr>
<td>2.1</td>
<td>Measuring Principle</td>
<td>2</td>
</tr>
<tr>
<td>2.2</td>
<td>Measuring Arrangements</td>
<td>2</td>
</tr>
<tr>
<td>2.2.1</td>
<td>Rod Source / Point Detector Arrangement</td>
<td>3</td>
</tr>
<tr>
<td>2.2.2</td>
<td>Rod Detector / Point Source Arrangement</td>
<td>3</td>
</tr>
<tr>
<td>2.2.3</td>
<td>Rod Source / Rod Detector Arrangement</td>
<td>4</td>
</tr>
<tr>
<td>2.2.4</td>
<td>Point Source / Point Detector Arrangement</td>
<td>4</td>
</tr>
<tr>
<td>2.3</td>
<td>Evaluation Unit LB 440</td>
<td>5</td>
</tr>
<tr>
<td>2.3.1</td>
<td>General Description</td>
<td>5</td>
</tr>
<tr>
<td>2.3.2</td>
<td>Menu Structure</td>
<td>6</td>
</tr>
<tr>
<td>2.3.3</td>
<td>Keypad Function</td>
<td>7</td>
</tr>
<tr>
<td>2.3.4</td>
<td>Detectors</td>
<td>9</td>
</tr>
<tr>
<td>2.3.5</td>
<td>Electrical Connections</td>
<td>10</td>
</tr>
<tr>
<td>2.3.6</td>
<td>Radioactive Sources</td>
<td>13</td>
</tr>
<tr>
<td>2.3.7</td>
<td>System Configuration Description</td>
<td>13</td>
</tr>
<tr>
<td><strong>3.</strong></td>
<td>Rod Detector Arrangement</td>
<td>19</td>
</tr>
<tr>
<td>3.1</td>
<td>Sources</td>
<td>19</td>
</tr>
<tr>
<td>3.2</td>
<td>Point Source Shielding 45°</td>
<td>19</td>
</tr>
<tr>
<td>3.3</td>
<td>Installation</td>
<td>20</td>
</tr>
<tr>
<td>3.3.1</td>
<td>Installation of 45° Shielding</td>
<td>20</td>
</tr>
<tr>
<td>3.3.2</td>
<td>Rod Detector Installation</td>
<td>23</td>
</tr>
<tr>
<td>3.3.3</td>
<td>Electrical Connections</td>
<td>25</td>
</tr>
<tr>
<td>3.4</td>
<td>System Configuration and Start-Up</td>
<td>26</td>
</tr>
<tr>
<td>3.5</td>
<td>Final Settings</td>
<td>30</td>
</tr>
<tr>
<td><strong>4.</strong></td>
<td>Rod Source Arrangement</td>
<td>31</td>
</tr>
<tr>
<td>4.1</td>
<td>Instrument Description</td>
<td>31</td>
</tr>
<tr>
<td>4.1.1</td>
<td>Rod Sources</td>
<td>31</td>
</tr>
<tr>
<td>4.1.2</td>
<td>Rod Source Shielding</td>
<td>31</td>
</tr>
<tr>
<td>4.2</td>
<td>Installation</td>
<td>32</td>
</tr>
<tr>
<td>4.2.1</td>
<td>General Safety Precautions</td>
<td>32</td>
</tr>
<tr>
<td>4.2.2</td>
<td>Rod Shielding Installation</td>
<td>32</td>
</tr>
<tr>
<td>4.2.3</td>
<td>Detector Installation</td>
<td>34</td>
</tr>
<tr>
<td>4.2.4</td>
<td>Source Installation in Dip Pipe</td>
<td>35</td>
</tr>
<tr>
<td>4.3</td>
<td>Electrical Connections</td>
<td>36</td>
</tr>
<tr>
<td>4.4</td>
<td>System Configuration and Start-Up</td>
<td>36</td>
</tr>
<tr>
<td>4.4.1</td>
<td>Basic Setting</td>
<td>37</td>
</tr>
<tr>
<td>4.4.2</td>
<td>Calibration</td>
<td>37</td>
</tr>
<tr>
<td>4.4.3</td>
<td>One-Point Calibration</td>
<td>39</td>
</tr>
</tbody>
</table>
CHAPTER 5. POINT SOURCE ARRANGEMENT ................................................................. 40
  5.1 Instrument Description .................................................................................. 40
  5.1.1 Point Source ............................................................................................ 40
  5.1.2 Point Source Shielding ............................................................................ 40
  5.2 Installation .................................................................................................... 41
  5.2.1 General Safety Precautions ...................................................................... 41
  5.2.2 Shielding Installation .............................................................................. 41
  5.2.3 Detector Installation ................................................................................ 42
  5.3 Electrical Connections .................................................................................. 43
  5.4 System Configuration and Start-Up ............................................................. 44
  5.4.1 Basic Settings .......................................................................................... 44
  5.4.2 Calibration ............................................................................................... 45

CHAPTER 6. Water Cooling ...................................................................................... 48
  6.1 Installation .................................................................................................... 48
  6.2 Cooling Water Consumption ....................................................................... 49

CHAPTER 7. TECHNICAL DATA ............................................................................... 52
  7.1 Evaluation Unit LB 440 ................................................................................ 52
  7.2 Detectors ....................................................................................................... 54

CHAPTER 8. SERVICING INSTRUCTIONS ............................................................. 56
  8.1 General Safety Precautions ........................................................................ 56
  8.2 Trouble Shooting Guide .............................................................................. 56
  8.3 Shielding and Source .................................................................................. 57
  8.4 Evaluation unit LB 440 ............................................................................... 58
  8.4.1 Error Messages ........................................................................................ 60
  8.4.2 Behavior in Case of Error ........................................................................ 62
  8.4.3 Service Menu Structure ......................................................................... 63
  8.5 Scintillation Detector ................................................................................... 65
  8.6 Interference Radiation Instructions ............................................................ 68
  8.6.1 Interference Radiation Detection Flow Chart ......................................... 70

CHAPTER 9. RADIATION PROTECTION ................................................................. 71
  9.1 General Information and Guidelines ............................................................ 71
  9.2 Safety Instructions ........................................................................................ 73
  9.2.1 Shielding Installation .............................................................................. 73
  9.2.2 Point Source Replacement on the Shielding Container LB 744X .......... 73
  9.2.3 Rod Source Replacement ....................................................................... 76
  9.2.4 Point Source Replacement on Rotary Cylinder Shielding .................... 79
  9.3 Radiation Dose Calculations ....................................................................... 82
  9.3.1 Shielding Installation ............................................................................. 83
  9.3.2 Point Source Replacement ..................................................................... 83
  9.3.3 Rod Source Replacement ....................................................................... 84
  9.4 Emergency Instructions ............................................................................... 85

CHAPTER 10. Menu Structure .................................................................................. 86
  10.1 Parameters .................................................................................................. 86
  10.2 Calibration Types ....................................................................................... 87

CHAPTER 11. Calibration with Rod Detector ............................................................ 89
  11.1 Flow Sheet .................................................................................................. 89
  11.2 Explanations ............................................................................................... 90
  11.3 Method A + B of Rod Detector Calibration .............................................. 91
CHAPTER 12. Installation of Limit-Switch Boxes ........................................... 92
12.1 Limit-Switch Box -003U EEx ed IIC T6........................................... 92
  12.1.1 Direct Installation........................................................................... 92
  12.1.2 Adjusting the Trip Cams................................................................. 93
  12.1.3 Technical Specification / Electrical Wiring...................................... 93
  12.1.4 Correction of the Switching Points............................................... 94
12.2 Limit-Switch Box -004U................................................................. 95
  12.2.1 Direct Installation........................................................................... 95
  12.2.2 Adjusting the Trip Cams................................................................. 95
  12.2.3 Technical Specification / Electrical Wiring...................................... 96
  12.2.4 Correction of the Switching Points............................................... 97

CHAPTER 13. PTB / TÜV CERTIFICATES .................................................. 98
13.1 Evaluation Unit .................................................................................. 98
13.2 Wall Housing..................................................................................... 107
13.3 Scintillation Counter ......................................................................... 110
13.4 CE Certificate................................................................................... 117

CHAPTER 14. Start-Up Protocol ................................................................. 118
14.1 Parameter List................................................................................... 118
  14.1.1 Rod Detector Calibration Values..................................................... 119
  14.1.2 2-Point Linear Calibration Values.................................................... 119
  14.1.3 Exponential Calibration Values....................................................... 119

CHAPTER 15. Appendix.............................................................................. 120
## Revision History

<table>
<thead>
<tr>
<th>No</th>
<th>Date</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>26.10.99</td>
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</tr>
<tr>
<td>6</td>
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<td>NT1 PTB expertise 2093 added</td>
</tr>
<tr>
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<td>22.04.02</td>
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</tr>
<tr>
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<td>25.08.04</td>
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<tr>
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<td>01.12.06</td>
<td>Update: Chapter Source exchange for point sources, rod sources. Added: Point source exchange with rotary cylinder shielding, limit switch installation; ATEX certificate.</td>
</tr>
</tbody>
</table>
Safety Summary

GENERAL WARNINGS

Equipment Environment
All components, whether in transportation, storage or operation must be in a non-corrosive environment.

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

Special Handling
This measuring system uses Electrostatic Sensitive Devices.

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.

SPECIFIC CAUTIONS

This measuring device utilizes radioactive sources. Strict adherence must be made with regard to the rules of Radiation Protection in this manual and the local regulations pertaining to the use of radioactive sources.

Installation, dismantling, relocation, maintenance, testing involving the radioactive source, or its shielding shall be performed by persons specifically licensed. Radioactive sources, which are not in use have to be stored at a save place which is tamperproof.
The Level Gauge LB 440 utilizes the radiometric measuring method, i.e. the absorption of Gamma radiation passing through the product being measured. In order to obtain an optimum measuring effect at minimal source activity, the ideal measuring geometry is calculated for the respective measuring location and the source is designed accordingly. The installation positions and the source and detector design will be specified when preparing the quotation, or, at the latest, immediately after the order is placed and entered in drawings or sketches of the measuring location or put down in detailed descriptions. To ensure the proper function of the measurement, it is, therefore, important to observe these specifications closely when installing the shielding with the source and positioning the detectors. If the project documentation is not available or if some things are still unclear, please don’t hesitate to contact the supplier.

Radiometric measuring facilities utilize radioactive substances which are manufactured in compliance with official regulations and which are protected by suitable shieldings. When handled properly, any hazards to personnel due to built-in radioactive substances can be ruled out. As prescribed by law, these measuring facilities may be operated only by specifically licensed persons with sufficient expertise and training.

The hardware and software of the LB 440 system makes it easy to adapt the system to rather different measuring geometries and measuring tasks. Therefore, the settings and parameters of the measuring instrument have to be defined with care for the respective measuring task when taking the system into operation. Important parameters may not be changed later, in order not to jeopardize the reliable operation of the system. The system should be taken into operation and settings changed only by persons who know how to work with the instrument. Therefore, all users should read these operating instructions carefully. We recommend documenting all settings in a setup protocol.

This user’s manual describes several possible measuring arrangements and instrument versions. The best system configuration is selected for each measuring task during the planning stage. Therefore, the respective project documentation has to be observed and taken into account. For further technical information please refer to the sheets Technical Information LB 440.

Before starting any work, please read this user’s manual carefully!
2.1 Measuring Principle

The principle of measurement is the irradiation method. It utilizes the physical law of the absorption of radiation passing through matter. The resulting measuring effect is the ratio \( I/I_0 \) between the unattenuated radiation \( I_0 \) and the radiation \( I \) attenuated by the product being measured.

Figure 1 shows the basic configuration:

![Figure 1: Measuring principle](image)

The equation shows that with a given source and the respective mass attenuation coefficient \( \mu' \) the measuring effect is dependent only on the product density \( \rho \) and the measuring path \( d \). Since the measuring path is constant and possible product density changes with a certain measuring path due to exponential reasons do not have any effect any more, this measuring method is not affected by any chemical and virtually no physical properties of the product being measured. For this reason, the radiometric measuring principle ensures high reliability and low maintenance.

\[
I = I_0 \cdot e^{-\mu' \cdot \rho \cdot d}
\]

2.2 Measuring Arrangements

To be able to cover a certain measuring range continuously, a measuring arrangement must be realized where the dimensions of source and detector form a geometry which covers a measuring field of equal size. The different options that are available will be described below.

Which of these arrangements is chosen depends on the size of the measuring range and on the measuring geometry resulting from the measuring task. Moreover, constructional circumstances and customer-specific requirements may have an effect on the instrument selection. The respective selections are made during the planning stage and have to be taken into special account later during assembly and commissioning.
2.2 Measuring Arrangements

2.2.1 Rod Source / Point Detector Arrangement

Figure 2 shows a basic arrangement with rod-shaped source and point-shaped detector, as well as the respective calibration curve. The length of the rod source is adapted to the size of the required measuring range. The nonlinearities resulting from the measuring geometry and the dissemination and absorption conditions of the radiation are compensated for by means of a nonlinear activity distribution along the rod source, including the critical zone around the bottom end of the measuring range.

![Figure 2: Rod source arrangement](image)

Thus, the intensity changes at the detector are already in linear proportion to the level changes and the evaluation electronics can operate linear. Electronic linearization is therefore not required. Therefore, it is much easier to take the level gauging system into operation or to replace instruments.

2.2.2 Rod Detector / Point Source Arrangement

Figure 3 shows an arrangement with one rod-shaped detector and one point source. The length of the rod detector determines the length of the measuring range; for larger measuring ranges it is possible to work with several detectors. For unfavorable measuring geometries one can also work with two or more point sources. As the calibration curve shows, the measuring geometry results in nonlinearities which are compensated for by a correction line that is adjusted to the measuring location and stored in the evaluation electronics. The necessary calculations for a specific measuring location will be supplied by BERTHOLD.

![Figure 3: Rod detector arrangement](image)
2.2 Measuring Arrangements

2.2.3 Rod Source / Rod Detector Arrangement

For measuring geometries with an unfavorable ratio between measuring range and the source - detector distance or for very thick container walls, one can choose an arrangement as shown in Figure 4 to reduce the source activity. This arrangement consists of one rod source and one rod detector. In this case, the lengths of source and detector have to be adjusted to the size of the measuring range to be covered.

![Figure 4: Rod detector with rod source arrangement](image)

The nonlinearities obtained in the upper range of the calibration curve are compensated for by means of a correction line adjusted to the measuring location and stored in the evaluation electronics. The necessary calculations for a specific measuring location will be supplied by BERTHOLD.

2.2.4 Point Source / Point Detector Arrangement

In exceptional cases with little space and a very small measuring range, you can also choose an arrangement as shown in Figure 5. This arrangement consists of a point source and a point detector. The purely exponential nonlinearities obtained in the upper range of the calibration curve are automatically compensated for by means of a mathematical function included in the evaluation electronics.

![Figure 5: Point source with point detector arrangement](image)
2.3 Evaluation Unit LB 440

2.3.1 General Description

The evaluation electronics is designed as a 19\"-module in the format 3 HE, 21 TE. It includes the microprocessor-controlled evaluation electronics and supplies the operating voltage required for the detector. Signal processing is done in a 32 bit microprocessor. Six foil keys are foreseen to minimize the operating elements and to simplify operation. Three keys work as softkeys which allow user-guided definition of all instrument settings and input of the required parameters. Three more keys serve as function keys. The illuminated display field on the front panel shows the relevant instrument function on four lines. An RS 232 interface is also provided on the instrument front.

![Figure 6: Front panel LB 440](image)

The connector strip on the rear panel of the instrument includes all connections for power supply, for the detector, and for the analog and digital in- and output signals. The current output is isolated. The built-in relays for max.-min.-indication and for error messages include an isolated contact. Several evaluation units can be combined for multi-detector operation, with one instrument serving as master system for processing the signals from all detectors. The other slave systems are in charge of power supply and monitoring of individual detectors. Up to 7 slave systems can be operated with one master system.

The system automatically corrects for the decrease of source activity due to half-life over the entire service life of the source.

All calibration data is stored in a FLASH memory and is protected even in case of power failure. The illuminated display field of the instrument comprises 4 lines; the first three lines show the menu titles, the currently selected parameters or the current measurement value. The bottom line shows the current function of the softkey button located below or, when a measurement is running, the status “run”.

Figure 6: Front panel LB 440
2.3.2 Menu Structure

The diagram below shows in a simplified way the menu structure for parameter input and for operation. With <more> you select the various menu groups and from there you get to the respective menu with <sk1> or <sk2>. Within the menu you get to the individual windows with <more> and at the end of the menu you get back to the menu group with <done>. For a complete overview of the menu structure see the appendix to this manual.

Figure 7: Menu structure
2.3.3 Keypad Function

The Level Gauge is operated via the softkeys and function keys described below: Using these keys you can select the operating level you want within a menu structure in order to select a function or enter parameters. The menu guidance is illustrated in the quick overview of the menu structure and from the tables giving an overall view of the menu structure.

**Softkeys**

Softkeys are used to select different menu groups and operating levels within the menu structure. Depending on the current position in the menu structure, functions are assigned to these keys, as shown on the display above the respective key.

**Figure 8: Display LB 440**

<table>
<thead>
<tr>
<th>Softkey</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>sk1</td>
<td>Switch to the indicated menu (Figure 8a).</td>
</tr>
<tr>
<td>sk2</td>
<td>and sk2</td>
</tr>
<tr>
<td>more</td>
<td>Switch to the next menu group.</td>
</tr>
</tbody>
</table>

Text: scrolls through the various selection options (Figure 8b) 
Numerical values: increments the number marked by the cursor by 1

Moves the cursor to the left and at the end of the input field again to the start position (Figure 8c).

Scrolls forward / back in the submenus

Shows the end of the menu and takes you back to the menu group.
Figure 9: Function keys LB 440

<table>
<thead>
<tr>
<th>Function keys</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enter</td>
<td>Accepts the entry and moves the cursor to the next input field or toggles between two input fields.</td>
</tr>
<tr>
<td>Clear</td>
<td>Clears the numerical value</td>
</tr>
<tr>
<td>Run</td>
<td>Starts or ends a measurement or leads directly back to the display (Figure 9) and at the start of a measurement automatically changes to the measurement value display.</td>
</tr>
</tbody>
</table>

**Important:**
After data entry, the system has to be left running for at least 5 minutes to ensure that all data entered have been stored safely.
2.3.4 Detectors

Scintillation counters are used as detectors, since only these detector systems provide the required high sensitivity to Gamma radiation and their service life is independent of the intensity of the radiation field.

![Diagram of a scintillation detector]

Figure 10: Scintillation detector

Two different types of detectors are employed:

**Rod detector**: the scintillator consists of a special transparent plastic material in which flashes of light are generated when Gamma radiation is absorbed. Depending on the required measuring range, plastic detectors up to a length of 2 m are available. Multi-detector arrangements are used for longer measuring range.

**Point detector**: the detector material consists either of an artificially manufactured and specially dotted NaI crystal or of a block of plastic scintillator. Depending on the required sensitivity, different diameters and lengths from 25 mm to 150 mm are available.

The number of light flashes per time unit is a measure of the intensity of the radiation field. The individual flashes of light are very short, so that a high resolution is obtained and this detector can be employed for high pulse rates.

The flashes of light are converted into electrical signals in a photomultiplier, which is optically coupled to the detector. To achieve a very high accuracy and a high long-term stability, the optimum operation point of the photomultiplier is automatically set by the integrated processor and the limit values are monitored, and all detector-specific data is stored. The power supply is carried out via 2-wire technique; all measurement data and information between detector and evaluation unit can be transmitted at the same time.

The detector probe is assembled in a sturdy stainless steel housing which protects the instrument against normal environmental stress. To ensure reliable function and a long service life, the detector probe must not be subject to heavy mechanical stress and vibrations. Furthermore, the ambient temperatures must not exceed 55°C; otherwise, adequate cooling has to be provided.

For further technical information please refer to the sheets *Technical Information LB 440.*
2.3 Evaluation Unit LB 440

2.3.5 Electrical Connections

2.3.5.1 Detector

With intrinsically safe systems the housing of the detector must be connected to the equipotential bus bar of the facility. The detector is connected via a 2-wire \((2 \times 1^2)\) unshielded standard cable with a diameter of about 5..10 mm. A screened cable may be used for systems with extremely heavy electrical disturbances. The screen may only be placed on the detector one-sided.

The maximum wire length is dependent on the cable resistance, which in total (back and forth) must not exceed 40 Ohm. With the standard cable by BERTHOLD TECHNOLOGIES (ID No. 32024) this results in a cable length of 1000 m from the evaluation unit to the detector. With intrinsically safe systems, the maximum permissible inductivity and capacity of the cable has to be taken into account, in addition to the max. 40 Ohm. These values are defined in the certificate in CHAPTER 13. When installing the connection cable, you have to make sure that water cannot get into the connection box via the cable. With ambient temperatures >70°C, the cable has to be protected to prevent exceeding of the temperature limits of the cable. Following connection, check that the connection box is carefully closed and the cable bushing properly sealed.

2.3.5.2 Evaluation unit LB 440

Make the connections on the rear panel of the evaluation unit as shown in the wiring diagram in the appendix to this manual.

![Figure 11: Terminal connections on evaluation unit](image-url)
Caution!

- Connect the device only to the appropriate power outlet.
- Observe all safety provisions regarding the power supply.
- A separate fuse protection and an easy to access shutoff have to be foreseen, since the evaluation unit does not include its own mains switch.
- If the LB 440 is supplied with 24V, make sure that a ground conductor is connected (which is typical for 110/230VAC) as soon as more than 41 V AC/DC are connected to the relay contacts.

Refer to the wiring diagram in the appendix to this manual for the connections. The terminals are described as follows:

**Detector Terminals (2a/2c)**

Connection is made via 2-wire technique; the detector protection type is:
- not intrinsically safe
- intrinsically safe: II 2 G [EEx ib] II B
- intrinsically safe: II 2 G [EEx ib] II C

The maximum permissible cable length is dependent on the cable resistance, which in total (back and forth) must not exceed 40 Ohm. With the standard cable by BERTHOLD TECHNOLOGIES (ID No. 32024) this results in a cable length of 1000 m from the evaluation unit to the detector.

**Intrinsically Safe Installations**

The plastic block assembled in the factory must be installed for intrinsically safe installations, EEx [ib]. This plastic block, mounted on the connector strip (for 19" or panel installation), ensures the necessary minimum distance between intrinsically safe und not intrinsically safe connections. See also the drawing above.

In a wall housing, this is a black plastic plate (one for each channel) which is mounted on the motherboard. If this plastic block is not present, the cable wires must be protected by 10 mm long shrink-down plastic tubing at the connection ends towards the terminals.

With intrinsically safe systems following cables can be used to have an extended cable length up to 1000m.

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Outer Sheath Colour</th>
<th>Type</th>
<th>Berthold Part. No.</th>
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<tbody>
<tr>
<td>Helukabel</td>
<td>black</td>
<td>LiYC-Y 2x1,00mm²</td>
<td>32024</td>
</tr>
<tr>
<td>Lapp</td>
<td>blue</td>
<td>Unitronic BUS PA 1x2x1,00mm²</td>
<td>46413</td>
</tr>
<tr>
<td>Kerpen</td>
<td>blue</td>
<td>RE-2Y(St)Y-fl</td>
<td></td>
</tr>
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</table>

See CHAPTER 13 ATEX certificate / evaluation unit / 5th supplement.

If a other cable is used for intrinsically safe installation, the maximum permissible inductivity and capacity (see certificate) of the cable has to be taken into account. Usually that will limit the cable length to approx. 200m to 300m. The effective inner inductivity from the evaluation unit is negligible and the effective inner capacity is 12 nF.

**Terminal for Relay 2 (12a/12c)**

The relay can be used as Max. or Min. relay depending on the software configuration and the setting of the break-over point or for monitoring the detector temperature.

**Terminal for Relay 3 (14a/14c)**

The relay can be used as Max. or Min. relay depending on the software configuration and the setting of the break-over point or for monitoring the detector temperature.
2.3 Evaluation Unit LB 440

**Terminal for Relay 1 (16a/16c)**

The relay is used for error alarm signaling.

**Stop Measurement**

Option to stop the measurement for special applications.

**Reset Alarm**

Reset error alarm caused by interfering radiation and restart of measurement.

**RS 485**

Terminal for data transfer between evaluation units in a networked system.

**0/4-20 mA**

Isolated current output. Max. load 500 Ω.

**Power Supply**

Power supply depending on power supply unit (see label on instrument rear panel!).

**Important!**

Before turning on the power supply, carefully check all connections once more to rule out any damage to the instruments.
2.3.6 Radioactive Sources

Radioactive sources for industrial applications are always "encapsulated radioactive substances". They are tightly welded into a sturdy stainless steel capsule, so that the radioactive substance cannot leak out. Contamination is therefore ruled out. Moreover, any activation of the product being measured by the sources used is not possible for physical reasons.

The following sources are primarily used for level measurements:

$^{60}$Co has a relatively high energy of 1.17 and 1.33 MeV, respectively. It is used when the radiation has to pass through very thick pipe or container walls. Its half-life period is 5.27 years.

$^{137}$Cs: Its energy of 0.660 MeV is sufficient to penetrate commonly used pipe and container walls. Due to the lower energy, the measuring effect is better than with Co-60. Also, the shielding costs for a Cs-137 source are lower than for a Co-60 source. The half-life period of Cs-137 is approx. 30 years.*

*According to NBS, half-life is defined as: Time for the activity of any particular radioisotope to be reduced to half its initial value.

2.3.7 System Configuration Description

The factory setting is listed in the CONFIGURATION CHECKLIST in the appendix. There, you should enter the final operating settings. Please keep in mind that the entry in all operating levels is made with the <^^^> key and the new value is accepted with <enter>.

<table>
<thead>
<tr>
<th>General Data</th>
</tr>
</thead>
</table>

**Password:**

You can enter a number comprising up to 6 digits. Upon confirmation with <enter>, the system is protected against unauthorized manipulation of the parameters. All parameters can still be viewed, however. The password protection is canceled when you enter the correct numerical value and confirm your entry with <enter>. The test generator is reset automatically if a password will be entered.

**Date:**

Enter the current date in the format DD.MM.YY. The correct date is important for automatic correction of the activity decay of the source.

**Time:**

Enter the current time in the format HH.MM. Time deviations have hardly any effect on the correction of the activity decay; checking the time can serve to check the instrument function.
CHAPTER 2. SYSTEM DESCRIPTION

2.3 Evaluation Unit LB 440

System/Version:
Display of instrument type and program version of the software. Please specify your program version if you contact the manufacturer regarding your instrument.

Language:
You can choose German or English as dialog language by pressing the <^_^> key.

Print Parameter:
A printer can be connected on the front panel. All parameters can be printed for documentation. The printout in the appendix shows an example.

Factory Setting:
Pressing “Sk1” und “clear” at the same time will reset all parameters and calibration data to standard values.

### Operating Mode

**Rod Detector:**
For measurements with rod detector and point- or rod-shaped radiation sources.

**Exponential:**
For absorption measurements with small measuring ranges.

**Linear:**
For measurements with rod source and point-shaped detector.

**Polygon:**
For special measurements with rod source and point-shaped detector.

The desired operating mode is determined by the required measuring arrangement.

**Error Mode:**
Select if the measurement is to be aborted or to be continued when an error occurs. If you select „continue measurement“, the error display is automatically cleared as soon as the error does not occur any more.

**Alarm relay in error case:**
Select if in the fault mode the alarm relay contact should hold the latest status or whether it should follow the specified fault current.

**Example for "Current Following":**
Setting of fault current: 22mA
If the measurement is stopped when an error occurs, the "Limit value relay Max" indicates Alarm and the "Limit value relay Min" Normal.

### Meas. Parameter

**Detector Code:**
Detector-specific code number to take into account the parameters to be defaulted for the measuring geometry and the detector version (see „Technical Data“). You have to enter the operation code!

**Isotope:**
Select the isotope to be used for the measurement. This will control the decay compensation.
**CHAPTER 2. SYSTEM DESCRIPTION**

2.3 Evaluation Unit LB 440

*Time Constant:*

The system calculates a sliding average from the measured values supplied by the detector using the entered time constant. In order to reduce statistical variations, you should select the highest time constant that is still permissible. It is dependent upon the permissible error during the maximal possible level changing speed. A time constant of less than 20 seconds will therefore be required only in exceptional cases.

*Rapid Switch-Over:*

The function "Rapid Switch-Over" is needed only for special applications with small container dimensions and sudden level changes, in order to adjust the output signal quickly to the new value. This function is enabled and disabled via <**ON**> and <**OFF**>. Sigma defines a range (window) which the display change has to exceed before the selected time constant automatically switches over to a value smaller by a factor of 10. When the rapid switch-over function is in effect, the measurement first operates with the selected basic time constant. If sudden level changes occur, which are greater than the selected sigma range, the system switches over to the 10-times smaller time constant and the display and the output signal can follow the level change much quicker. The statistical variation will increase by a factor of 3. If the level becomes stable again, the system automatically switches back to the longer basic time constant after a period that corresponds to the basic time constant. When using the rapid switch-over function, you should at least enter "4" or better "5" as Sigma value, to make sure that a switch-over of the time constant is not trigger too often merely by statistical variations or minor level changes. We recommend to determine the optimum entry during routine operation.

*Radiation Interference:*

The function "Radiation Interference" is needed only when unforeseeable influences due to interfering radiation are to be expected (radio-graphing for weld quality). This function is enabled and disabled via <**ON**> and <**OFF**>. The system is triggered if the count rate is 1.5 times the empty container count rate or if the change in count rate is more than would be expected due to normal statistical fluctuations and level change. Sigma defines a count rate change rate that has to be exceeded before the radiation interference is triggered. For most applications the default value of sigma of 5.0 should not be changed, as it guarantees an optimal triggering of the radiation interference system. Upon trigerring of the radiation interference an error message will be displayed, the current output goes into a “hold-mode”, and the failure relay is initiated. If desired the display error message and the alarm relay function can be removed by simply pushing the “enter” key. However the current output and the displayed level value will still be frozen. For more information see page 68.

*Radiation Interference Delay Time:*

If the radiation interference feature is <**ON**> the next software category will be “Delay Time”. If the radiation interference circuit is <**OFF**> the “Delay Time” selection will not be shown on the display. The default “Delay Time” is 20 seconds, which is user adjustable. The delay time begins when the radiation interference is first detected. During the delay time an error message will be displayed, the current output goes into a “hold” mode and the failure relay is initiated. After the “Delay Time” has elapsed the measurement will automatically go back into the run mode, if the count rate is below 1.5 times the empty container count rate. If the count rate is still too high the “hold” mode will continue for another “Delay Time” until the count rate drops below 1.5 times the empty count rate. After the measurement has returned to the run mode the sigma count rate change triggering function will be disabled for three time constants. After the measurement has returned to the run mode the sigma count rate change triggering function will be disabled for three time constants. After the three time constants the radiation interference trigger mode will be fully reset.
Maximum Rate:
This entry is used for plausibility checks of the system. If the respective value is exceeded, the measurement is stopped. To rule out any false alarms, you should enter a pulse rate which cannot be reached under normal operating conditions. It should, therefore, correspond to at least 2-times the calibration pulse rate at level “0”. If this function is not important for your operation, you can disable it by entering “0”. The measurement continues normally once the current pulse rate is below the Maximum Rate value.
To make it easier to set the minimum rate, the pulse rate at full container is displayed in this window after calibration.

Minimum Rate:
This entry allows you to suppress interferences due to short-term high absorptions. In most cases, this requires another design of the radiation source.
If this function is not important for your operation, you can disable it by entering „0“. To make it easier to set the maximum rate, the pulse rate at empty container is displayed in this window after calibration.

Source Replacement:
A count rate is displayed at empty container, indicating that the source should be replaced. This count rate is automatically calculated during calibration when the value is “0”. With a value ≠ 0 the value is retained. Before starting calibration as well as after replacement of the source you have to enter “0“. The calculated value is 30% of the initial count rate. When this count rate is reached, a warning is displayed. You can still work with the measuring system over a period of at least 6 months.
Manual modification of the calculated value is possible.

<table>
<thead>
<tr>
<th>Output Parameter</th>
</tr>
</thead>
</table>
Current Output:
Set the initial value 0 or 4 mA of the current output signal for EMPTY level.

Current Output Limits:
Define the current output limits relative to the end values of the entered level measuring range. Typical: 0/4 mA for 0% and 20 mA for 100%.

Current Output Error:
You can choose if – in case an error is detected - the last measurement value is to be retained, or if a preselected value between 0 and 22 mA is set.

Relay 2/3:
Each relay can be used for one of the following three functions:
a) Minimum monitoring (input 0...100%)
b) Maximum monitoring (input 0...100%)
c) Monitoring of max. detector temperature (input 0...60°C)

The relay is de-energized (circuit opening connection) when the alarm status is reached. Enter the relay break-over point within the selected level measuring range (e.g. 0 to 100%). Depending on the setting as Max. or Min. function, the relay is de-energized (circuit opening connection) when the selected value is exceeded or not reached. If the displayed value drops again, the relay picks up again, delayed by the value of the selected hysteresis. The switching hysteresis should be about 5%.
CHAPTER 2. SYSTEM DESCRIPTION

2.3 Evaluation Unit LB 440

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**Interfaces**

**RS 232:**
Select the connected device:
- Printer: to print the entered data.
- PC: calibration as well as comprehensive test options including up- and download of data are possible via a PC program.

**PC Access Control**
You can choose between
- Data manipulation
- Data query
Choose „Data Query“ as standard setting to rule out any data manipulation by unauthorized persons.

**RS 485:**
No selection possible, since only Master or Slave devices can be connected to the RS 485 interface.

**Number of Detectors:**
Enter the number of detectors used at the measuring location.

**Slave 1...n:**
Define the addresses of the slave units when using more than 1 detector. The factory default is the same address as the number of the slave unit. A maximum of 7 slave units can be operated together with one master unit.

---

**Calibrate**
Calibration of the various measurement configurations is described in the respective sections.

---

**Live Display**
In this menu, you can go back from any window directly to the menu group by pressing the `<menu>` softkey.

**Level:**
The current level in the pre-selected range is displayed, e.g. *between 0 and 100%*

**I-mean:**
The averaged pulse rate is displayed. The entered basic time constant used as time constant.

**Detector (n):**

- **HV:** Displays the selected high voltage.
- **Pulse rate:** Displays the current pulse rate.
- **Temperature:** Displays the detector temperature.
In networked systems (Master/Slave operation) with several detectors, the data of all detectors can be queried sequentially.

**CAUTION:**
If „TEST“ is displayed, a test rate has been entered in the Service menu. The test rate simulates the detector and leads to a result display. To get back to the run mode, the test rate value has to be zero. See also Service menu / Test calculation.

---

**Service Menu**

See: CHAPTER 8 SERVICING INSTRUCTIONS.
3.1 Sources

Typically, point-shaped Co-60 or Cs-137 Gamma sources are used for these measuring arrangements. In rare cases, e.g. with adverse measuring geometries and/or large container wall thicknesses rod-shaped radiation source will be used. Please see the installation instructions in Section CHAPTER 4.

3.2 Point Source Shielding 45°

Apart from a few special cases, the sources are firmly installed in shieldings which have an opening for the useful beam that is released towards the detector. During transportation, installation and servicing, the useful beam can be shielded by means of a rotating lock.

The type of shielding is dependent upon the desired shielding effect. The following issues have to be taken into account during project planning:

- Type and activity of source
- Official regulations
- Local conditions at the measuring site point and possible requests by the user

Depending on the measuring range, a larger radiation field is required for the rod detector; therefore, a useful beam is released in vertical direction at an angle of 45°. The special advantage of the shielding construction used is that it can be placed vertically onto a mounting bracket regardless of the angle of the radiation field to the detector. This simplifies construction of the fastening bracket and installation of the shielding significantly.

For sources that are specially designed for installation into dip pipes, shieldings can be used that allow extending and retracting of the source by means of ropes or rods. Detailed information on the construction and function of the shieldings can be found in section 4.2.4, and in the Technical Information LB 440 that are part of the documentation.

Figure 12: Point source shielding 45°
3.3 Installation

General Safety Precautions

The shielding with the radioactive source is delivered in compliance with the regulations concerning the transportation of radioactive substances. The shielding must be stored in a location that is guarded against unauthorized access until it is installed.

Using the drawings of the shielding and taking into account the circumstances at the measuring site, carefully install the mounting brackets and fixings. Make sure that the mechanical stability of mounting devices matches the weight of the shielding. The shielding should be assembled just prior to taking the system into operation. All screws and fixing parts have to be secured, so they cannot come undone during operation, and the shielding cannot fall down.

To keep the radiation exposure of the assembling personnel as low as possible, only licensed personnel who have been trained on how to handle radioactive substances are allowed to assemble or disassemble the shielding with the source. The 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 modified or damaged.

NOTE!
Please read and follow the Radiation Protection Guidelines (see section CHAPTER 9)!

3.3.1 Installation of 45° Shielding

Important Note:
When using the rod detector you should perform the basic settings described in section 4.4.1 and, in particular, run a background measurement before installing the shielding. Also make sure that the detector cannot be affected by any other sources located in the vicinity!

The top point of the measuring range to be covered is determined by a horizontal line between the mounting position of the point source and the top point of the rod detector. When planning the measuring system, this position is defined in drawings, sketches or written instructions. For assembly, these specifications have to be observed closely, since deviations may cause malfunctions of the measuring system.

The standard arrangement in Figure 13 shows the mounting position of the shielding with point source; "G" indicates the topmost point of the measuring range that can be covered. The shielding must be mounted on a suitable holder that is provided by the customer in the appropriate height, so that the upper edge of the shielding is positioned above the measuring range offset by the size "G". See the respective dimensional drawings for the dimensions of the various shieldings.
3.3 Installation

Figure 13: Rod detector arrangement

Figure 14 shows a proposal for a mounting bracket for the source shielding. The size and stability has to match the size and weight of the shielding. The bracket has to be mounted in the appropriate height, if possible, directly on the container or on an external supporting structure.

Figure 14: Proposal for mounting bracket
3.3 Installation

For difficult measuring geometries, it may be necessary or advantageous to use two point sources within the measuring range in order to reduce the total activity and to improve the chances for linearization.

Figure 15 shows the respective measuring geometry. The shieldings are mounted one below the other offset by the size "H" such that, if not specified otherwise, the distance between the sources cuts the measuring range in half. Depending on the size of the measuring range, this arrangement can be realized with one or several detectors. The arrangement is fixed during the planning stage and entered in a drawing or defined in writing. These details have to be observed carefully, as otherwise the indicated linearization data are not correct.

Following installation of the shielding, the function of the locking mechanism has to be checked. Depending on the operation conditions, the function check has to be repeated in appropriate intervals, at the latest, after one year.
3.3 Installation

3.3.2 Rod Detector Installation

The rod detector is mounted vertically on the outside of the container, as shown in the drawings (Figure 13, Figure 15, and Figure 17). The top point of the effective detector length is marked by a groove which also defines the top point of the measuring range that can be covered. Please note the dimensional drawings of the rod detector.

The rod detector is mounted as shown in Figure 16, with one fixing clamp above the groove and one in the bottom part of the detector housing. Please note the different diameters of the fixing clamps. The cable bushing has to be aligned such that no water can flow along the cable into the bushing. The distance from the center of the detector to the surface of the container or the surface of a thermal insulation is about 100 mm. The clamps have to be fixed such that no heat is transferred to the detector. If it is not sure that the temperature at the installation site stays < 55°C, a water cooling device has to be used which is in operation even when the instrument is turned off when the temperature may rise above 55°C. The required cooling water volume is dependent on the cooling water temperature and the possible heat transmission. Also, heavy vibrations must not be transferred to the detector, as otherwise its service life could be confined.

Figure 16: Rod detector installation
3.3 Installation

To cover measuring ranges of > 1.5 or 2 meters; these detectors, somewhat offset on the side, are arranged such that the sensitive areas of the detector are overlapping.

Each detector works with its own evaluation unit which supplies the mains voltage, controls and monitors the connected detectors. The evaluation units are linked with each other via the connections RS 1 and RS 2 of the RS 485 interface. The first instrument operates as master unit (LB 440-0x/ -2x/ -4x) which integrates and processes all detector signals, and generates the common output signal. The second and all other units (up to 7) are slave units (LB 440-1x/ -3x/ -5x) serve only for intrinsically safe supply and for the control of the connected detectors.

For reduction of the background rate rod detectors can be mounted in dedicated lead shielding. Thereby a better measuring accuracy is achieved and the detector becomes more insensitive to radiation interference. The rod detector shielding can be attached to the container according to Figure 18.

For detailed information on the construction and function of the shieldings please refer to the technical drawing in CHAPTER 15.
3.3 Installation

Recommendation:

For outdoor installation, the scintillation counter should be protected by a shed which protects the scintillation counter against exposure to direct sunlight.

3.3.3 Electrical Connections

The electrical connections are made as described in section 2.3.5.
3.4 System Configuration and Start-Up

The basic configuration is defined as described in section 2.3.7. The special configuration required for measurements with rod detector is described below.

Turn the measuring system on at least 30 minutes before taking the system into operation.

Operating Mode

Rod detector:
The operating mode is determined by the required measuring arrangement. Select it with <\^\^\^> and confirm your selection with <enter>. For the operating mode described in this section you have to select Rod detector.

Meas. Parameter

Detector Code:
The detector code defines the control characteristics for the high voltage setting of the photomultiplier. Different values have to be entered for different detector lengths. The detector code for the detectors connected to the slave systems is entered in the respective slave unit.

Rod detectors with plastic scintillator

<table>
<thead>
<tr>
<th>Type</th>
<th>Sensitive length in mm</th>
<th>New detector code</th>
<th>Old detector code</th>
</tr>
</thead>
<tbody>
<tr>
<td>LB 4405-01</td>
<td>500</td>
<td>22</td>
<td>24</td>
</tr>
<tr>
<td>LB 4405-02</td>
<td>750</td>
<td>22</td>
<td>24</td>
</tr>
<tr>
<td>LB 4405-03</td>
<td>1000</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>LB 4405-04</td>
<td>1250</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>LB 4405-05</td>
<td>1500</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>LB 4405-06</td>
<td>2000</td>
<td>10</td>
<td>12</td>
</tr>
</tbody>
</table>

Note:
When using rod detectors from a former production series, the old detector code has to be used.

Detectors from the older production series are identified by the ID number 32511 on the type plate of the probe electronics. Detectors from the new production series have the ID numbers 36846 or 35208 and work with the new detector code. New detectors have a higher sensitivity.

Replacement of a rod detector from the older production series by a new one:
If a rod detector from the older production series is replaced by a new one having the same length, the old detector code may also be used in the new rod detector. With the old detector code, rod detectors from the new production series reach the sensitivity of rod detectors from the older production series.
Note:
The high voltage control for rod detectors works with a large time constant. Without any additional provisions it would take up to 30 minutes before the operating point is reached. To reduce this time a start value for the high voltage control is defaulted in the detector. After power failure this start value is used to reach the operating point for high voltage control quicker. The start value can be read off and set new in the Service menu (menu item „Read start value / Store start value“). If the difference between the adjusted high voltage after approx. 1 h and the start value >50V, you should set the start value to the adjusted high voltage.

See also CHAPTER 11.

Calibration is performed in three steps:

1. Measure background. For this, the shielding should not yet be installed.

Caution:
Set all level values you may have entered into the instrument and the associated count rates to „0“ before performing the next step.

Figure 19: Sequence for deleting values
2. Enter calculated count rates, the associated level values and then measure the count rate at empty container. For this, the shielding with radiation source has to be installed.

OR

3. Measure count rate at different levels. For this, the shielding with radiation source has to be installed.

4. Measure count rate at full container. For this, the shielding with radiation source has to be installed.

Background measurement:

The term background refers to the count rate created by natural radiation in the environment. The background is not taken into account in decay compensation, since it has to be considered as constant. An error in measuring the background will later result in drifts during measurement. Any influence from radiation sources in the vicinity has to be ruled out.

The measurement should be carried out:

a) Best solution
With empty or full container, with mounted detector but without shielding or without the source being installed in the shielding.

b) Second best solution
With full container, with mounted detector and shielding and installed radiation source with closed radiation exit channel.

c) Possible solution but not recommended
With empty container, with mounted detector and shielding and installed radiation source with closed radiation exit channel. In this case, the detector picks up only a minor residual radiation from the radiation source.

Background
Select Background menu.
Push <run> to start the reading-in process and read in counts over at least 100 s.
Push <run> to stop reading-in.
Accept the value with <enter>.

CAUTION:
Further steps are possible only after the background has been measured!

IMPORTANT:
Final calibration must be performed under operating conditions (pressure, temperature), especially for high-pressure containers. An existing heating jacket must be filled with the medium at operating temperature. With stirrer containers, the stirrer must be in operation to detect any potential influence. If wall deposits build up during operation, an empty calibration should be performed after some time.

NOTE:
Disturbances caused by gas density fluctuations, wall deposits, etc. can be reduced when using Co-60 instead of Cs-137 radiation sources.
3.4 System Configuration and Start-Up

**Calibration curve**

There are two ways of performing a calibration:
- Enter calibration curve
- Read calibration curve

**Caution:**

Set all level values you may have entered into the instrument and the associated count rates to „0“ before performing the next step (see also Figure 19).

**a) Enter calibration curve:** Enter the pre-calculated relative count rates here. They are not changed by the calibration.

You can enter up to 25 value pairs in any order. The correlation level – count rate must be observed. No gaps must occur, since the input is terminated with the value pair 0/0 (0% level / 0 cps).

<table>
<thead>
<tr>
<th>Value pair</th>
<th>Level in %</th>
<th>Rel. count rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>11</td>
<td>94</td>
</tr>
<tr>
<td>3</td>
<td>22</td>
<td>88</td>
</tr>
<tr>
<td>4</td>
<td>33</td>
<td>79</td>
</tr>
<tr>
<td>5</td>
<td>44</td>
<td>70</td>
</tr>
<tr>
<td>6</td>
<td>56</td>
<td>59</td>
</tr>
<tr>
<td>7</td>
<td>67</td>
<td>46</td>
</tr>
<tr>
<td>8</td>
<td>78</td>
<td>31</td>
</tr>
<tr>
<td>9</td>
<td>89</td>
<td>16</td>
</tr>
<tr>
<td>10</td>
<td>100</td>
<td>2</td>
</tr>
</tbody>
</table>

*Figure 20: Example of linearization table*

For empty and full calibration all shielding containers have to be installed at the measuring location. The radiation exit channels must be open.

Read-in the count rate with empty container and confirm it with <enter>.

**Full calibration**

Read-in the count rate with full container and confirm it with <enter>.

**NOTE:**

Empty and full calibration may **temporarily** be performed at a level of >0% and <100%. In this case, the actual level has to be entered in the respective menu field. However, this method is error-prone; the likelihood that error may occur is the greater, the farther the calibration point is away from the respective final point. A correct empty and full calibration should be carried out as soon as possible, as this is the only way to ensure proper system performance.
3.5 Final Settings

**Live Display**

To start the measurement, call the menu item *Live Display* and start the measurement with `<run>`. Then lock the keyboard again by entering the password.

**Caution:**
Set all level values you may have entered into the instrument and the associated count rates to „0“ before performing the next step (see also Figure 19).

**Calibration curve**

**b) Read calibration curve:** Read-in the count rates at different levels and confirm with `<enter>`. To do this, enter the respective level value.

- Up to 25 value pairs can be read in.
- The order and the correlation of level – count rate has to be observed.
- No gaps must occur.
- All unused value pairs have to be set to 0/0.
- Additional value pairs can be entered when „enter“ is operated during empty calibration.

3.5 Final Settings

In the measurement mode, you can change over to the display of the current pulse rate, the automatically set high voltage and to the detector temperature check by pressing `<more>`.

Compare the automatically set high voltage with the default value (*Read Default* in the Service Menu). If you detect a deviation of >50V, increase the default value accordingly, so that the final high voltage value will be reached faster following an interruption of the power supply.
4.1 Instrument Description

4.1.1 Rod Sources

In Co-60 rod sources, the radioactive substance is contained in a wire. Depending on the required activity distribution, the wire is wound around a spike in different slopes and then tightly welded into a stainless steel pipe. Rod-shaped Cs-137 source are assembled from several parts.

The length of the rod source is adapted to the size of the requested measuring range; for measuring ranges of more than 1 m, the rod source is made of several parts.

4.1.2 Rod Source Shielding

Apart from a few special cases, the sources are firmly installed in shieldings which have an opening for the useful beam that is released towards the detector. During transportation, installation and servicing, the useful beam can be shielded by means of a rotating lock.

Cylinder-shaped shieldings that are as long as the source are used for rod sources; these shieldings include a radiation exit slit. To lock the cylinder, rotate it by 90° against an auxiliary shielding. This shielding is placed on a suitable bracket at the measuring location and for larger measuring ranges several parts are mounted on top of each other.

The robust construction, especially the mobile parts of the rotating lock, ensures reliable performance even in heavy-duty environments. The closed steel jacket provides additional protection for the built-in source.

The shielding is designed for a specific measuring geometry and the size of the required measuring range.

The type of shielding and the shielding effect are selected with respect to the type of radiation and the source activity in compliance with official regulations, the local conditions at the measuring location and possible requests by the user. It has to be ensured that the radiation protection areas around the shielding will be kept rather small.

Figure 21: Rod source shielding
4.2 Installation

4.2.1 General Safety Precautions

The shielding with the radioactive source is delivered in compliance with the regulations concerning the transportation of radioactive substances. Take the shielding out of the box just prior to installation. Up to that time, store in a location that is guarded against unauthorized access.

Using the drawings of the shielding and taking into account the circumstances at the measuring site, carefully install the mounting brackets and fixings. Make sure that the mechanical stability of mounting devices matches the weight of the shielding. The shielding should be assembled just prior to taking the system into operation. All screws and fixing parts have to be secured, so they cannot come undone during operation, and the shielding cannot fall down.

To keep the radiation exposure of the assembling personnel as low as possible, only licensed personnel who have been trained on how to handle radioactive substances are allowed to assemble or disassemble the shielding with the source. The 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 modified or damaged.

NOTE!
Please read and follow the Radiation Protection Guidelines (see section CHAPTER 9)!

4.2.2 Rod Shielding Installation

The size and position of the measuring range to be covered is determined when planning the measuring system; it is defined in drawings, sketches or written instructions. For assembly, these specifications have to be observed closely, since deviations may cause malfunctions of the measuring system.

Figure 22 shows a standard arrangement. The size and position of the measuring range to be covered is defined by the source length and the mounting position. The shielding must be mounted at the measuring location, so that the top point of the rod source ("G") and the center of the detector are on a horizontal line which defines the upper point of the measuring range (Max). See the respective dimensional drawings for the various shielding dimensions. The installation height of the supporting structure that is to be provided by the customer has to be determined using the dimensional drawings of the shielding.

The size and stability of the supporting structure or another suitable mounting device for the shielding has to match the size and total weight of the shielding. For safety reasons, the rod source shielding has to be secured in addition by a brace against tipping over.
The shielding should be installed fairly close to the container surface (or the surface of a thermal insulation), so that the covered measuring range is not diminished and it is not possible to reach into the useful beam, which has to be ruled out for radiation protection reasons.

Single part shieldings for rod sources have to be marked TOP and BOTTOM to rule out any side-inverted installation.

Multi-part shieldings are in addition marked by the letters A, B, C etc., from top to bottom (Figure 23). The individual parts are arranged directly below each other and fixed with screws. Each part must be secured against tipping over, e.g. by a brace made of flat iron.
4.2 Installation

Following installation of the shielding, check the function of the locking mechanism. Depending on the operation conditions, the function check has to be repeated in appropriate intervals, at the latest, after one year.

**NOTE:** If the measuring system is used in a heavy-duty environment, the shielding should be provided with an additional protective cover. In case of increased radiation heat, thermal shields have to be attached to prevent the shielding temperature from rising over approx. 100°C.

4.2.3 Detector Installation

As shown in Figure 22 the center point of the detector is on a horizontal line which is formed by the top point of the rod source and the top point of the measuring range. The direction of irradiation is radial. Note the alignment of the radiation window as shown in the dimensional drawing. The distance from the center of the detector to the surface of the container or the surface of a thermal insulation is about 100 mm. It is installed onto a suitable bracket using clamps or a bar, such that the radiation window facing the source is not covered (Figure 24 and Figure 25).

![Figure 24: NaI point detector installation](image-url)
4.2 Installation

The cable bushing has to be aligned such that no water can flow along the cable into the bushing. When selecting the fixing point, keep in mind that the detector should not be affected by mechanical stress or heavy vibrations, in order not to restrict its service life. The temperatures should not significantly exceed 50°C. A radiation protection shield made of a thin sheet metal should be foreseen against radiation heat and solar radiation. The cable and the cable feeding should not be exposed to temperatures beyond 70°C. If higher temperatures than 50°C are likely, water cooling jackets have to be mounted on the detector, which are available as accessories. The required quantity of cooling water is dependent on the possible heat transmission and the cooling water temperature.

For outdoor installation, the scintillation counter should be protected by a shed which protects the scintillation counter against exposure to direct sunlight.

4.2.4 Source Installation in Dip Pipe

Special container constructions may require installation of the rod source inside the container. Essentially, this does not change the function and the basic arrangement, as shown in Figure 26. Due to the shorter distance between source and detector and due to the fact that only one container wall has to be irradiated, the required source activity can be reduced significantly. For this arrangement, the source is often delivered in a shielding which can be placed onto the flange of the protection tube. The source is then pushed into the protection tube to the desired position via a rope or an extension rod. To avoid damaging the wire rope, the shutter should only be closed, when the source is inside the shielding and the upper end of the rod source is visible. If several sources are contained within one container, one has to pay attention to the sequence of lowering the sources into the container (lowest source first) and withdrawing the sources back into the container (highest source first). A technical drawing of such a shielding for flange mount is provided on in CHAPTER 15.

The protection tube for the source has to be provided by the customer; it should be installed such that the source can be withdrawn any time without interrupting the production process. The stability of the protection tube must match the potential mechanical and chemical stress. Damage to the protection tubes must be obvious immediately, so that the source can be secured in time.
Figure 26 shows a proposal for installation which fulfills the highest safety requirements. A double-walled protection tube is used; the space between both walls is filled with a protection gas and any damage or leak is signaled immediately via a pressure control switch.

4.3 Electrical Connections

The electrical connections are made as described in section 2.3.5.

4.4 System Configuration and Start-Up

The measuring systems can be taken into operation before the source is installed. After power on, the evaluation unit must display the instrument identification (Figure 9). Now check the date and the factory-set parameters. The background is displayed as detector signal. The instruments should remain turned on until completion of final commissioning. The source with shielding has to be installed before final commissioning. The lock of the shielding has to be opened to release the useful beam towards the detector.
4.4 System Configuration and Start-Up

4.4.1 Basic Setting

The basic setting is carried out as described in 2.3.7. The special configuration for measurement with rod sources and point detectors is described below.

4.4.2 Calibration

IMPORTANT:
Final calibration must be performed under operating conditions (pressure, temperature), especially for high-pressure containers. An existing heating jacket must be filled with the medium at operating temperature. With stirrer containers, the stirrer must be in operation to detect any potential influence. If wall deposits build up during operation, an empty calibration should be performed after some time.

Turn the measuring system on at least 30 minutes before taking the system into operation.

Operating Mode

Linear:
The operating mode is determined by the required measuring configuration. Select it with < and confirm your selection with <enter>. For the operating mode described in this section you have to select Linear.

Meas. Parameter

Detector Code:
The detector code defines the control characteristics for the high voltage setting of the photomultiplier. Scintillation counters with NaI crystal or the Super-Sens detector (LB 443X / LB 543X) are used for the application described here. The detector code for the detectors connected to the slave systems is entered in the respective slave unit.

<table>
<thead>
<tr>
<th>Type</th>
<th>Crystal size (diameter/length)</th>
<th>Ex protection</th>
<th>Detector code</th>
</tr>
</thead>
<tbody>
<tr>
<td>LB 4401-01</td>
<td>25/25</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>LB 4401-02</td>
<td>40/35</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>LB 4401-03</td>
<td>50/50</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>LB 443X</td>
<td>150/150</td>
<td>+</td>
<td>23</td>
</tr>
<tr>
<td>LB 5401-01</td>
<td>25/25</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>LB 5401-02</td>
<td>40/35</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>LB 5401-03</td>
<td>50/50</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>LB 543X</td>
<td>150/150</td>
<td>-</td>
<td>23</td>
</tr>
</tbody>
</table>
A 2-point calibration has to be carried out to adjust the measuring range to the display. To this end, read in the pulse rate at empty and full container.

1. Select the menu group *Interfaces / Calibrate* with <etc.>.

2. Push <sk2> to call the Calibrate menu.

**Empty calibration:**
For empty and full calibration all shielding containers of the measuring system have to be installed. The radiation exit channels must be open. The container should be empty or, at most, filled up to the lower point of the measuring range (Min). The lower calibration point can be calibrated temporarily with partially filled container if you know the exact current level. In this case, enter the value associated with this calibration point as level reading. The error that may occur is the greater, the farther away the calibration point from the min. point of the measuring range. We recommend that you perform a correct empty calibration as soon as possible.

3. Enter the respective level value for empty (e.g. 0%) and accept the value with <enter>.

4. Read in the respective count rate with <run> and stop reading-in with <run> as soon as the value has become stable.

5. Accept the value with <enter>.

6. Push <more> to go to the next parameter.

**Full calibration:**
The container should be full or at least filled up to the upper point of the measuring range (Max). The upper calibration point can be calibrated temporarily with partially filled container if you know the exact current level. In this case, enter the value associated with this calibration point as level reading. The error that may occur is the greater, the farther away the calibration point from the max. point of the measuring range. We recommend that you perform a correct full calibration as soon as possible.

7. Enter the respective level value for full (e.g. 100%) and accept the value with <enter>.

8. Read in the respective count rate with <run> and stop reading-in with <run> as soon as the value has become stable.

9. Accept the value with <enter>.

10. Push <done> to return to the menu group and from there with <run> back to the measurement mode.
4.4.3 One-Point Calibration

A one-point calibration is acceptable if the container cannot be filled for the first commissioning or later. Only the empty calibration is performed by reading in the pulse rate and then the pulse rate for the full calibration is calculated and entered manually. With a product density of about \( \rho = 1 \text{ g/cm}^3 \) and a container diameter \( d \) of \( > 1 \text{ m} \), the value „0“ can be entered as full pulse rate with sufficient accuracy. For container diameters \(< 1 \text{ m} \) the empty pulse rate \( I_0 \) measured at 0% level is multiplied by an attenuation factor and entered as full pulse rate. The following calculations are then carried out:

\[
\text{for Co-60: } I = I_0 \times e^{-0.0044 \times \rho \times d}
\]

\[
\text{for Cs 137: } I = I_0 \times e^{-0.006 \times \rho \times d}
\]

Example for Co-60 and \( d < 1 \text{ m} \):

Container diameter \( d = 500 \text{ mm}, \rho = 0.8, \) empty pulse rate = 600 cps
Full pulse rate \( I = 600 \times e^{-0.0044 \times 0.8 \times 500} = 600 \times 0.172 = 103 \text{ cps} \)

If the container can be filled completely later, we recommend to carry out the more accurate full calibration by reading in the full pulse rate.
CHAPTER 5. POINT SOURCE ARRANGEMENT

5.1 Instrument Description

5.1.1 Point Source

Point-shaped Co-60 or Cs-137 Gamma sources are used for these measuring arrangements.

5.1.2 Point Source Shielding

Apart from a few special cases, the sources are firmly installed in shieldings which have an opening for the useful beam that is released towards the detector. During transportation, installation and servicing, the useful beam can be shielded by means of a rotating lock. The radiation exit is cone shaped with an angle of about 10°.

The type of shielding and the shielding effect are selected with respect to the type of radiation and the source activity in compliance with official regulations, the local conditions at the measuring location and possible requests by the user. It has to be ensured that the radiation protection areas around the shielding will be kept rather small.

The shielding can either be installed on a bracket or on a flange. Note the dimensional drawings with installation proposals for the respective shielding.

For sources that are specially designed for installation into dip pipes, shieldings can be used that allow extending and retracting of the source by means of ropes or rods.

For detailed information on the construction and function of the shieldings, see the drawings that are part of the documentation.
5.2 Installation

5.2.1 General Safety Precautions

The shielding with the radioactive source is delivered in compliance with the regulations concerning the transportation of radioactive substances. Take the shielding out of the box just prior to installation. Up to that time, store in a location that is guarded against unauthorized access.

Using the drawings of the shielding and taking into account the circumstances at the measuring site, carefully install the mounting brackets and fixings. Make sure that the mechanical stability of mounting devices matches the weight of the shielding. The shielding should be assembled just prior to taking the system into operation. All screws and fixing parts have to be secured, so they cannot come undone during operation, and the shielding cannot fall down.

To keep the radiation exposure of the assembling personnel as low as possible, only licensed personnel who have been trained on how to handle radioactive substances are allowed to assemble or disassemble the shielding with the source. The 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 modified or damaged.

NOTE!
Please read and follow the Radiation Protection Guidelines (see section CHAPTER 9)!

5.2.2 Shielding Installation

The size and position of the measuring range to be covered is determined when planning the measuring system; it is defined in drawings, sketches or written instructions. For assembly, these specifications have to be observed closely, since deviations may cause malfunctions of the measuring system.

As Figure 28 shows, the size of the measuring range is obtained via the angle of irradiation which has to be taken into account when installing the shielding. The installation situation is illustrated in the project drawings, sketches and descriptions.

The mounting flange or mounting bracket for the shielding must take into account the angle foreseen when preparing the installation. Installation parts such as adjustable angles allow adjustments or modifications later within certain limits.
5.2 Installation

5.2.3 Detector Installation

Using fixing clamps, the detector is horizontally mounted onto a suitable holder that is provided by the customer and the radiation window is aligned towards the source (see also Figure 28). The direction of irradiation is radial.
The distance to the surface of the container or the surface of a thermal insulation should be about 100 mm. It is installed onto a suitable bracket using clamps or a bar, such that the radiation window facing the source is not covered (Figure 29 and Figure 30).

The cable bushing has to be aligned such that water cannot flow along the cable into the bushing. When selecting the fixing point, keep in mind that mechanical stress or heavy vibrations should not affect the detector in order not to restrict its service life.

A radiation protection shield made of a thin sheet metal should be foreseen against radiation heat and solar radiation. The cable feeding should not be exposed to temperature beyond 70°C. If higher temperatures than 50 °C are likely, water cooling jackets have to be mounted on the detector, which are available as accessories. The required quantity of cooling water is dependent on the possible heat transmission and the cooling water temperature.

**Recommendation:**
For outdoor installation, the scintillation counter should be protected by a shed, which protects the scintillation counter against exposure to direct sunlight.

### 5.3 Electrical Connections

The electrical connections are made as described in section 2.3.5.
5.4 System Configuration and Start-Up

The basic setting is carried out as described in 2.3.7. The special configuration for measurement with point sources is described below.

The measuring systems can be taken into operation before the source is installed. After power on, the evaluation unit must display the instrument identification (Figure 9). Now check the date and the factory-set parameters. The background is displayed as detector signal. The instruments should remain turned on until completion of final commissioning. The source with shielding has to be installed before final commissioning. The lock of the shielding has to be opened to release the useful beam towards the detector.

Turn the measuring system on at least 30 minutes before taking the system into operation.

5.4.1 Basic Settings

<table>
<thead>
<tr>
<th>Operating Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Exponential:</strong></td>
</tr>
<tr>
<td>The operating mode is determined by the required measuring arrangement. Select it with &lt;^&gt; and confirm your selection with &lt;enter&gt;. For the operating mode described in this section you have to select <strong>Exponential.</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Detector Code:</th>
</tr>
</thead>
<tbody>
<tr>
<td>The detector code defines the control characteristics for the high voltage setting of the photomultiplier. Scintillation counters with NaI crystal or Super-Sens are used for the application described here. The detector code for the detectors connected to the slave systems is entered in the respective slave unit.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type</th>
<th>Crystal size (diameter/length)</th>
<th>Ex protection</th>
<th>Detector code</th>
</tr>
</thead>
<tbody>
<tr>
<td>LB 4401-01</td>
<td>25/25</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>LB 4401-02</td>
<td>40/35</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>LB 4401-03</td>
<td>50/50</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>LB 443X</td>
<td>150/150</td>
<td>+</td>
<td>23</td>
</tr>
<tr>
<td>LB 5401-01</td>
<td>25/25</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
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<td>40/35</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>LB 5401-03</td>
<td>50/50</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>LB 543X</td>
<td>150/150</td>
<td>-</td>
<td>23</td>
</tr>
</tbody>
</table>
5.4 System Configuration and Start-Up

5.4.2 Calibration

Final calibration must be performed under operating conditions (pressure, temperature), especially for high-pressure containers. An existing heating jacket must be filled with the medium at operating temperature. With stirrer containers, the stirrer must be in operation to detect any potential influence. If wall deposit builds up during operation, an empty calibration should be performed after some time.

For preliminary commissioning you may perform a one-point calibration. For accurate and final calibration you should run a two-point calibration.

5.4.2.1 One-Point Calibration

A one-point calibration can be carried out if the container cannot be filled for first commissioning. To do this, enter an absorption coefficient as a1-value, which is calculated from the absorption path AP and the product density, and taking into account the isotope used. Only the empty calibration is performed by entering the initial level value in % and reading in the respective pulse rate. For full calibration you just have to enter the level end value. The respective pulse rate has already been calculated automatically from the a1-value.

The absorption coefficient are calculated as follows:

\[
\text{for Co-60: } a_1 = 0.0044 \times \rho \times AP \\
\text{for Cs-137: } a_1 = 0.006 \times \rho \times AP
\]

\(\rho\) is the density of the container filling in g/cm\(^3\) and AP the absorption path in mm.

**Example:** Level measuring range MR = 200 mm  
Absorption path AP = 280 mm  
Density \(\rho\) = 1  
Source: Co-60

\[
a_1 = 0.0044 \times 1 \times 280 = 1.2320
\]

![Diagram showing absorption path AP and measurement range MR](image1)

*Figure 31: Absorption path AP*
5.4 System Configuration and Start-Up

1. Select menu group Interfaces / Calibrate with <more>.

2. With <sk2>, call the Calibrate menu.

3. Enter the calculated a1-value.

**Empty calibration:**

The container must be empty or filled only up to the lower point of the measuring range (Min).

4. Define the level reading for empty (e.g. 0%) and accept it with <enter>.

5. Read in the respective pulse rate with <run> and after the measurement values have become stable, stop with <run>.

6. Accept the calibration value with <enter>.

7. Press <more> to switch to the next parameter.

**Full calibration:**

8. Enter only the level reading for full (e.g. 100%). The respective pulse rate is calculated automatically.

9. Press <done> to get back to the menu group and from there with <run> back to the measurement mode.

If the container can be filled completely later, we recommend to carry out the more accurate full calibration by reading in the full pulse rate, as for a two-point calibration.

5.4.2.2 Two-Point Calibration

Read in the pulse rates at empty and full container.

1. Select menu group Interfaces / Calibrate with <more>.

2. With <sk2>, call the Calibrate menu.

3. Do not enter a1-values. For a two-point calibration it is calculated automatically.
Empty calibration

The container must be empty or filled only up to the lower point of the measuring range (Min).

1. Define the *level reading* for empty (e.g. 0%) and accept it with `<enter>`.  
2. Read in the respective pulse rate with `<run>` and after the measurement values have become stable, stop with `<run>`.  
3. Accept the calibration value with `<enter>`.  
4. Press `<more>` to switch to the next parameter.

Full calibration:

The container must be full or at least filled up to the upper point of the measuring range (Max).

1. Define the *level reading* for full (e.g. 100%).  
2. Read in the respective *pulse rate* with `<run>` and after the measurement values have become stable, stop with `<run>` or enter a known pulse rate.  
3. Accept the calibration value with `<enter>`.  
4. Press `<done>` to get back to the menu group and from there with `<run>` back to the measurement mode.
6.1 Installation

A water-cooling device is needed if the ambient temperature may rise above the maximal permitted value of 50°C. If the temperature can exceed this value, the water-cooling has to be operated even if the detector is not operated. If a water cooling device is installed on the detector, the connection piece must be aligned such that they can be connected easily to the detector. Make sure that the water pipes to not lead past the radiation window.

Bear the following in mind during installation to prevent an air cushion from building up in the water-cooling device:

**Horizontal installation:**
- If the detector is installed horizontally, then the bottom connection piece is to be used as water inlet.

**Vertical installation:**
- If the detector is installed vertically, then the connection pieces must be on top.

**Super Sens Installation:**
- In a Super-Sens with water-cooling, the water-cooling devise is integrated in the housing. The water-cooling comprises two cooling jackets which must be connected with each other during installation.
6.2 Cooling Water Consumption

The amount of cooling water required may be taken from the graphs below. The x-axis shows the maximum possible ambient temperature, the y-axis shows the minimum required water flow in l/h. The different characteristic curves are valid for the respective inlet temperatures of the cooling water.

Warning! Risk of damage!

The cooling water flow must not be turned off if the maximum ambient temperature of the detector of 50°C can be exceeded, even if the facility is not in operation.

If there is a potential for frost, the water-cooling jacket must be emptied.

Dirty cooling water may cause build-up that will block the water cooling so that the detector may get overheated and destroyed. Make sure to use clean cooling water!

The water pressure in the cooling system must not exceed 6 bar.

![Figure 32: Cooling water consumption for point detectors](image)
6.2 Cooling Water Consumption

Figure 33: Cooling water consumption for rod detector 500 mm

Figure 34: Cooling water consumption for rod detector 750 mm and 1000 mm
CHAPTER 6. Water Cooling

6.2 Cooling Water Consumption

Figure 35: Cooling water consumption for rod detector 1250mm and 1500mm

Figure 36: Cooling water consumption for rod detector 1750mm and 2000mm
CHAPTER 7. TECHNICAL DATA

7.1 Evaluation Unit LB 440

Model:  
LB 440-0x/ -2x/ -4x Master System  
LB 440-1x/ -3x/ -5x Slave System for multi-detector arrangements  
Signal transfer to the master system via RS 485

Design:  
19" module 3 HE, 21 TE; protection type IP 20  
Wall mounted version: protection type IP 66

Power supply:  
115 V ± 10%  
230 V ± 10%  
18 to 32 V DC

Power consumption:  
approx. 30 VA or 30 W

Temperature range:  
19" rack version  
- Operating temperature: 0 - 50°C; no condensation  
- Wall mounted version LB 4460  
- Operating temperature: 0 - 40°C; no condensation  
- Max. ambient temperature for II 2 G [EEx ib] IIC/IIB: 40°C

Storage temperature: -40 to + 70 °C

CPU:  
32 bit computer, data storage in FLASH EPROM.

Inputs/Outputs (LB 440):  
Detector connection  
- not intrinsically safe  
- intrinsically safe: II 2 G [EEx ib] IIB  
- intrinsically safe: II 2 G [EEx ib] IIC  
The plastic block assembled in the factory must be installed for intrinsically safe installations, EEx [ib]. This plastic block, mounted on the connector strip (for 19" or panel installation), ensures the necessary minimum distance between intrinsically safe and not intrinsically safe connections. See also Figure 11.

In a wall housing, this is a black plastic plate (one for each channel) which is mounted on the motherboard. If this plastic block is not present, the cable wires must be protected by 10 mm long shrink-down plastic tubing at the connection ends towards the terminals.

The maximum permissible cable length is dependent on the cable resistance, which in total (back and forth) must not exceed 40 Ohm. With the standard cable by BERTHOLD TECHNOLOGIES (ID No. 32024) this results in a cable length of 1000 m from the evaluation unit to the detector.

With intrinsically safe systems, the maximum permissible inductivity and capacity of the cable has to be taken into account, in addition to the max. 40 Ohm. These values are defined in the certificate in the Appendix.

The effective inner inductivity from the evaluation unit is negligible. The effective inner capacity is 12 nF.
CHAPTER 7. TECHNICAL DATA

7.1 Evaluation Unit LB 440

2 digital inputs:
- passive for a) external start/stop of measurement procedure and
  b) external start after interfering radiation

Analog output: 0/4 - 20 mA isolated (max. 500 Ω)

Limit value outputs: 2 relay outputs for max. / min.
  1 relay output for collective failure alarm
Load:
  AC: Max. 250V, max. 1A, max. 200VA
  DC: Max. 300V, max. 1A, max. 60 W at resistive load

Display: LCD display with 4 x 20 characters, illuminated
  Data input via keypad.
  Dialog guidance with softkeys;
  Language: German, English, French, and Spanish;
  Modification of data only after entry of user-defined password.

Interfaces: RS 232, and RS 485

Time constant: 0.5 - 999 s with automatic reduction to 1/10 of the value in case of quickly changing values (can be switched off).
  Adjustable response threshold for time constant switch-over.

Automatic decay compensation: For $^{137}\text{Cs}$ and $^{60}\text{Co}$.

Weight: approx. 2 kg
CHAPTER 7. TECHNICAL DATA

7.2 Detectors

LB 4401..:  Scintillation counter with NaI (Tl) crystal 25/25, 40/35 or 50/50.
           stability: ± 0,1 %
           Gas Protection: II 2 G EEEx de IIC T6 / II 2 G EEEx ib d II C T6
           Dust Protection: II 2 D IP65 T80°C

LB 4405..:  Scintillation counter with plastic scintillator, long-term stability ± 1 %,
           sensitive lengths see table below.
           Gas Protection: II 2 G EEEx de IIC T6 / II 2 G EEEx ib d II C T6
           Dust Protection: II 2 D IP65 T80°C / II 2 D IP67 T80°C
           See also CHAPTER 13 PTB / TÜV CERTIFICATES.

LB 4430 :  Super-Sens: Scintillation counter with plastic scintillator 150/150.
           stability: ± 0,5 %
           Gas Protection: II 2 G EEEx de IIC T6 / II 2 G EEEx ib d II C T6

LB 5401..:  Scintillation counter with NaI (Tl) crystal 25/25, 40/35 or 50/50.
           stability: ± 0,1 %

LB 5430 :  Super-Sens: Scintillation counter with plastic scintillator 150/150.
           stability: ± 0,5 %

Protection type: IP 65 / Nema 4 X
Housing: Stainless steel housing
Cable entry: M16 for external cable diameter 7...11 mm.

Operating temperature:
For detectors LB 4401 / LB 5401 (point detectors with NaI crystal)
-40 to + 60°C
For detectors LB 4405 / LB 4430 / LB 5430 (with plastic scintillator)
-40 to + 55°C.
A water cooling is available for higher temperatures.
Monitoring of detector temperature and alarm when exceeding the max. permissible temperature.

Storage temperature:
For detectors LB 4401 (point detectors with NaI crystal) -40 to + 70°C
For detectors LB 4405 (rod detectors with plastic scintillator) -40 to + 55°C.

Connection cable: Two-wire
Max. cable length: See detector connection on page 52.
### 7.2 Detectors

#### Point detectors

<table>
<thead>
<tr>
<th>Type</th>
<th>Crystal Dimensions mm</th>
<th>Weight in kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>LB 4401-01/LB 5401-01</td>
<td>25/25 NaI</td>
<td>6</td>
</tr>
<tr>
<td>LB 4401-02/LB 5401-02</td>
<td>40/35 NaI</td>
<td>6</td>
</tr>
<tr>
<td>LB 4401-03/LB 5401-03</td>
<td>50/50 NaI</td>
<td>18</td>
</tr>
<tr>
<td>LB 4430 / LB 5430</td>
<td>150/150 plastic</td>
<td>54/52</td>
</tr>
</tbody>
</table>

#### Rod detectors with plastic scintillator

<table>
<thead>
<tr>
<th>Type</th>
<th>Sensitive length mm</th>
<th>Weight in kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>LB 4405-01</td>
<td>500</td>
<td>10</td>
</tr>
<tr>
<td>LB 4405-02</td>
<td>750</td>
<td>11.5</td>
</tr>
<tr>
<td>LB 4405-03</td>
<td>1000</td>
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</tr>
<tr>
<td>LB 4405-04</td>
<td>1250</td>
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<tr>
<td>LB 4405-05</td>
<td>1500</td>
<td>16</td>
</tr>
<tr>
<td>LB 4405-06</td>
<td>2000</td>
<td>19</td>
</tr>
</tbody>
</table>

#### Rod detectors with plastic scintillator and water cooling

<table>
<thead>
<tr>
<th>Type</th>
<th>Sensitive length mm</th>
<th>Weight in kg empty/full</th>
</tr>
</thead>
<tbody>
<tr>
<td>LB 4405-11</td>
<td>500</td>
<td>12.5/13.5</td>
</tr>
<tr>
<td>LB 4405-12</td>
<td>750</td>
<td>16/17</td>
</tr>
<tr>
<td>LB 4405-13</td>
<td>1000</td>
<td>18/19</td>
</tr>
<tr>
<td>LB 4405-14</td>
<td>1250</td>
<td>20.5/22</td>
</tr>
<tr>
<td>LB 4405-15</td>
<td>1500</td>
<td>23/25</td>
</tr>
<tr>
<td>LB 4405-16</td>
<td>2000</td>
<td>27.5/30</td>
</tr>
</tbody>
</table>
CHAPTER 8. SERVICING INSTRUCTIONS

8.1 General Safety Precautions

Any time you are working on electrical components, you have to observe the relevant safety regulations. Please refer to the GENERAL WARNINGS and SPECIFIC WARNINGS in the Safety Summary.

Any work in the direct vicinity of the shieldings containing the radioactive source may be performed only following proper training and/or professional guidance.

8.2 Trouble Shooting Guide

<table>
<thead>
<tr>
<th>Problem</th>
<th>Probable Cause</th>
<th>Potential Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>No display</td>
<td>No power supply</td>
<td>Check mains cables</td>
</tr>
<tr>
<td>Display unreadable</td>
<td>Processor error</td>
<td>Note error code Perform total reset Replace evaluation unit</td>
</tr>
<tr>
<td>No pulse rate (Error code 2)</td>
<td>Detector is faulty</td>
<td>Replace detector</td>
</tr>
<tr>
<td>Pulse rate too low</td>
<td>Alignment of useful beam toward detector not correct</td>
<td>Correct and optimize alignment</td>
</tr>
<tr>
<td>Container installations in the path of radiation</td>
<td>Offset irradiation levels</td>
<td></td>
</tr>
<tr>
<td>Wall deposit in containers</td>
<td>Remove wall deposits</td>
<td></td>
</tr>
<tr>
<td>Source has reached the end of its service life</td>
<td>Renew source (Co-60 after 5 to 10 years, at the earliest)</td>
<td></td>
</tr>
<tr>
<td>Entry of final level end values incorrect</td>
<td>Check correlation pulse rate and level reading</td>
<td></td>
</tr>
<tr>
<td>No or incorrect level reading</td>
<td>Entry of final level end values incorrect</td>
<td>Check correlation pulse rate and level reading</td>
</tr>
<tr>
<td>Output current incorrect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level reading fluctuates strongly</td>
<td>Time constant too small</td>
<td>Increase time constant in the Parameter menu (min 20 s)</td>
</tr>
<tr>
<td>Rapid switch-over with too small Sigma value</td>
<td>Disable rapid switch-over or increase Sigma value</td>
<td></td>
</tr>
<tr>
<td>Pulse rate too low</td>
<td>Check age of source and irradiation level. Replace detector</td>
<td></td>
</tr>
<tr>
<td>Level reading shows drifts</td>
<td>Detector stabilization faulty</td>
<td>Replace detector</td>
</tr>
<tr>
<td>Photomultiplier faulty</td>
<td>Replace photomultiplier</td>
<td></td>
</tr>
<tr>
<td>Level reading drifts for some time following power failure</td>
<td>HV control set to manual.</td>
<td>Set HV control to automatic mode (Service menu)</td>
</tr>
<tr>
<td>Start value for HV control incorrect</td>
<td>High voltage value &gt; 30 min. Read it off after power failure and enter this value as start value.</td>
<td></td>
</tr>
<tr>
<td>Photomultiplier faulty</td>
<td>Replace photomultiplier</td>
<td></td>
</tr>
</tbody>
</table>
8.3 Shielding and Source

The shieldings do not include any wearing parts or mechanically moving parts that under normal operating conditions require maintenance. For safety reasons, however, it should be possible any time to lock the useful beam. A function check has to be performed in appropriate intervals of one or half a year, depending on the ambient strain. The radiation protection manager has to be informed immediately if any faults on the shielding or a sluggish locking mechanism are detected. If the problem cannot be solved by simple measures such as cleaning, you have to stop working with the system until it has been repaired.

As long as the shielding does not show any significant mechanical damage or strong corrosion, the built-in source will be protected. Refer to the radiation protection guidelines in section CHAPTER 9 to check or replace the source.

The radioactive source used and the measuring system has a service life of 5 to 10 years. A source has to be replaced when statistical variations which increase in the course of time become intolerably high and any compensation by increasing the time constant is not permitted, e.g. due to control engineering reasons.

**Important:** An empty calibration has to be performed any time you replace a source!

For information on the design of source and shielding see the technical documentation and the identity plate (Figure 37).

![Identity plate](image)

Figure 37: Identity plate

If the source has to be renewed, you have to include the manufacturing number of the original source in your new order. This manufacturing number consists of three groups of digits, for example:

```
1234 - 11 - 94
```

The first group is a consecutive number, the second group identifies the month (here: November) and the third the year the source was manufactured (here: 1994). It is included on the identity plate of the shielding and also on the seal certificate that comes with every source.
8.4 Evaluation unit LB 440

After power on, the instrument identification must appear on the evaluation unit display (Figure 9). With more you go on to the operating parameters of the various menu structures. If no entry is made, the program automatically switches from the current menu to the display mode after a few minutes.

The evaluation unit includes an error-monitoring device, which also covers the detector functions and displays faults as error codes on the display. For information on the error and the potential cause see the Error Code Listing. If a hardware error occurs, the evaluation unit has to be replaced.

If no error code is displayed, this means that the electronics is working correctly and all measured values and parameters are within the normal range. Possible function problems must then have another cause. Please refer to the Trouble Shooting information in section 8.2.

In case of power failure, the measurement responds as follows:
If the instrument was in the RUN mode prior to power failure, then the measurement starts in the RUN mode after return of the power supply.
If the instrument was in the STOP mode prior to power failure, then the measurement is still in the STOP mode after return of the power supply.
Upon return of the power supply, the message "reading flash memory" is displayed for about two seconds.
The parameters are still available after every power failure.

Figure 38: Position of the battery on the LB 440 circuit board

Battery
A battery buffers the date and time. The service life of the battery is about 7 years, provided the evaluation unit is supplied with mains power during this time. Without power supply, the battery may operate the clock module for about 1 year before its capacity is exhausted. The message "change battery" appears if the battery is 6 years old. After the exchange of the battery, the battery change date must be actualized in the service menu. The battery is localized on the circuit board; the front panel has to be partly removed for a battery change. As a standard a Varta CR2032 battery with 3 V / 220 mAh is used (Berthold Id.-No. 17391).
Push the Clear key - while the instrument is turned off - and turn the instrument on at the same time to perform a "General Reset". All parameters are reset to standard values.

Push the Sk1 button while the instrument is turned off and turn on the power supply to reset the instrument without loss of parameters.
### 8.4 Evaluation unit LB 440

#### 8.4.1 Error Messages

With networked instruments, the instrument in which the error occurred is also indicated.

Example: a) error 2 → detector error in Master.  
b) error 3 Slave n → high voltage error in Slave n

<table>
<thead>
<tr>
<th>Problem</th>
<th>Cause</th>
<th>Remedy</th>
</tr>
</thead>
</table>
| 1 | Pulse rate overflow  
Pulse rate > 450000 cps.  
Interference radiation due to welding seam tests?  
Detector faulty. | If necessary, replace detector |
| 2 | No pulses from detector  
Fault in detector | Replace detector |
| 3 | HV wrong  
HV < 500V or > 1500V, out of controlled range | Replace detector |
| 6 | Detector temperature > 65°C  NTC-temperature > 65°C | Use water cooling |
| 7 | Trouble with detector communication  
Data flow from detector to evaluation unit wrong or not connected | Check connection cable and connections.  
Check if electromagnetic interferences, e.g. due to frequency converters, have an effect on the cable between detector and evaluation unit. In principle, signal cable must not be installed parallel to supply cables!  
Replace detector  
Replace evaluation unit |
| 8 | Measurement halted  
Measurement is stopped by closed contact 20 a/c (Input 2) | |
| 9 | Detector temperature > 78°C  NTC-temperature > 80°C | Replace detector (was probably destroyed)  
Use water cooling |
| 10 | No calibration  
Calibration incomplete | Run calibration |
| 11 | Power failure >1 month  
Check time | Check and correct date and time  
If error recurs after short-term power failure: replace Li battery |
| 12 | No input allowed  
Input locked by password | Enter password |
| 32 | Wrong password  
Wrong input | Enter correct password |
| 33 | Interference radiation  
Interference radiation detected | Wait for end of delay time |
| 34 | Wrong input value  
Input value out of range | |
| 35 | Calibration error  
Wrong calibration | Check calibration values |
| 36 | Pulse rate < minimum  
Measured pulse rate < minimum | Check input value for min. pulse rate, if necessary, set it to „0“ |
| 37 | Pulse rate > maximum  
Measured pulse rate > maximum | Check input value for max. pulse rate, if necessary, set it to „0“. The function is then disabled. |
| 38 | Communication trouble RS 485  
Communication with indicated slave not possible any more | Check wiring. Replace Slave, replace Master. |
| 39 | Source replacement  
Operation is still possible. However, the radiation source should be replaced as soon as possible. |
| 40 | Multiplier replacement  
Operation is still possible. However, the photomultiplier should be checked as soon as possible, and if necessary replaced. |
| 41 | Characteristic curve not monotonous  
One or more calibration pairs are incorrect (only with polygon and rod detector) | Correct value pairs.  
Falling count rates must results in rising levels. |
| 42 | Calibrate measurement new  
Calibration mode was changed. | A new calibration is required. |
### 8.4 Evaluation unit LB 440

<table>
<thead>
<tr>
<th></th>
<th>Battery failure Check time</th>
<th>The change of date is greater than 1 year and 1 month</th>
<th>If this change was caused after power failure, then the Li battery has to be replaced.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Change battery</td>
<td>Since the latest battery change have passed 6 years.</td>
<td>Exchanging battery. Enter new battery change date.</td>
</tr>
<tr>
<td></td>
<td>Setup batt. date!</td>
<td>Battery change date was set to default by general Reset.</td>
<td>Enter the date of the latest Battery exchange.</td>
</tr>
</tbody>
</table>
8.4 Evaluation unit LB 440

8.4.2 Behavior in Case of Error

Valid for program version 2.11

<table>
<thead>
<tr>
<th>No.</th>
<th>Message</th>
<th>Operating Mode: Cancel</th>
<th>Operating Mode: Continue</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Measurement</td>
<td>Relay</td>
</tr>
<tr>
<td>1</td>
<td>Count rate overflow at 450.000 cps</td>
<td>Halt</td>
<td>Error</td>
</tr>
<tr>
<td>2</td>
<td>No pulses from detector</td>
<td>Abort</td>
<td>Error</td>
</tr>
<tr>
<td>3</td>
<td>HV wrong</td>
<td>Abort</td>
<td>Error</td>
</tr>
<tr>
<td>6</td>
<td>Detector Temp. &gt;65°C</td>
<td>Continue</td>
<td>Error</td>
</tr>
<tr>
<td>7</td>
<td>Detector communication trouble</td>
<td>Abort</td>
<td>Error</td>
</tr>
<tr>
<td>8</td>
<td>Measurement stopped</td>
<td>Halt</td>
<td>Error</td>
</tr>
<tr>
<td>9</td>
<td>Detector Temp. &gt;78°C</td>
<td>Abort</td>
<td>Error</td>
</tr>
<tr>
<td>10</td>
<td>No calibration</td>
<td>Abort</td>
<td>Error</td>
</tr>
<tr>
<td>11</td>
<td>Power failure &gt; 1 month – time?</td>
<td>Abort</td>
<td>Error</td>
</tr>
<tr>
<td>12</td>
<td>No input allowed!</td>
<td>Continue</td>
<td>Normal</td>
</tr>
<tr>
<td>33</td>
<td>Interference radiation</td>
<td>Halt</td>
<td>Error</td>
</tr>
<tr>
<td>34</td>
<td>Wrong input</td>
<td>Continue</td>
<td>Normal</td>
</tr>
<tr>
<td>35</td>
<td>Calibration faulty</td>
<td>Abort</td>
<td>Error</td>
</tr>
<tr>
<td>36</td>
<td>Rate &lt; Minimum</td>
<td>Halt</td>
<td>Error</td>
</tr>
<tr>
<td>37</td>
<td>Rate &gt; Maximum</td>
<td>Halt</td>
<td>Error</td>
</tr>
<tr>
<td>38</td>
<td>Communication trouble RS 485</td>
<td>Abort</td>
<td>Error</td>
</tr>
<tr>
<td>39</td>
<td>Source replacement</td>
<td>Continue</td>
<td>Normal</td>
</tr>
<tr>
<td>40</td>
<td>Multiplier replacement</td>
<td>Continue</td>
<td>Normal</td>
</tr>
<tr>
<td>41</td>
<td>Not monotonous</td>
<td>Abort</td>
<td>Normal</td>
</tr>
<tr>
<td>42</td>
<td>Calibrate new</td>
<td>Abort</td>
<td>Error</td>
</tr>
<tr>
<td>43</td>
<td>Battery failure Time?</td>
<td>Abort</td>
<td>Error</td>
</tr>
<tr>
<td></td>
<td>Change battery</td>
<td>Continue</td>
<td>Normal</td>
</tr>
<tr>
<td></td>
<td>Setup batt. date!</td>
<td>Continue</td>
<td>Normal</td>
</tr>
</tbody>
</table>

**Halt:** Measurement is stopped until the normal status returns. If you push the ENTER button to acknowledge "Halt", the failure relay changes to the normal status.

**Abort:** Measurement is aborted and has to be restarted manually. If you push ENTER to acknowledge the error message, the failure relay still indicates an error, until the measurement is restarted with RUN. The fault current is still available after the acknowledgement, until the measurement is started new.

The failure relay is in normal status only, when the measurement is in "RUN" and no error has been detected.
8.4.3 Service Menu Structure

In the service menu you can define possible test settings and switch functions. In addition to defaulted pulse rates that are used to check the output current, you can check the relay and external switch functions, and start an automatic plateau recording of the NaI-crystal-multiplier assembly. The result can be read out from the plateau recording submenu and plotted as a curve.

Moreover, you can preset the high voltage for the detector or turn off the automatic high voltage control. In another menu you can adjust the current output.
8.4 Evaluation unit LB 440

**Service Menu**

*Test pulse rate:*
You can enter any pulse rate within the calibration range to simulate an output current or a level reading.

*Result:*
As a result of the defaulted pulse rate, the output current and the respective level reading is displayed.

*Set Output:*
You can set any output current within the range to test the connected instruments.

*View input current:*
Function foreseen only for tests by the manufacturer.

*Relay 1/2/3:*
The relays can be switched to test the signal circuits.

*Input 1/2/3:*
Function test showing if inputs are open or closed.

*High Voltage:*
With the standard default „0“ the detector operates with its automatic high voltage control. For servicing, a high voltage value can be entered. Thus, the high voltage control is switched off. The high voltage applied to the photomultiplier then corresponds to the entered value.

**For normal operation you have to enter 0.**

*Save Default:*
You can enter a high voltage default for quicker setting to the optimum operation point following power down.

*Read Default:*
The high voltage default stored in the detector is displayed.

*Det. Temp.:*
Displays the temperature in the detector.

*HV:*
Displays the currently entered high voltage.

*Pulse rate:*
Displays the current pulse rate coming from the detector.

*Resetting detector:*
Reset the detector electronics.

*Plateau Measurement:*
With <sk1> you can automatically record the plateau of the detector (duration approx. 10 min) in steps of 60 Volt, e.g. to check the correct function of the NaI-crystal-multiplier assembly.
The results can be read out via <sk2> and can be plotted as a curve to assess them.

*Current 1.8 or 18 mA:*
Calibrate the output current to the values 1.8 mA and 18 mA by increasing or reducing the offset value indicated.

*Battery:*
Input of the battery change date. The message "change battery" appears, on the display after 6 years.
Note: The message "enter battery date" appears after a general Reset was performed. Enter the date of the last battery exchange. This messages appear next to the level reading.
8.5 Scintillation Detector

Scintillation counters do not include any wearing parts and their service life is not limited, provided they are used under normal operating conditions. Malfunctions in the scintillation detector can only be caused by excessive mechanical or thermal stress. The transfer of heavy vibrations or shocks to the detector has to be prevented by suitable measures, such as separate installation or shock absorbers. Moreover, with temperatures of above 50°C at the installation site, heat shields or water cooling devices have to be foreseen for the detector.

Nal Detectors

Note: These service instructions apply only to Nal point detectors!

Malfunctions of the scintillation counter are not always indicated by a missing pulse rate; it is also possible that the specific Gamma sensitivity appears to have changed or obvious instabilities are apparent. In the case of detectors with Nal-crystals, these errors can be detected only by means of a plateau check. The evaluation unit LB 440 includes a function for automatic plateau recording.

When recording a plateau, you may leave the detector at the measuring location. The level must be at least 100 mm below the threshold values. Make sure that the conditions in the container do not change during plateau recording. Otherwise you have to dismantle the detector. You may then carry out the check in a lab using a test source. Plot the measured results in a curve (Figure 39). The plateau is OK when you get a clearly visible plateau over a voltage range of approx. 100 V and the slope in this range does not exceed 5%. The position of the plateau within the high voltage range does not matter.

![Plateau curve](image)

Figure 39: Example for plateau curve of Nal detector

If the pulse rate changes by more than 5% per 100 Volt high voltage, the scintillation counter will operate unstable and the complete detector or the crystal-multiplier assembly has to be replaced.
8.5 Scintillation Detector

Replacing the crystal-multiplier assembly

Switch the scintillation counter to idle. Unscrew the housing and carefully pull out the electronics with the crystal-multiplier assembly horizontally. Replace the crystal-multiplier assembly and carefully close the housing again.

Following replacement, record another plateau. The optimum operation point is automatically set after power on. You have to enter the new operation point in the Service menu under the item „Save Default“.

Note:
Just as after replacement of a complete detector, you should repeat the EMPTY calibration as soon as possible.

Checking the crystal-multiplier assembly

Faults in the crystal-multiplier assembly are indicated by the plateau becoming too small or too steep. They can often be detected through visual inspection. To do this, take the crystal-multiplier assembly apart. To separate both parts, remove the Mu-metal shielding and then detach the crystal carefully from the multiplier window by gently sliding the crystal sideways. Wipe silicon oil traces off the mating faces of crystal and multiplier using a soft cloth. While you are doing this, make sure that the multiplier is not exposed to bright sunlight.

![Figure 40: Crystal-multiplier assembly](image)

The crystal must be perfectly clear inside and not show any cracks or dull areas. The normal coloring is slightly greenish. A yellowish to brownish coloring is a sign of thermal overload and indicates that the crystal must be replaced.

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 overheating, 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.

Before re-assembly, apply a drop of clean silicon oil between crystal and multiplier, and distribute it evenly by gentle rubbing to ensure a sound optical connection between the two components. Using the adhesive tape, replace the Mu-metal screen, making sure that it is only under light tension.
8.5 Scintillation Detector

Rod Detectors & Super-Sens

In the case of rod detectors, we get a continuously rising calibration curve by changing the high voltage; no plateau as shown in Figure 39 is evident in this calibration curve.

The rod detectors LB 4405-XX and Super-Sens LB 4430 / LB 5430 may not be dismantled by the customer and must, therefore, be returned to the manufacturer. The mechanical assembly of the rod detectors and the special light coupling to the multiplier, as well as the special adjustment of the high voltage for stabilization require working methods which can only be handled by the manufacturer or by specially trained personnel. If there is an error in the rod detector or Super-Sens, the complete detector has to be replaced.

After replacement of a detector, you should perform a new EMPTY calibration as soon as possible, and also check the high voltage setting, so that absolute sensitivity and the optimum operation point will be obtained.
8.6 Interference Radiation Instructions

The high Gamma sensitivity of scintillation detectors may cause a false reading that incorrectly indicates a too low level due to outside radiation (e.g. radiation caused by welding seam devices) aimed at the detector.

To detect interfering radiation, an automatic plausibility check can be performed which monitors a) the maximum possible pulse rate (empty calibration), and b) the mean value of the current pulse rate. The system sensitivity, i.e. the distance of the alarm thresholds is defined as the multiple of the mean statistical variations and can be entered as Sigma value as needed. The time constant is one second. When reaching the alarm threshold, a message is output via the error relay and in the instrument display.

The alarm is triggered by the following two conditions:

a) \[ I_S > I_0 \times 1.5 \]

\( I_S \) = current pulse rate integrated over one second

\( I_0 \) = maximum pulse rate at empty calibration

b) \[ I_S > I_m + n \times \text{Sigma} \]

\( I_S \) = current pulse rate integrated over one second

\( I_m \) = mean of current pulse rate over selected time constant

\( n \) = multiple value of Sigma

To a):

A relative limit value is monitored, i.e. the alarm threshold is reached when exceeding a maximum dose rate (calibration value at empty container) at the detector. False alarms due to operative factors are not possible. However, only stronger interfering radiation is detected.

to b):

A differential limit value is monitored, i.e. each fast rise of the dose rate triggers an alarm. Even minor outside radiation is detected, when it occurs erratically. Operative factors such as fast emptying or opening of the container can result in false alarms.

Select the parameter *Radiating Interference* in the *Parameter* menu with <more>. At the same time, enter the required Sigma value, taking the following note into account:
Note:

To rule out false alarms with sufficient statistical safety, you should enter \( n > 5 \). The mathematical correlation shows that the distance of the alarm threshold is dependent upon the respective mean pulse rate \( I_m \). For calculation it holds: \( \Sigma = \sqrt{I/m} \).

Example:

Pulse rate \( I_m = 300 \text{ cps} \), \( n = 6 \)

\[
I_S = I_m + n \cdot \sqrt{I_m}
\]

\[
I_S = 300 + 6 \cdot \sqrt{300} = 404 \text{ cps}
\]

Thus, an alarm is signaled as soon as \( I_S \) exceeds the value of 404 cps.

Note:

Due to the dynamic behavior of the interfering radiation detection, a quick increase of the pulse rate due to operative factors (e.g. very fast emptying of the container or big short-term level changes caused by stirrers) can be interpreted as interfering radiation.

For example, opening the useful beam channel on the shielding can also cause a quick increase of the pulse rate. You have to reset the alarm that is then triggered. Better, do not enable the interfering radiation detection at first. Enable the interfering radiation detection only after the calibration has been performed.
8.6.1 Interference Radiation Detection Flow Chart

If interference radiation is detected, the measurement switches to the HALT mode.
- Measured value and current output are "held".
- Error relay indicates alarm.

The measurement is "held" up to the end of the defined waiting time.

At the end of the waiting time the system checks if the arriving pulse rate is smaller than 1.5-times the calibrated empty pulse rate (Io).
See a) If not, the waiting time is started again.

If the pulse rate is below 1.5-times the empty pulse rate, the measurement automatically switches to the RUN mode.
Sigma detection (see b) is disabled for 3 x measuring time (= dead time).
Example: If the measurement time is 20s, the dead time is 60s.
This time is needed for the measurement to adjust to a possibly changed level, without triggering interference radiation detection. During this time, interference radiation is detected only when the pulse rate has increased to 1.5-times the empty pulse rate.

Once the dead time is over, Sigma detection is enabled again.
9.1 General Information and Guidelines

In order to prevent adverse health effects caused by working with radioactive substances, limits for the maximum permissible radiation exposure of operating personnel have been agreed upon on an international level. Appropriate measures in designing the shieldings and arranging the measuring system at the measuring location will ensure that the radiation exposure of the personnel will remain below the maximum permissible value of 5 mSv (500 mrem) per year.

A Radiation Safety Officer has to be appointed who is responsible for all questions relating to radiation protection. He will monitor handling of the radiometric measuring system and, if necessary, formalize the safeguards and any special precautions applicable to a given establishment in formal procedural instructions, which in special cases may serve as a basis for radiation protection guidelines. These may stipulate that access to the container shall only be permitted after the useful beam is shielded. Radiation protection zones outside the shielding must be - if they are accessible - marked and guarded. These instructions should also include checks of the shutter device of the shielding and measures for heavy operational trouble - such as fire or Explosion. Any special event has to be reported to the Radiation Safety Officer immediately. He will then investigate any damage and immediately take suitable precautions if he detects defects that may adversely affect the operation or safety of the system.

The Radiation Safety Officer has to make sure that the provisions of the Radiation Protection Regulations will be observed. In particular, his duties include instructing the staff on the proper handling of radioactive substances.

Radioactive sources that are no longer in use or have reached the end of their service life must be returned to the national radioactive waste disposal center or to the manufacturer.

Generally, every member of staff should endeavor to minimize any radiation exposure - even within the permissible limits - by careful and responsible action and by observing certain safety standards.

The total sum of the radiation dose absorbed by a body is determined by three factors. On the basis of these factors, certain fundamental radiation protection rules can be derived:
CHAPTER 9. RADIATION PROTECTION

9.1 General Information and Guidelines

Distance

This means the distance between the radioactive source and the human body. The radiation intensity (dose rate) decreases - like light - in proportion to the square of the distance, i.e., doubling the distance to the source reduces the dose rate to one quarter.

Conclusion:
When handling radioactive substances, maximum distance to the source should be maintained. This is especially true for persons that are not directly involved in this work.

Time

The total time a person stays in the vicinity of a radiometric measuring system and the body is exposed to radiation. The effect is cumulative and increases therefore with the duration of the radiation exposure.

Conclusion:
Any work in the vicinity of radiometric measuring system has to be prepared carefully and organized such that it can be carried out in the shortest time possible. Having the proper tools handy is of particular importance.

Shielding

The shielding effect is provided by the shielding material surrounding the source. As the shielding effect depends, following an exponential function, on the product of thickness multiplied by the density, it follows that material with a high specific weight will normally be used for shielding purposes. Suitable dimensions are usually calculated by the supplier.

Conclusion:
Before installing or dismantling the shielding, make sure that the radiation exit channel is closed. The source must not be removed from the shielding and not remain unshielded.
9.2 Safety Instructions

9.2.1 Shielding Installation

To keep the radiation exposure of the assembling personnel as low as possible, only licensed personnel who have been trained on how to handle radioactive substances are allowed to assemble or disassemble the shielding with the source. The 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 modified or damaged.

Following installation of the shielding, the function of the locking mechanism has to be checked. Depending on the operation conditions, the function check has to be repeated in appropriate intervals, at the latest, after one year.

When replacing a source, you have to attach the new source number to the shielding or replace the type label.

9.2.2 Point Source Replacement on the Shielding Container LB 744X

Caution!
Radioactive sources may be replaced only by competent and licensed persons, taking into account official regulations.

Caution!
Since these persons have to work with an unshielded source for a short time, they have to carry a pocket dosimeter indicating the level of radiation, so that the actual radiation exposure during work can be documented. It has to be coordinated with the competent Radiation Protection Manager.

Point sources have to be fixed on source holders which are then screwed into the shielding, positioning the source in the center of the shielding.

IMPORTANT
Prerequisite for this work is that the personnel are familiar with the exact shielding construction; therefore, drawings must be available.
9.2 Safety Instructions

Preparation

All necessary work has to be prepared such that it can be carried out quickly, so that exposure to the unshielded source is kept to a minimum. Using a drawing of the shielding, you should plan the best procedure and have the following tools at hand:

- Allan keys in the required sizes.
- 2 pairs of pliers to take hold of source and source holder.

If sufficient space is available, the source can be replaced in the shielding installed at the measuring site. To this end, bring the new source in its transport shielding close to the measuring site. Prepare a suitable, clean space, if possible with an auxiliary shielding (shielding container, lead bricks, concrete stones, etc.) and place the source holder and the source there on a piece of paper to protect it against dirt.

Depending on the construction, you either have to open the lock on the shielding and turn the lever to center position between ON and OFF until the hexagon head bolt of the source holders becomes visible, or remove the locking plate, so that you can unscrew the source holder.

Source Replacement

Proceed as follows for standard point source shieldings (Figure 41):

1. Open the lock of the shielding (1) halfway, so that you can unscrew the source holder (2) together with the source (3) using a socket wrench.

CAUTION

You may touch the source holder at the far end of the threaded part with your hands. Hold it far away from your body and put it down behind an auxiliary shielding.

2. Unscrew the source from the source holder using a socket wrench (SW 10). Hold the source holder using a second socket wrench (SW 12).
CHAPTER 9. RADIATION PROTECTION

9.2 Safety Instructions

CAUTION
For this work, you should use the shielding housing as auxiliary shielding between source and body.

3. Take hold of the source using a pair of pliers and immediately put it into the transport shielding or another shielding.

CAUTION
Do not touch the source to prevent a high partial body dose. Make sure the source is not mixed up with the new or another source.

4. If necessary, clean and grease the thread on the source holder and the shielding.

5. Using a pair of pliers, take the new source out of the transport shielding and firmly fix it onto the source holder together with the locking washer.

6. Put the source holder with the source again into the shielding and fix it using the socket wrench.

7. Check the proper ON/OFF function.

8. Carefully close the transport shielding again, after you have put the old source into the transport shielding.

IMPORTANT
The special regulations regarding labeling and transport of the shielding back to the manufacturer have to be observed.

IMPORTANT
After replacement of a source, you have to attach the new source number on the shielding or replace the type label.
9.2 Safety Instructions

9.2.3 Rod Source Replacement

Rod sources usually have to be replaced in shieldings that are constructed according to drawing 21 157.001 or shieldings of similar design. When replacing a rod source, you have to work with the unshielded source for a short time.

**IMPORTANT**
Therefore, you have to carry a pocket dosimeter during work to measure the personal dose.

**CAUTION!**
This work may be conducted only by trained and authorized personnel, taking into account the local regulations. It has to be coordinated with the Radiation Protection Manager in charge. The personal dose has to be measured during work.

**Preparation**
All necessary work has to be prepared such that it can be carried out quickly, so that exposure to the unshielded source is kept to a minimum. Using a drawing of the shielding, the best approach has to be planned and the following tools should be at hand:

- Allan keys sizes 4; 5; 6; 8 and 10.
- 2 pairs of pliers (e.g. a pair of combination pliers or multigrip pliers)

Cordon off an area consistent with the activity of the source. Prevent persons from approaching.

Turn the shieldings to the “CLOSED” position and secure it. We recommend placing the individual shielding upright. In particular, the rotating cylinder has to be secured against tipping over, before releasing the head flange. Bring the transport shielding containing the new source close to the measuring site and open it such that the new source can be taken out and the old rod source put into the transport shielding as quickly as possible.

Check that the sources are installed in the proper position. Note the respective marking rings on the source (top = 1 ring; bottom = 2 rings (see Figure 42).

When working with several sources, make sure that the sources cannot be mixed up. Multi-part sources must be set up in the proper order. The installation pattern of multi-part sources is indicated by the letters A, B, C etc. from top to bottom (see (Figure 43).

With multi-part sources, the rings on the rod source indicate the installation order and position. It is important to observe these instructions when replacing a source.
CHAPTER 9. RADIATION PROTECTION

9.2 Safety Instructions

Figure 42: Markings on shielding and rod source

Figure 43: Markings of multi-part sources and shieldings
Source Replacement

The following description of the individual shielding items refers to Figure 44. Please proceed as follows:

1. Unscrew the head flange (1) using a suitable Allan key.

2. Open the locking cover (2).

3. Pull out the rod source (4) using the Ms-extension bar (3), hold it with two pairs of pliers and insert it into a transport shielding. Unscrew the extension bar (3) first using two pairs of pliers.

4. Pull the new source out of the transport shielding so much that the Ms-extension bar can be fixed at the top with screws. Make sure not to mix up the parts, especially when working with multi-part sources.

5. Pull the new source out of the transport shielding using the pair of pliers and place it into the working shielding.

6. Attach the Ms-cover (2) again after you have checked if the O-ring seal is clean and undamaged.

7. Attach the head flange again and carefully secure it with screws.

8. Check the correct ON/OFF function.

9. Replace the type label on the shielding or attach the new source number.

10. Carefully close the transport shielding again, after you have put the old source into the transport shielding.

Caution!
The special regulations regarding labeling and transport of the shielding back to the manufacturer have to be observed.

11. Set up the working shieldings as planned. With multi-part shieldings be sure to observe the correct order.
9.2.4  Point Source Replacement on Rotary Cylinder Shielding

In this section we will describe how to replace point sources on shieldings with the following ID no.:
17491
17492
17493
28808

Important:
When replacing a rod source, you have to work with the unshielded source for a short time. Therefore, you have to carry a pocket dosimeter during work to measure the personal dose.

CAUTION!
This work may be conducted only by trained and authorized personnel, taking into account the local regulations. It has to be coordinated with the Radiation Protection Manager in charge. The personal dose has to be measured during work.

Important:
In Germany a source may be replaced by the customer only when:
- the necessary technical qualification is available
- replacement of the source has been approved explicitly.

Preparation

All necessary work has to be prepared such that it can be carried out quickly, so that exposure to the unshielded source is kept to a minimum. Using a drawing of the shielding, you should plan the best procedure and have the following tools at hand:

- Allan keys sizes 4; 5; 6; 8 and 10.
- 2 pairs of pliers (e.g. a pair of combination pliers or multigrip pliers)

Cordon off an area consistent with the activity of the source. Prevent persons from approaching.
Turn the shieldings to the “CLOSED” position and secure it. We recommend placing the individual shielding upright. In particular, the rotating cylinder has to be secured against tipping over, before releasing the head flange. Bring the transport shielding containing the new source close to the measuring site and open it such that the new source can be taken out and the old rod source put into the transport shielding as quickly as possible.
Prepare a suitable, clean space, if possible with an auxiliary shielding (shielding container, lead bricks, concrete stones, etc.) and place the source holder and the source there on a piece of paper to protect it against dirt.
When working with several sources, make sure that the sources cannot be mixed up.
9.2 Safety Instructions

Source Replacement

Dismantle the shielding

1. Unscrew the head flange (1) using a suitable Allan key.
2. Open the locking cover (2).
3. Unscrew the source holder (3) with the source (4) from the shielding. Use an Allan key size 12.

![Diagram of rotary cylinder point source shielding]

Figure 45: Dismantling the rotary cylinder point source shielding

Caution
You may touch the source holder at the far end of the threaded part with your hands. Hold it far away from your body and put it down behind an auxiliary shielding.

Take source out of shielding

4. Unscrew the source from the source holder using a socket wrench (SW 10). Hold the source holder using a second socket wrench (SW 13).

Caution
For this work, you should use the shielding housing as auxiliary shielding between source and body.

5. Take hold of the source using a pair of pliers and immediately put it into the transport shielding or another shielding.

Caution:
Do not touch the source to prevent a high partial body dose. Make sure the source is not mixed up with the new or another source.

6. If necessary, clean and grease the thread on source holder and shielding.
9.2 Safety Instructions

Install new source
7. Using a pair of pliers, take the new source out of the transport shielding and firmly fix it onto the source holder together with the locking washer.
8. Put the source holder with the source again into the shielding and fix it using the socket wrench.

Assemble shielding again
9. Attach Ms-cover (2) again after you have checked if the O-ring seal is clean and undamaged.
10. Attach head flange (1) again and carefully secure it with screws.
11. Check the proper ON/OFF function.
12. Carefully close the transport shielding again, after you have placed the old source into the transport shielding.

IMPORTANT
After replacement of a source, you have to attach the new source number on the shielding or replace the type label.

Replace type label
13. Replace the type label on the shielding or attach the new source number.
14. Carefully close the transport shielding again, after you have placed the old source into the transport shielding.

CAUTION
The special regulations regarding labeling and transport of the shielding back to the manufacturer have to be observed. If in doubt, please contact the Berthold source transportation manager.
9.3 Radiation Dose Calculations

When preparing work on radiometric measuring systems, it is important to pre-calculate the radiation exposure to be expected, since this has consequences on the required safety precautions.

The expected radiation exposure can be calculated quite easily and with sufficient accuracy, provided you know the isotope and the activity of the source used. You can take this information from the source documentation, or from the type label on the shielding.

The radiation exposure to be expected for a shielded source is calculated as follows:

\[ D = \frac{A \cdot k \cdot t}{r^2 \cdot s} \]

A is the activity of the source and \( k \) the respective specific Gamma radiation constant (see the table below). The distance from the measuring point to the source is \( r \) and the duration of stay at this point is \( t \). \( s \) is the shielding factor of the shielding used; it is listed in the shielding brochure or can be calculated. \( s = 1 \) when calculating the dose rate for work with an unshielded source.

<table>
<thead>
<tr>
<th>NUCLIDE</th>
<th>( k )</th>
<th>DIMENSIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Co-60</td>
<td>0.35</td>
<td>( \mu\text{Sv} \cdot \text{m}^2 \cdot \text{h} \cdot \text{MBq} )</td>
</tr>
<tr>
<td>Cs-137</td>
<td>0.09</td>
<td>( \mu\text{Sv} \cdot \text{m}^2 \cdot \text{h} \cdot \text{MBq} )</td>
</tr>
</tbody>
</table>

Calculation examples:

The dose in a distance of 50 cm of a Co-60 source with an activity of 350 MBq and a time of 30 minutes (0.5h) in this distance has to be calculated. The source is shielded by a shielding with an shielding factor of 30:

\[ D = \frac{350 \text{ MBq} \cdot 0.35 \mu\text{Sv} \cdot \text{m}^2 \cdot 0.5 \text{ h}}{(0.5 \text{ m})^2 \cdot \text{h} \cdot \text{MBq} \cdot 30} = 8.2 \mu\text{Sv} \]
9.3 Radiation Dose Calculations

9.3.1 Shielding Installation

A simplified calculation of the radiation exposure during installation of the shielding is possible with adequate accuracy by using the dose rate value in 1 meter distance from the shielding as indicated on the identity plate.

Shieldings for measuring systems are usually designed such that, regardless of the activity and the type of source (point or rod source), the limit of the controlled area with 3 µSv/h is in a distance of max. 1 meter around the shielding. This value can be taken for granted when the mean distance is 0.5 m for doing such work as installing the shielding or operating the lock. As a result, we get a dose rate of max. 12 µSv/h at this point. If work in the vicinity of the shielding is prepared well, it will not take more than 20 minutes (= 1/3 hour) and from this we can calculate a dose of 4 µSv for working a shorter time in the vicinity of the shielding.

If you compare this dose with the permissible annual doses of 1 mSv for the eligible circle, this work can be carried out 250 times per year by one and the same person. Due to the very low radiation exposure it is not necessary to carry a person dosimeter for this work, since the lower detection limit of these measuring systems lies just above this dose.

9.3.2 Point Source Replacement

It is important to calculate the possible radiation exposure in advance. An exact calculation is possible using the equation above.

The anticipated working hours should be split up in work in the direct vicinity of the shielding during installation and dismantling the source holders and work with the unshielded source while fixing and dismantling the source and the source holder. The dose obtained while working in the vicinity of the shielding and the dose obtained while working with the unshielded source have to be calculated separately and added up.

Again, a rather simplified estimation is possible when the work is prepared well. Based on the assumptions of a mean distance of 0.5 m for the whole body radiation and the time you are working with the unshielded source of 6 minutes (= 1/10 hour), the radiation exposure can be calculated for different activities (A) as follows:

\[
Dose \, D = A \cdot 0.15 \, \text{at Co-60}
\]
\[
Dose \, D = A \cdot 0.04 \, \text{at Cs-137}
\]

Enter the activity in MBq and the dose is calculated in µSv.

Using a pocket dosimeter with direct reading, measure the accurate radiation exposure during this work, even if the radiation exposure presumably lies below the detection limit of dosimeters.
9.3 Radiation Dose Calculations

9.3.3 Rod Source Replacement

It is important to calculate the possible radiation exposure even before mounting or dismantling rod sources. An exact calculation is possible using the equation above.

The anticipated working hours should be split up in work in the direct vicinity of the shielding during mounting and dismantling the source holders and work with the unshielded source while fixing and dismantling the source and the Ms extension bar.

Again, a rather simplified estimation is possible when the work is prepared well. Based on the assumptions of a mean distance of 0.5 m for the whole body radiation and the time you are working with the unshielded source of 6 minutes (= 1/10 hour), the radiation exposure can be calculated for different activities (A) as follows:

\[ D = A \times 0.15 \text{ at Co-60} \]

For multi-part rod sources, the estimated radiation exposure has to be multiplied with the number of source parts.

**Calculation example**

A single part rod source with an activity of 400 MBq (approx. 11 mCi) has to be replaced. Using the above assumptions concerning distance and time and the above equation, we get the following result:

\[ D = 400 \times 0.15 = 60 \mu\text{Sv} \]

The radiation exposure in the vicinity of the shielding was already calculated to be 10 \( \mu\text{Sv} \). The total exposure including mounting and dismantling can then be estimated as being 70 \( \mu\text{Sv} \) for a single part source.

**Note:** If the above assumptions do not apply, the calculations have to be corrected accordingly. Actually, it can only be another working time which has a proportional effect on the result of the calculated dose rate.
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, the Radiation Safety Officer has to be notified immediately. He will then investigate the situation immediately and take all necessary provisions to prevent further damage and to avoid more exposure of the operating staff to radiation.

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

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

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

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

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

- **Password:** xxx "locked/unlocked"
- **Date & Time:**
  - Date: 01.02.96
  - Time: 12.21
- **Detector Software:**
  - BERTHOLD
  - LB 440-MV 2.10
  - LEVEL
- **Language:**
  - German
  - English
  - French
  - Spanish
- **Printer Parameter**
- **Factory Setting**

**Error Mode:**
- Stop measure/
- Continue measure in error case

**Alarm relay in error case**
- Hold state /
- Current following

**Detector and Isotope**
- Code: 1
- Isotope: Co60

**Time Constant**
- Value: 20.0 sec

**Rapid Switch-Over**
- OFF/ON
- Sigma: 4.000

**Radiating Interference**
- OFF/ON
- Sigma: 5.000

**Radiating Interference Delay Time**
- 20s

**Maximum Pulse Rate**
- Value: 100000/s
- 0%: 1234/s

**Minimum Pulse Rate**
- Value: 0/s
- 100%: 1234/s

**Source Replacement**
- A1: 370/s
- 0%: 1234/s

**Current Output**
- Range: 4 - 20 mA
- 0 - 20 mA

**Current Output Limits**
- 0/4 mA: 0,0%
- 20 mA: 100,0%

**Current Output Error**
- Current: Hold/Value
- Value: 3 mA

**Relay 2**
- Minimum: 10%
- Hysteresis: 5%

**Relay 3**
- Maximum: 90%
- Hysteresis: 5%

**Slave 1**
- Address: 1

**Slave 2**
- Address: 2

**Slave n**
- Address: n

**PC Access Control**
- Only Data Query /
- Data Manipulation
10.2 Calibration Types

- sk1: Interfaces
- sk2: Calibrate
- sk1           sk2      more

Operating Mode
- Linear
  - Empty
    - Level: 0.0 %
    - Pulse Rate: 1000/s
  - Full
    - Level: 100.0 %
    - Pulse Rate: 100/s

- Polygone
  - Value Pair 1
    - Level: 0.0 %
    - Pulse Rate: 1234/s
  - Value Pair 25
    - Level: 100.0 %
    - Pulse Rate: 123/s

- Rod Detector
  - Background
    - Pulse Rate: 234/s
  - Calibration Curve
    - Value Pair enter/read
      - Value Pair 1
        - Level: 0.0 %
        - Pulse Rate: 1234/s
  - Value Pair ..xx
  - Value Pair 25
    - Level: 100.0 %
    - Pulse Rate: 123/s

- Exponential
  - Coefficient
    - Value: \(a=\ln(\frac{I}{I_0})/L\)
    - Value: 0.05
  - Value Pair 1
    - Level: 0.0 %
    - Pulse Rate: 1234/s
  - Value Pair 1
    - Level: 100.0 %
    - Pulse Rate: 456/s

- Value Pair ..xx
  - Value Pair 25
    - Level: 100.0 %
    - Pulse Rate: 123/s

- Empty
  - Level: 0.0 %
  - Pulse Rate: 123/s

- Full
  - Level: 100.0 %
  - Pulse Rate: 3456/s
11.1 Flow Sheet

If a basic curve is required because a non-linearity has been created by the existing geometry, then a BERTHOLD product specialist can pre-calculate a value table. This table can be entered in the basic characteristic curve.

Following empty calibration, the table is automatically transferred into the measure curve and is extrapolated.

Count rates for different levels can be read into the measure curve.

Value pairs in the measure curve can be edited or entered manually.

The evaluation unit uses the measure curve to display the level. Therefore, the measure curve is important for a correct reading.

Background
Affects the count rates of the measure curve

Calibration curve
Enter/read

Enter
Basic curve
Value pairs

Read
Measure curve
Value pairs

<table>
<thead>
<tr>
<th></th>
<th>0%</th>
<th>1000 cps</th>
</tr>
</thead>
<tbody>
<tr>
<td>11%</td>
<td>963 cps</td>
<td></td>
</tr>
<tr>
<td>22%</td>
<td>893 cps</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 cps</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>0%</th>
<th>5443 cps</th>
</tr>
</thead>
<tbody>
<tr>
<td>11%</td>
<td>5256 cps</td>
<td></td>
</tr>
<tr>
<td>22%</td>
<td>4903 cps</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>401 cps</td>
</tr>
</tbody>
</table>

Safety query
Erase calibration curve?
- will overwrite the measure curve -
(only when using the basic curve)

Empty calibration
Adjustment of count rates in the measure curve

Full calibration
Adjustment of count rate at 100% in measure curve
## 11.2 Explanations

### Function

- A pre-calculated characteristic curve can be stored in the **basic curve**.
- The **measure curve** includes the value pairs the instrument works with in the RUN mode.
- If an empty calibration is performed after having passed through the basic curve, all value pairs are transferred to the measure curve and the count rates are extrapolated in percent. A safety query helps to rule out incorrect entries.
- If the measure curve is passed through and then the empty calibration is performed, the count rates of the measure curve are extrapolated.
- A full calibration only corrects the 100% value of the measure curve.
- Empty and full calibration do not have any influence on the value pairs of the basic curve. It can only be edited manually.

### Support

- In order to sort the value pairs in the measure curve, press the "enter" button while "empty calibration" is displayed.
- The characteristic curves are quit following a value pair with the contents 0.0. Thus, it is not necessary to run through all 25 value pairs.
- **With the button combination "SK1 and Clear"**, you can delete all value pairs of the **measure curve**. The button combination can be triggered if one is at the measure curve.
- The monotony is checked following empty and full calibration.
- After empty calibration, the program checks if the count rate at 100% is bigger than the background. If not, an error message is output.
11.3 Method A + B of Rod Detector Calibration

A
Individual levels are controlled and calibrated in the measure curve.

B
If a pre-calculated basic curve is available, then you may enter it. With the following empty and full calibration the value pairs are automatically transferred into the measured characteristic curve and calibrated.

• Gauging the capacity by liters in the measure curve
  1) Measure background
  2) Gauge capacity of measure curve by liters
  3) Transfer count rate at 0% to empty calibration.

• With pre-calculated basic curve
  1) Measure background
  2) Enter basic curve
  3) Empty calibration
  4) Full calibration
12.1 Limit-Switch Box -003U EEx ed IIC T6

Note:
If the limit-switch box is delivered separately, it has to be stored in a plastic bag until it will be installed. The certification will keep its validity only if the limit-switch box has been installed correctly on the swivel drive.

For indirect installation, the limit-switch box can be supplied, on customer’s request, with installation dimensions according to VDI/VDE 3845 or according to KINETROL’s factory norm (see below).

12.1.1 Direct Installation

1. Unscrew the cover of the supplied limit-switch box and pull it off, as shown in the illustration, while pushing down the limit-switch shaft. Caution: Do not lose the cover sealing.
2. Remove shaft mounting bracket by opening the screws and take off the limit-switch shaft.
3. Clamp swivel drive in vise (use soft jaws).
4. Apply LOCTITE (or a similar adhesive) on mounting thread, put on the supplied cork sealing and attach the bottom part of the limit-switch box. Fix it using the screws supplied.
5. The two trip cams on the limit-switch shaft are fixed by one screw each. Untighten these screws.
6. Place limit-switch shaft with the Allen key onto the upper four cornered shaft of the drive or the spring lock unit. DO NOT HAMMER – DO NOT APPLY FORCE!
7. Install shaft mounting bracket again.
12.1.2 Adjusting the Trip Cams

1. Set revolving wings of the swivel drive to the initial position.

   **CAUTION:** The mechanical end stops of the swivel drive should have been set already to make subsequent correction of the trip cams superfluous.

2. Move the respective trip cams on the guide ring until a soft click indicates that the contact of the micro push-button has switched. To be on the safe side, move the trip cams by about 2-3 degrees further and tighten the clamping screw.

3. Move revolving wings to the opposite stop position. Compressed air is needed for single-acting swivel drives with spring lock unit.

4. Proceed as described under 2 with the second trip cam.

### 12.1.3 Technical Specification / Electrical Wiring

**Circuit diagram**

BARTEC 07-1501-6130-63 (changer) for drive size 05-14

<table>
<thead>
<tr>
<th>Volt</th>
<th>Load (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC 250</td>
<td>DC 125</td>
</tr>
<tr>
<td>Resistor</td>
<td>Inductive</td>
</tr>
<tr>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>up to 12</td>
<td>up to 24</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>up to 48</td>
<td>up to 250</td>
</tr>
<tr>
<td>0.3</td>
<td>0.03</td>
</tr>
</tbody>
</table>

**Material**
- Zinc die casting
- Epoxy resin, burned-in
- O-rings (Nitril)

**Housing**
- Weight: 1.40 kg

**Coating**
- Temp range: -25°C to +60°C

**Sealing**
- Sealing: up to 250

**Cable inputs**
- Connection cross-section 2.5 mm², grounded conductor clamp 2.5 mm², earthed conductor clamp 4.0 mm²

**Protection type**
- IP54-65

After connecting, tighten the stuffing box fitting.

Slightly grease the housing cover in the shaft duct with Mo S₂ grease, attach it and tighten cover screws.

**CAUTION:** Make sure that the cover sealing is inserted in its groove!
12.1 Limit-Switch Box -003U EEx ed IIC T6

View: without housing cover

Direct Installation

Installation according to factory norm

12.1.4 Correction of the Switching Points

The open and closed switching points can be adjusted via the adjustable cams in the housing of the limit-switch box.
12.2 Limit-Switch Box -004U

For indirect installation, the limit-switch box can be supplied, on customer’s request, with installation dimensions according to VDI/VDE 3845 or according to KINETROL’s factory norm (see below).

12.2.1 Direct Installation

1. Unscrew the cover of the supplied limit-switch box and pull it off, as shown in the illustration, while pushing down the limit-switch shaft. **Caution:** Do not lose the cover sealing.

2. Remove shaft mounting bracket by opening the screws and take off the limit-switch shaft.

3. Clamp swivel drive in vise (use soft jaws).

4. Apply LOCTITE (or a similar adhesive) on mounting thread, put on the supplied cork sealing and attach the bottom part of the limit-switch box. Fix it using the screws supplied.

5. The two trip cams on the limit-switch shaft are fixed by one screw each. Untighten these screws.

6. Place limit-switch shaft with the Allen key onto the upper four cornered shaft of the drive or the spring lock unit. **DO NOT HAMMER – DO NOT APPLY FORCE!**

7. Install shaft mounting bracket again.

12.2.2 Adjusting the Trip Cams

1. Set revolving wings of the swivel drive to the initial position. **CAUTION:** The mechanical end stops of the swivel drive should have been set already to make subsequent correction of the trip cams superfluous.

2. Move the respective trip cams on the guide ring until a soft click indicates that the contact of the micro push-button has switched. To be on the safe side, move the trip cams by about 2-3 degrees further and tighten the clamping screw.

3. Move revolving wings to the opposite stop position. Compressed air is needed for single-acting swivel drives with spring lock unit.

4. Proceed as described under 2 with the second trip cam.
12.2 Limit-Switch Box -004U

12.2.3 Technical Specification / Electrical Wiring

Circuit diagram

Micro changer regular dimensions according to DIN41635

<table>
<thead>
<tr>
<th>Material</th>
<th>Volt</th>
<th>Load (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AC 250</td>
<td>DC 125</td>
</tr>
<tr>
<td>Zinc die casting</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Epoxy resin, burned-in</td>
<td>15 up to 12</td>
<td>15 up to 12</td>
</tr>
<tr>
<td>O-rings (Nitril)</td>
<td>up to 24</td>
<td>10</td>
</tr>
<tr>
<td>-20°C to +80°C</td>
<td>up to 48</td>
<td>3</td>
</tr>
<tr>
<td>1.40 kg</td>
<td>up to 250</td>
<td>0.25</td>
</tr>
<tr>
<td>The following can be delivered: M20x1.5; Pg 13.5; ¼&quot;NPT; 4 pole connector (DIN 43650A)</td>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td>Connection cross-section 2.5mm², grounded conductor clamp 2.5mm², earthed conductor clamp 4.0mm²</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>IP54-65</td>
<td>0.025</td>
<td></td>
</tr>
</tbody>
</table>

After connecting, tighten the stuffing box fitting.
Slightly grease the housing cover in the shaft duct with Mo S₂ grease, attach it and tighten cover screws.
CAUTION: Make sure that the cover sealing is inserted in its groove!
12.2 Limit-Switch Box -004U

**View: without housing cover**

- Adjustable cams
- Shaft
- Shaft mounting bracket

**Direct installation**

- Mounting screw
  - (secure with LOCTITE etc.)
- Cork sealing

**Installation according to factory norm**

- 4 mounting drill holes
  - M6x5 mm on pitch circle for holes Ø50

---

**12.2.4 Correction of the Switching Points**

The open and closed switching points can be adjusted via the adjustable cams in the housing of the limit-switch box.
CHAPTER 13. PTB / TÜV CERTIFICATES

13.1 Evaluation Unit

Translation

EC TYPE-EXAMINATION CERTIFICATE

1. Equipment or protective system intended for use in potentially explosive atmospheres - Directive 94/9/EC

2. EC-Type Examination Certificate Number

TÜV 00 ATEX 1638 X

3. Equipment:
   Evaluation Unit type LB 4...

4. Hersteller:
   Berthold GmbH & Co. KG

5. Anschrift:
   Calmbacher Straße 22
   D-75323 Bad Wildbad

6. This equipment or protective system and any acceptable variation thereto is specified in the schedule to this certificate and the documents therein referred to.

7. The TÜV Hannover/Sachsen-Anhalt e.V., TÜV CERT-Certification Body, notified body number N° 0032 in accordance with Article 9 of the Council Directive of the EC of March 23, 1994 (94/9/EC), certifies that this equipment or protective system 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 N° 00PX17600.

8. Compliance with the Essential Health and Safety Requirements has been assured by compliance with:
   - EN 50 014: 1997
   - EN 50 020: 1994

9. If the sign "X" is placed after the certificate number, it indicates that the equipment or protective system is subject to special conditions for use so use specified in the schedule to this certificate.

10. This EC-type examination certificate relates only to the design and construction of the specified equipment or protective system according to Directive 94/9/EC. Further requirements of this Directive apply to the manufacture and placing on the market of this equipment or protective system.

11. The marking of the equipment or protective system must include the following:
   II (2) G (EEEx ib) IIC

TÜV Hannover/Sachsen-Anhalt e.V.
TÜV CERT-Zertifizierungsstelle
Am TÜV 1
D-30119 Hannover

[this signature]
Head of the Certification Body

This certificate may only be reproduced without any change, schedule included. Excerpts or changes shall be allowed by the TÜV Hannover/Sachsen-Anhalt e.V.
CHAPTER 13. PTB / TÜV CERTIFICATES

13.1 Evaluation Unit

SCHEDULE

EC-TYPE EXAMINATION CERTIFICATE N° TÜV 00 ATEX 1638 X

Description of equipment

The Evaluation Unit type LB 4... is used for displaying and evaluating signals as well as for supplying power and transferring data to the connected detector and for the safe galvanic separation between the intrinsically safe circuit from non-intrinsically safe circuits.

The maximum permissible ambient temperature is 50°C.

Electrical data

Supply circuit: Version 1:
(Connections 30a, 30c, 32a) 24 V a. c. or 24 V d. c.
Um = 30 V

Version 2:
230 V ± 10%, 50 ... 60 Hz, approx. 20 VA,
Um = 253 V

Output circuits relay: for each potential-free contact: 250 V a. c., 1 A
(Connections 12a, 12c; 14a, 14c; Um = 253 V
16a, 16c)

Digital circuits: for each input: 6 V
(Connections 18a, 18c; 20a, 20c; Um = 30 V
22a, 22c)

Current output: 0 ... 24 mA
(Connections 26a, 26c) Um = 30 V

Current input: 0 ... 24 mA
(Connections 28a, 28c) Um = 30 V

RS232C interface: ± 12 V
(Socket on the front board) Um = 30 V

RS485 interface: 0 ... 5 V
(Connections 24a, 24c) Um = 30 V

Output circuit: 24 V, approx. 20 W
(Connections 10a, 18a) Um = 30 V
13.1 Evaluation Unit

Schedule EC-Type Examination Certificate No. TÜV 00 ATEX 1638 X

Output circuit .................................. in type of protection Intrinsically Safe or EEx ib IIC EEx ib IIB
(Connections 2a, 2c)

Maximum values:

<table>
<thead>
<tr>
<th></th>
<th>EEx ib IIC</th>
<th>EEx ib IIB</th>
</tr>
</thead>
<tbody>
<tr>
<td>$U_o$</td>
<td>16,8 V</td>
<td></td>
</tr>
<tr>
<td>$I_o$</td>
<td>81 mA</td>
<td>118 mA</td>
</tr>
<tr>
<td>$P_o$</td>
<td>1,36 W</td>
<td>2 W</td>
</tr>
</tbody>
</table>

Characteristic line: rectangular

The maximum permissible outer inductivity and capacity have to be taken from the following table:

<table>
<thead>
<tr>
<th>EEx ib IIC</th>
<th>EEx ib IIB</th>
</tr>
</thead>
<tbody>
<tr>
<td>maximum permissible outer inductivity</td>
<td>0,15 mH</td>
</tr>
<tr>
<td>maximum permissible outer capacity</td>
<td>344 nF</td>
</tr>
</tbody>
</table>

The effective internal inductivity is negligibly small. Effective internal capacity: 12 nF

The intrinsically safe output circuit is safe galvanically separated from the non-intrinsically safe circuits up to a peak crest value of the voltage of 375 V.

(16) The test documents are listed in the test report no. 00PX1760.

(17) Special condition for safe use

The evaluation unit Type LB 4.. design with connector strip needs a partition wall to be inserted between the connections of the intrinsically-safe circuit and the non-intrinsically safe circuits in order to ensure the required filament size of 50 mm or each connection of the intrinsically-safe circuit must be covered with a shrinkage tube.

(18) Essential Health and Safety Requirements

no additional ones
13.1 Evaluation Unit

Translation

1. SUPPLEMENT to

EC TYPE-EXAMINATION CERTIFICATE No. TÜV 00 ATEX 1638 X

of the company: Berthold Technologies GmbH & Co. KG
formerly: Berthold GmbH & Co. KG
Calmbacher Str. 22
D-75323 Bad Wildbad

In the future, the evaluation unit type LB 4.. may also be manufactured according to the test documents listed in the test report.

The amendments concern one type of the device with the supply voltage of $U_r = 115 \text{ V a.c.}$ (version 3).

Electrical data

Supply circuit
(connections 30a, 30c, 32a) Version 1:
24 V a.c. resp. 24 V d.c.
$U_m = 30 \text{ V}$

Version 2:
230 V ± 10%, 50 ... 60 Hz, about 20 VA,
$U_m = 253 \text{ V}$

Version 3:
115 V ± 10%, 50 ... 60 Hz, about 20 VA,
$U_m = 126.5 \text{ V}$

All other data and the special conditions for safe use, as well, apply unchanged for this first supplement.

Test documents are listed in the test report N° 01PX11810.

TÜV Hannover/Buchsee Anhalt e.V.
TÜV CERT-Zertifizierungsstelle
Am TÜV 1
D-30519 Hannover

Hannover, 2001-05-17

Head of the Certification Body
2. SUPPLEMENT to

EC TYPE-EXAMINATION CERTIFICATE No. TÜV 00 ATEX 1638 X

of the company: Berthold Technologies GmbH & Co. KG
formerly: Berthold GmbH & Co. KG
Calmbacher Str. 22
D-75323 Bad Wildbad

The evaluation unit type LB 4.. is intended for the display and evaluation of signals, for the supply and data transmission to the connected detector and for the safety galvanically separation between the intrinsically safe circuit and the non intrinsically safe circuits, as well.

The intrinsically safe output circuit may also be led into potentially explosive areas with presence of combustible dust that require apparatus of category 2. The connected equipment has to meet the requirements of category 1D or 2 D and it has to be certified properly, too.

All other data and the special conditions for safe use, as well, apply unchanged for this second supplement.

Test documents are listed in the test report N° 01PX16410.

TÜV Hannover/Sachsen-Anhalt e.V.
TÜV CERT-Zertifizierungsstelle
Am TÜV 1
D-30519 Hannover

Hannover, 2001-07-12

Head of the Certification Body
Translation

3. SUPPLEMENT to

EC TYPE-EXAMINATION CERTIFICATE No. TÜV 00 ATEX 1638 X

of the company: Berthold Technologies GmbH & Co. KG
Calmbacher Str. 22
D-75323 Bad Wildbad

In the future, the evaluation unit type LB 4.. may also be produced according to the documents listed in the test report.
The changes refer to the electronic current limitation for the intrinsically safe output circuit.
The „Special conditions for safe use“ are extended (see section 17).
The evaluation unit type LB 4.. according to EC-Type Examination Certificate TÜV 00 ATEX 1638 X incl. of this 3. supplement also meets the requirements of EN 50 020:2002.
The electrical data as well as all other details remain unchanged.

(16) The test documents are listed in the test report no. 04YEX551293.

(17) Special conditions for safe use
1. The evaluation unit type LB 4.. designed with connector strip needs a partition wall to be inserted between the connections of the intrinsically-safe circuit and the non-intrinsically safe circuits in order to ensure the required filament size of 50 mm or each connection of the intrinsically-safe circuit must be covered with a shrinkage tube.
2. The evaluation unit type LB 4.. is only allowed to be installed in dry, clean and well controlled environments.

(18) Essential Health and Safety Requirements
no additional ones

TÜV NORD CERT GmbH & Co. KG
TÜV CERT-Zertifizierungsstelle
Am TÜV 1
D-30519 Hannover
Tel.: 0511 996-1470
Fax: 0511 996-2565

Hanover, 2004-05-06

Head of the Certification Body
Translation

4. SUPPLEMENT to

EC-TYPE EXAMINATION CERTIFICATE No. TÜV 00 ATEX 1638 X

Equipment: Evaluation unit type LB 4.
Manufacturer: Berthold Technologies GmbH & Co. KG
Address: Calmbacher Straße 22
D-75323 Bad Wildbad

In the future, the evaluation unit type LB 4.. may also be produced according to the documents listed in the test report.
The changes refer to the transistors of the electronic current limitation for the intrinsically safe output circuit.

All other details remain unchanged.

The equipment meets the requirements of
EN 50 014:1997+A1+A2 EN 50 020:2002

16 The test documents are listed in the test report N° 06 YEX 552518.

17 Special conditions for safe use
1. The evaluation unit type LB 4.. designed with connector strip needs a partition wall to be inserted between the connections of the intrinsically-safe circuit and the non-intrinsically safe circuits in order to ensure the required filament size of 50 mm or each connection of the intrinsically-safe circuit must be covered with a shrinkage tube.
2. The evaluation unit type LB 4.. is only allowed to be installed in dry, clean and well controlled environments.

3. Essential Health and Safety Requirements
no additional ones

TÜV NORD CERT GmbH & Co. KG
Am TÜV 1
D-39519 Hannover
Tel.: +49 (0) 511 986-1465
Fax: +49 (0) 511 986-1590

Hannover, 2006-01-18

Head of the Certification Body

page 1/1
CHAPTER 13. PTB / TÜV CERTIFICATES

13.1 Evaluation Unit

Translation

5. SUPPLEMENT

To Certificate No. TÜV 00 ATEX 1638 X
Equipment: Evaluation unit type LB 4...
Manufacturer: Berthold Technologies GmbH & Co. KG
Address: Calmbacher Straße 22
D-75323 Bad Wildbad
Order number: 8000553201
Date of issue: 2006-09-13

In the future, the evaluation unit type LB 4.. may also be produced according to the documents listed in the test report.
The changes refer to the ambient temperature range as well as the electrical data.
The permissible ambient temperature range is -30°C ... +70°C.

Electrical data
Output circuit ......................... in type of protection Intrinsic Safety EEx ib IIC
(Connections 2a, 2c) or EEx ib IIB

Maximum values:

<table>
<thead>
<tr>
<th></th>
<th>EEx ib IIC</th>
<th>EEx ib IIB</th>
</tr>
</thead>
<tbody>
<tr>
<td>U0</td>
<td>16,8 V</td>
<td></td>
</tr>
<tr>
<td>I0</td>
<td>81 mA</td>
<td>118 mA</td>
</tr>
<tr>
<td>P0</td>
<td>1,36 W</td>
<td>2 W</td>
</tr>
</tbody>
</table>

Characteristic line: rectangular

The connection of a cable according to the test documents of the manufacturer with a length of max. 1km is permissible for the apparatus group IIC.
For the apparatus group IIB, the values already certified for I0 and C0 are valid.

All other details as well as the “Special conditions for safe use” remain unchanged.

The equipment incl. of this supplement meets the requirements of these standards:

(16) The test documents are listed in the test report No. 06 YEX 553201.

(17) Special conditions for safe use

1. The evaluation unit type LB 4.. designed with connector strip needs a partition wall to be inserted between the connections of the intrinsically-safe circuit and the non-intrinsically-safe circuits in order to ensure the required filament size of 50 mm or each connection of the intrinsically-safe circuit must be covered with a shrinkage tube.

2. The evaluation unit type LB 4.. is only allowed to be installed in dry, clean and well controlled environments.

(18) Essential Health and Safety Requirements

no additional ones
13.2 Wall Housing

Translation

EC TYPE-EXAMINATION CERTIFICATE

(1) Equipment or protective system intended for use in potentially explosive atmospheres - Directive 94/9/EC

(2) EC-Type Examination Certificate Number

TÜV 99 ATEX 1511

(3) Equipment: Wall housing type LD 4460

(4) Manufacturer: Berthold GmbH & Co KG

(5) Address: Cailmacher Straße 22
D-75323 Bed Wildbach

(7) This equipment or protective system and any acceptable variation thereof is specified in the schedule to this certificate and the documents therein referred to.

(6) The TÜV Hannover/Sachsen-Anhalt e.V., TÜV CERT-Certification Body, notified body number N° 0032 in accordance with Article 9 of the Council Directive of the EC of March 23, 1994 (94/9/EC), certifies that this equipment or protective system 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 N° 99/PX14890.

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

EN 50 014: 1997
EN 50 020: 1994

(10) If the sign "X" is placed after the certificate number, it indicates that the equipment or protective system 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 or protective system according to Directive 94/9/EC. Further requirements of this Directive apply to the manufacture and placing on the market of this equipment or protective system.

(12) The marking of the equipment or protective system must include the following:

II (2) G [Ex ib] IIC

TÜV Hannover/Sachsen-Anhalt e.V.
TÜV CERT-Zertifizierungsstelle
Am TÜV 1
D-30521 Hannover

Head of the Certification Body

This certificate may only be reproduced without any change, schedule included. Excerpts or changes shall be allowed by the TÜV Hannover/Sachsen-Anhalt e.V.
CHAPTER 13. PTB / TÜV CERTIFICATES

13.2 Wall Housing

(14) EC-TYPE EXAMINATION CERTIFICATE N° TÜV 99 ATEX 1511

(15) Description of equipment

The wall housing type LB 4460 is used as protective enclosure and junction box for 1 resp. evaluation units type LB4.. and for the evaluation of signals.

The maximum permissible ambient temperature for the wall housing has to be taken from the following table:

<table>
<thead>
<tr>
<th>Number of the installed evaluation units</th>
<th>Max. permissible ambient temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>40°C</td>
</tr>
<tr>
<td>1</td>
<td>45°C</td>
</tr>
</tbody>
</table>

Electrical data

Supply circuit.................................. Version 1:
(terminais 1 ... 3) 230 V, 50 ... 60 Hz, about 20 VA, $U_m = 253$ V

Supply circuit.................................. Version 2:
(terminais 1, 2) 24 V a.c., $U_i = 30$ V resp.
24 V d.c., $U_i = 30$ V

Output circuits relay ...................... per potential free contact: 250 V a.c., 1 A
(terminais 15, 29/16, 30/17, 31 resp. 46, 60/47, 61/48, 62) $U_m = 253$ V

Digital circuits .......................... per input: 5 V
(terminais 12, 29/13, 27/14, 28 resp. 34, 55/44, 53/45, 59) $U_m = 30$ V

Current output ................................ 0 ... 24 mA
(terminais 10, 11 resp. 41, 42) $U_m = 30$ V

Current input .................................. 0 ... 24 mA
(terminais 6, 7 resp. 37, 38) $U_m = 30$ V

RS232C interface .......................... ± 12 V
(Plug on the corresponding) $U_m = 30$ V
front panel: ST3-1 ... 9

RS485 interface ............................ 0 ... 5 V
(terminais 8, 9 resp. 36, 40) $U_m = 30$ V

Output circuit .................................. 24 V, about 20 W
(terminais 4, 18/3, 19 resp. 35, 49/36, 50) $U_m = 30$ V
CHAPTER 13. PTB / TÜV CERTIFICATES

13.2 Wall Housing

Schedule EC-Type Examination Certificate No TÜV 99 ATEX 1511

Output circuits in type of protection „Intrinsic Safety“ EEx ib IIC
(terminals 33, 34 resp. 64, 65)

Maximum values:

<table>
<thead>
<tr>
<th></th>
<th>EEx ib IIC</th>
<th>EEx ib IIB</th>
</tr>
</thead>
<tbody>
<tr>
<td>( U_0 )</td>
<td>10.8 V</td>
<td></td>
</tr>
<tr>
<td>( I_\alpha )</td>
<td>61 mA</td>
<td>118 mA</td>
</tr>
<tr>
<td>( P_0 )</td>
<td>1.36 W</td>
<td>2 W</td>
</tr>
</tbody>
</table>

Characteristic line: rectangular

The maximum permissible external inductance and capacitance have to be taken from the following table:

<table>
<thead>
<tr>
<th></th>
<th>EEx ib IIC</th>
<th>EEx ib IIB</th>
</tr>
</thead>
<tbody>
<tr>
<td>max. permissible external inductance</td>
<td>0.24 mH</td>
<td>2.3 mH</td>
</tr>
<tr>
<td>max. permissible external capacitance</td>
<td>129 nF</td>
<td>329 nF</td>
</tr>
</tbody>
</table>

The intrinsically safe output circuits are safely galvanically separated from all other non intrinsically safe circuits up to a peak value of the nominal voltage of 375 V.

(16) Test documents consisting of 7 sheets including 10 drawings and one statement of conformity are listed in the test report.

(17) Special conditions for safe use
none

(18) Essential Health and Safety Requirements
no additional ones
CHAPTER 13. PTB / TÜV CERTIFICATES

13.3 Scintillation Counter

Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin

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:

(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:

Zertifizierungsstelle Explosionsschutz
By order of
Dr.-Ing. U. Johannsmeyer
Regierungsdirektor

Braunschweig, October 12, 2000

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
CHAPTER 13. PTB / TÜV CERTIFICATES

13.3 Scintillation Counter

SCHEDULE

EC-TYPE-EXAMINATION CERTIFICATE PTB 00 ATEX 2108

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, granly, 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.

Electrical 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:
U1 = 16.8 V
P1 = 2 W
L1 negligibly small
C1 = 11 nF

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

sheet 2/3
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:
  \[ U_0 = 16.8 \text{ V} \]
  \[ I_0 = 34 \text{ mA} \]
  \[ P_0 = 143 \text{ mW} \]
- linear characteristic
- \( L_1 \) negligibly small
- \[ C_1 = 11 \text{ nF} \]

<table>
<thead>
<tr>
<th></th>
<th>IIC</th>
<th>IIB</th>
</tr>
</thead>
<tbody>
<tr>
<td>( L_0 )</td>
<td>23 mH</td>
<td>87 mH</td>
</tr>
<tr>
<td>( C_0 )</td>
<td>290 nF</td>
<td>1300 nF</td>
</tr>
</tbody>
</table>

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

(16) **Test report** PTB Ex 00-2018B

(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
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 Ex iib d IIC T6 resp. Ex 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 Ex 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

Zertifizierungsbüro Explosionsschutz
By order

Draunschweig, July 24, 2001

Dr.-Ing. U. Johannsen
Regierungsdirektor
CHAPTER 13. PTB / TÜV CERTIFICATES

13.3 Scintillation Counter

Physikalisch-Technische Bundesanstalt
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 II C T6 bzw. EEx d e II C 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:

<table>
<thead>
<tr>
<th>Type</th>
<th>Temperature Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>In general</td>
<td>-20°C to +50°C</td>
</tr>
<tr>
<td>Without PT100 Output</td>
<td>-20°C to +60°C</td>
</tr>
</tbody>
</table>

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 II C T6 resp. EEx d e II C T6
Ex II 2 D IP65 T80°C resp. IP67 T80°C

Test report: PTB Ex 02-22033
Certification body for explosion-protection
Dr. Ing. U. Krausmeier
Regierungsdirektor

Draunschweig, 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
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: 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:
   II 2 G EEx de IIC T6 or
   II 2 G EEx ib d IIC T6
   II 2 G D EEx de IIC T6 IP 65 T 80 °C or IP 67 T 80 °C or
   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 ½" NPT
   M12*1.5 to ¼" NPT
   M16*1.5 to ⅜" NPT
   M12*1.5 to ⅝" 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.

PT100 output
Physikalisch-Technische Bundesanstalt
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:

Braunschweig, May 19, 2003

Dr.-Ing. M. Thedens
CHAPTER 13. PTB / TÜV CERTIFICATES

13.4 CE Certificate

EC-Declaration of Conformity

We herewith confirm that the construction of the following indicated products / systems / units is brought into circulation to comply with the relevant EC regulations.

This declaration is declared void should alterations or unintended use take place without our authorisation.

Title: Level Measuring System  
Type: LB 440  
Relevant EC regulation:

89/336/EWG (electromagnetic compatibility)  
reviewed 91/263/EWG, 92/31/EWG, 93/68/EWG, 93/97/EWG  
73/23/EWG (low voltage guidelines)  
reviewed 93/68/EWG

The following norms were considered for the assessment of the products:

EN 50082-1: 1997-08  
EN 50081-2: 1993-08  
EN 61326-A1: 1998-06  
EN 61000-4-2: Class B  
EN 61000-4-3: Class B  
EN 61000-4-4: Class B  
EN 61000-4-5: Class B  
EN 61000-4-6: Class B  
EN 61000-4-11: Class B  
EN 61010 Part 1: 1993-03

This declaration is issued by the manufacturer:

BERTHOLD TECHNOLOGIES GmbH & Co. KG  
Calmbacher Strasse 22  
75523 Bad Wildbad / Germany

by

Dr. M. Bickert  
Development Manager  
Bad Wildbad, 30.07.01
# 14.1 Parameter List

<table>
<thead>
<tr>
<th>Function</th>
<th>Range</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Password</td>
<td>0-999999</td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>YY.MM.DD</td>
<td>current date</td>
</tr>
<tr>
<td>Time</td>
<td>HH.MM</td>
<td>current time</td>
</tr>
<tr>
<td>Model/Version</td>
<td>e.g.: LB 440-M</td>
<td>version</td>
</tr>
<tr>
<td>Language</td>
<td>German/English</td>
<td></td>
</tr>
<tr>
<td>Operating Mode</td>
<td>lin/polyg/roddet/exp</td>
<td></td>
</tr>
<tr>
<td>Alarm relay</td>
<td>Hold state/current following</td>
<td></td>
</tr>
<tr>
<td>Isotope</td>
<td>Co / Cs</td>
<td></td>
</tr>
<tr>
<td>Time Constant (s)</td>
<td>0.5 .. 999</td>
<td></td>
</tr>
<tr>
<td>Rapid Switch-Over</td>
<td>OFF / ON</td>
<td></td>
</tr>
<tr>
<td>Sigma Rapid Switch-Over</td>
<td>0 - 9.9999</td>
<td></td>
</tr>
<tr>
<td>Interference Radiation</td>
<td>OFF / ON</td>
<td></td>
</tr>
<tr>
<td>Sigma Interf. Radiation</td>
<td>0 - 9.9999</td>
<td></td>
</tr>
<tr>
<td>Wait time in s</td>
<td>0 – 999</td>
<td></td>
</tr>
<tr>
<td>Pulse Rate, max</td>
<td>0 – 150000</td>
<td></td>
</tr>
<tr>
<td>Pulse Rate, min</td>
<td>0 - 99999</td>
<td></td>
</tr>
<tr>
<td>Current Output</td>
<td>0-20 mA / 4 -20 mA</td>
<td></td>
</tr>
<tr>
<td>Current on Error</td>
<td>Hold / Value 0-22 mA</td>
<td></td>
</tr>
<tr>
<td>Relay 2 (Min)</td>
<td>0-100%</td>
<td></td>
</tr>
<tr>
<td>Relay 2 (Hysteresis)</td>
<td>1-10.0 %</td>
<td></td>
</tr>
<tr>
<td>Relay 3 (Max)</td>
<td>0-100%</td>
<td></td>
</tr>
<tr>
<td>Relay 3 (Hysteresis)</td>
<td>1-10.0 %</td>
<td></td>
</tr>
<tr>
<td>Background</td>
<td>0 – 150000</td>
<td></td>
</tr>
</tbody>
</table>
### 14.1.1 Rod Detector Calibration Values

<table>
<thead>
<tr>
<th>Value pair No</th>
<th>Level in %</th>
<th>cps</th>
<th>Value pair No</th>
<th>Level in %</th>
<th>cps</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 14.1.2 2-Point Linear Calibration Values

<table>
<thead>
<tr>
<th></th>
<th>Level in %</th>
<th>cps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Empty calibration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full calibration</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 14.1.3 Exponential Calibration Values

<table>
<thead>
<tr>
<th>Function</th>
<th>Range</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>a1</td>
<td>0...9,9999</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Level in %</th>
<th>cps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Empty calibration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full calibration</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
14.1 Parameter List
Technical Information

Level Gauge LB 440

Level Gauge
Füllstandmessung

Field mounted components
Messstellen-Komponenten

Arrangement with Rod Detector
Anordnung mit Stabdetektor

Arrangement with Rod Source
Anordnung mit Stabstrahler
# LB 440

## 1 Rod Detector

### 1.1 Rod Detector

<table>
<thead>
<tr>
<th>Type</th>
<th>L</th>
<th>L (WC*)</th>
<th>L 1</th>
<th>Weight (kg)</th>
<th>Weight with WC* (kg)</th>
<th>Weight with WC* + Water (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LB 4405-01...</td>
<td>830</td>
<td>838</td>
<td>458</td>
<td>9.0</td>
<td>11.5</td>
<td>12.0</td>
</tr>
<tr>
<td>LB 4405-02...</td>
<td>1078</td>
<td>1086</td>
<td>708</td>
<td>10.5</td>
<td>14.0</td>
<td>15.0</td>
</tr>
<tr>
<td>LB 4405-03...</td>
<td>1326</td>
<td>1334</td>
<td>958</td>
<td>12.0</td>
<td>17.0</td>
<td>18.5</td>
</tr>
<tr>
<td>LB 4405-04...</td>
<td>1574</td>
<td>1582</td>
<td>1208</td>
<td>13.5</td>
<td>19.5</td>
<td>21.0</td>
</tr>
<tr>
<td>LB 4405-05...</td>
<td>1823</td>
<td>1831</td>
<td>1458</td>
<td>15.0</td>
<td>22.0</td>
<td>24.0</td>
</tr>
<tr>
<td>LB 4405-06...</td>
<td>2320</td>
<td>2328</td>
<td>1958</td>
<td>16.5</td>
<td>25.0</td>
<td>27.5</td>
</tr>
</tbody>
</table>

* WC/WK = Water Cooling / Wasserkühlung

## 1.2 Rod Detector with Water Cooling Jacket

All other dimensions see left hand.

Alle anderen Maße siehe links.

1x M16 for cable Ø 5...10
1x M16 für Kabel Ø 5...10
### 1.3 Mounting Clamps for Rod Detector

Befestigungsschellen für Stabdetektor

<table>
<thead>
<tr>
<th>D</th>
<th>h</th>
<th>l1</th>
<th>l2</th>
<th>s</th>
<th>part no. for single clamp</th>
<th>part no. for a set of clamps (2 clamps)</th>
<th>for rod detector:</th>
</tr>
</thead>
<tbody>
<tr>
<td>65</td>
<td>41.5</td>
<td>85</td>
<td>105</td>
<td>1.5</td>
<td>05675</td>
<td>05678</td>
<td>24840</td>
</tr>
<tr>
<td>85</td>
<td>52</td>
<td>100</td>
<td>122</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>48</td>
<td>85</td>
<td>105</td>
<td>1.5</td>
<td>05677</td>
<td>05678</td>
<td>24841</td>
</tr>
<tr>
<td>85</td>
<td>52</td>
<td>100</td>
<td>122</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 1.4 Sun Roof Against Strong Sun Radiation

Sonnendach gegen starke Sonnenbestrahlung

Direct sun radiation can overheat the detector. If the detector temperature can reach more than 50°C, a suitable sun roof must be installed. The heating of the detector by thermal radiation from the vessel can also be moderated by a thermal sheet, e.g. by a thin metal plate. For each detector is a water cooling (option) available.

Wird durch Sonneneinstrahlung eine Detektortemperatur von über 50°C erreicht, so ist ein geeigneter Sonnenschutz zu montieren. Auch die Aufheizung des Detektors durch Wärmeabstrahlung vom Behälter kann durch ein dünnes Wärmeableitblech gemildert werden. Für jeden Detektor steht auch eine geeignete Wasserkühlung (Option) zur Verfügung.
1.5 Examples for Measurement Arrangements with Rod Detector
Beispiele für Messanordnungen mit Stabdetektor

Arrangement with 2 Rod Detectors
Anordnung mit 2 Stabdetektoren

Arrangement with Rod Source
Anordnung mit Stabstrahler

Arrangement with 2 Point Sources
Anordnung mit 2 Punkt-Strahlenquellen

Arrangement with Rod Source in Dip Pipe
Anordnung mit Stabstrahler im Tauchrohr
1.6 Collimator for Rod Detector
Kollimator für Stabdetektor

for rod detectors without water cooling
für Stabdetektoren ohne Wasserkühlung

Effective lead thickness: ~ 35 mm.
Wirksame Bleidicke: ~ 35 mm.

<table>
<thead>
<tr>
<th>Rod detector length</th>
<th>L ges</th>
<th>H</th>
<th>part no.</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stabdetektor Länge</td>
<td></td>
<td></td>
<td>Id. Nr.</td>
<td></td>
</tr>
<tr>
<td>500</td>
<td>590</td>
<td>540</td>
<td>33113</td>
<td>74</td>
</tr>
<tr>
<td>750</td>
<td>840</td>
<td>790</td>
<td>33139</td>
<td>105</td>
</tr>
<tr>
<td>1000</td>
<td>1090</td>
<td>1040</td>
<td>33145</td>
<td>135</td>
</tr>
<tr>
<td>1250</td>
<td>1340</td>
<td>1290</td>
<td>33151</td>
<td>165</td>
</tr>
<tr>
<td>1500</td>
<td>1590</td>
<td>1540</td>
<td>33158</td>
<td>197</td>
</tr>
<tr>
<td>2000</td>
<td>2090</td>
<td>2040</td>
<td>33163</td>
<td>255</td>
</tr>
</tbody>
</table>
1.7 Collimator for Rod Detector
Kollimator für Stabdetektor

for rod detectors with water cooling
für Stabdetektoren mit Wasserkühlung

<table>
<thead>
<tr>
<th>Rod detector length</th>
<th>L ges</th>
<th>H</th>
<th>part no. Id. Nr.</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>549</td>
<td>506</td>
<td>37840-050</td>
<td>56</td>
</tr>
<tr>
<td>750</td>
<td>799</td>
<td>756</td>
<td>37840-075</td>
<td>76</td>
</tr>
<tr>
<td>1000</td>
<td>1049</td>
<td>1006</td>
<td>37840-100</td>
<td>97</td>
</tr>
<tr>
<td>1250</td>
<td>1299</td>
<td>1256</td>
<td>37840-125</td>
<td>123</td>
</tr>
<tr>
<td>1500</td>
<td>1549</td>
<td>1506</td>
<td>37840-150</td>
<td>148</td>
</tr>
<tr>
<td>2000</td>
<td>2049</td>
<td>2006</td>
<td>37840-200</td>
<td>196</td>
</tr>
</tbody>
</table>
1.8 Installation Support for Collimator with Rod Detector

Installationsvorschlag für Kollimator mit Stabdetektor
2.1 Mechanical Dimensions
Mechanische Abmessungen

<table>
<thead>
<tr>
<th>Type</th>
<th>Crystal</th>
<th>Ex</th>
<th>Collimator</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LB 5401-01</td>
<td>25/25</td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>LB 5401-02</td>
<td>40/35</td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>LB 5401-03</td>
<td>50/50</td>
<td></td>
<td></td>
<td>18</td>
</tr>
<tr>
<td>LB 4401-01</td>
<td>25/25</td>
<td>X</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>LB 4401-02</td>
<td>40/35</td>
<td>X</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>LB 4401-03</td>
<td>50/50</td>
<td>X</td>
<td></td>
<td>18</td>
</tr>
</tbody>
</table>
2.2 Point Detector Water Cooling Jackets and Adaptor Fittings
Punktdetektor Wasserkühlung und Adapter Anschlussstücke

- **standard water cooling jacket**
  - stainless steel 304, part no: 21326
  - carbon steel version: 38055

- **fitting adaptor for standard water cooling Rp ¼" → ½" NPT**
  - stainless steel 304, part no: 47189
  - Adapter für Standard Wasserkühlung Rp ¼" → ½" NPT
  - Edelstahl 1.4301, Id. Nr.: 47189

- **water cooling Jacket with Parker Ermeto Fittings**
  - stainless steel 304, part no: 37816
  - Wasserkühlung mit Parker Ermeto Anschlüssen
  - Edelstahl 1.4301, Id. Nr.: 37816

Further fitting adaptors for standard water cooling jacket:
- Rp ¼" → ½" NPT male, stainless steel 304, part no: 06352
- Rp ¼" → ¼" NPT male, stainless steel 304, part no: 06349

The above mentioned water cooling jackets and adaptor fittings offers following connection versions:

<table>
<thead>
<tr>
<th>Fitting Connection</th>
<th>Anschluss-Stutzen</th>
<th>part no., material Id.Nr. Werkstoff</th>
</tr>
</thead>
<tbody>
<tr>
<td>R ¼&quot; pipe connection, male</td>
<td>R ¼&quot; Außengewinde für Rohrverschraubung</td>
<td>21326 (304/1.4301)</td>
</tr>
<tr>
<td>European standard Whitworth pipe thread</td>
<td>europäisches Standard Whitworth-Rohrgewinde</td>
<td>38055 (Carbon Steel St37)</td>
</tr>
<tr>
<td>10 mm hose connection</td>
<td>Schlauchstutzen für Schlauch- Innendurchmesser 10 mm</td>
<td>21326 (304/1.4301)</td>
</tr>
<tr>
<td>for water hose connection ID 10 mm</td>
<td>Schlauchstutzen für Schlauch- Innendurchmesser 10 mm</td>
<td>38055 (Carbon Steel St37)</td>
</tr>
<tr>
<td>Ermeto Parker</td>
<td>Ermeto Parker für Rohrverschraubungen mit Rohren AD 8 mm</td>
<td>37816 (304/1.4301)</td>
</tr>
<tr>
<td>for connection with pipes OD 8 mm</td>
<td>Ermeto Parker für Rohrverschraubungen mit Rohren AD 8 mm</td>
<td></td>
</tr>
<tr>
<td>fitting adaptor ½&quot; NPT female</td>
<td>Adapter mit ½&quot; NPT Innengewinde</td>
<td>47189 (304/1.4301)</td>
</tr>
<tr>
<td>fitting adaptor ¼&quot; NPT female</td>
<td>Adapter mit ¼&quot; NPT Innengewinde</td>
<td>46743 (304/1.4301)</td>
</tr>
<tr>
<td>fitting adaptor ½&quot; NPT male</td>
<td>Adapter mit ½&quot; NPT Außengewinde</td>
<td>06352 (304/1.4301)</td>
</tr>
<tr>
<td>fitting adaptor ¼&quot; NPT male</td>
<td>Adapter mit ¼&quot; NPT Außengewinde</td>
<td>06349 (304/1.4301)</td>
</tr>
</tbody>
</table>
2.3 Mounting Clamps for Point Detector
Schellen für Punktdetektor

for point detectors **without** water cooling
für Punktdetektoren **ohne** Wasserkühlung

for point detectors **with** water cooling
für Punktdetektoren **mit** Wasserkühlung

Direct sun radiation can overheat the detector. If the detector temperature can reach more than 50°C, a suitable sun roof must be installed. The heating of the detector by thermal radiation from the vessel can also be moderated by a thermal sheet, e.g. by a thin metal plate. For each detector is a water cooling (option) available.

Wird durch Sonneneinstrahlung eine Detektortemperatur von über 50°C erreicht, so ist ein geeigneter Sonnenschutz zu montieren. Auch die Aufheizung des Detektors durch Wärmeabstrahlung vom Behälter kann durch ein dünnes Wärmeableitblech gemildert werden. Für jeden Detektor steht auch eine geeignete Wasserkühlung (Option) zur Verfügung.
2.4 Point Detector Mounting
Punktdetektor Montage

Gap necessary only for detectors with water cooling jacket.
Schlitz nur notwendig bei Detektoren mit Wasserkühlung.

Alternative mounting possibilities
Alternative Befestigungsmöglichkeiten
2.5 Point Detector Installation Examples
Punktendetektor Installationsbeispiele

Application with multipart rod source shielding
Anordnung mit mehrteiliger Stabstrahler-Abschirmung

Application with dip pipe
Anordnung mit Tauchrohr
3 Super-Sens, radial irradiation 66°
Super-Sens, seitliche Einstrahlung 66°

3.1 Mechanical Dimensions
Mechanische Abmessungen

<table>
<thead>
<tr>
<th>Type</th>
<th>ATEX</th>
<th>part no.</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LB 4431-04-0r-Gd-E</td>
<td>Gas Ex d II 2 G EEx de IIC T6</td>
<td>66°</td>
<td>60</td>
</tr>
<tr>
<td>LB 4431-04-0r-Gi-E</td>
<td>Gas Ex i II 2 G EEx ib d IIC T6</td>
<td>66°</td>
<td>60</td>
</tr>
<tr>
<td>LB 5431</td>
<td>–</td>
<td>66°</td>
<td>58</td>
</tr>
</tbody>
</table>

3.2 Installation Example for Super-Sens
Installationsbeispiel für Super-Sens

Radiation path
Strahlengang

Support
Konsole

Radiation window
Strahlenfenster

Cut-out for radiation path
Ausschnitt für Strahlenfenster

Side View
Seitenansicht

Top View
Ansicht von oben
3.3 Super-Sens, radial irradiation 66° and water colling jacket
Super-Sens, seitliche Einstrahlung 66° und Wasserkühlung

<table>
<thead>
<tr>
<th>Type</th>
<th>ATEX</th>
<th>part no.</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LB 4431-14-0r-Gd-E</td>
<td>Gas Ex d II 2 G EEx de IIC T6</td>
<td>66°</td>
<td>74</td>
</tr>
<tr>
<td>LB 4431-14-0r-Gi-E</td>
<td>Gas Ex i II 2 G EEx ib d IIC T6</td>
<td>66°</td>
<td>74</td>
</tr>
</tbody>
</table>
3.4 Water Cooling Installation Instructions
   Anweisungen zur Installation der Wasserkühlung

Horizontal Detector Installation
Horizontale Detektor Installation

install the detector with the connection at the top.
Installieren Sie den Detektor mit dem Anschlussgehäuse oben.

vertical detector installation
Vertikale Detektor Installation

Super-Sens installed horizontal
Super-Sens horizontal montiert

hose connection installed by customer
vom Kunden installierte Schlauchverbindung
4 Detector Cooling Water Demand
Detektor Kühlwasserbedarf
5.1 Shielding for Rod Source
Abschirmungen für Stabstrahler

The shieldings are marked with TOP and BOTTOM to rule out any side-inverted installation. Multi-part shieldings are additionally marked with the numbers 1, 2, 3, … from top to bottom.

Die Abschirmungen sind markiert mit OBEN und UNTEN um eine Seitenverkehrte Installation auszuschließen. Mehrteilige Stabstrahler sind zusätzlich von oben nach unten mit den Zahlen 1, 2, 3, … markiert.

<table>
<thead>
<tr>
<th>Type</th>
<th>d</th>
<th>kg/m approx</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>J</th>
<th>K</th>
<th>M</th>
<th>P</th>
</tr>
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<td>11.5</td>
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<td>105</td>
<td>130</td>
<td>340</td>
<td>305</td>
<td>140</td>
<td>80</td>
<td>41</td>
<td>14</td>
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<td>255</td>
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<td>120</td>
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<tr>
<td>150</td>
<td>159</td>
<td>300</td>
<td>465</td>
<td>425</td>
<td>195</td>
<td>100</td>
<td>65</td>
<td>18</td>
<td>147</td>
<td>375</td>
<td>20</td>
<td>334</td>
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<td>510</td>
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<td>184</td>
<td>450</td>
<td>25</td>
<td>400</td>
<td>180</td>
<td>14</td>
</tr>
<tr>
<td>270</td>
<td>267</td>
<td>780</td>
<td>580</td>
<td>510</td>
<td>230</td>
<td>125</td>
<td>100</td>
<td>26</td>
<td>207</td>
<td>545</td>
<td>25</td>
<td>503</td>
<td>222.5</td>
<td>14</td>
</tr>
</tbody>
</table>
5.2 Shielding for Rod Source
Abschirmung für Stabstrahler

In order to establish a continuous source length with a multiple source arrangement, different types of
shieldings must be used for interconnection. The different shielding types are mentioned with roman figures in
the drawing above.

 Damit eine mehrteilige Stabstrahler-Anordnung einen möglichst durchgängigen Strahler bildet, sind
unterschiedliche Abschirmungen zum Zusammenbau zu verwenden. Die dazu notwendigen einzelnen
Abschirmungstypen sind im Bild oben mit römischen Ziffern beschriftet.

<table>
<thead>
<tr>
<th>Ø</th>
<th>drawing no. Zeichnungs-Nr.</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>21157.000-000</td>
<td>92</td>
<td>92</td>
<td>18</td>
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</tr>
<tr>
<td>150</td>
<td>21159.000-000</td>
<td>132</td>
<td>106</td>
<td>21</td>
<td>32</td>
</tr>
<tr>
<td>200</td>
<td>21160.000-000</td>
<td>169</td>
<td>132</td>
<td>26</td>
<td>37</td>
</tr>
<tr>
<td>270</td>
<td>21161.000-000</td>
<td>202</td>
<td>140</td>
<td>30</td>
<td>40</td>
</tr>
</tbody>
</table>
5.3 Shielding for Point Source  
Abschirmung für Punkt Strahler

The shieldings are marked with BOTTOM to rule out any side-inverted installation.

Die Abschirmungen sind markiert mit UNTEN um eine seitenverkehrte Installation auszuschließen.

<table>
<thead>
<tr>
<th></th>
<th>point source</th>
<th>Punktstrahler</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>radiation channel</td>
<td>Strahlenaustritt</td>
</tr>
<tr>
<td>3</td>
<td>pad lock</td>
<td>Vorhängeschloss</td>
</tr>
<tr>
<td>4</td>
<td>position open</td>
<td>Stellung auf</td>
</tr>
<tr>
<td>5</td>
<td>position closed</td>
<td>Stellung zu</td>
</tr>
<tr>
<td>6</td>
<td>name plate</td>
<td>Typhenschild</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type</th>
<th>d</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>O</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>105</td>
<td>240</td>
<td>210</td>
<td>125</td>
<td>11</td>
<td>80</td>
<td>40</td>
<td>15</td>
<td>115</td>
<td>30</td>
<td>24</td>
<td>184</td>
<td>225</td>
<td>25</td>
<td>25</td>
<td>32</td>
</tr>
<tr>
<td>150</td>
<td>159</td>
<td>360</td>
<td>320</td>
<td>195</td>
<td>18</td>
<td>100</td>
<td>65</td>
<td>20</td>
<td>115</td>
<td>28</td>
<td>28</td>
<td>300</td>
<td>265</td>
<td>25</td>
<td>35</td>
<td>70</td>
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<tr>
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<td>203</td>
<td>410</td>
<td>360</td>
<td>220</td>
<td>23</td>
<td>120</td>
<td>75</td>
<td>25</td>
<td>155</td>
<td>22</td>
<td>22</td>
<td>366</td>
<td>340</td>
<td>30</td>
<td>40</td>
<td>150</td>
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<td>270</td>
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<td>580</td>
<td>510</td>
<td>315</td>
<td>26</td>
<td>300</td>
<td>101</td>
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<td>54</td>
<td>45</td>
<td>436</td>
<td>435</td>
<td>45</td>
<td>50</td>
<td>370</td>
</tr>
</tbody>
</table>
5.4 Proposal for Support
Vorschlag für Montagesockel

The design 1 of the support plate is easier to manufacture.

Der Montagesockel 1 ist leichter herzustellen.

The design 2 of the support plate with the oblong slot, allows an adjustment of the radiation beam to the detector.

Die Ausführung 2 des Montagesockels mit dem Langloch, ermöglicht die Ausrichtung des Strahlers auf den Detektor.
5.5 Pneumatic Actuator for Rod and Point Source Shielding (Type 80 ... 270)

Pneumatic Actuator for Rod Source Shielding, Fail-Save

For remote control a pneumatic shutter system which is available as an option the pneumatic is available with a limit switch open/close indication. The limit switch box is available in IP 65 or as an Ex-proofed system.

Attention: Multipart rod source shieldings can not be mounted on top of one another, but must be arranged sidewise out-of-line. For each shielding a separate pneumatic actuator is necessary. For the rod source shielding with pneumatic, use the shielding type I only.

Data for Pneumatic Actuator

Compressed Air:
min. 4 x 10^5 Pa (4 bar)
max. 4 x 10^5 Pa (7 bar)
connection: G 1/8

Air Quality:
clean as usual for compressed air tools, oil-free

Temperature Range:
-20°C ... + 80°C

Indication Open/Closed for Limit Switch

Option I:
IP65 2 contacts (Open/Closed) 48 V DC, 1A

Option II:
2 contacts (Open/Closed) max. 250 V AC, 1A,
Ex-protection of the limit switches: EEx d IIC T6
Ex-protection of the limit switch housing: EEx e II T6

Option III:
2 proximity switches for intrinsically safety

Signalisierung AUF/ZU

Option I:
IP65 2 Kontakte (AUF/ZU) 48 V DC, 1A

Option II:
2 Kontakte (AUF/ZU) max. 250 V AC, 1A,
Schutzart der Microeinbautaster: EEx d IIC T6
Gehäuseschutzart: EEx e II T6

Option III:
2 Näherungsnitiatoren für Eigensichere Speisung

Sofern Sie den Verschlussmechanismus fernsteuern wollen ist eine pneumatische Verschlusseinrichtung optional erhältlich. Die Pneumatic ist zusätzlich mit Endschatzer für die Positionsüberschreibung erhältlich.

5.6 Pneumatic Actuator, Arrangement and Electrical Data for Limit Switch

Pneumatik, Aufbau und elektrische Daten für Endschalter

Limit Switch Unit
Enschaltereinheit
Ex de Zone 1

Cable diameter
Kabeldurchmesser
6 … 12 mm

Square neck for position control or for hand actuating if necessary.
Außenvierkant zur Stellungsanzeige oder eventuellen Handbetätigung.

<table>
<thead>
<tr>
<th>Volt</th>
<th>max. Current (A)</th>
<th>max. Strom (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC</td>
<td>R</td>
<td>L</td>
</tr>
<tr>
<td>250</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>125</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>30</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>75</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>125</td>
<td>0,5</td>
<td>0,06</td>
</tr>
<tr>
<td>250</td>
<td>0,25</td>
<td>0,03</td>
</tr>
</tbody>
</table>

Fail safe spring return with pneumatic actuator
Rückstellfeder (Fail-Save) mit pneumatischem Antrieb

Shielding Type 80 … 270
Abschirmung Typ 80 … 270

adjustable cams
justierbare Nocken

Cable diameter
Kabeldurchmesser
6 … 12 mm

Position marked with a red coloured cut in the top.
Position mit eingefrästem roten Strich markiert.

<table>
<thead>
<tr>
<th>Volt</th>
<th>max. Current (A)</th>
<th>max. Strom (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC</td>
<td>R</td>
<td>L Lam p</td>
</tr>
<tr>
<td>250</td>
<td>15</td>
<td>3 1,5</td>
</tr>
<tr>
<td>125</td>
<td>15</td>
<td>3 1,5</td>
</tr>
<tr>
<td>30</td>
<td>15</td>
<td>3 1,5</td>
</tr>
<tr>
<td>75</td>
<td>10</td>
<td>2 1</td>
</tr>
<tr>
<td>125</td>
<td>10</td>
<td>2 1</td>
</tr>
<tr>
<td>48</td>
<td>3</td>
<td>0,6 0,3</td>
</tr>
<tr>
<td>250</td>
<td>0,25</td>
<td>0,05 0,025</td>
</tr>
</tbody>
</table>
5.7 Flange Shielding for Rod Source on Dip Pipe
Abschirmung für Stabstrahler am Tauchrohr
5.8 Operation of Flange Shielding
Bedienung der Flanschabschirmung

Steel cord must be latched into the source tail end.
Stahlseil muss in das Strahlerendstück eingeklinkt werden.

source tail end (inactive)
Strahlerendstück (inaktiv)

shielding head
Abschirmungskopf

Operation of the coupling device
Bedienung der Kupplung

A) source tail end with catch bolt
Strahlerendstück mit Kupplung

steel cord with latch for catch bold
Stahlseil mit Klinke für Kupplung

B) plug the latch into the catch bolt
Klinke in Kupplung einklinken

C) latch plugged into the catch bolt
Klinge in Kupplung eingeklinkt
5.9 Flange Adaptors for Rod Source Shieldings
Flansch Adapter für Stabstrahler-Abschirmungen

Dimensions in mm
Abmessungen in mm
Technical Information

Level Gauge LB 440

Level Gauge
Füllstandmessung

Evaluation Unit
Auswerteeinheit
6 Evaluation Unit
Auswerteeinheit

6.1 Mechanical Dimensions
Mechanische Abmessungen

In a Panel
In einer Schalttafel

In a 19 inch rack
In einem 19" Rahmen

Wall Mounted Housing
Im Wandgehäuse

10x M16 cable glands for cable 6-10mm
10x Verschraubungen M16 für Kabel 6-10mm
6.2 Electrical Connections for 19 Inch Rack and Panel Installation
Elektrische Anschlüsse für 19" Rahmen und Schalttafel-Installation

Plastic partition wall must be mounted for intrinsically safe installation.
Kunststoff-Trennwand muss für eigensichere Installationen montiert sein!

6.3 Multi-Detector Installation
Kaskadierung mehrerer Detektoren

up to 7 slaves
bis zu 7 Slaves
6.4 Connection Diagram for 19 inch Rack and for panel installation
Anschlussplan für 19" Rahmen und für Schalttafel-Installation
INDEX

B
Background measurement · 28

C
Calibrate · 27, 38
Calibration · 37
Calibration curve · 29, 30
Calibration Types · 87
Certificates · 98
Co-60 · 13
Cooling water consumption · 49
Cs-137 · 13
Current Output · 16

D
Date · 13
detector code · 26
Detector code · 37
Detector Code · 14
Detector Code: · 44
Detector Installation · 34, 42
detector protection type · 11
detectors · 9
Dip Pipe · 35
dose rate · 83

E
Electrical Connections · 10
Emergency Instructions · 85
Empty calibration · 29, 46
environmental stress · 9
Error Messages · 60
evaluation electronics · 5

F
Factory Setting · 14
Final Settings · 30
flange mount · 35
flange mount shielding · 35
Full calibration · 29, 38
Full calibration: · 46

G
General Safety Precautions · 32, 56

H
half-life · 5
high-pressure containers · 45

I
Installation of 45° Shielding · 20
Installation of point sources · 41
Installation of water cooling · 48
Installation rod source · 32
Instrument Description · 31
Interfaces · 17
Interference Radiation Detection Flow Chart · 70
Interference Radiation Instructions · 68

K
Keypad Function · 7

L
Level · 17
Live Display · 17
locking mechanism · 34

M
mass attenuation coefficient · 2
master unit · 24
Meas. Parameter · 26
Measuring Arrangements · 2
measuring effect · 2
measuring range · 32
Menu Structure · 6
Multi-part shieldings · 33

N
NaI Detectors · 65

O
One-Point Calibration · 39, 45
Output Parameter · 16

P
Parameters · 86
14.1 Parameter List

Password · 13
permissible annual dose · 83
photomultiplier · 9
plausibility check · 68
Point detector · 9
Point Source / Point Detector Arrangement · 4
Point Source Arrangement · 40
Point Source Replacement · 73, 83
Point source replacement on rotary cylinder shielding · 79
Point Source Shielding · 40
Point Source Shielding 45° · 19
principle of measurement · 2
Print Parameter · 14

Rod Source Shielding · 31
Rod Sources · 31

S

Safety Instructions · 73
Scintillation counters · 9
Scintillation Detector · 65
Service Menu Structure · 63
Shielding · 57
Shielding Installation · 41
Signal processing · 5
slave units · 24
Source · 57
Source Replacement · 74
Start-Up · 44
Start-Up Protocol · 118
System Configuration · 44
System Configuration Description · 13

T

TECHNICAL DATA · 52
Time Constant · 15
Trouble Shooting · 56
Two-Point Calibration · 46

W

Water cooling · 48
wire length · 10