Density, concentration and solids content

SmartSeries LB 414

Operating manual
56927BA2

Rev. No.: 04, 06/2024
Embedded software version 1.2.1

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Table of Contents

1 About this operating manual

1.1 Applicable Documents

This manual contains the following documents:

- Technical Information, 56927TI2 (see appendix)
- Informations sur la sécurité, 56925BA59 (see appendix)

1.2 Some prior remarks

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

This operating manual illustrates how to:

- set up/install the product
- establish the connections to the power supply
- carry out measurements
- apply software settings
- install (optional) extensions
- carry out maintenance on the product
- carry out troubleshooting
- disassemble the product
- dispose of the product.

Read these instructions thoroughly and completely before working with the product. We have tried to compile all the information for safe and proper operation for you. However, should questions arise which are not answered in this manual, please contact Berthold.

1.3 Storage Place

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

1.4 Target Group

This operating manual is addressed towards qualified specialist personnel who are familiar with handling electrical and electronic assemblies as well as with communication and measuring equipment.

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

1.5 Validity of the Manual

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

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

NOTICE

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

1.6 Structure of the Manual

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

1.7 Copyrights

1.8 Representation

Identifier	Meaning	Example
Quotation mark	Field in the software interface	"Calibrating"
Vertical line	Path specification	Settings | Selection
Pointed brackets	Keys and buttons	<Update>
Round brackets	Image reference	Connect the plug (fig. 1, item 1)

In the software description, the term "clicking" is used if a process is to be activated. This also refers to the pressing of a button (key) or an area on the touch display if a mouse is not used for controlling.

1.9 Warning Notes

⚠ Signal word

Source and consequence
Explanation, if required
▶ Measure
In case of emergency

- **Warning symbols:** (warning triangle) draws attention to the hazard
- **Signal word:** states the severity of the hazard
- **Source:** states the type and source of the hazard
- **Consequence:** describes the consequences if warning is ignored
- **Measure:** states how one can avoid the hazard.
- **In case of emergency:** states how to react in case of direct danger.

1.9.1 Symbols in the Manual

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

⚠ DANGER

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

⚠ WARNING

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

⚠ CAUTION

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

NOTICE

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

IMPORTANT

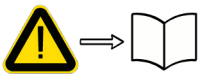
Sections marked with this symbol point out important information on the product or on handling the product.

Tip

Provides tips on application and other useful information.

1.9.2 Symbols on the device

Read the operating manual



Please observe the instructions in this operating manual.

Electrostatic discharge

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

Protective earth connection

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

Equipotential bonding connection

At this position, connect the equipotential bonding conductor.

Direct voltage

The device is operated with direct voltage and may only be connected with a direct voltage source.

Alternating voltage

The device is operated with alternating voltage and may only be connected with an alternating voltage source.

No domestic waste

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

1.10 Conformity

The company Berthold hereby declares in its sole responsibility that the design of this product in the distributed form complies with relevant EU directives stated in the original declaration of conformity.

This statement shall become void in the case of unauthorised changes or improper use.

2 Safety

2.1 Proper use

The product is used in connection with a suitable source of radiation in order to measure the radiation intensity occurring during a radiometric measurement. This measurement can be used for contactless determination of a measurement value (e.g. density) at containers or pipelines.

The following constitutes proper use:

- Adhering strictly to the instructions and operation sequences and not undertaking any different, unauthorised practices which could put your safety and the operational reliability of the product at risk!
- Observing the provided safety instructions!
- Carrying out the prescribed maintenance measures or having them carried out for you!
- Exclusively using measuring accessories offered by Berthold.

The following constitutes improper use and is to be avoided:

- Failing to observe the instructions on safety, operation, maintenance and disposal given in the manual.
- Applying conditions and requirements which do not conform to those stated in the technical documents, data sheets, operation and assembly instructions and other specific guidelines of the manufacturer.
- Use of the product if parts of it are damaged or corroded. This also applies for seals and used cables.
- Restructuring or changing the system components.
- Avoid the following circumstances:
- Using the product in systems in which explosive gases may escape into the surroundings. The product is not explosion-proof.
- The device is not approved according to IEC 61508 “Functional safety of safety-related electric/electronic/programmable electronic systems”.
- Using the product with
    - removed protective cover for the electrical connections
    - improperly closed connections,
    - improperly tightened or damaged screw connections, i.e. screw-type cable fittings, adapters or blind plugs.

- Operation without the safety precautions provided by the manufacturer.
- Manipulation or avoidance of existing safety equipment.

Berthold shall only accept liability for / guarantee the correspondence of the device to its publicised specifications.

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

2.2 Qualification of the Personnel

NOTICE

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

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

These three groups of people are:

- Employees with general knowledge
- Experts
- Authorised Persons.

Employees with General Knowledge

NOTICE

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

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

Experts

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

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

Authorised Persons

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

2.3 Operator's Obligations

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

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

2.4 Declaration of Conformity

BERTHOLD TECHNOLOGIES GmbH & Co. KG
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EC-Declaration of Conformity

We, hereby declare under our sole responsibility that the design of the following products / systems / units brought into circulation by us comply with the relevant EC regulations listed below.

This declaration loses its validity should modifications or unsuitable and improper use take place without our authorisation.

Description: ***Continuous Level and Density Measurement System SmartSeries***

Type: ***LB 41x***

	EC-Regulation And Reviews	Standards and Norms	
EMC	2004/108/EG	EN 61326-1	2006
		+A1	2008
		+A2	2011
		EN 55011	2009
		+A1	2010
		Namur NE021	2011
LVD	2006/95/EG	IEC 61010-1	2010
RoHS	2011/65/EU		

This declaration is issued by the manufacturer

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

released by

Dr. Jürgen Briggmann
Head of R&D
Bad Wildbad, 27th of September, 2013

Registergericht / Court of Registration Stuttgart HRA 330991
Persönlich haftende Gesellschafter / Fully liable Associates BERTHOLD TECHNOLOGIES Verwaltungs-GmbH
Registergericht / Court of Registration Stuttgart HRB 331520
Geschäftsführer / Chief Executive Officer Horst G. Knauff
USt.-Id-Nr. / VAT Reg.No. DE813050511
Deutsche Steuernummer / German Tax No. 49038/08038
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Commerzbank 75105 Pforzheim Konto/Account No. 6 511 120 (BLZ 666 800 13) SWIFT-BIC DRES DEFF 666
IBAN: DE05 6668 0013 0651 1120 00

3 System Description

3.1 Measuring principle

The device is used for contactless and continuous determination of the density of a product (liquid, suspension, bulk material density) by applying radiometric measuring technology. For this purpose, the radiation of radioactive material is quantitatively measured. If the radiation penetrates the measuring container (e.g. pipeline), its intensity is reduced. This intensity reduction is proportional to the density of the penetrated medium.

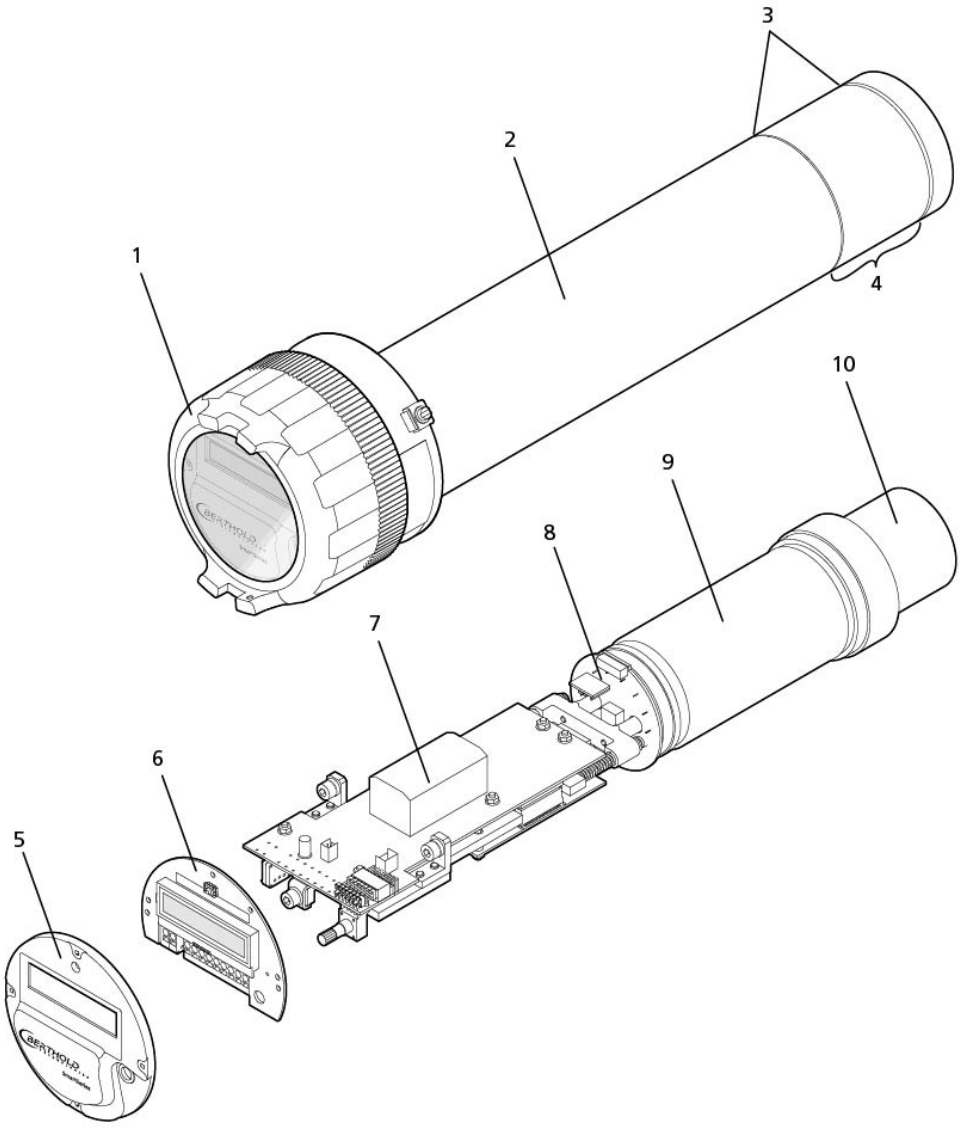
A complete measuring system includes the following components:

- Radiation emitter inside shielding
- Mounting fixture for radiation emitter and detector
- Detector for radioactivity with electronic evaluation unit.

This operating manual refers to the operation of the detector. The operation of the remaining system components is subject of the independent operating manuals of the particular system components. The field device can be operated uncomplicated on site and can be installed easily without causing work interruptions.

3.2 System Components

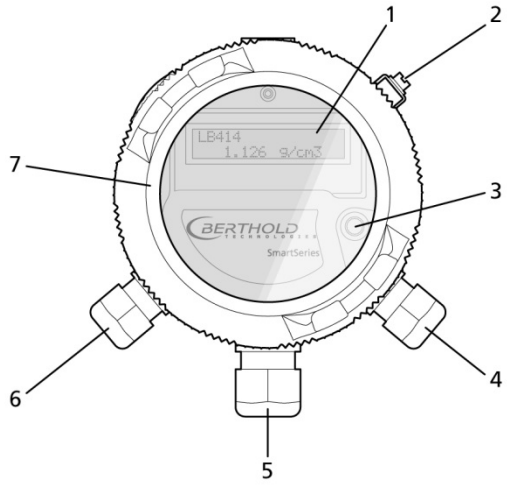
3.2.1 Overview



1 Cover made of shockproof and scratch-resistant plastic with viewing window. Optional: For temperature ranges below -20 °C (-4 °F), the field device will be provided with a stainless steel cover without viewing window.
2 Stainless steel housing for mechanical detector system, electronics holder and display/operating unit
3 Marking groves mark the sensitive area
4 Sensitive area
5 Contact protection
6 Display unit
7 Mounting plate with special electronics
8 Photomultiplier base
9 Photomultiplier
10 Scintillator (polymer, optionally: NaI)

Fig. 1 System components

3.2.2 Front View of the LB 414 Field Device



1 Local display
2 Equipotential bonding
3 Status LED and control button
4 M16 cable gland
5 M20 cable gland
6 M16 cable gland
7 Screw cover

Fig. 2 Front view of the LB 414 field device

3.2.3 Software

The field device is delivered with pre-installed software. It is designed for 3 measuring modes: Density and concentration measurement as well as solids content measurements.

The revision status (version) of the software is displayed on the screen display when starting up the field device or in the "Channel Setting" menu.

This operating manual describes the software version 1.2.1. Software updates are carried out with the Detector Service Modem (refer to accessories).

3.3 Accessories and Options

For accessories and options for the LB414 field device, please refer to chapter 9 in this manual.

4 Installation

4.1 General Instructions

NOTICE

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

Repair and maintenance at the SmartSeries field devices may only be carried out by experts (refer to chapter 2.2).

In case of doubt, the complete detector has to be returned to Berthold for repair.

NOTICE

The detectors of the SmartSeries field devices are equipped with a photomultiplier with glass housing and/or a fragile scintillation crystal. The field devices have to be handled with care to prevent breaking or splintering of the photomultiplier or the crystal.

NOTICE

For installation of the device, exclusively mounting fixtures approved by Berthold are to be used.

NOTICE

The device may only be operated if permanently installed.

NOTICE

For open-air installation, a weather protection cover has to be installed above the detector device. This cover provides protection against direct sunlight and subsequent heat with respect to specification (refer to chapter 11).

4.2 Unpacking/Scope of Delivery

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

4.3 Installation of Mounting Clamps

Mounting clamps are used for installation of the field devices. These clamps are installed on a mounting base, cross beams or similar which are to be provided by the operator. For further details, please refer to chapter “Technical Information” (chapter 11).

Please ensure that:

- Holders for the field device or the source do not obstruct the beam path.
- No tubes, flanges, agitators or other installations are existing in the radiation path.

This type of installation is only admissible if it had already been known during design of the measuring system. Otherwise, the characteristic curve is no longer linear and sections in the measuring range can occur where no changes to the measuring values are detected.

NOTICE

The field device holder must not transfer any vibrations, shocks or heat onto the field device as this might lead to malfunctions or failures of the field device.

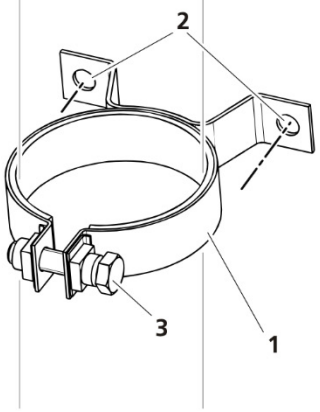
- For this reason, install the holder on a vibration-free support or dampen potential vibrations with vibration dampers.
- Prevent heat transfer onto the field device via the detector holder by applying appropriate insulation material.

The field device is installed vertically on the exterior of the pipe or container. The top point of the effective detector length is marked by a marking grove that also defines the top point of the effective measuring range.

The field device is mounted as illustrated in Fig. 3 or Fig. 4, with one clamp each on the top and bottom outside the marking groves. The distance from the centre of the detector up to the container surface or surface of heat insulation is assumed with approx. 100 mm when calculating the measuring position. Mounting of the clamps must prevent excessive heat transfer onto the detector.

The detector is installed with a holder (also refer to Fig. 4). For this, a suitable panel is to be provided and installed at the container. The distance to the container surface or potential heat insulation should be approx. 100 mm. Mounting is achieved using clamps or an installation kit on a suitable panel or rail without obstructing the radiation window to the emitter. The radiation window is to be aligned in the direction of the emitter.

Mounting clamp type 1

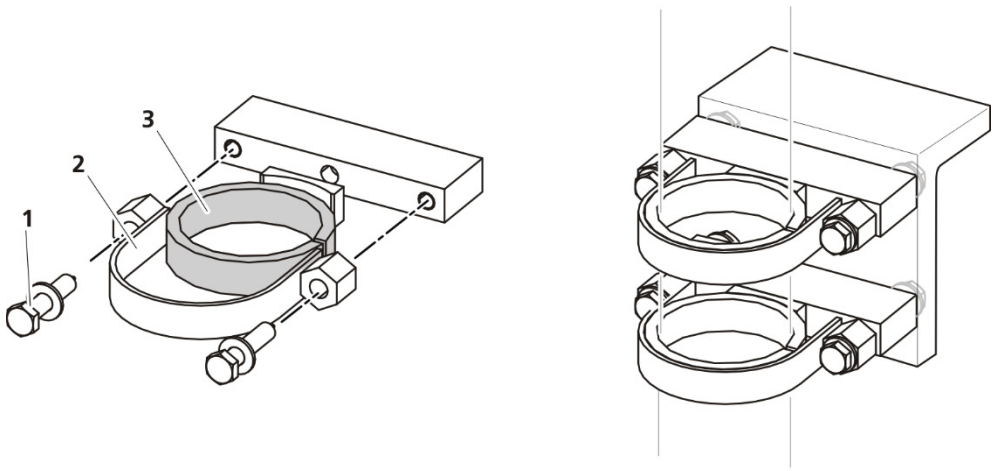


1 Hex Mounting clamp
2 Holes for mounting material
3 Hex screw M10

Fig. 3 Tension clamp

1. Unscrew the fastening screw on top of the mounting clamp.
2. Slide the clamp from over the detector housing.
3. Tighten the screw sufficiently so that the mounting clamp cannot slip on the detector.
   - ▶ The assembly is complete

Mounting clamp type 2 and device holder



1 Screw M10 incl. washer
2 Top part
3 Spacer ring

Fig. 4 Bracket clamp and stainless steel device holder

1. Unscrew the two screws on the side of the mounting clamp.
2. Take off the top part of the mounting clamp.
3. If necessary, remove the spacer ring if a detector with water cooling system is to be installed.

4. Place the detector in the bottom part of the mounting clamp
5. Refit the top part and tighten the screws until the mounting clamp can no longer slip on the detector.
   - ▶ The assembly is complete.

IMPORTANT

For each field device, at least two mounting clamps are to be used. The two clamps have to be mounted as far apart as possible (observe the installation situation). After installation, none of the two clamps may be in contact with the sensitive area of the field device (marked by the marking groves on the housing).

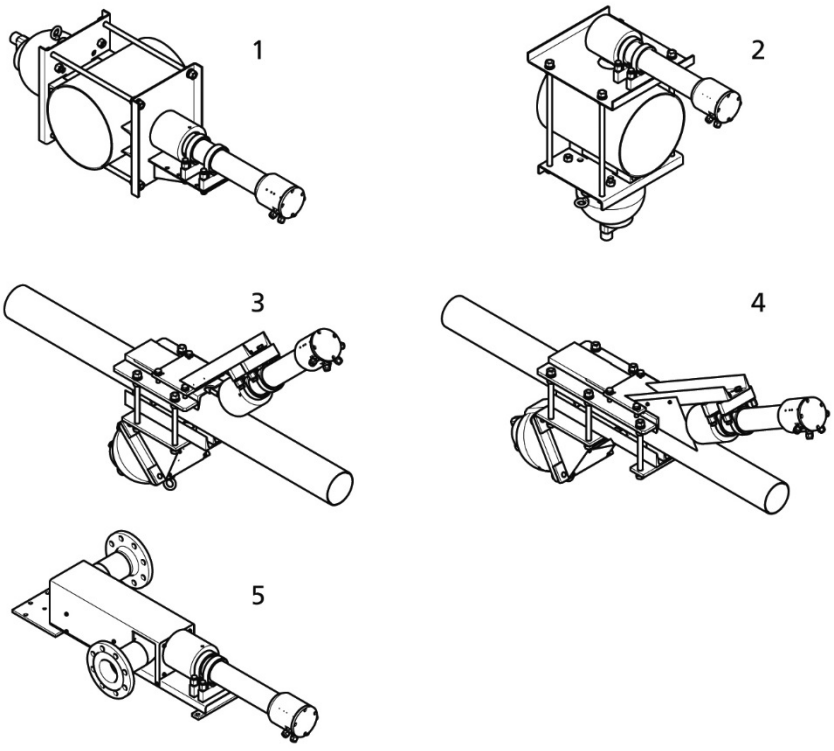
4.4 Installation on a Pipeline

Different mounting fixtures are available to install a field device and a source with shielding on a pipeline. These mounting fixtures are available with different angles (30°, 45°, 90°) and for various pipe diameters as well as in conventional, parallel and S and U shaped design.

For more detailed descriptions, please refer to the Technical Information chapter (chapter 11). The various types of mounting fixtures already include mounting clamps. To install the detector, please follow the instructions in chapter 4.3.

IMPORTANT

If the pipelines are running horizontally, the measuring system is also to be installed horizontally to minimize interfering impacts like air bubbles and/or deposits.



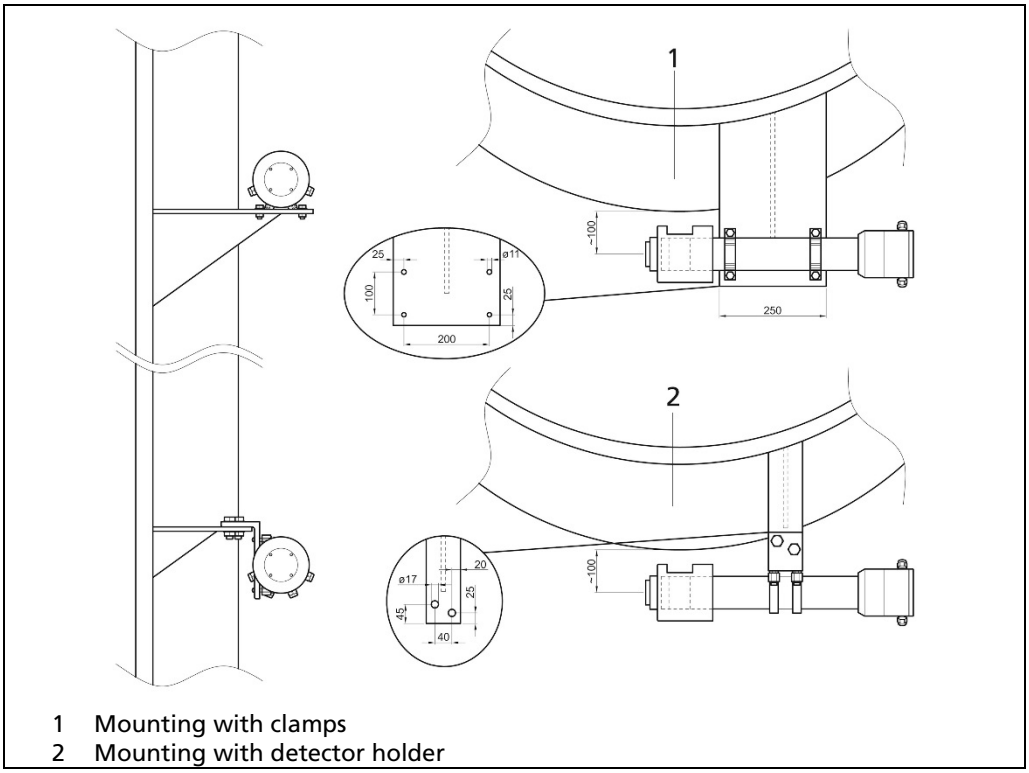
1 Mounting fixture for a radiation angle of 90° and vertical installation of the field device
2 Mounting fixture for a radiation angle of 90° and parallel installation of the field device
3 Mounting fixture for a radiation angle of 45°
4 Mounting fixture for a radiation angle of 30°
5 S shaped density measurement section

Fig. 5 Overview - Pipeline installation

- Use the provided four bolts and nuts to install the mounting fixture at the pipeline.

4.5 Installation on a container

For bulk material density measurements, a special holder is available to install the field device on a container. It has to be ensured that the detector is positioned in the beam path of the emitter.



1 Mounting with clamps
2 Mounting with detector holder

Fig. 6 Installation of the point detector

4.6 Water Cooling System

⚠ DANGER

Danger of death by electrical shock upon failure of the water cooling system!

- The installation may only be carried out by qualified electricians.
- All relevant safety regulations have to be observed.
- Use the temperature limit value at Dig-Out as pre-alarm.
- Have the temperature limit value indicated by residual current.

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

To protect the scintillators against overly high temperatures, a water cooling system is optionally available. A water cooling system has to be used if the ambient temperature of the field device could exceed +60°C.

In this respect, ambient temperature, sun light, radiant heat of hot components and the transition of heat from installation fixtures are to be considered. With water cooling, the detectors can be operated at a maximum ambient temperature of 100 °C.

NOTICE

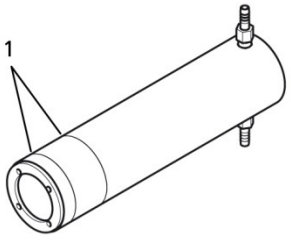
If the cooling water is left in the water cooling system when there is a risk of frost, this may lead to mechanical damage of the water cooling system.

NOTICE

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

NOTICE

Failure of the water cooling system or insufficient flow may overheat the detector and destroy it. For cooling, exclusively use water with drinking water quality.



1 Marking groves at the water cooling system of the field device

Fig. 7 Water cooling system

4.6.1 Minimum Cooling Water Requirement

For the minimum cooling water requirement, please refer to the following chart.

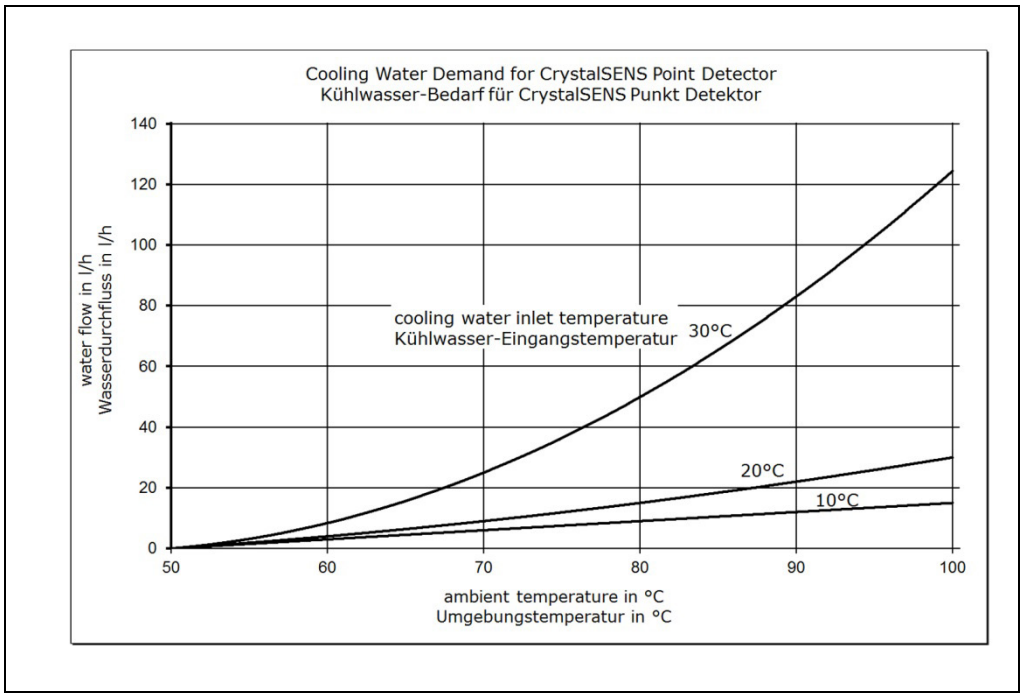
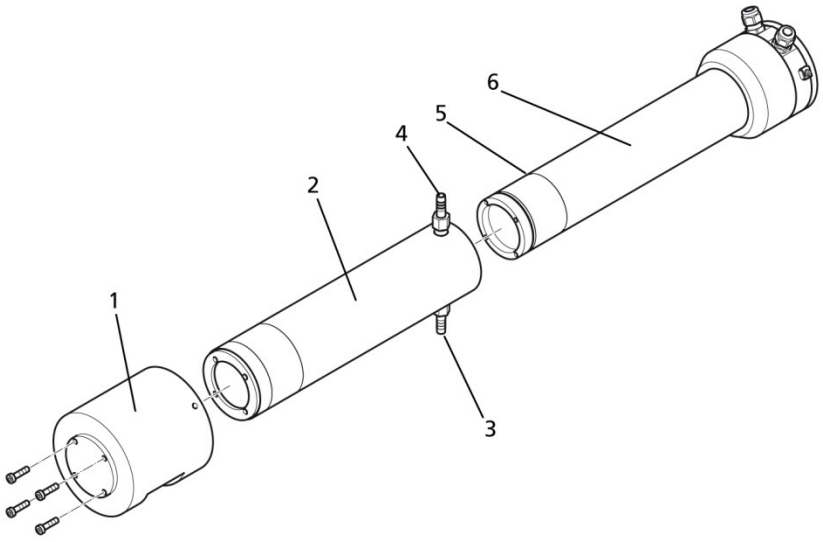


Fig. 8 Cooling water requirement

4.6.2 Installation and connection of the water cooling system

If the field device is equipped with a water cooling system, the position of the cooling connections must allow for unobstructed connection of the water supply. Make sure that the water lines do not run in front of the radiation window. To avoid air pockets in the water cooling system, the lines have to be installed as follows:



1 Collimator (if applicable)
2 Water cooling system
3 Water supply
4 Water discharge
5 Marking grove
6 Field device

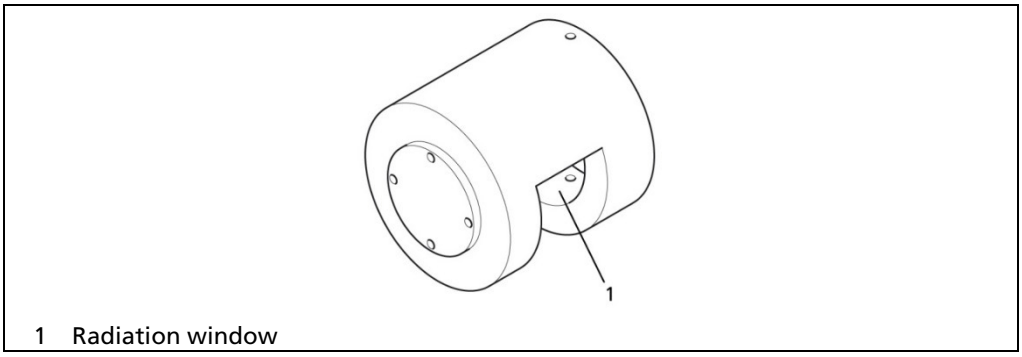
Fig. 9 Field device with water cooling system

1. Slide the water cooling system (Fig. 9, pos. 2) with the connection nozzles pointing forward towards the connection housing (Fig. 9, pos. 1).
2. Attach the water cooling system with the provided screws at the pipe of the field device.

If the field device has been installed in horizontal position, the bottom connection (Fig. 9, pos. 3) has to be used as water supply.

If the field device has been installed in vertical position, the connection housing has to be aligned to the top so that the connections are at the top end of the water cooling.

4.7 Collimator



1 Radiation window

Fig. 10 Collimator

The optionally available lead collimator provides protection from background radiation and ensures high reliability and measurement accuracy. The collimator is available with a radial (irradiation from the side) or axial (irradiation from the front) radiation window.

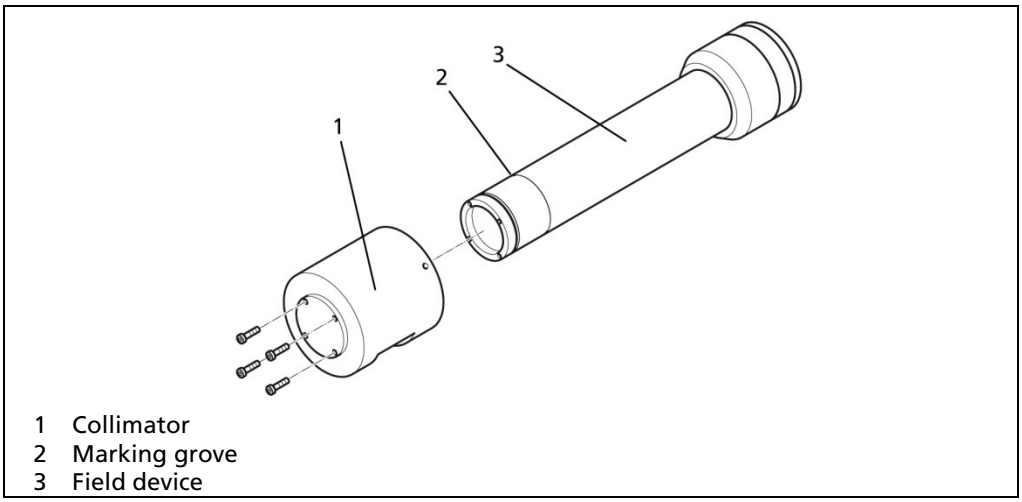
4.7.1 Collimator Installation

With Water Cooling System

1. Remove the plastic ring from the collimator by unscrewing the screws on the side.
2. Slide the collimator over the water cooling system so that the radiation window is positioned at the source. In this process, align the collimator and the water cooling system to the circular opening of the field device. Make sure the position of the connection nozzles does not obstruct later installation of the water supply (refer to Fig. 9).

Without Water Cooling System

1. Slide the collimator over the detector housing so that the radiation window is positioned at the emitter. In this process, align the collimator to the circular opening of the detector.



1 Collimator
2 Marking grove
3 Field device

Fig. 11 Collimator installation without water cooling system

5 Electric Installation

5.1 General Instructions

⚠ DANGER

Danger of death by electric shock!

- The installation may only be carried out by qualified electricians.
- All relevant safety regulations have to be observed.
- Open the housing only in a dry environment and for installation, maintenance and servicing.
- The contact protection may only be removed if the device has been de-energised.
- During installation and servicing at the hardware and particularly during wiring of the detector, the measuring system, potentially connected relay contacts and all inputs and outputs must be de-energised.
- Only connect devices to our products that comply with the requirements of the Low-voltage Directive (DIN EN 61010-1).

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

The supply source of the 24 VDC product version has to comply with the requirements of chapter 6.3 (limit values for accessible parts) of the Low-voltage Directive (DIN EN 61010-1) and be equipped with a double or reinforced insulation.

The voltage parameters of all devices connected to the outputs of the product (e.g. relay circuit, 3.3 V output, RS-485, current output) have to comply with the limit values of chapter 6.3 (limit values for accessible parts) of the Low-voltage Directive (DIN EN 61010-1) and be equipped with a double or reinforced insulation.

These protective measures are necessary to avoid the risk of contact with life-threatening voltages.

Changing the installation without precise knowledge of this operating manual is not permitted.

NOTICE

The connection chamber may only be opened in dry conditions, never when it is raining. Humidity in the connection chamber may lead to a short circuit.

The device can also be operated via the HART® communicator, an IR remote control or a PC (option), also if the cover is closed.

NOTICE

Material damage caused by overheating!

Make sure, that the device is also not operated in case of failure of a potentially installed water cooling system. For monitoring, make use of the internal temperature sensors.

General important points for installation

- Connect the PE conductor.
- Ground the housing.
- Please observe the information signs on the detectors.

NOTICE

For open-air installation, a weather protection cover is to be installed over the detector that also provides protection against direct sunlight and associated heat.

5.2 Circuit Breaker

A circuit breaker according to DIN EN 61010-1

- must be available,
- must be easily accessible for the maintenance personnel and
- is to be included in the company-intern documentation.

The field device is not equipped with a separate ON/OFF switch to connect or disconnect the voltage supply. Make sure that the field device can be de-energised via the external power supply (by means of an automatic fuse and/or main switch).

The circuit breaker can be installed as automatic fuse or switch and has to comply with the requirements according to IEC 947-1 and IEC 947-3. If a fuse is applied, it must not be triggered under a current strength of 4 A per device.

IMPORTANT

The circuit breaker must be located near the device and be properly marked as belonging to it.

5.3 Cables and Lines

- Lines are to be connected with special care.
- Connection lines and routing must comply with the applicable regulations.
- When routing the cables, make sure that the cable insulation cannot be mechanically damaged by sharp edges or movable metal parts.
- When routing the connection lines, make sure that
  - no dirt and humidity gets into the connection chamber,
  - the conductors are not damaged when the cable insulation is removed,
  - the conductor insulation or the sleeve of the wire end ferrules reach into the housing of the terminal unit,
  - blank, conductive segments of the lines (e.g. wires of a litz wire) do not reach outside the terminal unit,
  - the wire end ferrule or the stripped wire have a length of 8 mm so that the wire is held securely in the spring terminal,
  - the line insulation reaches into the sleeve of the wire end ferrule if these components are used,
  - the admissible bending radius for the respective line cross-section is not exceeded and
  - the cables are laid out in a strain-relieved and friction-free manner.

The cross-section of the used cables must always be suitable for the respective cable gland. The cables must comply with the requirements and cross-sections specified in the technical data.

The connected cables must be appropriate for temperatures of at least 10°C above the maximum admissible ambient temperature. Particularly when using a water cooling system, all connection cables must be designed for the respective temperature conditions.

The ends of multi-wire conductors or litz wires must not be tinned or soldered. Admissible options are wire end ferrules and direct connection of litz wires.

NOTICE

Make sure that all multi-wire conductors or litz wires run into the terminal and are clamped.

5.4 Cable Glands, Adapters and Blind Plugs

Cable glands must be suitable for the respective application. Cable glands, adapters and blind plugs must be approved at least according one of the following guidelines or standards:

- EN50262
- UL1565
- C22.2 No. 0.17.92
- ATEX

Please note that only one adapter per cable gland may be used. Screwing together several adapters is not permitted.

Cable glands that are not required for installation must be covered with blind plugs.

For reinforced cables, special cable glands are required. For information on the installation of cables, please refer to the installation instructions of the used cable gland.

Line cross-sections must comply with the respectively used cables.

Cable glands and blind plugs must comply with the applicable IP protection class and with the requirements for the operational environment.

In case of doubt, we recommend ordering additionally required cable glands, blind plugs or adapters from Berthold.

5.5 Protective Earth Conductor and Equipotential Bonding

The protective earth conductor has to be connected to the terminals marked with PE.

The housing must be connected to local equipotential bonding.

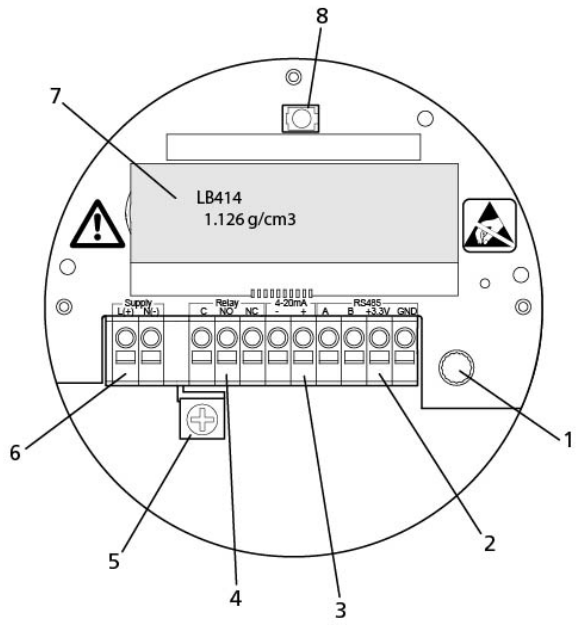
5.6 Initial Start-up

⚠ DANGER

Danger of death by electric shock!

- The installation may only be carried out by qualified electricians.
- All relevant safety regulations have to be observed.
- Installation/maintenance may only be carried out if the device has been de-energised.
- The contact protection may only be removed if the device has been de-energised.

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



1 Control button with status LED
2 RS485
3 Analogue output (4-20 mA, HART)
4 Digital output
5 PE connection (with screw)
6 Voltage supply
7 Display
8 IR receiver

Fig. 12 Connection chamber

1. De-energise the field device.
2. Unscrew and remove a possibly provided locking mechanism.
3. Remove the screw cover.
4. Unscrew and remove the four screws of the contact protection.
5. Connect the conductors to the respective positions.

Pin assignment

1	AC Wide Range (100-240 V) L or DC 24 V +
2	AC Wide Range (100-240 V) N or DC 24 V -
3	Relay C (change over)
4	Relay NO (normally open)
5	Relay NC (normally closed)
6	Current output – (galvanically isolated)
7	Current output + (galvanically isolated)
8	RS485 A *
9	RS485 B *
10	RS485 +3.3 V supply voltage *
11	RS485 GND supply voltage *
PE	Protective earth

* no galvanic isolation

6. Reattach the contact protection and fasten it with the four Phillips screws.
7. Mount the screw cover.
8. Replace a possibly provided locking mechanism.
9. Connect the field device to voltage supply.

NOTICE

To remove the conductors from the terminals, push a screwdriver into the slot.

6 Operation

6.1 LED Indicator

The LED (Fig. 2, pos. 3) under the display indicates the current operating state of the field device (according to Namur NE-107):

Green	Normal	The device is in regular operating state without any notifications.
Yellow	Out of specification	The device, a component or the process is operating outside of its respective specifications.
Orange	Function Check	• Entries are made at the detector. • A function check/simulation is being performed.
Red	Failure	The device is in an error state.

NOTICE

At a temperature of -20 °C, the display switches itself off automatically.

For further information on the operating states, please refer to chapter 7.3.

6.2 Condition on delivery and important information on initial commissioning

NOTICE

Before commissioning, the device must be calibrated. Use the Quick Start Wizard to calibrate. It is not possible to pre-calibrate the device at the factory.

- The current output is configured in the source mode. If the device is to be operated in Sink Mode, this mode must be set in the “Change Supply” menu (HART 2,5,6,2,8) .

NOTICE

If no external power is supplied the setting to “sink mode” causes the operation via the HART communicator no longer possible.

- Behaviour of the current output in the condition on delivery according to Namur NE-43: 3.8 mA LRV (lower measuring range), 20.5 mA URV (upper measuring range). The fault current is 22 mA.
- Status events are output according to Namur NE-107. All “Function Check events” are indicated (see HART 3,1,1,1).

- In the condition on delivery, the relay is only activated in the case of a “Failure” error. If you want the “Function Check” or “Out of Range” events to be indicated via the relay as well, this can be activated in menu 2,5,7,4,1.
- In the basic setting, process value alarms or temperature alarms are not output.
- All changes made in the “Calibration” menu are first saved to a calibration parameter set. The measurement is not influenced as it is based on the measuring parameter set. The measuring parameter set is only overwritten with the calibration parameter set when the CALIBRATE command is executed.
- By pressing RECALL, the measuring parameter set applied at the time of the measuring value calculation can be copied to the calibration parameter set. In this way, all changes carried out at the calibration parameter set are overwritten.

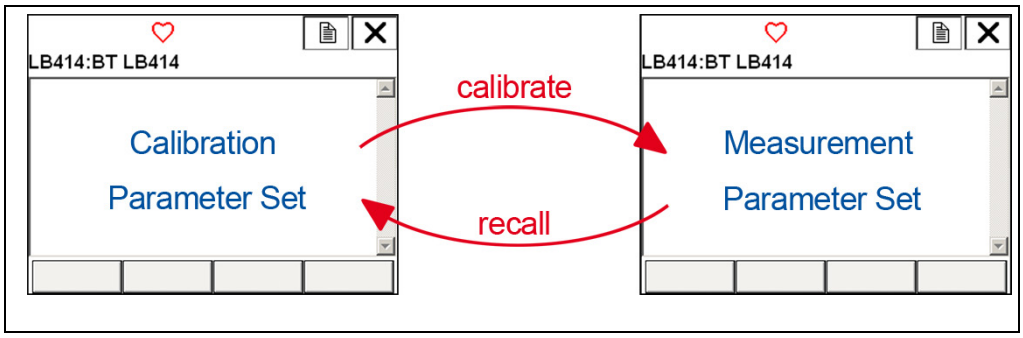


Fig. 13 Concept measuring and calibration parameter set

NOTICE

After a voltage dip, the system time continues running using the most recently saved time stamp. Set the time and date again, if the voltage was interrupted.

NOTICE

The device can be equipped with a write protection to protect it against unauthorized setting changes. It is recommended to activate the write protection after conducting the calibration (see HART 2,5,4,2).

NOTICE

Before an existing calibration with other measurement points will be added or modified, you have to carry out a "Recall".

6.3 Operating Concept

For operation, different user interfaces are available:

1. Local interface with control button
2. IR remote control (optional)
3. HART (e.g. via HART Communicator or other engineering tools)
4. PC software (via RS-485 connection and Detector Service Modem)

All user interfaces provide access to all detector functions.

The various operating concepts are illustrated below.

Afterwards, operation and configuration is illustrated on the HART Communicator. The menu structure can also be applied for usage via PC.

NOTICE

Do not use the various user interfaces at the same time to avoid data inconsistencies.

6.3.1 Local User Interface (LUI)

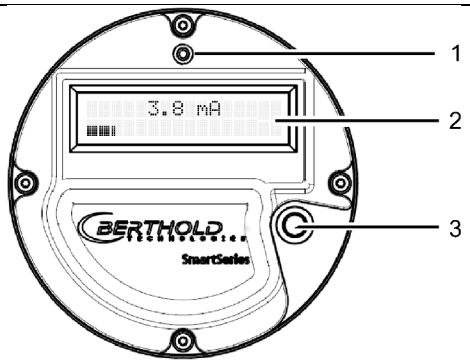
The local interface is controlled via a rotary knob which can be accessed by removing the housing cover. Alternatively, an IR remote control can be used which provides the same input possibilities as the rotary knob.

With the rotary knob, menu entries can be selected by turning (left or right). The submenu can be accessed by pushing the button. By quickly pushing twice (“double-click”), a superordinate menu level can be accessed.

The menu structure will be the same as described for the HART communicator in general. Some parameters might be named slightly different due to the limited space on the display.

NOTICE

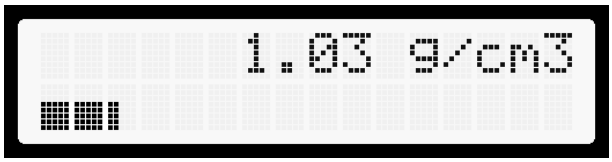
At a temperature of -20 °C, the display switches itself off automatically.



1 Infrared Sensor
2 Display
3 Status LED and rotary knob

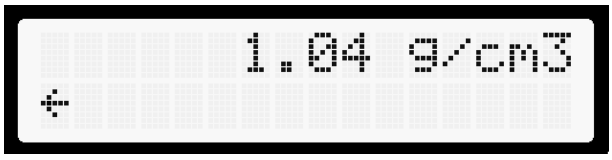
Fig. 14 Local User Interface

6.3.1.1 Symbols

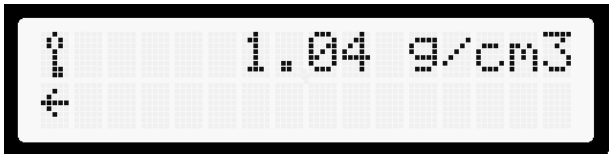


Top: Process Variable (PV) with unit

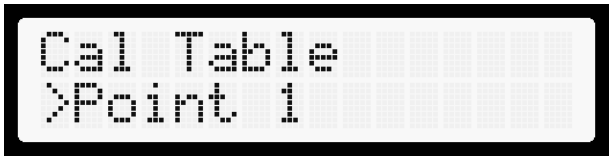
Bottom: Bar graph showing the PV range. (percentage representation over measurement range 4 … 20 mA).



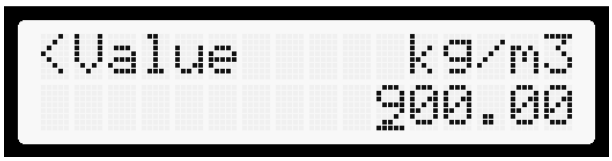
A measured value below or above the PV range will be indicated by an arrow.



A write protection is indicated as a key symbol in the top row.



The arrow '>' indicates the existance of a submenu. For editable values you will enter the edit mode.



The arrow '<' indicates: No submenu existing. Pushing the button leads a menu level higher.

This will be effective for read-only variables as well as in editing mode.

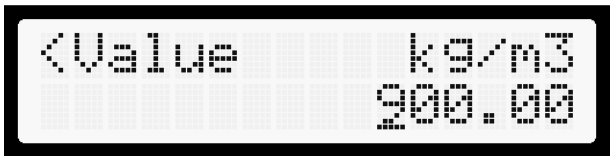
6.3.1.2 Operation

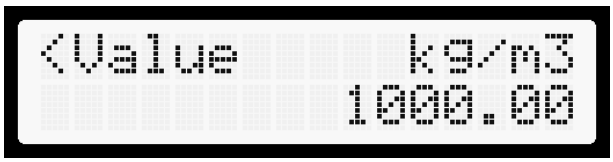
	Pushing button one time shortly:	Move one step down / Confirm.
	Pushing button two times shortly (double click):	Move one step up / Cancel.
	Pushing button for longer time (when editing value):	Write edited value to device: • The operation is finished successfully (The LED quickly flashes green). • The value is rejected (The LED shortly flashes yellow).
	Pushing button for longer time: (all other menus):	Jump back to main menu.

6.3.1.3 Editing mode

Numerical input:

1. Push button to enter edit mode. The underscore cursor will be displayed permanently.
2. Navigate to the digit to edit.
3. Push the button.
4. The underscore cursor will flash.
5. Turn the button until the desired value is displayed.
   a. Increasing a digit above 9 will also increase to next higher digit.
   b. The reduction of an equivalent value will delete one decimal.





6. Push the button and repeat steps 2-6 until all desired values are correct.
7. Push the button long to accept edited value or double click to discard it.

Character input

1. Push to get in edit mode. The underscore cursor will be displayed constantly.
2. Navigate to the character to edit.

3. Push the button.
4. The underscore cursor will flash.
5. Turn the button until the desired character appears.
6. Push the button and repeat step 2-6 until all desired characters are correct.
7. Push the button for long time to accept the edited value or double click to discard changes.

Menu selection:

Some menus offer different presettings. This options will be displayed in CAPITALS.

To change the value or action:

1. Push to enter edit mode. The option starts flashing.
2. Turn the button until the desired option/action appears.
3. Push the button for long time to activate the option/action or double click to discard changes.

6.3.2 IR LED Remote Control (optional)

Operation via infrared remote control is identical to operation via LUI. The indicators are displayed in the local display.

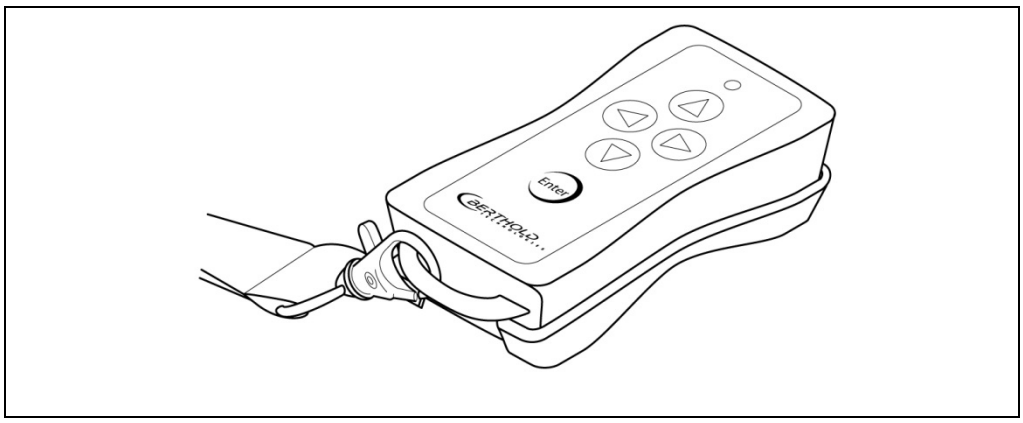


Fig. 15 Infrared LED Remote Control

6.3.2.1 IR channel activation

Below, combinations of numbers are illustrated in the margin column. By entering the individual numbers (without comma) in the online menu on the operating field of the HART Communicator, the respectively described menu item can be directly accessed.

2,5,9	Browse to the menu item Device Setup / Setup / Interface,
2,5,9,3	continue to menu item “IR Remote Control”.
2,5,9,3,1	set the Receiver to “ON”.
2,5,9,3,2	set the desired Channel.

6.3.2.2 Remote control usage

In order to use the remote control a link between the receiver and transmitter channel needs to be established. Accordingly point the remote control towards transmission direction to the LUI and press one of the buttons 1-4 (Fig. 16) to activate.

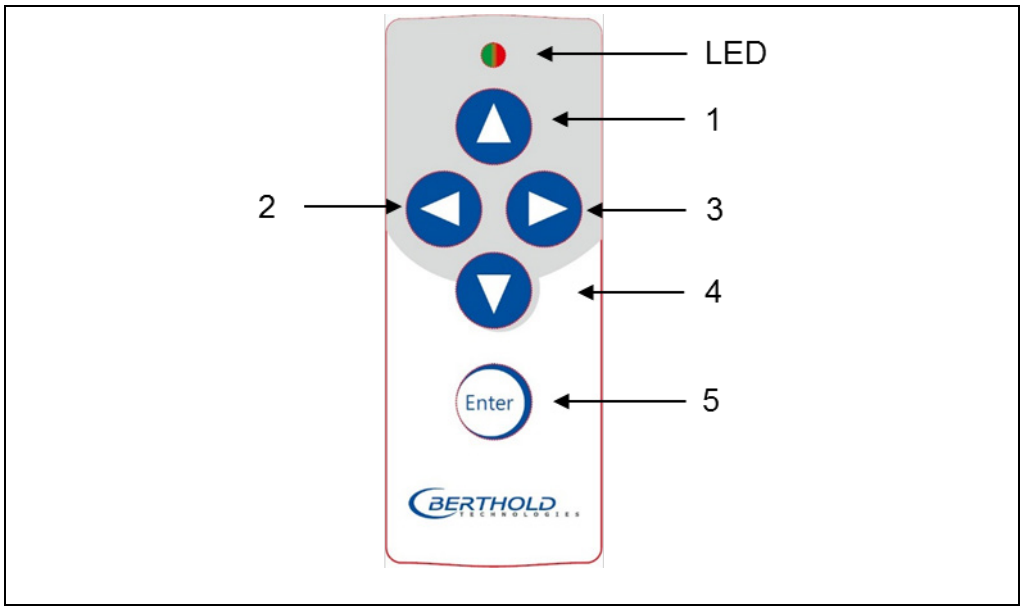


Fig. 16 Button configuration

If both, the IR receiver -and transmission channel are aligned the LED will flash green and immediately activate the LUI display. Further maneuver of menu and device configuration are available via button (1 to 5) and simultaneously shown on the local display. Factory settings configure a transmission via channel 1.

6.3.2.3 Selected IR channel

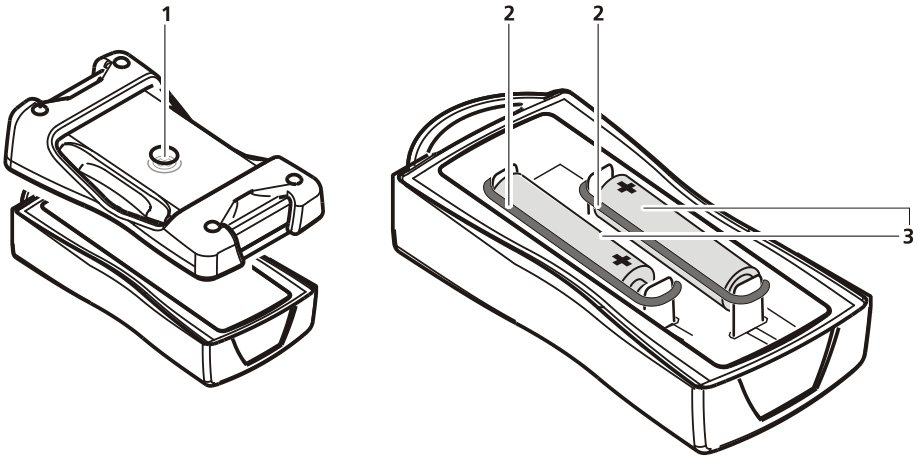
In case several detectors are in close range, an unintended operation can be prevented by multifunctional channel set-up of the remote control. Here, different signal channels are available. To select the requested broadcast channel, simultaneously push button 2 and 3 for a few seconds until LED flashes red. Now choose the preferred channel by pressing a button (1 - 5), confirmed by LED flashing green.

6.3.2.4 Remote Control operation

Enter	Short push button (5)	• Input will not be saved, move one level up
Enter	Long push button (5)	• Move out of menu • Input will be saved, LED flash green
	Short push button (2)	• Move one level up • Choose editable value
	Short push button (3)	• Move one level down • Choose editable value
	Short push button (1) (4)	• Scroll entries per level • Select editable value

If entry activity on idle for a longer period, the LUI automatically moves out of the menu level, any prior inputs are not saved.

6.3.2.5 Replacing the batteries



1 Phillips screw
2 Safety rings
3 Battery 1,5 V, type AA

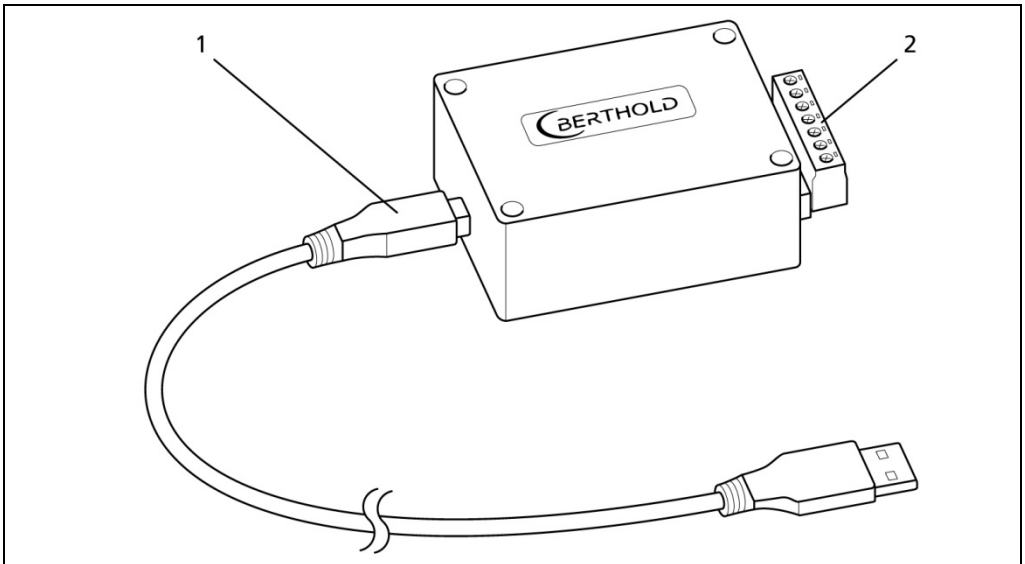
Fig. 17 Replacing the batteries

1. Loosen the Phillips screw (Fig. 17, item 1) at the bottom side and open the housing.
2. Remove the safety rings (Fig. 17, item 2) and replace both batteries (Fig. xx, item 3).
3. Attach the both safety rings (Fig. 17, item 2) an.
4. Attach the bottom side of the housing and tighten the Phillips screw (Fig. 17, item 1).

6.3.3 PC Software

The following system requirements have to be met:

System requirements	Menu language: English Windows XP or higher 512 MB RAM 1 GHz processor USB port
Connections	USB port RS 485 to detector
Software LB 41x PC Control	Display of count rate Display of field device temperature Display of extreme values of field device temperature Setting of high voltage for operation of the photomultiplier (Automatic or manually) Automated process for acquiring the amplifier plateau of the photomultiplier Access to the change log of the connected field device Access to the error log of the connected field device Software update Resetting the field device to the factory settings



1 USB cable
2 Terminal strip for the field device

Fig. 18 Detector Service Modem

Software installation

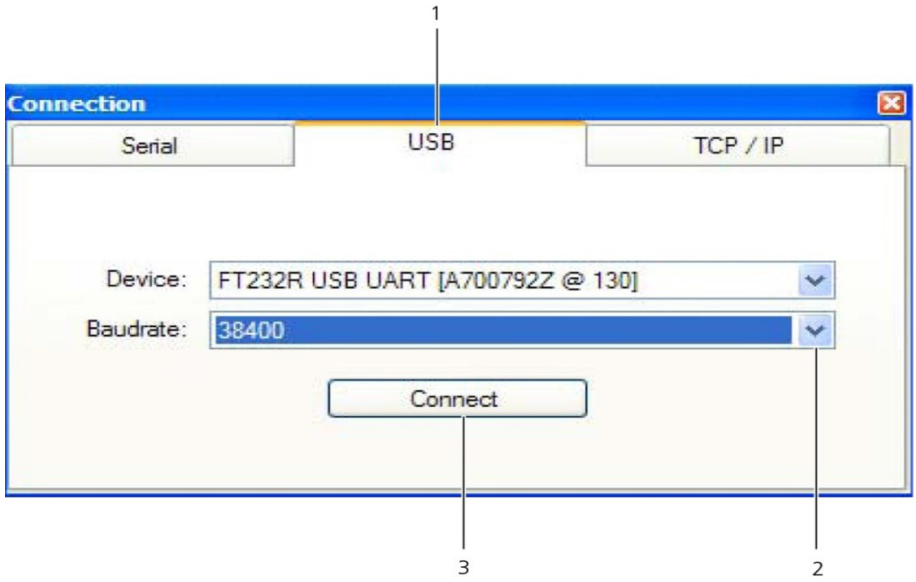
1. Install the drivers by executing the driver file "BertholdRS485.exe" before connecting the Detector Service Modem.
2. Execute the installation file "Setup.exe" in order to install the operating software "LB 41x PC control".

The operating software "LB 41x PC control" provides access to software of the field device.

3. Connect the control cable with the Socket for “ext. Communication” of the field device.
4. Alternative solution: Connection directly in the connection housing of the field device. For this purpose, remove the cover and connect the „Detector Service Modem“ to RS 485 A/B (Fig. 12, Terminal 8 and 9).
5. Connect the field device to the terminal strip at the “Detector Service Modem" (Fig. 18, pos. 2).
6. Connect the “Detector Service Modem" via the supplied USB cable (Fig. 18, pos. 1) to a free USB port on your PC.
7. Start the program "LB 41x PC control.exe".

The program opens.

8. Click on the tab <USB> (pos. 1).
9. In the drop-down menu (pos. 2), select a baud rate of 38400.
10. Click on <Connect> (pos. 3).



1 USB tab
2 Selection of baud rate
3 Connect button

Fig. 19 Connection page, “LB 41x PC control” operating software

▶ The start page of the program “LB 41x PC control” opens:

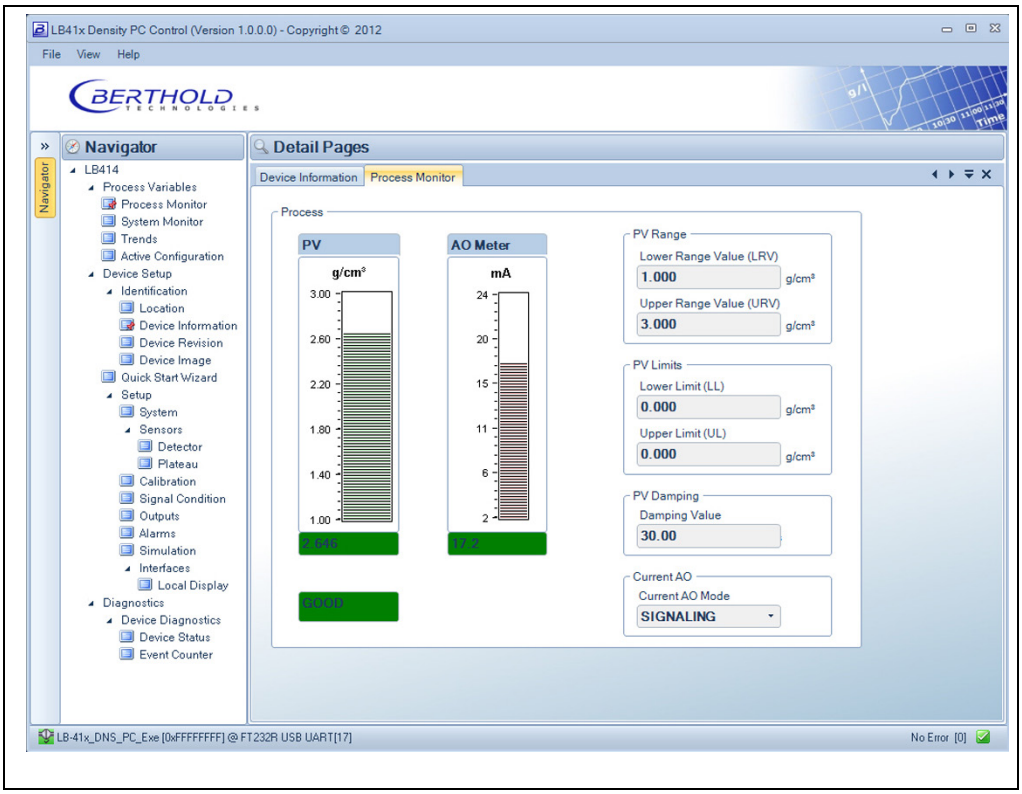
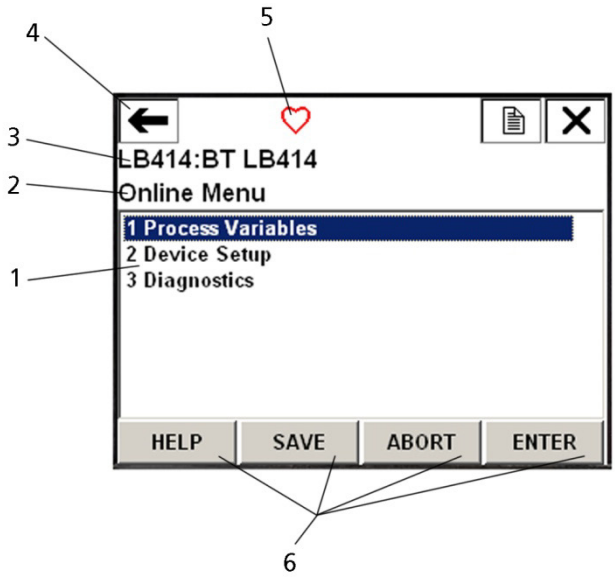


Fig. 20 Start page, “LB 41x PC control” operating software

6.3.4 Operation via HART Communicator

The HART Communicator is connected to the current loop. If a HART/RS485 plug is available, this plug can be used (refer to chapter 9, accessories).



1 Available menu items
2 Currently accessed menu
3 Name of the connected device
4 Back to the last step
5 "HART Beat", displaying the communication to the device
6 Space for up to four varying buttons

Fig. 21 General set-up of the HART Communicator screen

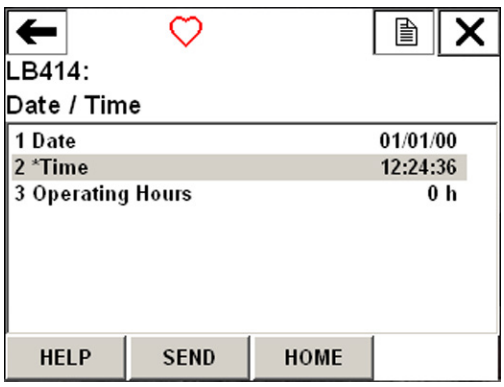


Fig. 22 Input window example

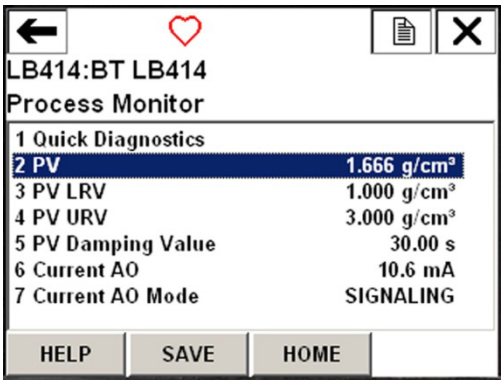


Fig. 23 Entry mask (example)

6.3.4.1 How does the HART Communicator work?

SEND

Changed values are first marked with an asterisk. These values are saved in the field device by pressing the SEND button. The asterisk and the yellow marking disappear.

SAVE

The data can be saved to the HART Communicator (“Internal Flash”) or to an external data carrier (“System Card”) and named.

NOTICE

Changes that are made via the OFFLINE menu are not supported.

EXIT

When pressing the EXIT button, the previous value is kept.

HELP

A short information on the displayed values is provided.

HOME

return to the highest menu level.

2,5,3,2,1,4

Below, combinations of numbers are illustrated in the margin column. By entering the individual numbers (without comma) in the online menu on the operating field of the HART Communicator, the respectively described menu item can be directly accessed.

6.4 Physical background

6.4.1 "Density" Mode

The density ρ is calculated from the measured count rate I according to the following equation

$$\ln(I - I_{BG}) = a_0 + a_1 \rho d$$

with I measured count rate,
I_{BG} background count rate
d absorption length.

The coefficients a_0 and a_1 are defined as

$$a_0 = \ln(I_0)$$

$$a_1 = \mu$$

with I_0 is the theoretical count rate at zero density
μ μ (with $\mu < 0$) the linear mass absorption coefficient for the selected radionuclide.

If at least two calibration points are available, both coefficients are determined numerically. With one calibration point, only a_0 is determined numerically.

6.4.2 "Concentration" Mode

The concentration is calculated from the measured count rate I according to the following equation

$$\ln(I - I_{BG}) = b_0 + b_1 c d$$

with I measured count rate
I_{BG} background count rate
d absorption length.

The coefficients b_0 and b_1 are determined numerically if at least two calibration points are available. If only one calibration point is available, b_0 is determined numerically and b_1 by means of

$$b_1 = \mu \cdot \left(1 - {}^{\rho_L}/_{\rho_S}\right)$$

of the empirical linear mass absorption coefficient for the selected radionuclide μ (with $\mu < 0$) and the densities of the fluid or solid phases ρ_L or ρ_S.

In order to achieve comparability with the coefficients of a density measurement, the coefficient b_i can be converted to the coefficient a_i according to

$$a_0 = b_0 - \frac{\rho_L \cdot b_1 \cdot d}{1 - {}^{\rho_L}/_{\rho_S}}$$

$$a_1 = \frac{b_1}{\left(1 - {}^{\rho_L}/_{\rho_S}\right)}$$

6.4.3 "Solid Concentration" Mode

Direct input, single-point, two-point calibration

The solids content *s* (with $0 < s < 1$) is calculated from the measured count rate I according to the following equation

$$\ln(I - I_{BG}) = \frac{c_1 \cdot d}{c_2 \cdot s + 1} + c_0$$

with
- I measured count rate
- I_{BG} background count rate
- d absorption length.

The coefficients can be calculated by means of

$$c_1 = \mu \cdot \rho_L$$

$$c_2 = \frac{\rho_L}{\rho_S} - 1$$

the empirical linear mass absorption coefficient for the selected radionuclide μ (with $\mu < 0$) and the densities of the fluid or solid phases $\rho_L$or ρ_S if less than three calibration points are available.

Multi-point calibration (3 calibration points or more)

The solids content *s* (with $0 < s < 1$) is calculated from the measured count rate I according to the following equation

$$s = d_2(I - I_{BG})^2 + d_1(I - I_{BG}) + d_0$$

The coefficients are determined numerically.

6.5 Device Setup Menu Overview

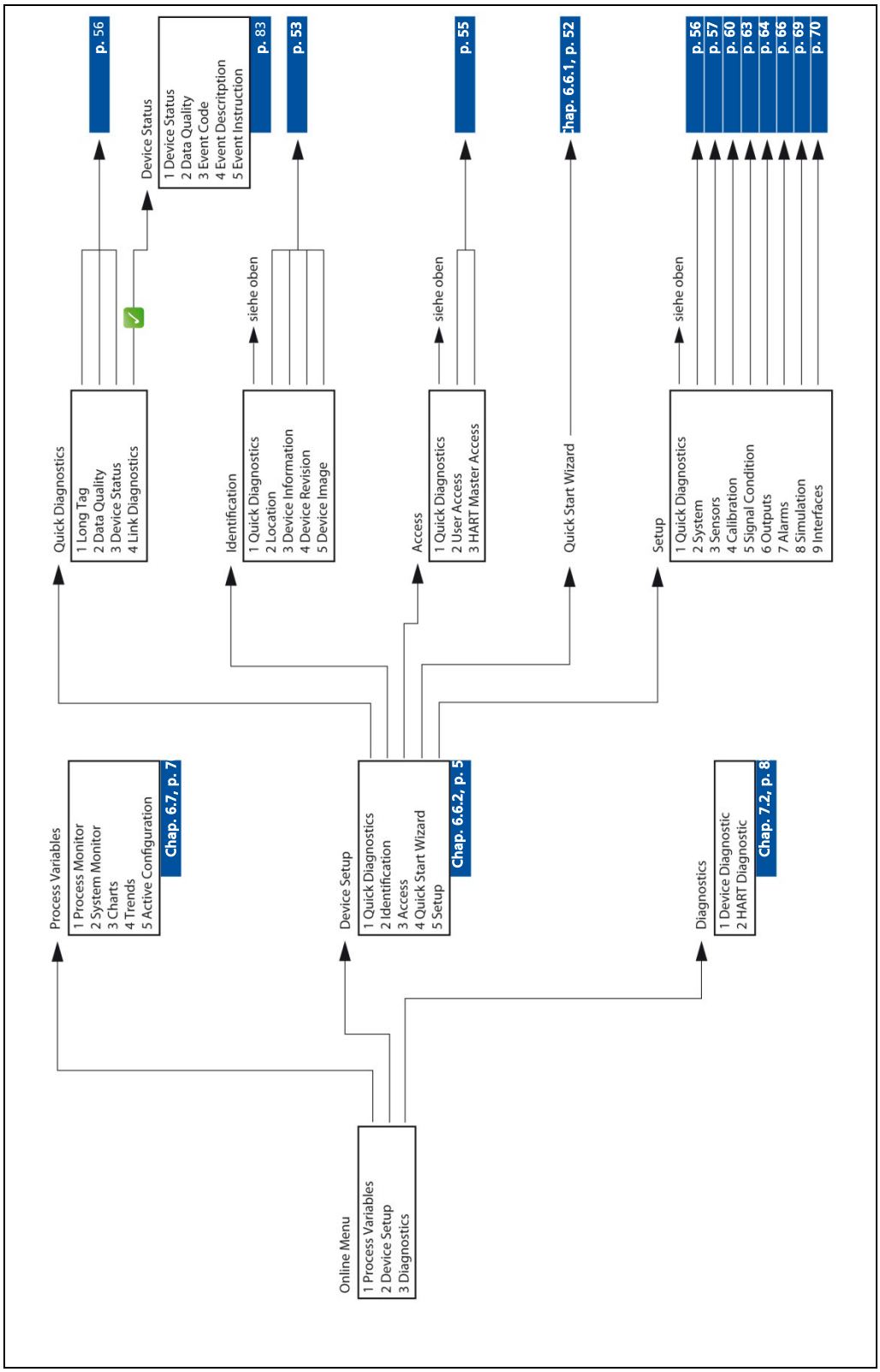


Fig. 24 HART Communicator: Online menu overview, Device Setup (DD Rev. 1)

6.6 Device Configuration

6.6.1 Quick Start Wizard

IMPORTANT

The Quick Start Wizard is not available via the local UI.

2,4

The Quick Start Wizard guides you quickly and easily to the most important parameters to be set before starting the measurement. The Quick Start Wizard also enables quick and easy changes later on.

General Information

Each individual step can be confirmed by pressing “OK” or cancelled by pressing “ABORT”. With “OK” or “ENTER”, the next set-up menu respectively is opened, by pressing “ABORT”, you are returned to the “Device Setup” menu.

After starting the Quick Start Wizard, the welcome screen is displayed followed by two warning messages. These point out that the previous values are overwritten.

Selection windows often provide the option to skip the offered step by pressing “Skip”, to return to the previous window by pressing “back” or to cancel the entire Quick Start Wizard process by pressing “Abort”. Below, only those steps are explained, that lead through the process:

- “Edit” opens an input window.
- “Yes” or “No” lead to different other procedures to be chosen from.

If the Quick Start Wizard is started for the first time, the editing menu is directly opened.

After starting the Quick Start Wizard, either a new calibration parameter set can be created (run new calibration) or an existing measuring parameter set can be edited (recall actual measurement parameter set).

Procedure

1 Date

Due to the radioactive decay of the used source, the entered date has a significant influence on the constant accuracy of the measuring values.

2 Time

3 Scintillator

- **NaI 40x35:** This point is to be selected if the device contains a NaI crystal.
- **Polymer 50x60:** This point is to be selected if the device contains a polymer crystal.

Scintillator code is set by the factory.

4 Nuclide

- **Cs-137:** This point is to be selected if a caesium source is used.
- **Co-60:** This point is to be selected if a cobalt source is used.

5 Measuring mode

- **2 DENSITY:** This point is to be selected if the detector is used for density measurements.
- **3 CONCENTRATION:** This point is to be selected if the detector is used for concentration measurements. Solids concentration is defined as the mass of solid matter in the total volume of the suspension. The unit (e.g. g/l) must not be mixed up with the density.
- **4 SOLIDS CONTENT:** This point is to be selected if the detector is used for solids content measurements. Solids content is defined as the solid matter in relation to the total mass of the suspension. From this, the unit % is derived, which is understood as weight percentage [wt%/wt].

6 Phys. unit

Select the desired unit. The following are available:

- **g/cm³**
- **kg/m³**
- **lb/gal**
- **lb/ft³**
- **g/l**
- **SGU (Specific Gravity Unit)**

In measuring mode SOLIDS CONTENT, the unit wt% is set by default.

7 Calibration method

- **DIRECT:** Select this point if the coefficients of the calibration equations (refer to chap. 6.4) are known. This is particularly the case if the measurement has already been calibrated once (e.g. after replacing the detector).
- **1-POINT:** One calibration point is required for calibration. The remaining parameters (e. g. the mass absorption coefficient μ) have to be entered directly.
- **2-POINT (only available in mode SOLIDS CONTENT):** Two calibration points are entered, the remaining free parameters have to be entered directly.
- **MULTIPOINT:** Sufficient calibration points are available to calculate the calibration line. A maximum of 11 points is possible.

Depending on the selected setting, the menu is continued differently.

8 Measuring path

Calibration of the length of the measuring path of the useful beam in the measured medium.

9 Automatic reading in of the count rate

If automatic reading in of the count rate is not desired, e.g. during a measurement, the values can be entered manually. The following options are available:

- **1 Yes** **continue with 9.10**
- **2 No** **continue with 9.20**

9.10 Defining the reading in time (Is repeated until all points have been entered.)

It is recommended to set a value between 60 and 180 seconds. The longer the reading in time, the more precise the average of the measured value or the less the impact of the static fluctuations of radioactive decay on the measurement result.

9.11 Reading in calibration points

First, the count rate for background radiation is read in. Depending on the selected calibration method, the automatic read-in process ends here (DIRECT) or is followed by reading in of the calibration point/points.

9.20 Entering calibration points (Is repeated until all points have been entered.)

First, the count rate for background radiation is entered. Depending on the selected calibration method, the calibration point/points is/are entered afterwards.

9.21 Entering coefficients

Depending on the selected measuring and calibration method, one or several additional coefficients may need to be entered (compare chap. 6.4). The modes CONCENTRATION and SOLIDS CONTENT do not only offer the option of directly entering coefficients. Additionally, besides by entering the coefficients, is also the option of calculating them by entering the suspension and solids density. Also refer to the equations in chap. 6.4.

10 LRV (Lower Range Value,bottom limit value of the measuring range)

The measuring value is put out as a current between 4 and 20 mA. The lower measuring limit defines the measuring value, which is 4 mA.

11 URV (Upper Range Value, upper limit value of the measuring range)

The upper measuring limit value defines the measuring value. It is 20 mA.

12 Damping Value

Entering the time constant of the measuring value filtration dampening statistical decay.

13 Write to device

The new configuration is applied in the calibration parameter set of the field device.

14 Finish Set up

- **Calibrate:** The measuring parameter set is to be overwritten. After overwriting the measuring parameter set, the Quick Start Wizard is closed. The set changes are immediately applied for measurement.
- **Exit:** The measuring parameter set is not to be overwritten. The Quick Start Wizard is closed, the values are applied in the calibration parameter set and can be overwritten in the measuring parameter set and activated for measuring by executing “Calibrate” (HART 2,5,4,2) at a later time.

6.6.2 Device Setup

In the “Device Setup” menu, all relevant parameters for measurement are set and can be changed. In the following overview, display fields are marked grey, input fields white.

2,1 Quick Diagnostics

Brief overview of the most important parameters. The “Quick Diagnostics” menu can be directly accessed from every sub-menu.

HART No. (Example)	Name	Display	Meaning
2,1,1	Long Tag	BT LB414	Device name entered by the user (refer to 2,2,2,2).
2,1,2	Data Quality		Measuring value quality output.
		GOOD	The calculated measuring value has a good quality.
		UNCERTAIN	No statement can be made on the quality of the measuring value. Check whether a result is available.
		FIXED	The measuring value is fixed to a constant value. No measuring value calculation is carried out.
		BAD	The calculated measuring value has a bad quality. Check whether a result is available.
2,1,3	Device Status	NORMAL	The device is in regular operating state without any notifications.
		MAINTENANCE REQUIRED (M)	The system requires maintenance. For further instructions, refer to the help text of the respective event number.
		OUT OF SPECIFICATION (S)	The device, a component or the process is operated outside of its respective specifications. For further instructions, refer to the help text of the respective event number.
		FUNCTION CHECK (C)	Indicates that entries are made at the detector or a function check/simulation is being performed. For further instructions, refer to the help text of the respective event number.
		FAILURE (F)	The device is in an error state. For further instructions, refer to the help text of the respective event number.
2,1,4	**Diagnostics Link**		Directly opens menu 3,1,1 Device Status.

2,2 Identification

Free (number) input fields that can be used to identify the device.

HART No. (Example)	Name	Display (Example)	Meaning
2,2,1	**Quick Diagnostics**		Refer to chapter 6.6.2, HART No. 2,1.
2,2,2	**Location**		
2,2,2,1	Short Tag	(BT LB414)	Free input field. Recommended use: Unique designation of the system or the control system in which the field device is used.
2,2,2,2	Long Tag	(BT LB414)	Input field similar to 2,2,2,1, however with up to 32 characters (ISO Latin 1).
2,2,2,3	Descriptor		Free input field, for example, for the name of the user writing onto the field device.
2,2,2,4	Message		Free input field, for example, for a comment related to the field device.
2,2,2,5	Date	(01/01/2013)	Free input field for a date. This date remains unchanged and has the function of a time stamp.
2,2,2,6	Final Assembly No.		Free input field. The number can be used for identification.
2,2,3	**Device Information**		
2,2,3,1	Device ID	(1)	Identification number of the present field device.
2,2,3,2	Device Type	LB414	Type designation of the present field device.
2,2,3,3	Manufacturer	BERTHOLD	Manufacturer name.
2,2,3,4	Ident No.	(56927)	Berthold article number.
2,2,3,5	Serial No.	(6001)	Berthold serial number.
2,2,3,6	HART Serial No.	(795)	Free (number) input field that can be used to identify the device.

2,2,4	**Device Revision**		
2,2,4,1	Universal Rev.	(7)	Revision number of the Universal Device Description
2,2,4,2	DD Rev.	(1)	Revision number of the specific Device Description
2,2,4,3	Device Rev.	(1)	Revision number of the field device hardware
2,2,4,4	Software Rev.	(1)	Revision number of the software running on the field device
2,2,4,5	Firmware Rev.	(01.00.00)	Revision number of the Berthold firmware running on the field device.
2,2,4,6	Firmware Date	(20.06.13)	Date of the software running on the field device

2,2,5	**Device Image**		Displays an image of the field device

2,3 Access

A write protection is generally recommended to prevent unintentional changes to parameters.

HART No. (Example)	Name	Display (Example)	Meaning
2,3,1	**Quick Diagnostics**		Refer to chapter 6.6.2, HART No. 2,1.
2,3,2	**User Access**		
2,3,2,1	Write Protect	No/Yes	Displays the status of the write protection of the system.
2,3,2,2	Access Level	STANDARD	Displays the current access rights of the system.
		BASIC	In BASIC mode, no parameter changes can be carried out.
2,3,2,3	Access Code	(0)	The system is set to BASIC mode by entering a password. If the system is already in BASIC mode, the STANDARD user level is activated again if the password is entered.
2,3,3	**HART Master Access**		
2,3,3,1	Device Lock Status	0x00	Displays whether the device is locked or unlocked.
2,3,3,1,1	Locked	ON/OFF	Displays whether and by whom the device is locked or unlocked.
2,3,3,1,2	Locked Permanent	ON/OFF	
2,3,3,1,3	Locked by Primary Master	ON/OFF	
2,3,3,2	Lock / Unlock		Sets the device in a locked or unlocked state. This is followed by a query as to whether the device is to be locked (permanently) or unlocked. Locking the device prevents unauthorised access.

2,5 Setup

Under the menu item “System”, basic settings like date, time and used units can be displayed. The field device can also be restarted or all values reset to the default factory settings.

HART No. (Example)	Name	Display (Example)	Meaning
2,5,1	**Quick Diagnostics**		Refer to chapter 6.6.2, HART No. 2,1.
2,5,2	**System**		
2,5,2,1	**Quick Diagnostics**		Refer to chapter 6.6.2, HART No. 2,1.

2,5,2,2	**Date / Time**		
2,5,2,2,1	Date	(06/27/2013)	System date **Note** The date has to be set correctly for proper compensation of the radioactive decay of the emitter. **Note** The system time and date have to be entered again, after disconnection of the voltage supply. Reason: The internal clock continues running and uses the most recently saved time stamp (once a day or at calibration).
2,5,2,2,2	Time	(19:16:07)	System time
2,5,2,2,3	Operating Hours	(48 h)	Accumulated operating hours of the system

2,5,2,3	**Units**		
2,5,2,3,1	Density Unit	(g/cm³)	Density output unit in the “Density” measuring mode
2,5,2,3,2	Concentration Unit	(g/l)	Concentration output unit in the “Concentration” measuring mode
2,5,2,3,3	Solids Content Unit	(wt%)	Output unit of the solids content in the “Solids Content” measuring mode
2,5,2,3,4	Product Unit	(g/cm³)	Input unit of liquids and solids densities (only in mode “Solids Content”)
2,5,2,3,5	Temp. Unit	(°C)	Temperature unit
2,5,2,3,6	Length Unit	(m)	Unit of the measuring path length

2,5,2,4	**Format**		
2,5,2,4,1	PV Format	x.xxx	Number of post decimal positions of the measuring value
2,5,2,4,2	Coeff Format	x.xxxExx	Format of the coefficients (input and output)

2,5,2,5	**Reset Device**		
2,5,2,5,1	Reboot		Performs a restart of the field device
2,5,2,5,2	Factory Reset		Resets the field device to the default factory settings.

2,5,3

With the menu item “Sensors”, the settings can be displayed.

With the menu item “Detector” the settings can be displayed and partially changed.

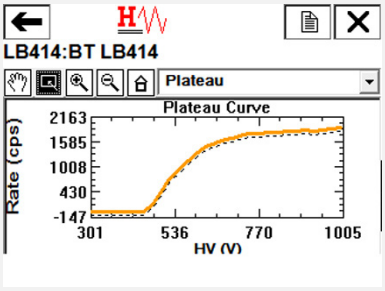
HART No. (Example)	Name	Display (Example)	Meaning
2,5,3	**Sensors**		
2,5,3,1	**Quick Diagnostics**		Refer to chapter 6.6.2, HART No. 2,1.

2,5,3,2	**Detector**		
2,5,3,2,1	**Quick Diagnostics**		Refer to chapter 6.6.2, HART No. 2,1.
2,5,3,2,2	**High Voltage**		
2,5,3,2,2,1	Detector Type	NaI 40x35 Polymer 50x60	Setting the used Scintillator **Note** A wrong setting may have a negative impact on the long-term stability of the device or may lead to other forms of malfunction.
2,5,3,2,2,2	HV Mode		Display of the high-voltage mode the system is working in.
		AUTO	The optimum high-voltage supply of the photomultiplier is automatically determined and set by the device
		MANUAL	The high-voltage is kept on a constant value defined by the user.
		PLATEAU	A plateau measurement is active.
2,5,3,2,2,3	HV Feedback	(799 V)	Measured supply voltage of the photomultiplier

2,5,3,2,2,4	HV Manual	(800 V)	Input field for the manually defined high-voltage if HV Mode is set to “Manual”.
2,5,3,2,2,5	HV Default	(700 V)	High voltage value used on start-up of the detectors. Pre-set by Berthold and gradually changed with active control.
2,5,3,2,2,6	Live Rate	(282 cps)	Actual, unfiltered count rate
2,5,3,2,2,7	Change HV Mode		The high-voltage mode can be switched from automatic to manual.

2,5,3,2,3	**Temperature**		
2,5,3,2,3,1	Detector Temp.	(36.5°C)	Actual detector temperature
2,5,3,2,3,2	Detector Temp. Min	(20.5°C)	Minimum measured detector temperature
2,5,3,2,3,3	Detector Temp. Max	(37.5°C)	Maximum measured detector temperature

2,5,3,2,4	**Plateau**		
2,5,3,2,4,1	**Quick Diagnostics**		Refer to chapter 6.6.2, HART No. 2,1.
2,5,3,2,4,2	**Plateau Measurement**		
2,5,3,2,4,2,1	HV Mode		Display of the high-voltage mode the system is working in
		AUTO	The optimum high-voltage supply of the photomultiplier is automatically determined and set by the device.
		MANUAL	The high-voltage is kept on a constant value defined by the user.
		PLATEAU	A plateau measurement is active.
2,5,3,2,4,2,2	HV Start	(300 V)	High-voltage start value for a plateau measurement
2,5,3,2,4,2,3	HV Stop	(1000 V)	High-voltage end value of a plateau measurement
2,5,3,2,4,2,4	HV Step	(25 V)	Stepwise between two points during plateau measurement
2,5,3,2,4,2,5	Meas. time	(4 s)	Measuring time input for each plateau measuring point
2,5,3,2,4,2,6	HV Feedback	(799 V)	Actual high-voltage feedback from the multiplier
2,5,3,2,4,2,7	Live Rate	(282 cps)	Actual, unfiltered count rate
2,5,3,2,4,2,8	Start / Stop		Starts or stops the plateau measurement

2,5,3,2,4,3	**Plateau Data**		
2,5,3,2,4,3,1	Plateau Date	(06/27/2013)	Date, on which the plateau record was taken
2,5,3,2,4,3,2	Plateau Records	(9)	Number of taken plateau curves
2,5,3,2,4,3,3	Refresh Plateau		Reads out the plateau record data from the device again
2,5,3,2,4,3,4	Plateau Curve		 Display of the plateau curve
2,5,3,2,4,3,5	Plateau Table		Display of the plateau measuring points

2,5,4

Calibration

All changes made in the “Calibration” menu are first saved to a calibration parameter set. The measuring results of the running measurement are not influenced as they are based on the measuring parameter set. The measuring parameter set is then overwritten by executing the command CALIBRATE.

By pressing RECALL, the measuring parameter set applied at the time of the measuring value calculation can be copied to the calibration parameter set. This way, all changes carried out at the calibration parameter set are overwritten.

The HART short commands (numbers) and the menu items displayed under “Calibration” differ according to the selected measuring mode and the calibration method. Also the values to be changed depend on these pre-settings. Therefore, most of the fields below are not marked in colour.

The following table contains all available menu items. For better illustration, however, the HART numbers are only displayed for the DENSITY measuring mode and 1-POINT calibration method.

HART No. (Example)	Name	Display (Example)	Meaning
2,5,4,1	**Quick Diagnostics**		Refer to chapter 6.6.2, HART No. 2,1.

2,5,4,2	**Calibrate**		
2,5,4,2,1	Calibrate		By executing this command, the currently used measuring parameter set is overwritten by the calibration parameter set. All changes in the “Calibrate” menu only become active after this command is executed. Coefficients are recalculated.
2,5,4,2,2	Cal Date	(06/27/2013)	Display of the date, on which the calibration was performed
2,5,4,2,3	Cal Status	OK	Calibration status
2,5,4,2,4	Cal Help		Explanation of the calibration status if it is not OK.
2,5,4,2,5	Cal Instruction		Suggestion for correcting a calibration status that is not OK.
2,5,4,2,6	Recall		Loads the measuring parameter set applied at the time of the measuring value calculation. This way, all changes carried out at the calibration parameter set are overwritten.

2,5,4,3	**Cal Table (not for DIRECT)**		
2,5,4,3,1	Cal Table		Display of the calibration table. It is possible to edit existing calibration points. Additional points can only be added in mode “MULTIPOINT”. If an additional point is to be added to a single-point calibration, a multi-point calibration has to be selected via the Quick Start Wizard. In this case, changes to the calibration table are not applied.
2,5,4,3,2	Refresh		Reads out the table values from the device again
2,5,4,3,3	Clear		Deletes the values of the calibration table

2,5,4,4	**Cal Points** (not for **DIRECT**)		
2,5,4,4,1	Select Point		Selection of the displayed calibration point
2,5,4,4,2	Cal Point No.	(1)	Displays the calibration point for which the following values apply
2,5,4,4,3	Cal Value	(2.000 g/cm³)	Measuring value for which the count rate is read in.
2,5,4,4,4	Cal Rate	(282 cps)	Count rate to the measuring value. Can be edited either manually or read in automatically via “Read-in”.
2,5,4,4,5	Read-in Time	60.0 s	Duration of the read-in process of the count rate
2,5,4,4,6	Read-in		Starts the reading in process for the selected calibration point. On cancellation of the read-in process, the average count rate that was determined until the process was cancelled is applied.

2,5,4,5	**Cal Background**		
2,5,4,5,1	Background	(44 cps)	Input of the value for background radiation
2,5,4,5,2	Read-in Time	(60.0 s)	Duration of the read-in process of the count rate
2,5,4,5,3	Read-in		Starts the reading in process for the background rate. On cancellation of the read-in process, the average count rate that was determined until the process was cancelled is applied.

2,5,4,6	**Cal Coeffs**		For detailed information on the coefficients, refer to chapter 6.4.
2,5,4,6,1	Set by User	TRUE / FALSE	TRUE: Enter coefficients directly FALSE: Enter product conditions
2,5,4,6,2	Coefficient 0	(2.880E+000)	Calibration coefficient 0
2,5,4,6,3	Coefficient 1	(1.487E-002 cm^2/g)	Calibration coefficient 1
2,5,4,6,4	Coefficient 2	(-6.660E-001 cm^4/g^2)	Calibration coefficient 2

	Cal Product Condition (only for CONCENTRATION or SOLIDS CONTENT)		
	Abs.Coefficient	(0.000E+000 cm^2/g)	Linear mass absorption coefficient
	Liquid Density	(1.000 g/cm^3)	Density of the carrier liquid in the suspension
	Solid Density	(3.000 g/cm^3)	Density of the solid matter in the suspension

2,5,4,7	**Cal Settings**		
2,5,4,7,1	Meas. method	DENSITY CONCENTRATION SOLIDS CONTENT	Display of the selected measuring method The measuring method should only be changed via the Quick Start Wizard.
2,5,4,7,2	Cal Method	DIRECT 1-POINT 2-POINT MULTIPOINT	Display of the selected calibration method The calibration method should only be changed via the Quick Start Wizard.
2,5,4,7,3	Nuclide	Cs-137 Co-60	Input of the used nuclide
2,5,4,7,4	Measuring Path	(0.4 m)	Input of the length of the measuring path
2,5,4,7,5	Cal LRV	(1.000 g/cm^3) (50.000 g/l)	Lower limit of the measuring range. Is also used as lower limit of the current output during calibration. It can, however, be adjusted separately at a later time. To change the current output limit values, refer to 2,5,5,3 (Signal Condition \ Range).
2,5,4,7,6	Cal URV	(3.000 g/cm^3) (250.000 g/l)	Upper limit of the measuring range. Is also used as lower limit of the current output during calibration. It can, however, be adjusted separately at a later time. To change the current output limit values, refer to 2,5,5,3 (Signal Condition \ Range).

	Cal Limits (only for SOLIDS CONTENT)		
	Cal LL	(20.000 wt%)	Calculated lower limit value in which the calibration is still valid, i.e. monotone.
	Cal UL	(80.000 wt%)	Calculated upper limit value in which the calibration is still valid, i.e. monotone.

2,5,5

Signal Condition

Values changed in this menu directly influence the measuring result!

HART No. (Example)	Name	Display (Example)	Meaning
2,5,5,1	**Signal Condition**		Refer to chapter 6.6.2, HART No. 2,1.

2,5,5,2	**Damping**		
2,5,5,2,1	PV Damping Value	(30.00 s)	Defines the time constant of the measuring value filtration dampening statistical decay. A lower value provides quicker results and the result is “more irregular”. At a larger value, it takes longer until the result is available and the measuring value is “more regular”.

2,5,5,3	**Range**		
2,5,5,3,1	PV LRV	(1.000 g/cm³)	Assigns the entered measuring value to the analogue output value 4 mA. This value is overwritten with the value “Cal LRV” if a calibration is performed (execution of Calibrate or Quick Start Wizard).
2,5,5,3,2	PV URV	(3.000 g/cm³)	Assigns the entered measuring value to the analogue output value 20 mA. This value is overwritten with the value “Cal URV” if a calibration is performed (execution of Calibrate or Quick Start Wizard).
2,5,5,3,3	PV% Range	(87.56 %)	Display of the current measuring value in % in the range between PV LRV and PV URV.

2,5,5,4	**Tuning**		
2,5,5,4,1	PV Factor	(1.000)	Multiplication of the measuring value to be calculated with a constant factor. This value is reset to 1 if a calibration is performed (execution of Calibrate or Quick Start Wizard).
2,5,5,4,2	PV Offset	(0.000 g/cm³)	Addition of a constant quantity to the calculated measuring value. This value is reset to 0 if a calibration is performed (execution of Calibrate or Quick Start Wizard).

2,5,6

Outputs

Under the menu item “Outputs”, the settings regarding output signals and type of error messages can be displayed and partially changed.

HART No. (Example)	Name	Display (Example)	Meaning
2,5,6,1	**Quick Diagnostics**		Refer to chapter 6.6.2, HART No. 2,1.

2,5,6,2	**Current AO**		
2,5,6,2,1	Current AO	(20.5 mA)	Currently put out current
2,5,6,2,2	Current AO Status		Displays the status of the current output.
		SIGNALING	The current output puts out the measuring value.
		FIXED	The current output is set to a fixed value.
		SATURATED	Measuring value is outside the limit of the current output (refer to 2,5,5,3 PV URV and LRV).
2,5,6,2,3	Alarm Type	HIGH	Current output signal in case of an alarm 22 mA.
		LOW	Current output signal in case of an alarm 2 mA.
		VALUE	In case of an alarm, the current output signals the current value set under 2,5,6,2,4.
2,5,6,2,4	Error Value	(22.0 mA)	Current value that is signalled by the current output in case of an alarm. This value can be freely selected if the Alarm Type is set to “Value”.
2,5,6,2,5	Lower Limit	(3.8 mA)	Defines the lowest value of the current output for measuring value signalling (according to NE-43).
2,5,6,2,6	Upper Limit	(20.5 mA)	Defines the highest value of the current output for measuring value signalling (according to NE-43).
2,5,6,2,7	Supply Mode	SOURCE	The current output loop is supplied by the field device.
		SINK	The external supply voltage for the current output loop must be created.
2,5,6,2,8	Change Supply	SOURCE SINK	Changes the supply mode
2,5,6,2,9	DAC Trim		Starts the routine for adjusting the current output. For this, connect a current measuring device to the current output loop and follow the instructions.

2,5,6,3	Relay DO		
2,5,6,3,1	Relay Assignment		Assigning the function of the relay output
		FAILURE	Relay switching in case of system status “Failure”
		FAILURE OOS	Relay switching in case of system status “Failure” or “Out of Specification (OOS)”.
		PV ALARM	Relay switches if the measuring value threshold set under Process Alarm (2,5,7,2) is violated.
		TEMP ALARM	Relay switches, if the internal detector temperature thresholds set under Temperature Alarm (2,5,7,3) are violated.
2,5,6,3,2	Relay State	ALARM NO ALARM	Displays the current state of the relay.

2,5,6,4	HART DO		
2,5,6,4,1	Poll Addr	(0)	Address used to identify the field device in polling mode (zero: no polling).
2,5,6,4,2	Set Poll Addr		For entering a polling address
2,5,6,4,3	No. Req Preams	(5)	Number of sent preambles in case of a request by the master.
2,5,6,4,4	No. Resp Preams	(5)	Number of sent preambles on field device response.

2,5,7 Under the menu item “Alarms”, values can be entered to define triggering of alarms.

HART No. (Example)	Name	Display (Example)	Meaning
2,5,7	**Alarms**		
2,5,7,1	**Quick Diagnostics**		Refer to chapter 6.6.2, HART No. 2,1.
2,5,7,2	**Process Alarm**		
2,5,7,2,1	Diagnostic behaviour		Defines the behaviour after violation of the values set below. This setting does not have any impact on the behaviour of the digital output set under 2,5,6,3 (Relay Output).
		OFF	No impact on the system status
		OOS	A violation of the values set below is detected in the system status as Out of Specification (OOS).
		FAILURE	A violation of the values set below is recognised in the system status as FAILURE.
2,5,7,2,2	PV Lower Limit	(1.000 g/cm³)	For entering the lower limit value on violation of which a measuring value triggers a process value alarm.
2,5,7,2,3	PV Upper Limit	(3.000 g/cm³)	For entering the upper limit value on violation of which a measuring value triggers a process value alarm.
2,5,7,2,4	Hysteresis	(0.100 g/cm³)	To prevent permanent activation of the alarm, the alarm is only deactivated if the measuring value deviates from the limit values set above by the value set here. (Example: Lower Alarm at 1.0 g/cm³ and hysteresis at 0.1 g/cm³ means that the alarm will not be deactivated before a process value of 1.1 g/cm³ is reached.)

2,5,7,3	**Temperature Alarm**		
2,5,7,3,1	Diagnostic behaviour		Defines the behaviour after violation of the values set below. This setting DOES NOT have any impact on the behaviour of the digital output set under 2,5,6,3 (Relay Output). **Notice** Independent of the values set here, the detector temperature is constantly monitored and an OOS event is indicated if the temperature exceeds a value set by Berthold.
		OFF	No impact on the system status
		OOS	A violation of the values set below is detected in the system status as Out of Specification (OOS).
		FAILURE	A violation of the values set below is detected in the system status as FAILURE.
2,5,7,3,2	Upper Limit	(60.0°C)	For entering the upper limit value on violation of which a measuring value triggers the temperature alarm.
2,5,7,3,3	Lower Limit	(-20.0°C)	For entering the lower limit value on violation of which a measuring value triggers the temperature alarm.
2,5,7,3,4	Hysteresis	(3°C)	To prevent permanent activation of the alarm, the alarm is only deactivated if the measuring value deviates from the limit values set above by the value set here. (example: Lower Alarm at -20°C and hysteresis at 1°C means that the alarm will not be deactivated before a process value of 19°C is reached.)

2,5,7,4	**Diagnostics Alarm (NE107)**		
2,5,7,4,1	Function Check	OFF	Switches off all Function Check events. This means that no events are displayed as Function Check, independent of below settings.
		SIGNALING	Activates all Function Check event codes (Code Cxxx). Additional Function Check events can be switched on (see below).
2,5,7,4,2	Primary Master	OFF SIGNALING	SIGNALING: The device status is set to Function Check if the device is communicating with a Primary Master. (Only if Function Check is set to SIGNALING)
2,5,7,4,3	Secondary Master	OFF SIGNALING	SIGNALING: The device status is set to Function Check if the device is communicating with a Secondary Master. (Only if Function Check is set to SIGNALING)
2,5,7,4,4	Local User Interface	OFF SIGNALING	SIGNALING: The device status is set to Function Check if the device is controlled via the local user interface. (Only if Function Check is set to SIGNALING)
2,5,7,4,5	Current Behaviour	OFF SIGNALING	SIGNALING: Function Check events (Code Cxxx) set the current output to a fixed value). (Only if Function Check is set to SIGNALING)
2,5,7,4,6	Current Value	(22.0 mA)	If Current Mode is set to SIGNALING, this fixed value is output at the current output.

2,5,8

In the “Simulation” menu, values for a simulation can be entered.

HART No. (Example)	Name	Display (Example)	Meaning
2,5,8	**Simulation**		
2,5,8,1	Current Mode	OFF	Displays the selected current mode (OFF: no simulation)
2,5,8,2	Test Current	4 mA 20 mA Other End	Sets the current output to a fixed current output value.
2,5,8,3	PV Mode	OFF SIMULATE	Starting and stopping the measuring value simulation. If activated, the process value set under PV is output.
2,5,8,4	PV	(2.51 g/cm³)	Measuring value output if PV Mode is set to SIMULATE.
2,5,8,5	Pulse Rate Mode	OFF SIMULATE	Starting and stopping the count rate simulation. If activated, a fixed count rate is used to calculate the measuring value. The count rate is set under Pulse Rate.
2,5,8,6	Pulse Rate	(210 cps)	Entry of a fixed count rate which is used for calculating the measuring value if the Pulse Rate Mode is set to SIMULATE.
2,5,8,7	Relay Mode	OFF SIMULATE	Activates or deactivates the test function of the relay. If activated, the relay is set to the state specified under Relay.
2,5,8,8	Relay	ALARM NO ALARM	Defines the state the relay is set to if Relay Mode is set to SIMULATE.

2,5,9 In the “Interfaces” menu, local display and infrared remote control settings can be entered.

HART No. (Example)	Name	Display (Example)	Meaning
2,5,9	**Interfaces**		
2,5,9,1	**Quick Diagnostics**		Refer to chapter 6.6.2, HART No. 2,1.
2,5,9,2	**Local Display**		
2,5,9,2,1	Language	(English)	Display language selection
2,5,9,2,2	Content	PV CURRENT AO CPS	Display selection on the local display.
2,5,9,2,3	Format	(x.xx)	Display accuracy for measuring values on the local display (0 to 5 decimal positions).
2,5,9,2,4	Brightness	(6)	Sets the brightness of the local display (value between 1 and 10).
2,5,9,3	**IR Remote Control**		
2,5,9,3,1	Receiver	ON OFF	Switches on the IR receiver. This is a prerequisite for using an IR remote control.
2,5,9,3,2	Channel	(1-4)	Sets the IR reception channel. If several detectors are installed in close proximity to each other, different channels are to be used to prevent accidental activation via remote control.

6.7 Menu Overview: Display of the process variables

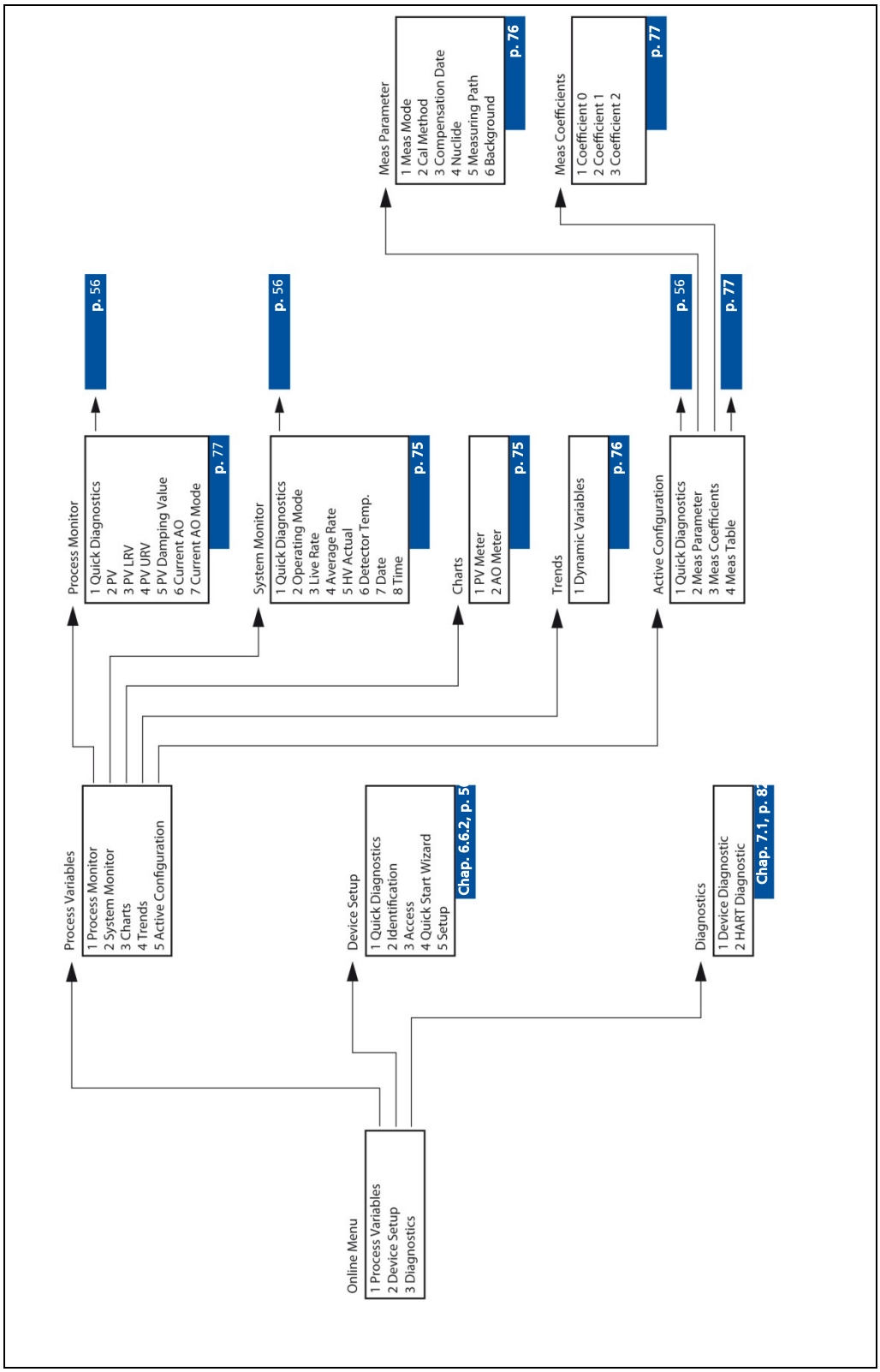


Fig. 25 HART Communicator: Online menu overview, Process Variable

In the “Process Variables” menu, the most important measurement parameters are displayed. Modification of values is not possible in this menu. For this, the “Device Setup” menu is to be used.

6.8 Process Variables

1,1 Quick Diagnostics

Refer to chapter 6.6.2, HART No. 2,1

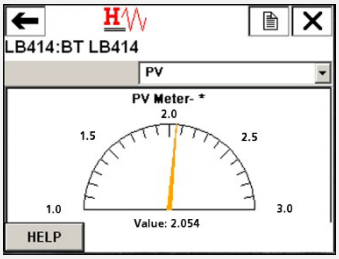
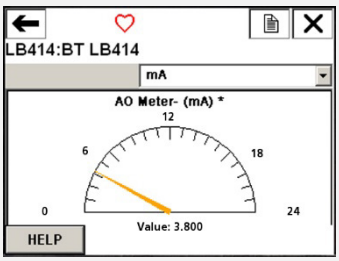
1,2 Process Monitor

HART No. (Example)	Name	Display (Example)	Meaning
1,2,1	Quick Diagnostics		Refer to chapter 6.6.2, HART No. 2,1
1,2,2	PV	(1.666 g/cm³)	Measuring value calculated from the average count rate
1,2,3	PV LRV	(1.000 g/cm³)	Lower limit of the measuring range, i.e. 4 mA , refer to chapter 6.6.2, HART No. 2,5,5,3,1
1,2,4	PV URV	(3.000 g/cm³)	Upper limit of the measuring range, i.e. 20 mA , refer to chapter 6.6.2, HART No. 2,5,5,3,2
1,2,5	PV Damping Value	(30.00 s)	Time constant of the measuring value filter, refer to chapter 6.6.2, HART No. 2,5,5,2,1
1,2,6	Current AO	(10.6 mA)	Displays the current output value
1,2,7	Current AO Mode	SIGNALING	The current output puts out the measuring value
		FIXED	The current output is set to a fixed value.
		SATURATED	Measuring value representation is outside the limit values of the current output. Refer to chapter 6.6.2, HART No. 2,5,6,2,2

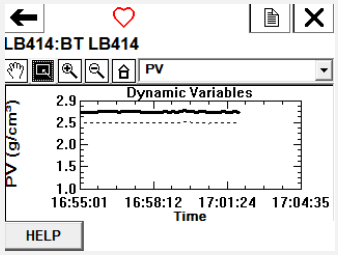
1,3 System Monitor

HART No. (Example)	Name	Display (Example)	Meaning
1,3,1	Quick Diagnostics		Refer to chapter 6.6.2, HART No. 2,1
1,3,2	Operating Mode	INIT STARTUP SHUTDOWN ERROR WARNING HOLD TEST RUN	Current system operating mode
1,3,3	Live Rate	(282 cps)	Not averaged, read-in count rate
1,3,4	Average Rate	(284 cps)	Current, dampened count rate.
1,3,5	HV Actual	(799 V)	Current high voltage at the photomultiplier.
1,3,6	Detector Temp.	(34.5°C)	Actual detector temperature
1,3,7	Date	06/27/2013	System date
1,3,8	Time	15:19:44	System time

1,4 Charts

HART No.	Name	Display (Example)	Meaning
1,4,1	PV Meter		Display of the measuring value
1,4,2	AO Meter		Display of the actual output current (CurrentOut, AO)

1,5 Trends

HART No. (Example)	Name	Display (Example)	Meaning
1,5,1	Dynamic Variables		Display of various values. The following settings are possible: • Measuring value • Current output • Count rate • Detector temperature.

1,6 Active Configuration

HART No. (Example)	Name	Display (Example)	Meaning
1,6,1	**Quick Diagnostics**		Refer to chapter 6.6.2, HART No. 2,1
1,6,2	**Meas Parameter**		
1,6,2,1	Meas Mode	(DENSITY)	Set measuring method, refer to chapter 6.6.2, HART No. 2,5,4,7,1
1,6,2,2	Cal Method	(2-POINT)	Set calibration method, refer to chapter 6.6.2, HART No. 2,5,4,7,2
1,6,2,3	Compensation Date	(06/27/2013)	Date, on which the last decay compensation was carried out.
1,6,2,4	Nuclide	(Cs-137)	Selected nuclide, refer to chapter 6.6.2, HART No. 2,5,4,7,3
1,6,2,5	Measuring Path	(0.4 m)	Measuring path length, refer to chapter 6.6.2, HART No. 2,5,4,7,4
1,6,2,6	Background	(14 cps)	Background rate, refer to chapter 6.6.2, HART No. 2,5,4,5,1

HART No. (Example)	Name	Display (Example)	Meaning
1,6,3	**Meas Coefficients**		
1,6,3,1	Coefficient 0	-1.06373	Refer to chapter 6.6.2, HART No. 2,5,4,6,2
1,6,3,2	Coefficient 1	0.01738 cm^2/g	Refer to chapter 6.6.2, HART No. 2,5,4,6,3
1,6,3,3	Coefficient 2	0.00000 cm^4/g^2	Refer to chapter 6.6.2, HART No. 2,5,4,6,4
1,6,3,4	R-Squared	0.00	Quality of the linear regression. Values between 0 and 1. The closer the value is to 1, the higher the quality. This display is only available in the 2-POINT or MULTIPOINT calibration method.

HART No.	Name	Display (Example)	Meaning
1,6,4	**Meas Table**		List of used, preset calibration data points.

6.9 Instruction texts

The following texts may be displayed during operation of the device (selection):

Message	Meaning	Consequence
Calibration Point Rate has to be greater than Background Rate!	The background count rate exceeds the lowest calibration point count rate. This message may occur if an emitter nearby is captured upon reading in the background rate.	This message may occur if an interfering radiation is detected upon reading in the background rate. Make sure, that no emitters are in close proximity to the detector if the background count rate is being read in.
WARN - After Reset you have to reconnect the device to the HART - otherwise there might be data inconsistency.	Warning message that the HART Communication has to be reestablished after a reset to prevent data inconsistency.	Restart the HART Communication after a reset.
WARN - All calibration parameters will be overwritten with the actual used measurement parameters!	Warning message indicating that the current calibration parameter set is overwritten by the currently used measuring parameters. Changes to the calibration parameter set are lost.	Only continue if you are sure about the consequences of the changes.
WARN - Be aware that changing Supply Mode will cut off HART Communication as long as the loop isn't supplied in correct manner!	Warning message indicating that changing the Supply Mode will interrupt HART Communication.	Change only the Supply Mode if you are sure it is set incorrectly. A connection in Sink Mode via HART is only possible with external voltage supply!
WARN - Be aware that PV alarm setup must be adapted to the changed measurement configuration!	Warning message indicating that calibration was changed. A process value alarm is active.	The process value alarm may be incorrect due to the changed calibration and must be checked (refer to 2,5,7,2 PV Alarm)
WARN - Current AO should be removed from automatic control!	Warning message indicating that the current output value has suddenly changed when carrying out the action.	A potentially connected process control system should not interpret the current output value as process value in order to prevent sudden impacts on the process.
NOTE - Current AO may be returned to automatic control	The current output value represents the measuring value.	A potentially connected process control system can interpret the output value as measuring value again and apply it for process control.
WARN - This action will overwrite your measurement settings!	Warning message indicating that the current measuring parameter set will be changed. This action will affect the calculation of the measuring value from the count rate.	Only proceed, if you are sure of the effects your changes will have.

7 Troubleshooting

7.1 Diagnostics Menu Overview

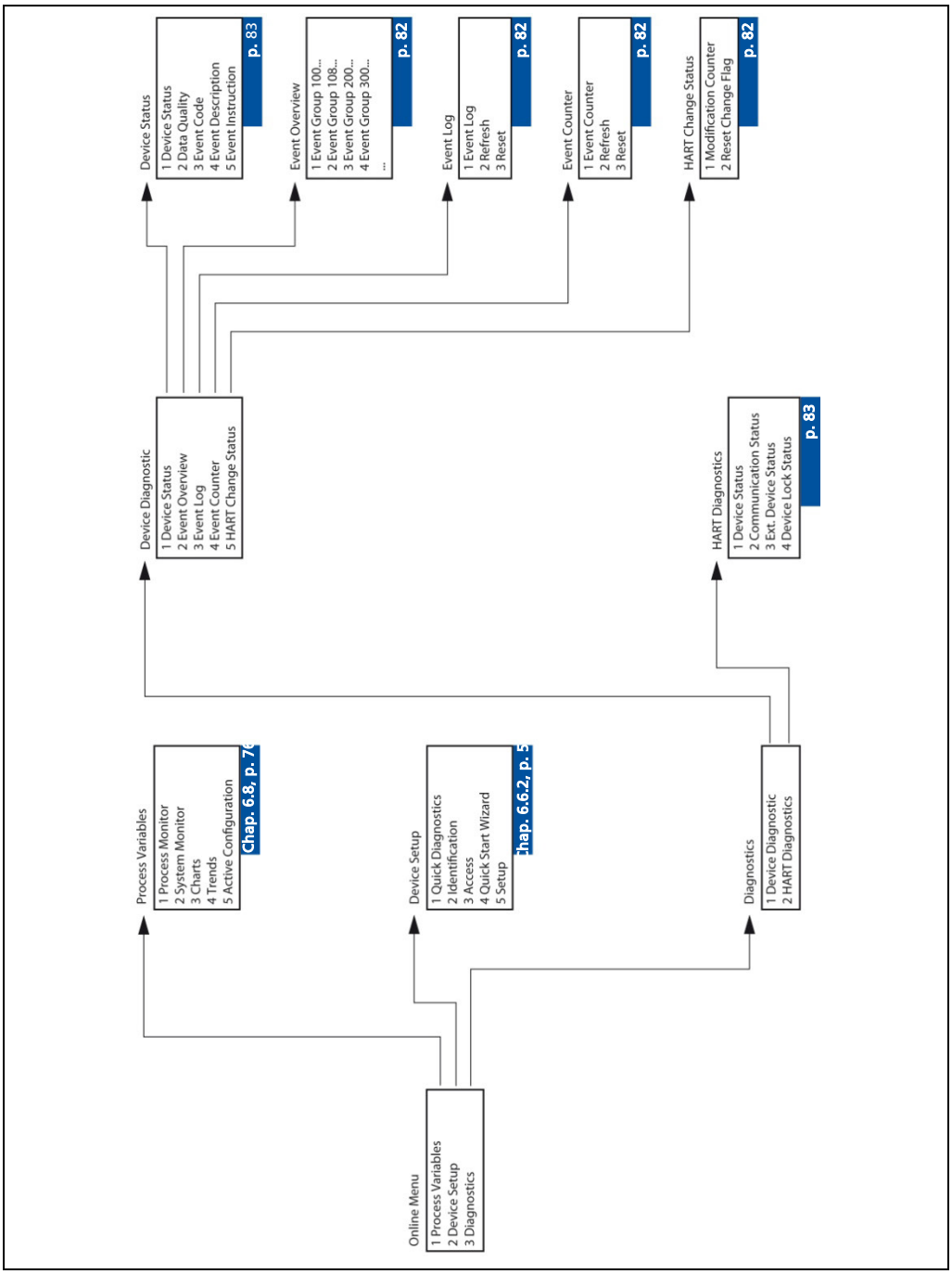


Fig. 26 HART Communicator: Online menu overview, Diagnostics

7.2 Diagnostics

In the following overview, display fields are marked grey, input fields white.

3,1 Device Diagnostic

HART No. (Example)	Name	Display	Meaning
3,1,1	**Device Status**		
3,1,1,1	Device Status	NORMAL	The device is in regular operating state without any notifications.
		MAINTENANCE REQUIRED (M)	Maintenance of the device is required. Further information on the current event can be found under “Event Description” and “Event Instruction”.
		OUT OF SPECIFICATION (S)	The device, a component or the process is operated outside of its respective specifications. Further information on the current event can be found under “Event Description” and “Event Instruction”.
		FUNCTION CHECK (C)	Indicates that entries are made at the detector or a function check/simulation is being performed. Further information on the current event can be found under “Event Description” and “Event Instruction”.
		FAILURE (F)	The device is in an error state. Further information on the current event can be found under “Event Description” and “Event Instruction”.
3,1,1,2	Data Quality		Measuring value quality output.
		GOOD	The calculated measuring value has a good quality
		UNCERTAIN	No statement can be made on the quality of the measuring value. Check whether a result is available.
		FIXED	The measuring value is fixed to a constant value. No measuring value calculation is carried out.
		BAD	The calculated measuring value has a bad quality. Check whether an event is available.
3,1,1,3	Event Code	NO EVENT	Current event code transmitted by the field device, refer to chapter 7.3
3,1,1,4	Event Description		Short description of the active event. A detailed list can be found in this manual.

HART No. (Example)	Name	Display	Meaning
3,1,1,5	Event Instruction		Short description for correction of the active event. A detailed list can be found in this manual.
3,1,1,6	Acknowledge		Acknowledges the active error if it has to be confirmed and the cause of the error is no longer present.

3,1,2	**Event Overview**		Displays currently active events. Particularly if several events are simultaneously active, this list provides an overview.

3,1,3	**Event Log**		
3,1,3,1	Event Log		List of the last 25 events with date, time and description
3,1,3,2	Refresh		Refreshes the event log. Execute this command if the event log is empty.

3,1,4	**Event Counter**		
3,1,4,1	Event Counter		Displays the counter for groups of events that occurred and the time stamp of the last five events.
3,1,4,2	Refresh		Refreshes the list (according to groups).
3,1,4,3	Reset		Resets the event counter list.

3,1,5	**HART Change Status**		
3,1,5,1	Modification Counter	(1)	Displays the number of entries from a HART device.
3,1,5,2	Reset Change Flag		Resets the “Change Flag”.

3,2 HART Diagnostics

Displays HART-specific diagnostic messages in four groups.

HART No.	Name	Display	Meaning
3,2,1	Device Status	(0x00)	Device status. If the total value is not 0x00, the device detected a status change. This change can concern the hardware, the quality of the measuring value, the device status or an internal process. Parameter changes are also indicated by this. The following information may be displayed:
	PV out of limits		The process value (PV) is outside its defined limits.
	Non PV out of limits		A device variable (not PV) is outside its defined limits.
	PV AO saturated		The current output value has taken up a value outside its possible range and can therefore not react to a process value change.
	PV AO fixed		The current output value is kept at a fixed value and does not react to a process value change.
	More status available		Currently, additional device status information is available via Command48.
	Cold start		A device reset or Master reset has occurred or the device power supply was interrupted.
	Configuration changed		The configuration of the field device was changed.
	Device malfunction		A fatal error influencing the operation of the device has occurred.

3,2,2	Communication Status	(0x00)	Status of the communication. If the total value is not 0x00, the device detected a status change. During a host system request, errors were detected by the field device. For this reason, the command was not executed. The following information may be displayed:
	Buffer overflow		A reception buffer overflow has occurred
	Longitudinal parity error		A longitudinal parity error has occurred
	Framing error		A framing error has occurred
	Overrun error		An overrun error has occurred
	Vertical parity error		A vertical parity error has occurred.
3,2,3	Extended Device Status	(0x00)	Advanced device status. If the total value is not 0x00, the device detected a status change. The field device provides additional status information via the extended device status. The following information may be displayed:
	Maintenance required		Device maintenance is required.
	Device variable alert		A device variable alert has occurred.
	Critical Power failure		A critical error has occurred in the system supply.
3,2,4	Lock Status	(0x00)	Status locked. If the total value is not 0x00, the device detected a status change. The field device provides information on its current lock status. The following information may be displayed:
	Locked		Lock status
	Locked Permanent		Permanent lock status
	Locked by Primary Master		Status of locking by a primary master.

7.3 System Events

Below, a list of all possible device event messages with troubleshooting options is provided. Event messages are automatically hidden if the cause of the event is no longer present. Exceptions are marked in the list. In this case, the event has to be confirmed manually in menu 3,1,1,6.

System events are classified in

- FAILURE (F)
- OUT OF SPECIFICATION (S)
- FUNCTION CHECK (C)
- MAINTENANCE REQUIRED (M).

FAILURE (F)

Fatal device error. Usually, the current output is set to fault current. Whether the differential relay is to disconnect can be set under “Digital Output” (2,5,6,3).

Out of specification (S)

The detector, one of its components or the process itself, are out of normal specification. These events could be indicated by the differential relay. The differential relay can be configured under 2,5,8,7.

Function Check (C)

Indicates that entries are made at the detector or a function check/simulation is being performed. Under Digital Output (2,5,6,3) and Diagnostics Alarm (NE107) (2,5,7,4), it can be configured whether and which Function Check events influence the relay and/or the current output.

Code	Text	Description	Correction
System			
F100	HW Compliance	Corrupt hardware electronics module	If the error occurs more frequently, please contact the Berthold Service.
F101	Permanent memory	Permanent memory error, no parameter set was found	If the error occurs more frequently, please contact the Berthold Service.
F102	Data memory	A memory error has occurred	If the error occurs more frequently, please contact the Berthold Service.
F103	System failure	A system failure has occurred	If the error occurs more frequently, please contact the Berthold Service.
S104	RTC OOS	Real time clock, date and time. The last valid date is written	If the error occurs more frequently, please contact the Berthold Service. The error has to be confirmed manually (3,1,1,6).

Code	Text	Description	Correction
F105	WD Reset	The Watchdog has triggered a restart of the device.	If the error occurs more frequently, please contact the Berthold Service. Check if strong electromagnetic interferences have caused this error.
F106	Download failure	Data transmission interruption during upload/download.	Repeat upload/download. The error has to be confirmed manually (3,1,1,6).
C107	Local operation	The device is operated via the local display.	None necessary. Pure signaling function. If this message is not desired, it can be deactivated under Diagnostic Alarm (NE107) (2,5,7,3).
C108	Download active	A data transmission is running.	None necessary. Pure signaling function. If this message is not desired, it can be deactivated under Diagnostic Alarm (NE107) (2,5,7,3).
C109	Sampling active	The count rate is read.	None necessary. Pure signaling function. If this message is not desired, it can be deactivated under Diagnostic Alarm (NE107) (2,5,7,3).
C110	Plateau active	A plateau measurement is performed.	None necessary. Pure signaling function. If this message is not desired, it can be deactivated under Diagnostic Alarm (NE107) (2,5,7,3).
C111	Calibration active	Calibration is performed.	None necessary. Pure signaling function. If this message is not desired, it can be deactivated under Diagnostic Alarm (NE107) (2,5,7,3).
C112	AO simulation	The current output (AO) is operated in simulation mode.	None necessary. Pure signaling function. If this message is not desired, it can be deactivated under Diagnostic Alarm (NE107) (2,5,7,3).
C113	PV simulation	The process value (AO) is operated in simulation mode.	None necessary. Pure signaling function. If this message is not desired, it can be deactivated under Diagnostic Alarm (NE107) (2,5,7,3).

Code	Text	Description	Correction
C114	DO simulation	The relay (DO) is operated in simulation mode.	None necessary. Pure signaling function. If this message is not desired, it can be deactivated under Diagnostic Alarm (NE107) (2,5,7,3).
S115	RTC OOS	Real Time Clock. Out of specification limit	None necessary. Pure signaling function. The error has to be confirmed manually (3,1,1,6).
S116	Device not calibrated	The device is not yet calibrated and has loaded default parameters in the measuring parameter set.	Calibrate the device with the Quick Start Wizard (2,4).
Mainboard			
F200	Runtime failure	Error during execution of the software	If the error occurs more frequently, please contact the Berthold Service.
F201	HW failure	Hardware error	Contact the Berthold Service The hardware is defective and has to be replaced.
F202	HW failure	Hardware error	Contact the Berthold Service The hardware is defective and has to be replaced.
F203	HW failure	Hardware error	Contact the Berthold Service The hardware is defective and has to be replaced.
F204	HW failure	Hardware error	Contact the Berthold Service The hardware is defective and has to be replaced.
Detector			
F300	Runtime failure	Error during execution of the software	If the error occurs more frequently, please contact the Berthold Service.
S301	DAC calibration	Hardware error	Restart the device. If the error occurs more frequently, please contact the Berthold Service. The error has to be confirmed manually (3,1,1,6).
S302	ADC calibration	Hardware error	Restart the device. If the error occurs more frequently, please contact the Berthold Service. The error has to be confirmed manually (3,1,1,6).
F303	HW failure	Hardware error	Contact the Berthold Service The hardware is defective and has to be replaced.
F304	HW failure	Hardware error	Contact the Berthold Service The hardware is defective and has to be replaced.

Code	Text	Description	Correction
F305	Cps zero (Meas)	No count rate in the measuring channel	The photomultiplier may be defective. Check the photomultiplier or contact the Berthold Service.
S306	Cps zero (Ctrl)	No count rate in the control channel	The photomultiplier may be defective. Check the photomultiplier or contact the Berthold Service.
S307	Cps zero (Aux)	No count rate in the auxiliary channel	The photomultiplier may be defective. Check the photomultiplier or contact the Berthold Service.
S308	Cps zero (Res)	No count rate in the replacement channel	The photomultiplier may be defective. Check the photomultiplier or contact the Berthold Service.
S309	Cps instable	The count rate fluctuates excessively	Check the detector electronics or the photomultiplier/scintillator combination and replace if necessary.
F310	Cps deviation	Count rate deviation in redundant channels	Check the detector electronics or the photomultiplier/scintillator combination and replace if necessary.
S311	Threshold (Meas)	The voltage of the measuring channel deviates from the admissible set value.	Restart the device. If the error occurs more frequently, please contact the Berthold Service.
S312	Threshold (Ctrl)	The voltage of the control channel deviates from the admissible set value.	Restart the device. If the error occurs more frequently, please contact the Berthold Service.
S313	Threshold (Aux)	The voltage of the auxiliary channel deviates from the admissible set value.	Restart the device. If the error occurs more frequently, please contact the Berthold Service.
S314	HV voltage	An error in the high-voltage supply of the photomultiplier has occurred.	Check the detector electronics or the photomultiplier/scintillator combination and replace if necessary.
F315	HV voltage monitor	An error in the high-voltage supply of the photomultiplier has occurred.	Check the detector electronics or the photomultiplier/scintillator combination and replace if necessary.
F316	HV limited	An error in the high-voltage supply of the photomultiplier has occurred. The current high voltage deviates from the average high voltage by more than 20%.	Check the detector electronics or the photomultiplier/scintillator combination and replace if necessary. Check the Default-HV value for plausibility.

Code	Text	Description	Correction
F317	HV LL failure	An error in the high-voltage supply of the photomultiplier has occurred. The average HV is exceeded by the Default-HV by more than 20%.	Check the detector electronics or the photomultiplier/scintillator combination and replace if necessary.
S318	HV UL OOS	An error in the high-voltage supply of the photomultiplier has occurred. The average HV exceeds the Default-HV by more than 40%.	Check the detector electronics or the photomultiplier/scintillator combination and replace if necessary.
S319	Temperature sensor	The temperature sensor of the detector is defective.	Contact the Berthold Service The hardware is defective and has to be replaced.
S320	Temperature close to limit	The internal detector temperature has exceeded 75°C.	Install or check the water cooling system.
F321	Temperature exceeded limits	The internal detector temperature has exceeded 85°C.	Proper function of the device can no longer be guaranteed. It is recommended to have the device checked by Berthold, even if it still seems to work properly.
F322	Detector malfunction	An error in the state machine of the detector has occurred	Restart the device. If the error occurs more frequently, please contact the Berthold Service.
F323	HW failure	Hardware error	Contact the Berthold Service The hardware is defective and has to be replaced.
Density application:			
F400	Runtime failure	Error during execution of the software	If the error occurs more frequently, please contact the Berthold Service.
F401	Measurement Configuration	A measuring parameter set error has occurred.	Recalibrate the device. The error has to be confirmed manually (3,1,1,6).
S402	Meas.Decay Comp.	An error has occurred during decay compensation of the measuring parameter set.	If the error reoccurs, restart and recalibrate the device. If the error reoccurs, a hardware or software error is the case. The error has to be confirmed manually (3,1,1,6).
S403	Cal.Decay Comp.	An error has occurred during decay compensation of the calibration parameter set.	If the error reoccurs, restart and recalibrate the device. If the error reoccurs, a hardware or software error is the case. The error has to be confirmed manually (3,1,1,6).
S404	PV Upper Limit OOS	The measuring value exceeds the set upper limit value.	Check the process or adjust the limit values (2,5,7,2).

Code	Text	Description	Correction
S405	PV Lower Limit OOS	The measuring value is exceeded by the set bottom limit value.	Check the process or adjust the limit values (2,5,7,2).
F406	PV Upper Limit failure	The measuring value exceeds the set upper limit value.	Check the process or adjust the limit values (2,5,7,2).
F407	PV Lower Limit failure	The measuring value is exceeded by the set bottom limit value.	Check the process or adjust the limit values (2,5,7,2).
S408	Temp. Upper Limit OOS	The detector temperature exceeds the set upper limit value.	Check the ambient conditions or adjust the limit values (2,5,7,3). If required, install the water cooling system or heating jacket.
S409	Temp. Lower Limit OOS	The detector temperature is exceeded by the set bottom limit value.	Check the ambient conditions or adjust the limit values (2,5,7,3). If required, install the water cooling system or heating jacket.
F410	Temp. Upper Limit failure	The detector temperature exceeds the set upper limit value.	Check the ambient conditions or adjust the limit values (2,5,7,3). If required, install the water cooling system or heating jacket.
F411	Temp. Lower Limit failure	The detector temperature is exceeded by the set bottom limit value.	Check the ambient conditions or adjust the limit values (2,5,7,3). If required, install the water cooling system or heating jacket.
S412	Restore failure	During restore, a failure has occurred.	Carry out the restore again. The error has to be confirmed manually (3,1,1,6). If the error reoccurs, restart the device. Potentially, a hardware defect has occurred.
S413	Meas Count Rate UL OOS	The count rate has reached the bottom of the calibration range (only in “Solids Content” mode) and is limited.	Check the calibration and process conditions.
S414	Meas Count Rate LL OOS	The count rate has reached the top of the calibration range (only in “Solids Content” mode) and is limited.	Check the calibration and process conditions.
S415	PV calculation OOS	The iterative calculation algorithm for calculating the measuring values is not convergent.	If the error reoccurs, the calibration has to be checked.

Code	Text	Description	Correction
S416	Alarm notification	Message that a calibration was carried out (only for active Process Alarm, refer to 2,5,7,2).	The PV alarm limit has to be checked due to the changed calibration. The error has to be confirmed manually (3,1,1,6).
Others			
F500	Runtime failure	Error during execution of the software	If the error occurs more frequently, please contact the Berthold Service.
F503	CLoop malfunction	A control error at the current output has occurred.	The function of the current output cannot be guaranteed. Restart the device. If the error reoccurs, please contact the Berthold Service. Potentially, a hardware defect has occurred.
F600	Runtime failure	Error during execution of the software	If the error occurs more frequently, please contact the Berthold Service.
S601	DO malfunction	A control error at the relay has occurred.	The function of the relay cannot be guaranteed. Restart the device. If the error reoccurs, please contact the Berthold Service. Potentially, a hardware defect has occurred.
F700	Init failure	An error has occurred during initialisation.	If the error occurs more frequently, please contact the Berthold Service.
F701	Runtime failure	Error during execution of the software	If the error occurs more frequently, please contact the Berthold Service.
F800	Init failure	An error has occurred during initialisation.	If the error occurs more frequently, please contact the Berthold Service.
F801	Runtime failure	Error during execution of the software	If the error occurs more frequently, please contact the Berthold Service.
F900	Runtime failure	Error during execution of the software	If the error occurs more frequently, please contact the Berthold Service.

8 Maintenance and Repair

8.1 Safety Instructions

⚠ DANGER

Risk of electrical shock when cleaning with a jet of water!

There is a risk of injury by electrical shock if the live measuring system is cleaned with a full jet of water or a high-pressure cleaner.

- The measuring system must not be cleaned with a high-pressure cleaner.

⚠ DANGER

Risk of electrical shock in case of humidity in the connection chamber!

There is a risk of injury by electrical shock if humidity penetrates the connection chamber and if work is performed at live lines connected to the connection chamber.

- Regularly check the cable glands for tightness.

IMPORTANT

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

Repair and servicing at the detectors may only be carried out by experts (refer to chapter 2.2). In case of doubt, the complete detector is to be returned to Berthold.

NOTICE

Repair at electronic circuits on the circuit boards of SmartSERIES field devices may only be carried out by the manufacturer.

When working at electronic components, the relevant safety regulations must always be observed. Particularly observe the safety instructions in the respective chapter “Safety manual”. De-energise the detector and potentially connected relay contacts as well as all inputs and outputs.

IMPORTANT

To achieve optimum measuring accuracy, we recommend to recalibrate the measuring system after a repair (not after changing the housing).

The following parts may be replaced, at the users own risk and with loss of any potential warranty, by Berthold:

- the complete electronics system of the detector
- the scintillator
- the multiplier (photomultiplier)
- the multiplier/scintillator combination
- the detector housing
- the display front plate.

Detectors must only be repaired by the Berthold Service or by third parties authorised.

Only original spare parts of Berthold are to be used.

8.2 Software Update

Release Date	Firmware Revision	Software Revision	Field Device Revision
2014-02-11	1.1.0	1	1
2014-10-24	1.2.1	1	1

The following chapter describes the process of a software update at the field device with the Detector Service Modem.

NOTICE

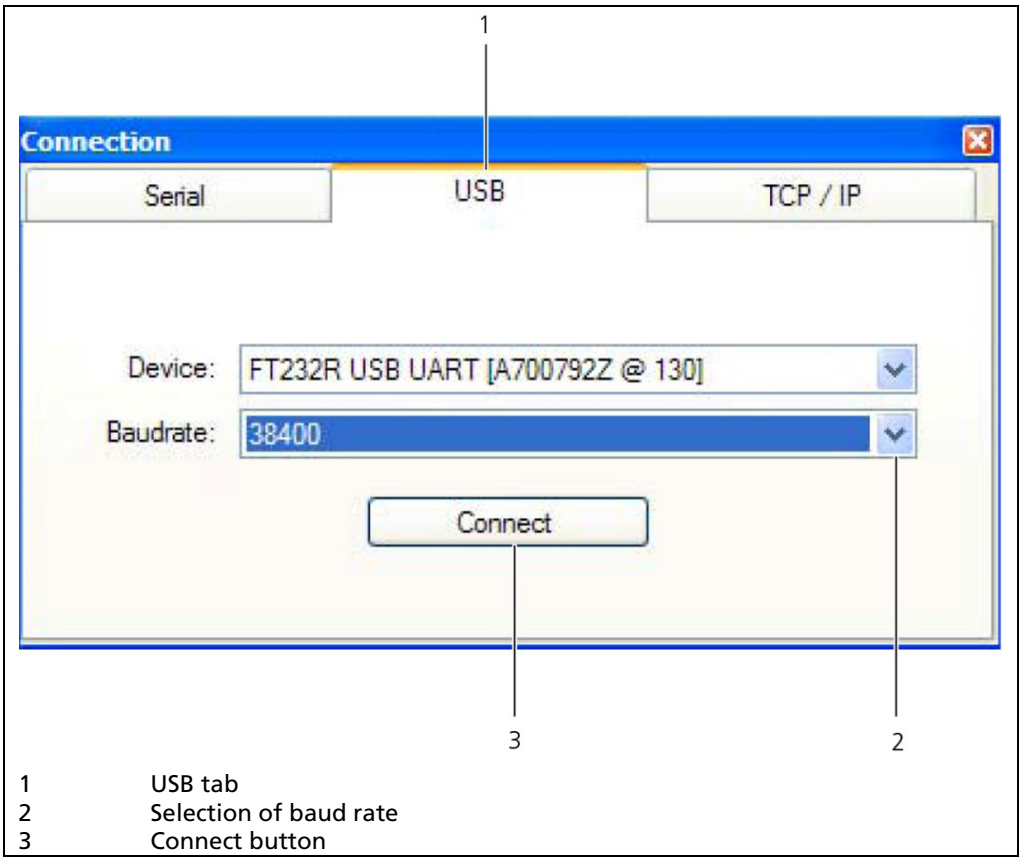
Reset the field device to default factory settings if the first or second digit of the version number has changed. This can be done by using the software “LB 41x PC Control” or in the HART menu (2,5,2,5).

Save your settings previously and start import sequence after Factory Reset.

NOTICE

For software updates, Flash Loader version 2.1.0 or higher is required.
If an older version is installed, it has to be uninstalled before.

1. Install the drivers by executing the driver file. "BertholdRS485.exe" before connecting the detector service modem.
2. Run the installation file "Setup.exe" to install the service program "FLASH Loader". The software of the detector can be updated with the service program "FLASH Loader".
3. Connect the detector to the terminal strip of the "detector service modem".
4. Connect the "detector service modem" via the supplied USB cable to a free USB port on your PC.
5. Start the program "FlashLoader.exe"



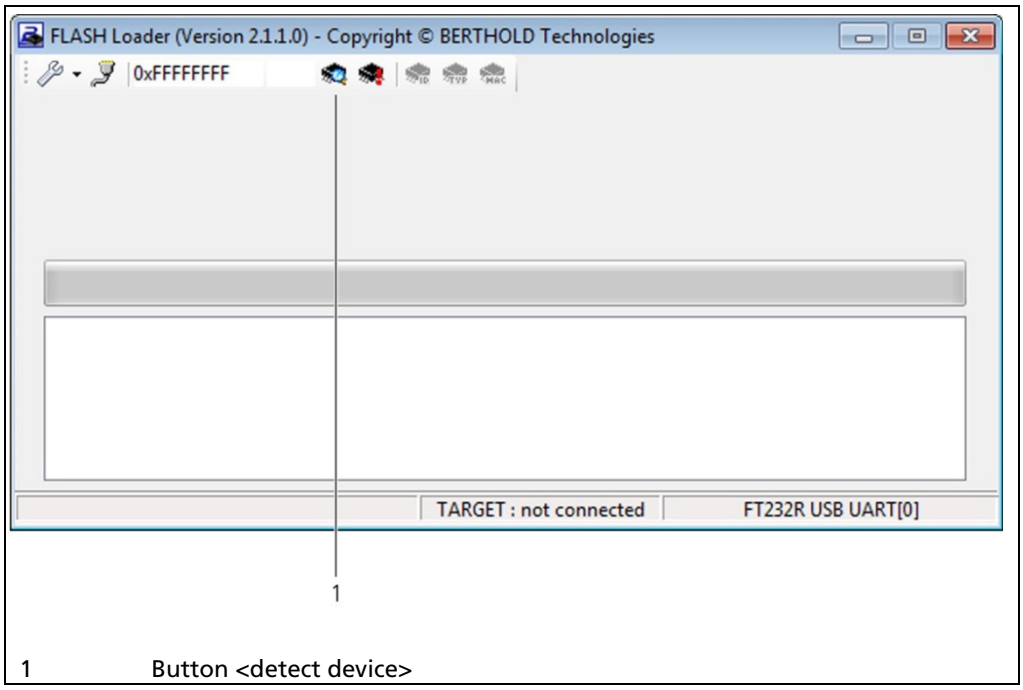
1 USB tab
2 Selection of baud rate
3 Connect button

Fig. 27 Connection Window "Flash Loader"

- The program opens.

6. Click on the tab <USB>.
7. Select a baud rate of 38400 in the selection menu.
8. Click on <Connect>.

▶ The **Flash** Loader Start screen will appear.

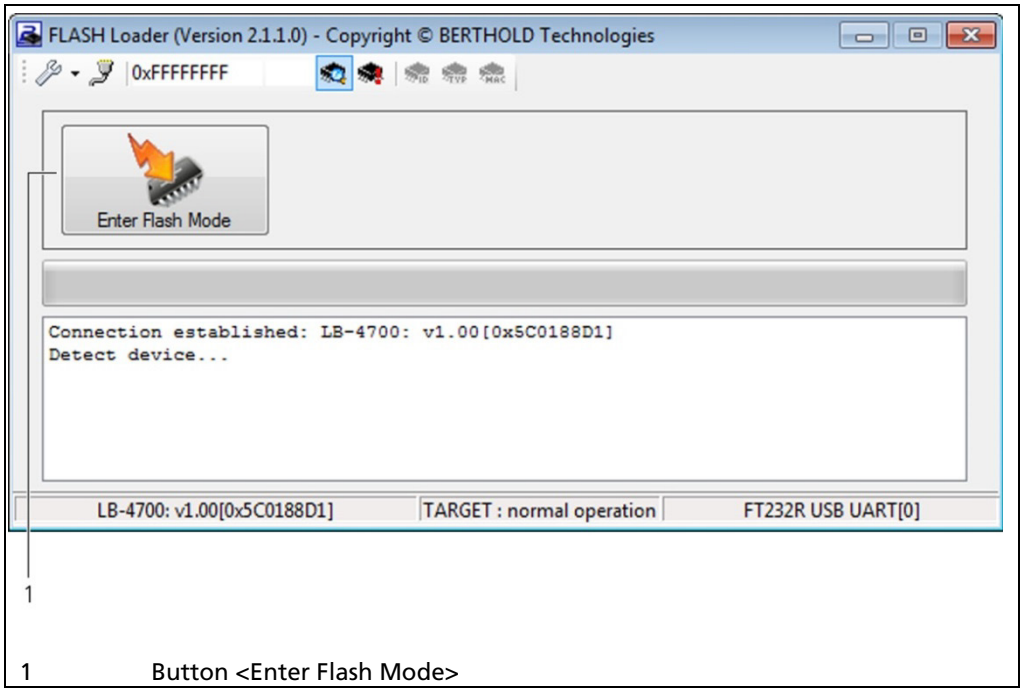


1 Button <detect device>

Fig. 28 Flash Loader Main Screen

9. Click on the button **<detect device>**.

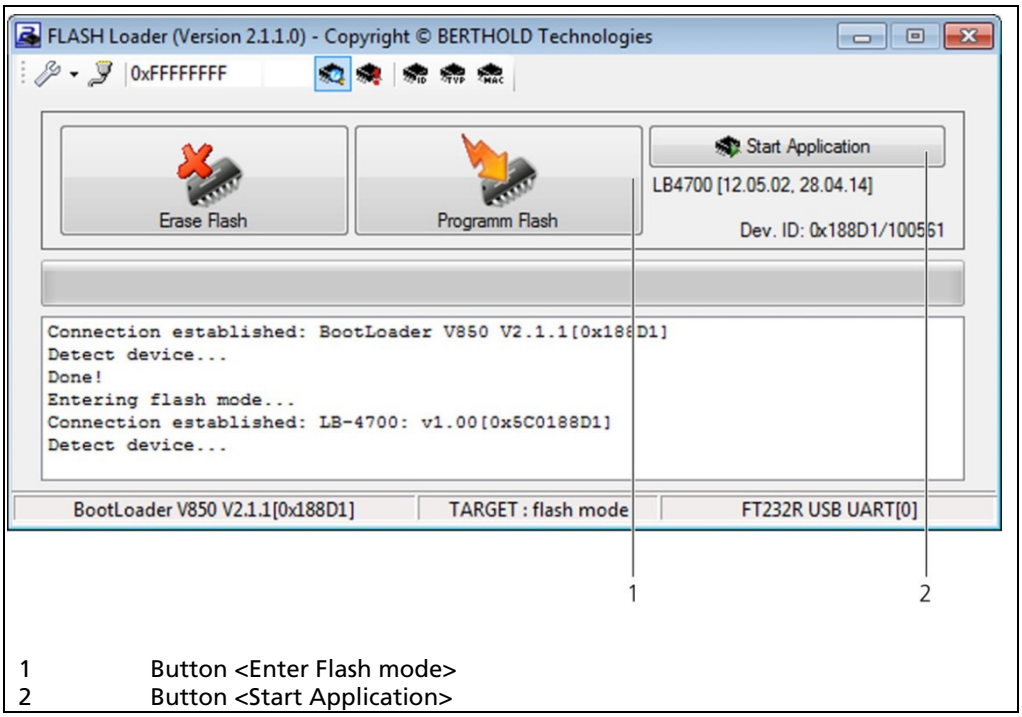
▶ The program establishes a connection to the detector.



1 Button <Enter Flash Mode>

Fig. 29 Flash Loader Connection

10. Click on the button **<Enter Flash Mode>.**



1 Button <Enter Flash mode>
2 Button <Start Application>

Fig. 30 Flash Loader “Program Flash” Page

11. Click on the button <Program Flash>

- A dialogue window will open.

12. Select the corresponding file for the software update.

- The detector is programmed with the respective software.

NOTICE

This flash process may take several minutes to complete. During this time, the communication must not be interrupted.
The Flash process is split into “Deletion of Flash content” and “Reprogramming Flash“.

13. Click on the button <Start Application>. (Fig. 14, item 2) after the programming has ended.

8.3 Visual Inspection of Housing and Cables

- Check the gable glands in regular intervals for tightness and secure connection. Replace untight cable glands.
- Check cables and housing components in regular intervals for corrosion. Replace any corroded parts.
- Check the cover in regular intervals for tightness and secure connection. Replace untight covers.

8.4 Visual Inspection of Scintillator and Photomultiplier

⚠ DANGER

Danger of death by electric shock!

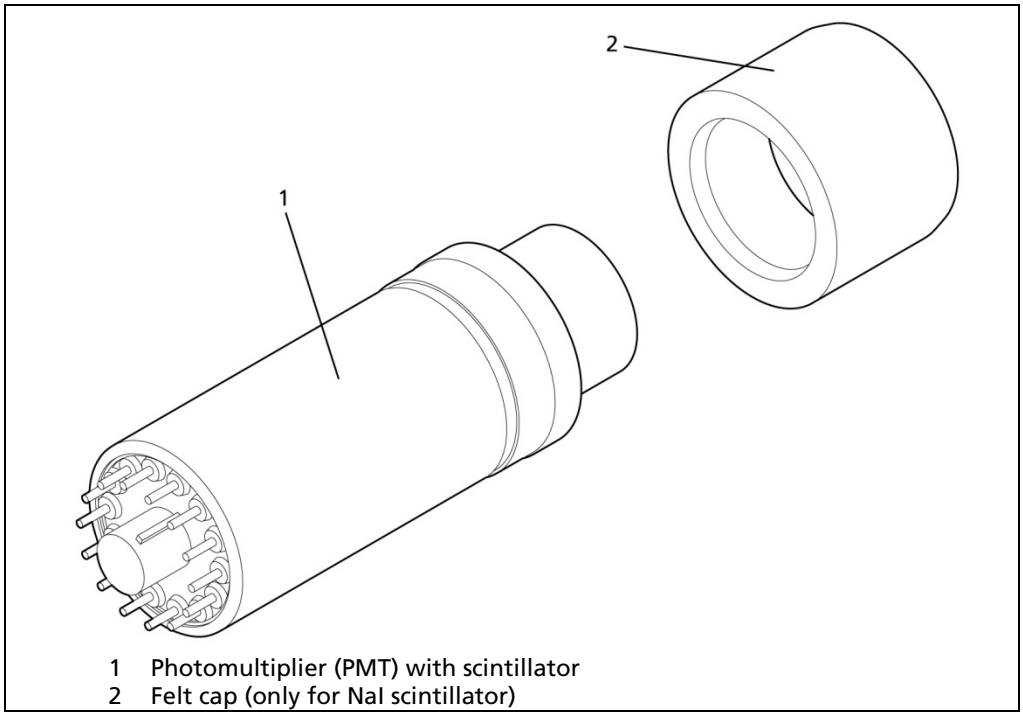
- The installation may only be carried out by qualified electricians.
- All relevant safety regulations have to be observed.
- Installation/maintenance may only be carried out if the device has been de-energised.
- Only open the device when it is de-energised.

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

Errors at the scintillator/multiplier combination are indicated by too small or steep plateaus (see HART 2,5,3,2,4). These can often already be detected by a visual inspection. For this, the scintillator/multiplier combination has to be disassembled.

The scintillator has to be crystal clear on the inside and neither have any cracks nor dull spots. The colour is usually slightly green (NaI) or blue (polymer). A clear change in colour indicates a thermal overload and requires the scintillator to be replaced.

The window of the multiplier is covered by an evaporated layer as photocathode. This layer causes the window to have a slightly brownish or smoked glass colour. If this layer is no longer present or if it is stained, this means that the cathode has been destroyed (e.g. by overheating, glass breakage or incidence of light). In this case, the multiplier has to be replaced.



1 Photomultiplier (PMT) with scintillator
2 Felt cap (only for NaI scintillator)

Fig. 31 Figure of the scintillator and the photomultiplier

8.5 Replacing the Entire Detector

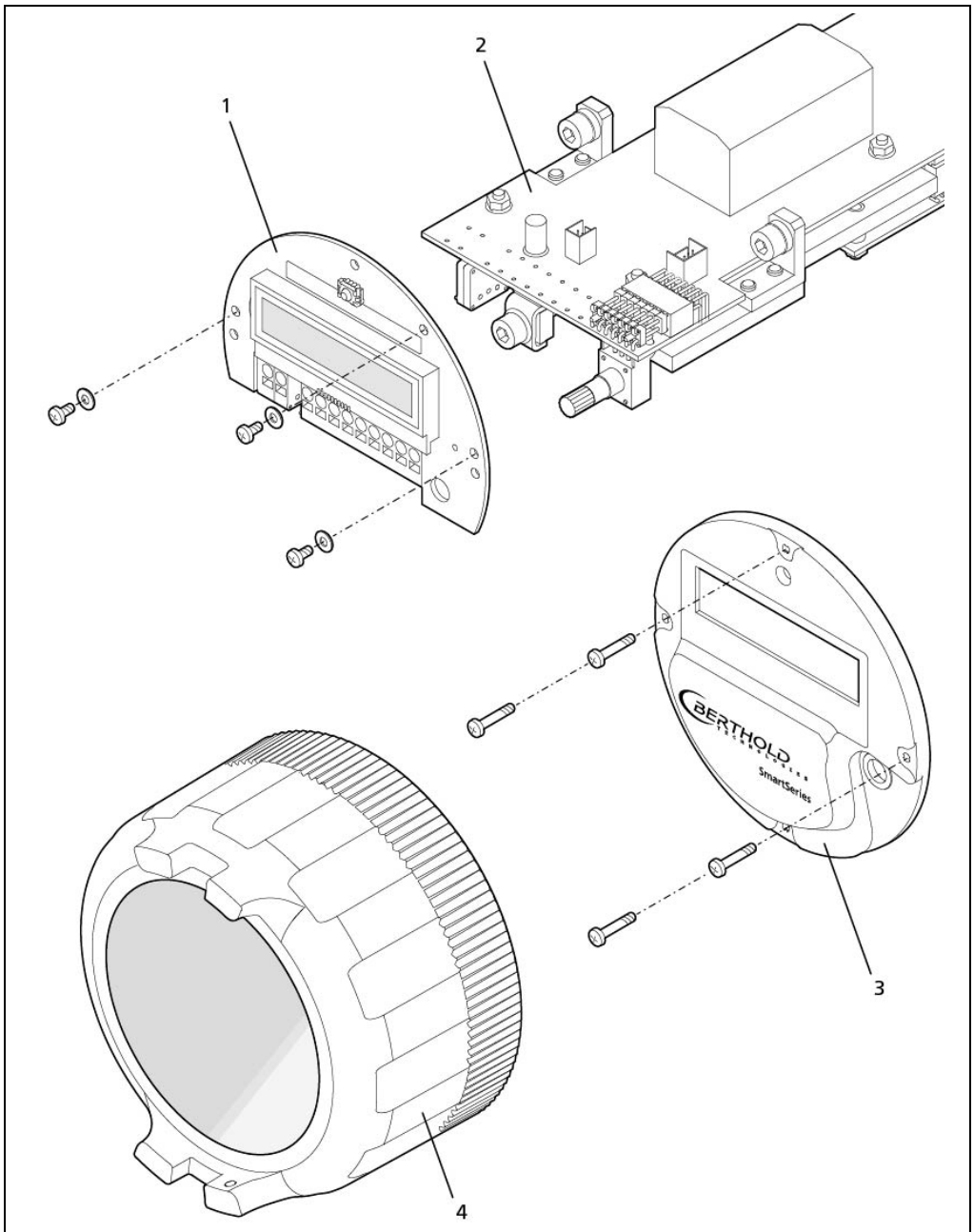
To replace the detector, proceed as follows:

1. Document all software parameters of the installed detector
2. Take the old detector out of operation as described in chapter “Decommissioning”.
3. Install the new detector as described in chapter “Installation”.
4. Install the electrical system as described in chapter “Electric Installation”.
5. Transfer the software parameters of the old detector to the new one.

NOTICE

Software parameters can also be stored and transmitted with the 475 HART Communicator.

8.6 Replacing the Display



1 Display
2 Base unit with special electronics
3 Contact protection
4 Housing cover

Fig. 32 Replacing the display

1. Screw off the housing cover (pos. 1).
2. Remove the contact protection by unscrewing the 4 Phillips screws.
3. Remove the display unit by loosening the 3 Phillips screws.
4. Replace the display unit and retighten it and the contact protection.
5. Reattach the housing cover.

8.7 Replacing the Electronics Module

NOTICE

Field device parts must be assembled and disassembled in a clean workshop environment.

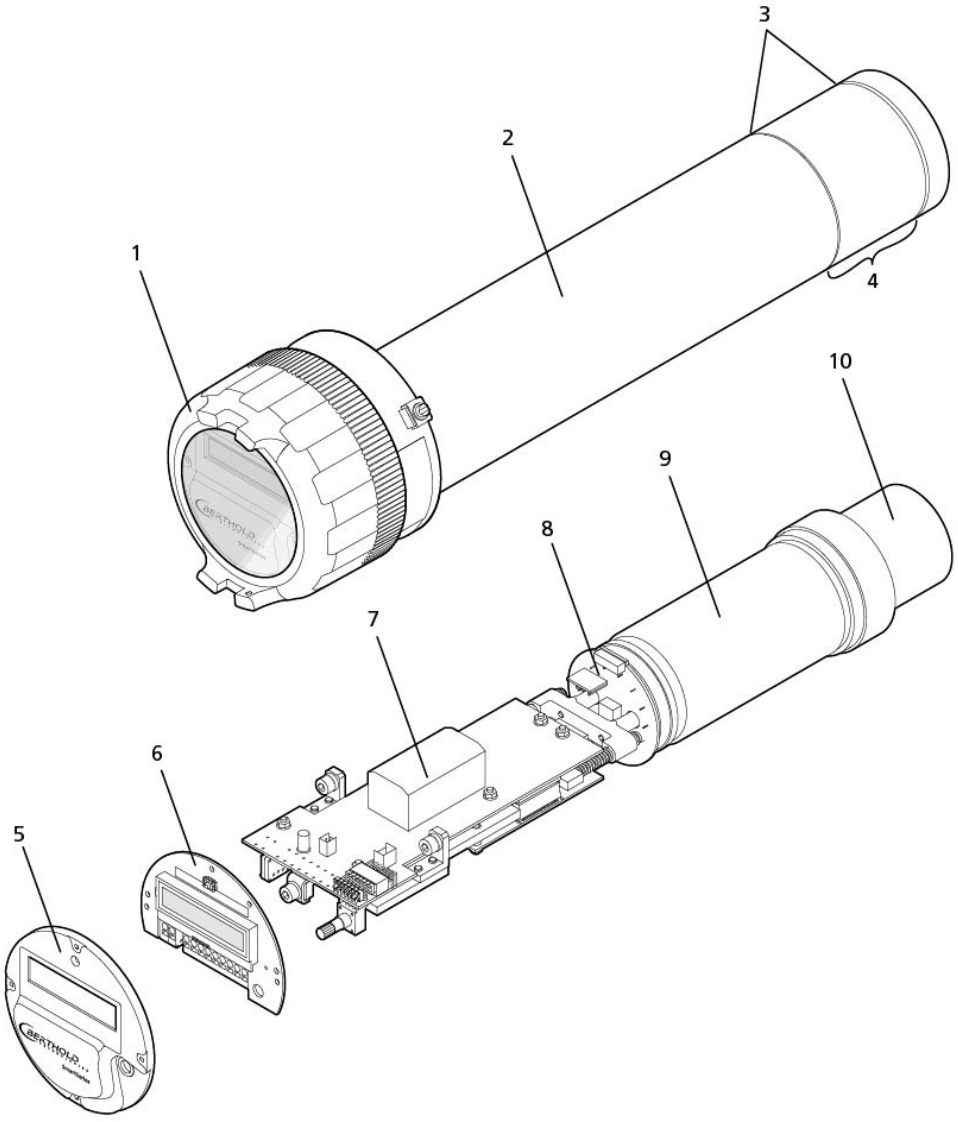
8.7.1 Disassembling the Electronics Module

⚠ DANGER

Danger of death by electric shock!

- The installation may only be carried out by qualified electricians.
- All relevant safety regulations have to be observed.
- If the housing is opened, there is a risk of contact to live parts if the power supply is switched on.
- Only open the device when it is de-energised.

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



1 Cover made of shockproof and scratch-resistant plastic with viewing window. Optional: For temperature ranges below -20 °C, the field device can be provided with a stainless steel cover without viewing window.
2 Stainless steel housing for mechanical detector system, electronics holder and display/operating unit
3 Marking groves Mark the sensitive area
4 Sensitive area
5 Contact protection
6 Display unit
7 Mounting plate with special electronics
8 Photomultiplier base
9 Photomultiplier
10 Scintillator (polymer. Optional: NaI)

Fig. 33 System Components

1. Document all software parameters of the installed detector
2. Disconnect the detector from the power supply and de-energise it and any potentially connected peripherals.
3. Screw off the housing cover (pos. 1).
4. Remove the contact protection by unscrewing the 4 Phillips screws.
5. Remove the display unit after loosening the 3 Phillips screws.

6. Remove the 2 Allen screws that connect the base unit (pos. 7) with the detector housing.
7. If necessary, mark the cables and unplug them.
8. Carefully pull out the base unit with the scintillator/multiplier combination.
9. Disconnect the base unit from the scintillator/multiplier combination. Ensure that the spring unit (pos. 8) remains intact and the springs are not damaged.
10. Now, the complete electronics module can be replaced.

8.7.2 Installing the Electronics Module

To assemble the electronics module, proceed in reverse order.

1. Make sure that no humidity or metal chippings are inside the connection chamber.
2. Carefully reassemble the base unit and the scintillator/multiplier combination. Please observe the coding lug.
3. Check the spring unit for proper function.
4. Carefully insert the base unit with the scintillator/multiplier combination into the housing.
5. Reattach the base unit at the detector housing. Tighten the screws alternating and equally on both sides.
6. Check the O ring sealing the housing and replace it if necessary.
7. Insert the display unit and screw it tight.
8. Reconnect the cables.
9. Reattach the contact protection.
10. Carefully close the housing with the housing cover.
11. Cover the number of the device ID on the name plate with the provided adhesive label.
12. Reconnect the supply voltage to the detector.
13. Reset the software parameters according to the list you created in the beginning.

NOTICE

Software parameters can also be stored and transmitted with the 475 HART Communicator.

8.8 Replacing the Scintillator

8.8.1 Disassembling the Scintillator

The multiplier should not be subject to bright light during the following working steps.

1. Disassemble the electronics module as described in steps 1 to 9 in chapter 8.7.1.
2. Carefully screw off the scintillator from the photomultiplier.
3. Clean the optical contact surfaces with a soft cloth from silicon oil residues.

8.8.2 Installing the Scintillator

1. Before assembly, apply a drop pure silicon oil (BERTHOLD ID no. 18844) between the scintillator and the multiplier and slightly distribute it by rubbing to ensure a good optical connection between the two components.
2. Reassemble the scintillator and the multiplier and install the holder by re-tightening the 4 Phillips screws.

8.9 Replacing the Scintillator/Multiplier combination

1. Disassemble the electronics module as described in steps 1 to 9 in chapter 8.7.1.
2. Plug the new multiplier into the socket. Please observe the coding lug.
3. Reinstall the electronics module as described in chapter 8.7.2.
4. Check the measuring function. In case of deviations, carry out recalibration (refer to chapter 6.3).

8.10 Cleaning

NOTICE

Risk of damage to plastic components!

Organic solvents and abrasive agents may cause damage to plastic components.

- ▶ Plastic components may only be cleaned with a damp cloth.

- Clean the device only with a damp cloth.
- The device must not be cleaned with a high-pressure cleaner.

9 Accessories

9.1 Water Cooling System

To protect the scintillators against overly high temperatures, a water cooling system is optionally available. A water cooling system has to be used if the ambient temperature of the field device could exceed +60°C.

In this respect, ambient temperature, sun light, radiant heat of hot components and the transition of heat from installation fixtures are to be considered. With water cooling, the detectors can be operated at a maximum ambient temperature of 100 °C.

NOTICE

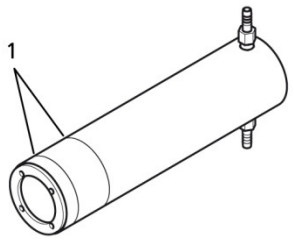
If the cooling water is left in the water cooling system when there is a risk of frost, this may lead to mechanical damage of the water cooling system.

NOTICE

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

NOTICE

Failure of the water cooling system or insufficient flow may overheat the detector and destroy it. For cooling, exclusively use water with drinking water quality.

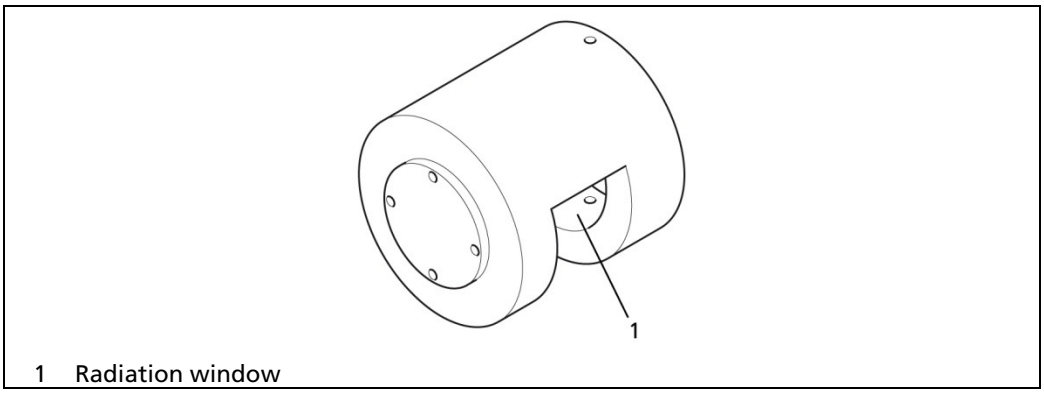


1 Marking groves at the water cooling system of the field device

Fig. 34 Field device water cooling system

Installation, connection of the water cooling system and minimum cooling water requirement: See chap. 4.6.2.

9.2 Collimator



1 Radiation window

Fig. 35 Collimator

The optionally available lead collimator provides protection from background radiation and ensures high reliability and measurement accuracy. The collimator is available with a radial (irradiation from the side) or axial (irradiation from the front) radiation window.

Collimator mounting: See chap. 4.7.1.

9.3 IR Remote Control

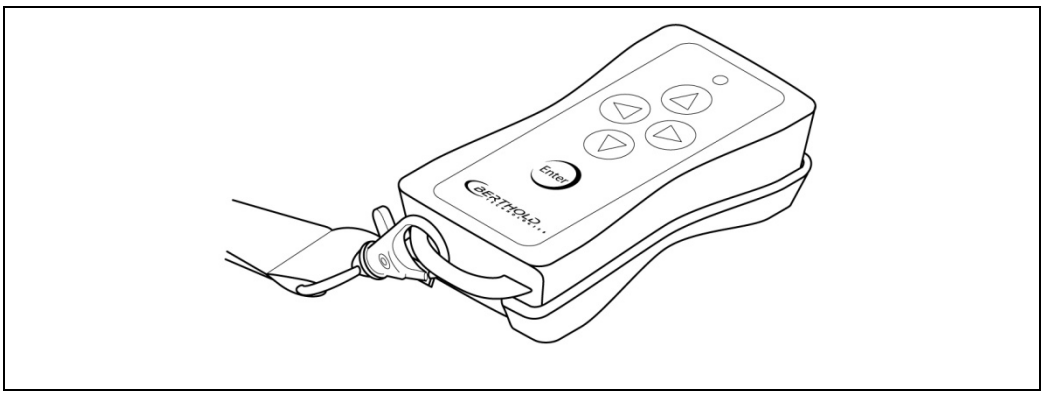
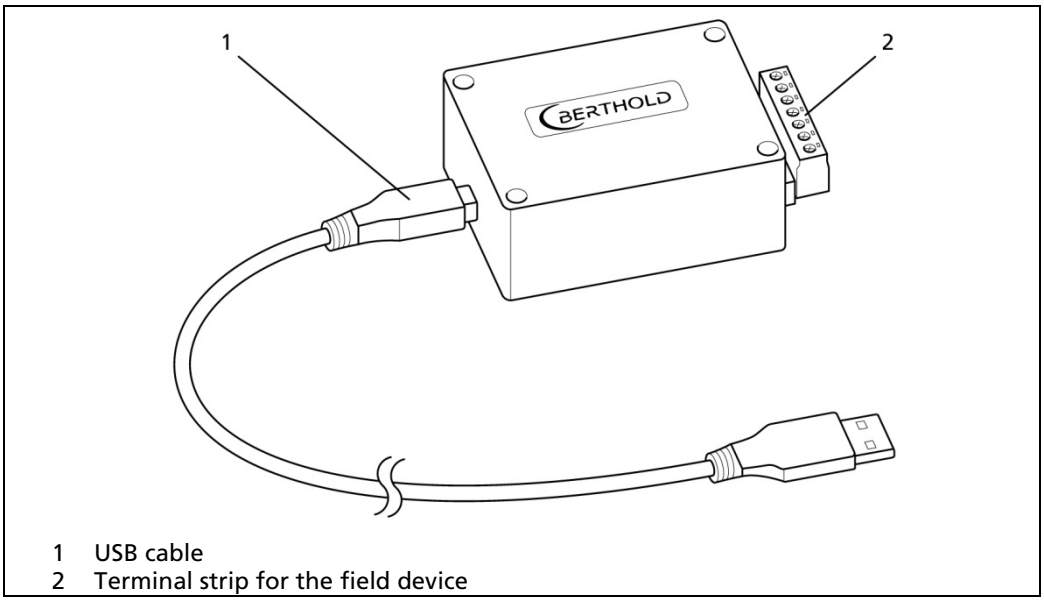


Fig. 36 IR Remote Control

The “IR Remote Control” infrared control unit can be used alternatively to the operating knob. If the field device is controlled by IR Remote Control, the screw cover does not need to be removed. The infrared control unit has to be activated by means of a software.

9.4 Detector Service Modem



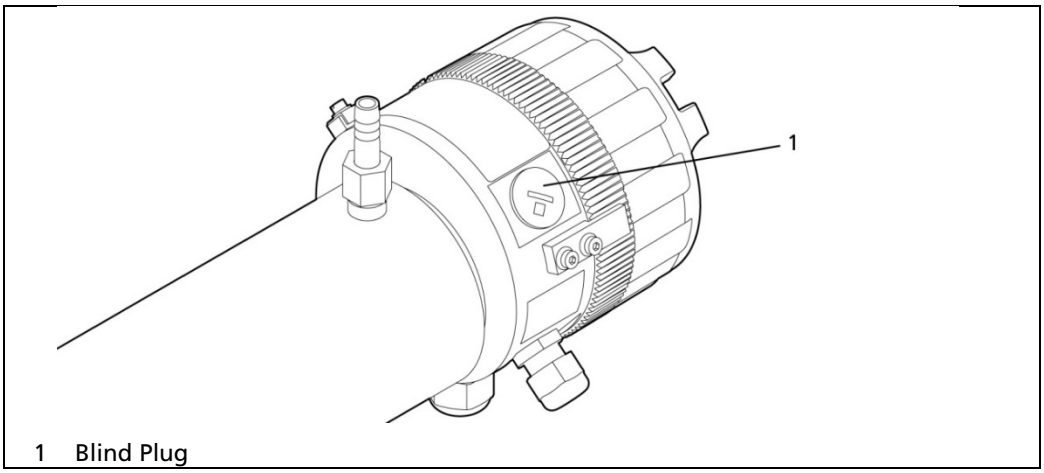
1 USB cable
2 Terminal strip for the field device

Fig. 37 Detector Service Modem

With the help of the Detector Service Modem, the field device can be connected to a PC to check it in a workshop, for software updates and for parametrization.

For information on system requirements, PC connection and driver software, refer to chapter 6.3.3.

9.5 Mounting connection “External Communication”

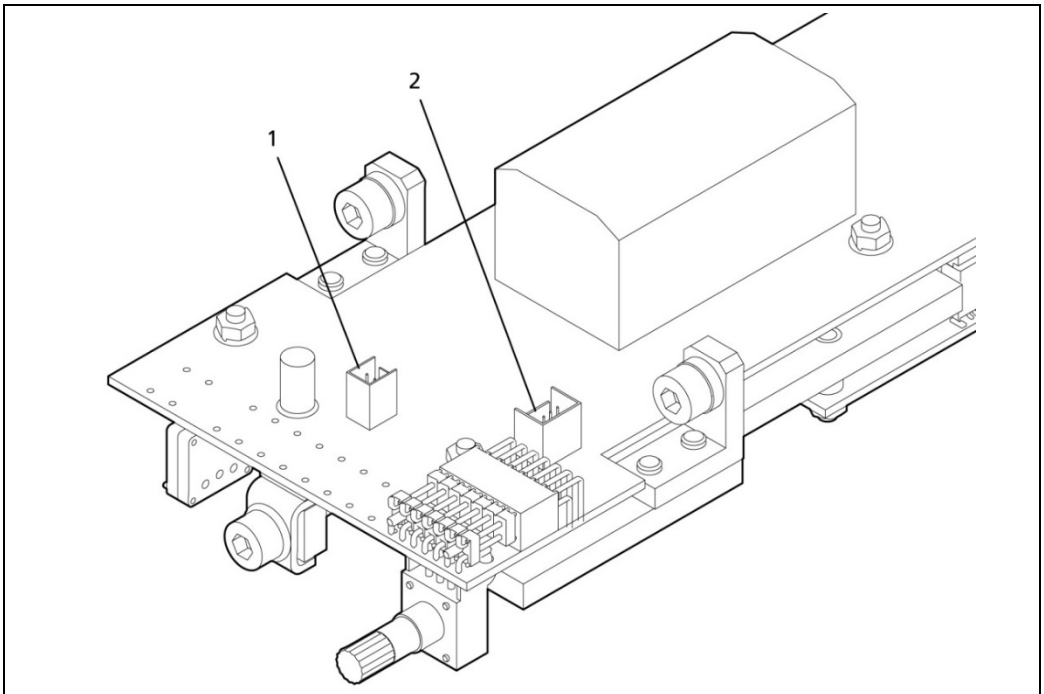


1 Blind Plug

Fig. 38 Blind Plug

1. De-energise the field device.
2. Remove the locking (if existing).
3. Open the cover.
4. Remove the contact protection and the display unit.

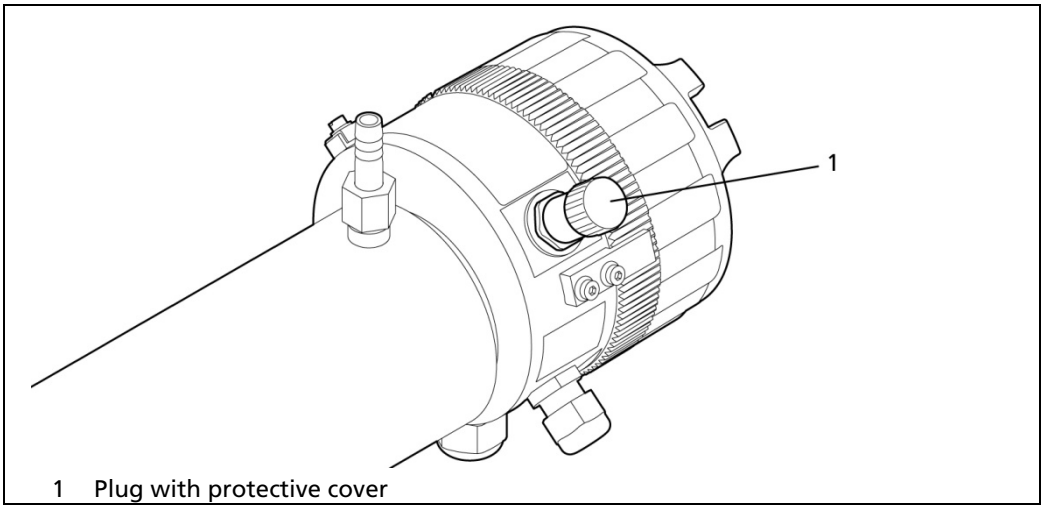
5. Remove the blind plug from the field device.
6. Insert the cables into the opening and plug it to the respective sockets (Fig. 39).



1 Connecting position for 2-pin plug
2 Connecting position for 3-pin plug

Fig. 39 Connector plug installation on PCB

7. Screw in the connection plug.

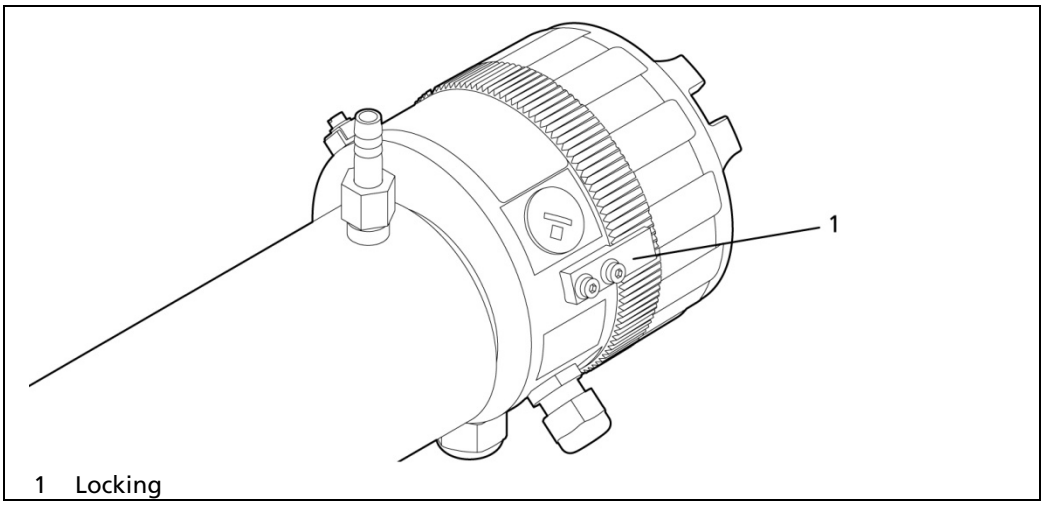


1 Plug with protective cover

Fig. 40 Connection plug

8. Reattach the display unit and the contact protection.
9. Carefully close the housing with the housing cover.
10. Attach the locking by fixing the Allen screws (if existing).

9.6 Locking



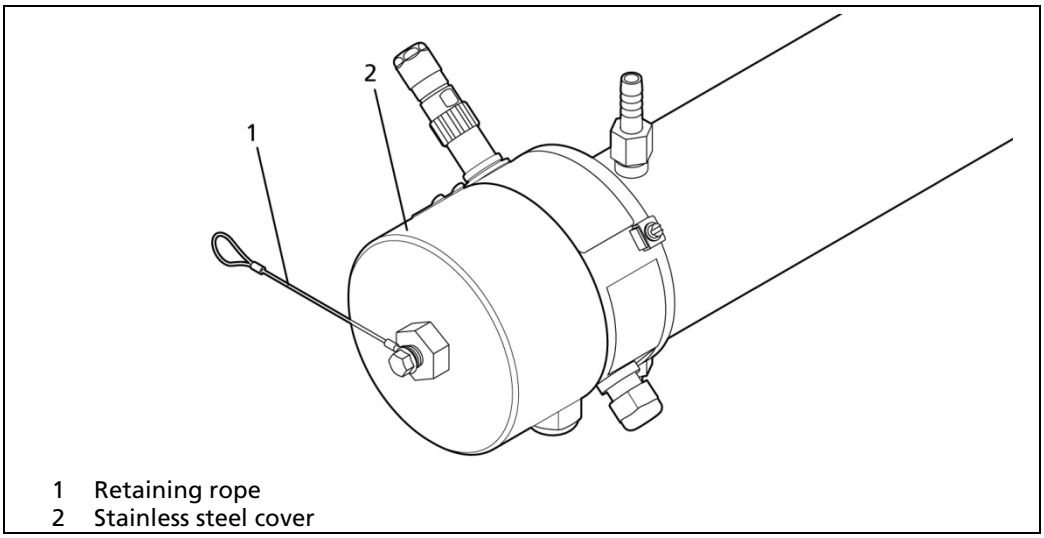
1 Locking

Fig. 41 Locking

Locking prevents accidental unscrewing of the cover.

1. Attach the locking by inserting the Allen screws into the provided threaded holes.

9.7 Stainless Steel Cover



1 Retaining rope
2 Stainless steel cover

Fig. 42 Stainless steel cover

The stainless steel cover is designed for temperatures below -20°C and, in combination with a water cooling system, for temperatures exceeding +60°C.

9.8 Blind plugs and Cable Glands

Blind plugs and cable glands are provided separately. If necessary, they are to be installed at the desired positions (not illustrated).

10 Decommissioning

10.1 Preparatory Activities

⚠ DANGER

Danger of death by electric shock!
Decommissioning may only be carried out by qualified electricians.

- All relevant safety regulations have to be observed.
- Decommissioning may only be carried out if the device has been de-energised.
- Only open the device when it is de-energised.

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

For decommissioning, proceed as follows:

1. Remove all connection cables from the product.
2. Disassemble the product.

10.2 Disposal

⚠ CAUTION

Toxic!
The product contains electronic components containing toxic substances that are harmful to health.

- The device is to be disposed of according to applicable legal regulations by a specialised waste management company.

If the device is to be decommissioned, have it disposed of according to legal regulations (e.g. RL 2002/96/EC) by a specialised waste management company.

11 Technical Information

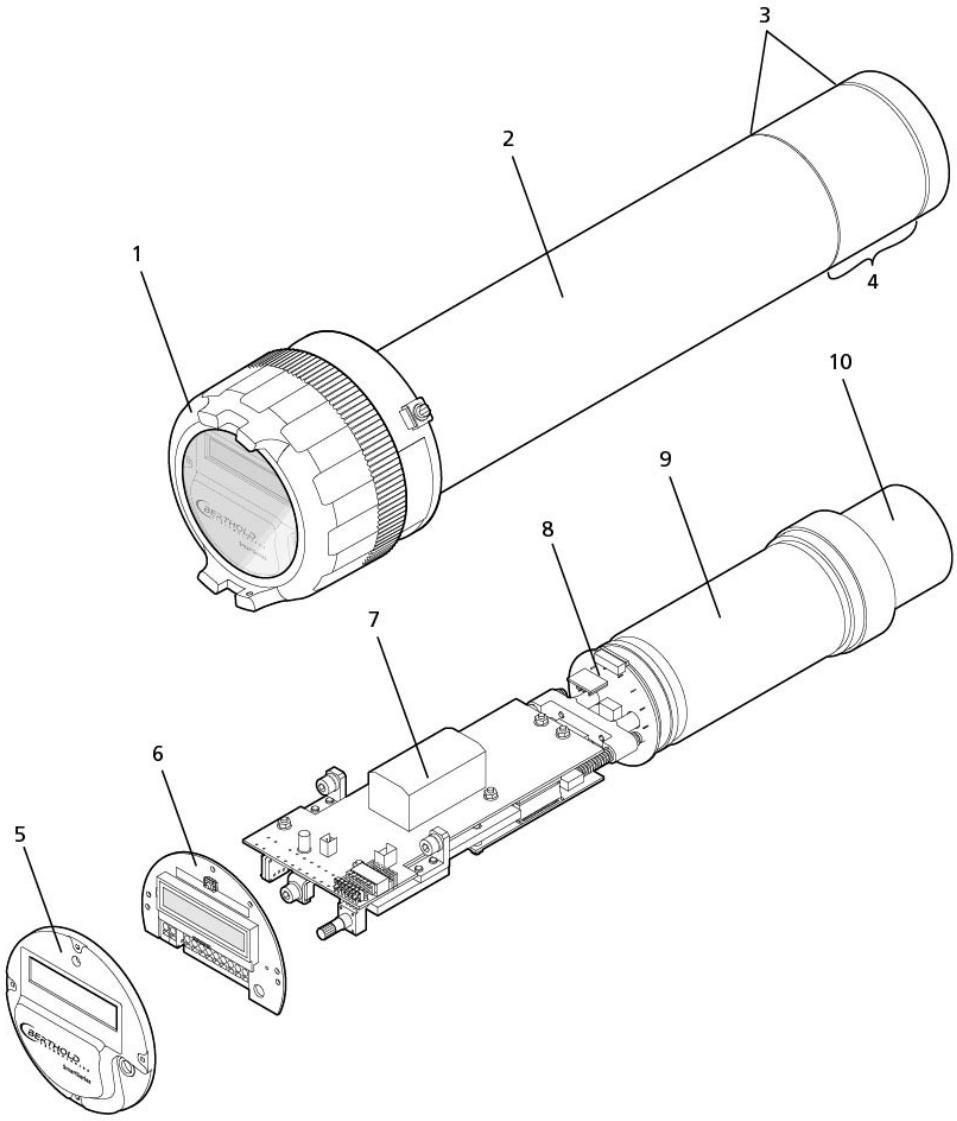
11.1 Technical Data

Mechanical Design	
Ambient temperatures	-20…+60°C (-4…+140°F) extended temperature range with metal cover and metal cable glands: -40… +60°C (-40…+140°F) with Water Cooling System: -40… 100°C (-40…+212°F)
Housing material	Stainless steel ISO 1.4301 / AISI 304 (other materials on request)
Plastic components	PBT or PC
Weight	approx. 10 kg
Length	approx. 483 mm
Degree of protection (with closed cover)	IP 66 / IP 67 (according to IEC 60529)
Degree of protection (with open cover)	IP 40 (according to IEC 60529)
Vibration mech. shock	Vibration (according to DIN EN 60086-2-6 and 60068-2-27) mech. shock: 30 g
General ambient conditions	Degree of pollution 2 Installation category II Height above sea level up to 3,000 m Humidty ≤ 90%
Water Cooling System	Optional, stainless steel ISO 1.4301 / AISI 304; Water pressure up to 6 bar Tube connection R1/4”, d=10mm Weight approx. 3.5 kg
Collimator	Optional, lead, painted To reduce background radiation ID no. 4506 and 11814 Weight approx. 9.5 kg
IR Remote Control	Optional, can be used alternatively to the operating knob. This enables operation of the field device without removing the screw cover. Id. No. 61167

Electrical Design	
Supply voltage	Variant 1: 100…240 VAC +/- 10%, 50…60 Hz max. 8 VA Variant 2: 24 VDC, 18…32 VDC max. 8 W 1x fuse 1A/T
EMC	Emitted interference according to EN 61326-1, operating equipment class A interference immunity according to EN 61326-1, NAMUR NE21 Low-voltage Directive EN 61010-1
Approvals	CE, $_{c}$CSA$_{US}$ general area
Line glands	2x M20 x 1.5 mm 2x M16 x 1.5 mm
Wire cross section for spring terminals	1 mm^2 to 2.5 mm^2; 8 mm insulation stripping
Relay output	Relay contact (SPDT) with max. 24 V switching voltage at 5 A max. current carrying capacity and 5AT safety fuse. Can be configured by means of software for: • System status messages • Detector temperature violations • exceeding / short falling process value limits.
Current output	HART current output 4...20 mA, potential-free, passive or active Resolution above 6 µA. Active impedance range: 120 Ohm to 500 Ohm Passive impedance range: max. 250 Ohm at 12 V, max. 500 Ohm at 24 V. For safe HART® communication, at least 250 Ohm are required. The maximum cable length of the HART® loop depends on the connected resistance as well as on the capacity and inductance of the cable. Max. cable length with BERTHOLD cable (ID no. 32024): • 3300 m at 120 Ohm • 1600 m at 250 Ohm • 800 m at 500 Ohm.
RS485	For software updates and PC software interface Max. cable length 30 m
External connection plug	M20 plug and cable for Detector Service Modem or 475 HART Communicator connection.
System integration	Via 4...20 mA current interface with optional HART® protocol according to BEL-202 FSK standard.
Temperature monitoring	Measuring sensor inside the detector, deviation of max. 3 K
Temperature stability	≤ 0.01 %/°C (-20...+50°C, -4…+122°F) for polymer scintillator ≤ 0.002 %/°C (-20...+50°C, -4…+122°F) for NAI(Tl) crystal

Digital electronics	32 bit microprocessor with Watchdog timer and self-monitoring 2x16 digits display with backlight, one-button operation and integrated status LED
Scintillator	
Scintillator	NaI point detector 40x35 mm Polymer point scintillator 50x60 mm Sensitivity: Dose rate approx. 1 µSv/h for 300 cps
Software	
Measuring application	Density (e.g. of fluids, suspensions or bulk material) • Measuring units: g/cm³, kg/m³, g/l, SGU, % (wt/wt), lb/gal, lb/ft³ • Conformity according to NE-21, NE-43 and NE-107 • Safety write protection for software available. Prevents unauthorised operation. • Data backup in non-volatile memory
Automatic decay compensation	Cs-137, Co-60
User interfaces	All interfaces enable full parameterisation and calibration: • Local User Interface • HART® (device description is provided) • PC Interface (with Detector Service Modem and special software) • IR Remote Control.

11.2 System Components



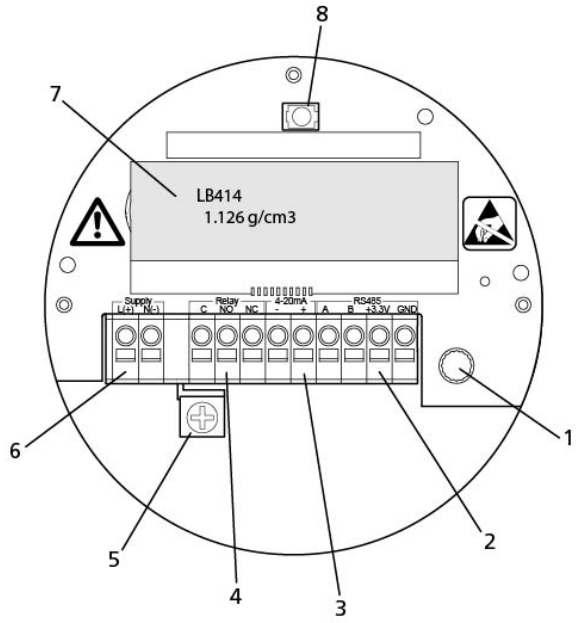
1 Cover made of shockproof and scratch-resistant plastic with viewing window. Optional: For temperature ranges below -20 °C (-4 °F), the field device can be provided with a stainless steel cover without viewing window.
2 Stainless steel housing for mechanical detector system, electronics holder and display/operating unit
3 Marking groves Mark the sensitive area
4 Sensitive area
5 Contact protection
6 Display unit
7 Mounting plate with special electronics
8 Photomultiplier base
9 Photomultiplier
10 Scintillator (polymer. Optional: NaI)

Fig. 43 System Components

11.3 Spare Parts (selection)

No	Description
4506	Collimator for NaI Detector, side irradiation
11814	Collimator for NaI Detector, frontal irradiation Ø 50mm
47189	Adaptor for water cooling, Rp1/4" to 1/2" NPT
48254	Collimator for NaI Detector, frontal irradiation Ø 50 mm, reinforced
48925	Collimator for NaI Detector, side irradiation, reinforced
4498-S	Multiplier crystal combination NaI(Tl) 40x35
5295-S	2" Photomultiplier for point detectors
5450-S	Ersatzteilsatz NaI (Tl) Kristall 40x35 mm
58094-S	Spare part detector housing
58110-S	Spare part stainless steel cover
59024-S	Spare part display panel
59229-S	Electronic assembly (24 VDC)
59231-S	Electronic assembly (100...240 VAC)
59237-S	Cover for electrical contacts
59239-S	Polymer cover
59244-S	Felt cap for NaI crystal 40x35 mm
60594-S	Mulitplier-scintillator combination (polymer 50x60 mm)
60801-S	Spare part kit cable glands, polymer
60802-S	Spare part kit cable glands, brass
62545-S	Mounting material

11.4 Connection plan



1 Control button with status LED
2 RS485 (A , B, +3.3V supply voltage, GDN supply voltage, not galvanically isolated)
3 Analogue output (4-20 mA, HART, + and - galvanically isolated)
4 Digital output, Relay C (Change Over), NO (Normally Open), NC (Normally Closed)
5 PE connection with screw
6 Voltage supply: AC Wide Range (100-240 V) L or DC 24V (+ and –)
7 Display
8 IR receiver

Fig. 44 Connection chamber Master

Pin assignment

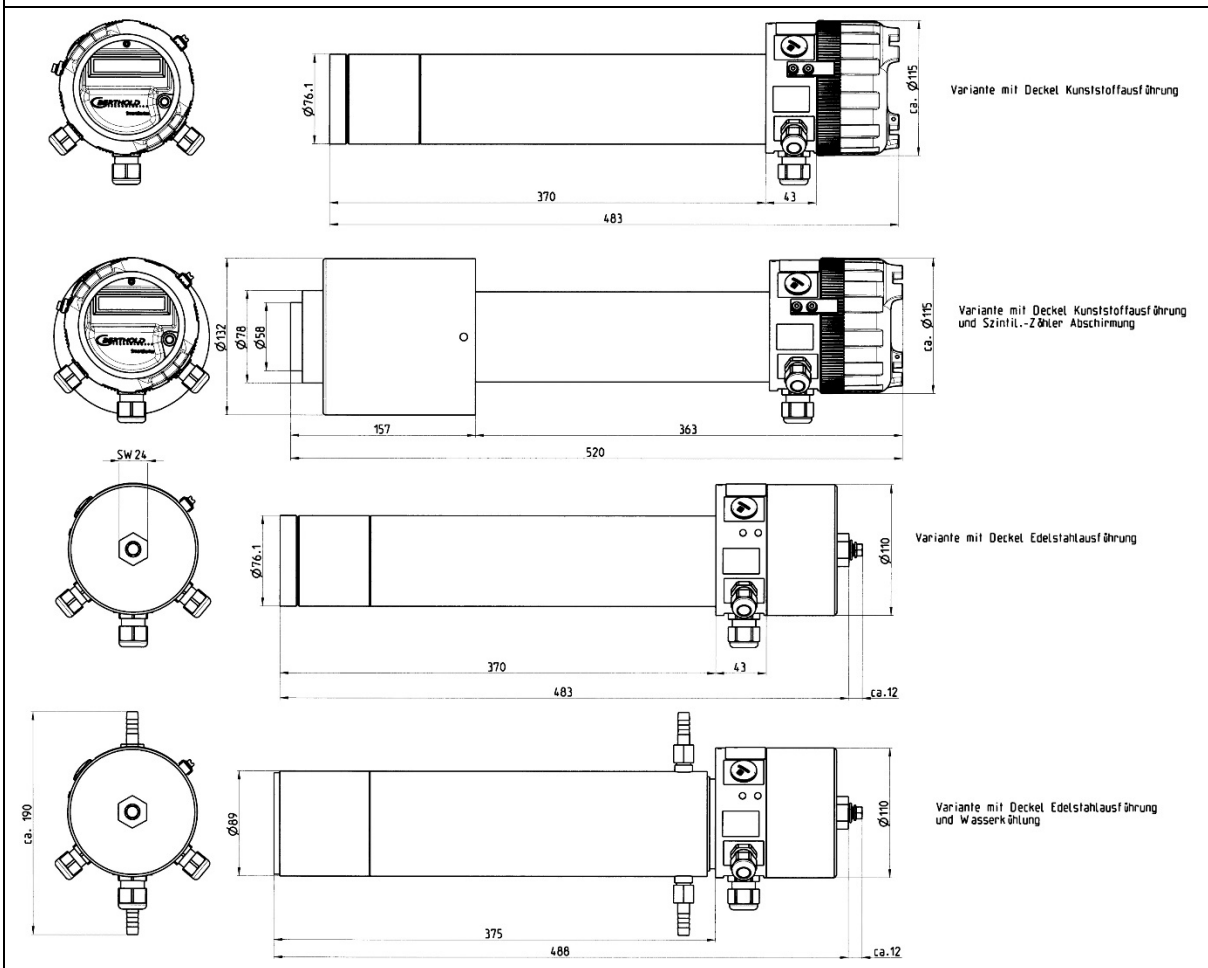
1	AC Wide Range (100-240 V) L or DC 24 V +
2	AC Wide Range (100-240 V) N or DC 24 V -
3	Relay C (change over)
4	Relay NO (normally open)
5	Relay NC (normally closed)
6	Current output – (galvanically isolated)
7	Current output + (galvanically isolated)
8	RS485 A *
9	RS485 B *
10	RS485 +3.3 V supply voltage *
11	RS485 GND supply voltage *
PE	Protective earth

* no galvanic isolation

11.5 Dimensional drawings

LB41x SmartSeries
LB41x SmartSeries

Dimensions in mm
Abmessungen in mm



11.6 Accessories / Options

11.6.1 Water cooling system (ID no. 59262)

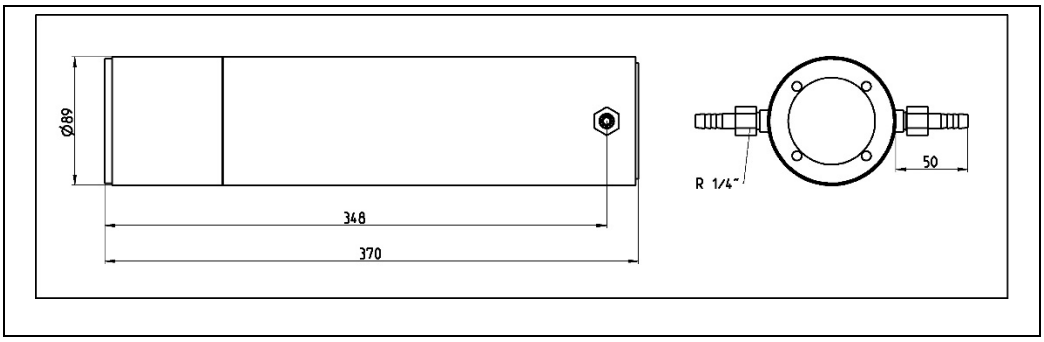


Fig. 45 Field device water cooling system

Installation and connection of the water cooling system: See chap. 4.6.2.

For the minimum cooling water requirement, please refer to the following chart.

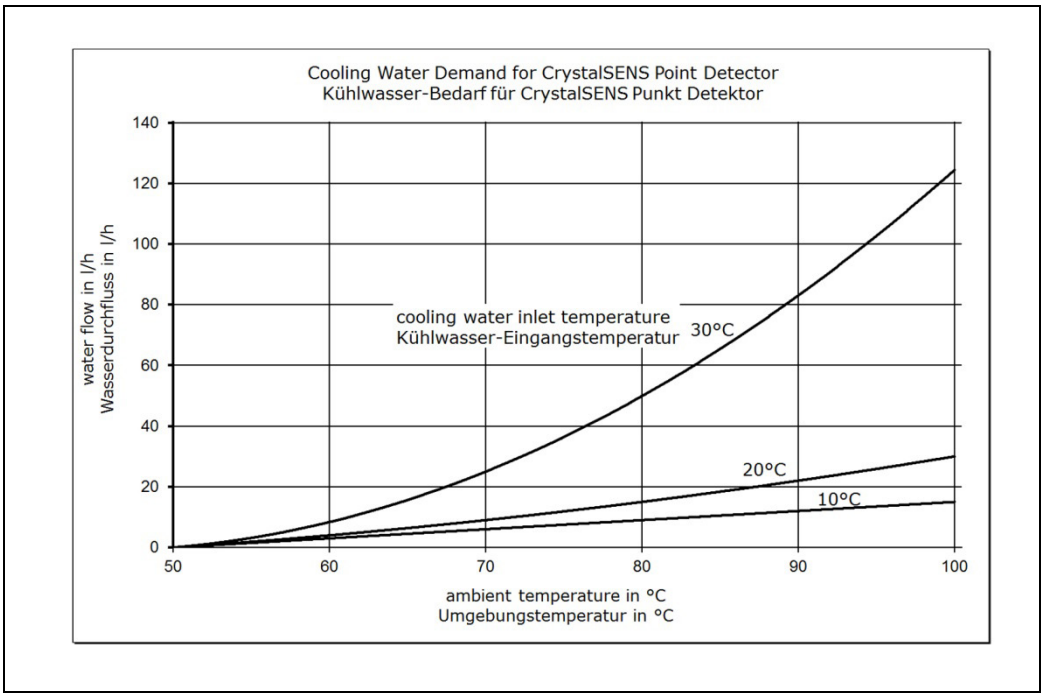


Fig. 46 Cooling water requirement

11.6.2 IR Remote Control (ID no. 61167)

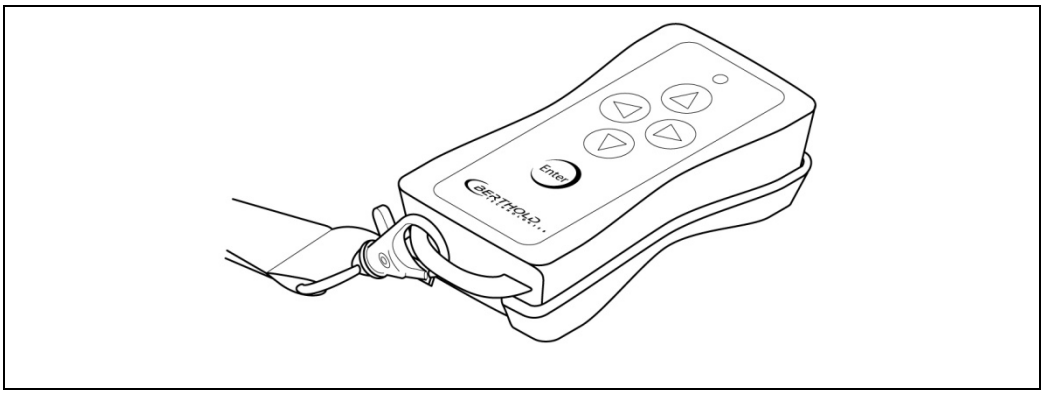
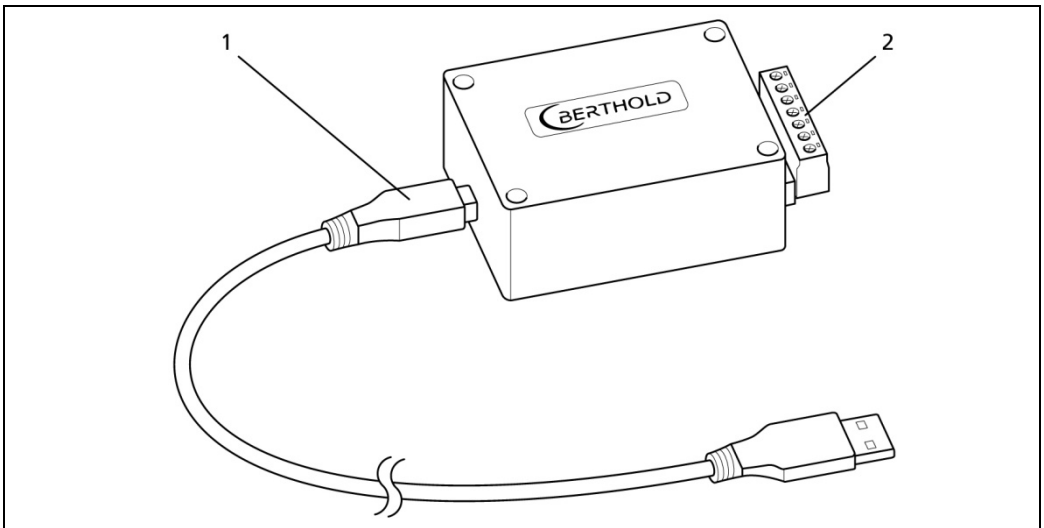


Fig. 47 IR Remote Control

The “IR Remote Control” infrared control unit can be used alternatively to the operating knob. If the field device is controlled by IR Remote Control, the screw cover does not need to be removed. The infrared control unit has to be activated by means of a software (see chapter 6.3.2).

11.6.3 Detector Service Modem (ID no. 60606)



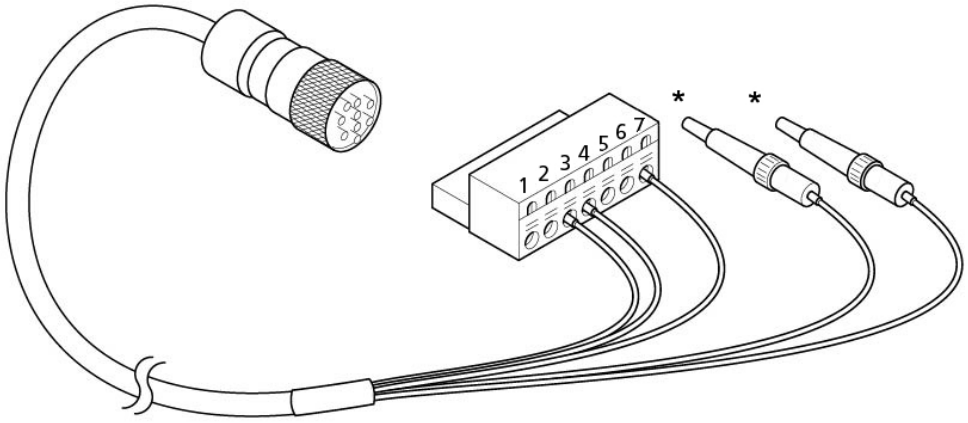
1 USB cable
2 Terminal strip for the field device

Fig. 48 Detector Service Modem

With the help of the Detector Service Modem, the field device can be connected to a PC to check it in a workshop, for software updates and for parametrization.

For information on system requirements, PC connection and driver software, refer to chapter 6.3.3.

11.6.4 HART / RS485 Plug (ID no. 60644)



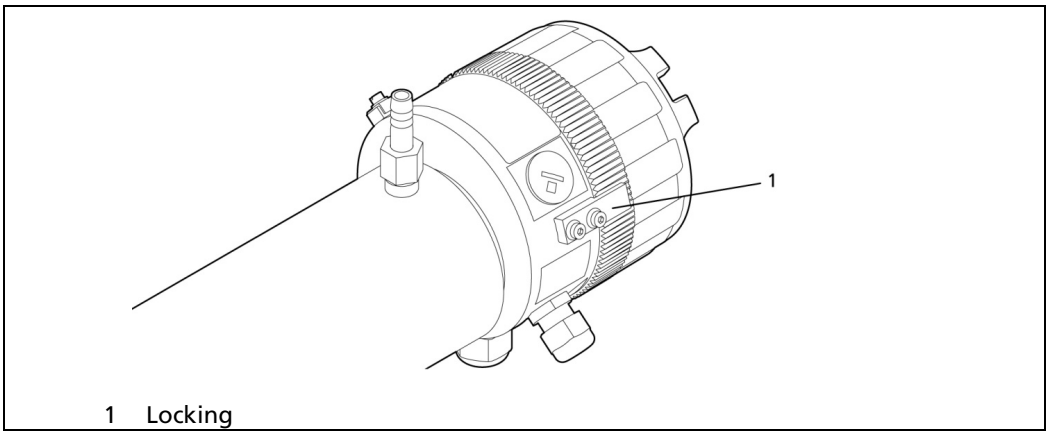
1 Plug and cable with Detector Service Modem or 475 HART Communicator

Fig. 49 Control cable 3 m

Terminal assignment Detector Service Modem

1	N/A	
2	N/A	
3	RS 485 A	Orange
4	RS 485 B	White
5	N/A	
6	N/A	
7	Ground	Blue
*	475 Hart Kommunikator +	Red
*	475 Hart Kommunikator –	Black

11.6.5 Locking (ID no. 60529)



1 Locking

Fig. 50 Locking

Locking prevents accidental unscrewing of the cover.

11.6.6 Sun cover against strong insolation

If a detector temperature of more than 50 °C (122°F) is reached due to insolation, an appropriate sun cover must be installed.
A thin heatsink can also prevent the detector from being heated up excessively by the heat emissions of the container.
In addition, an appropriate water cooling system (option) is available for each detector.

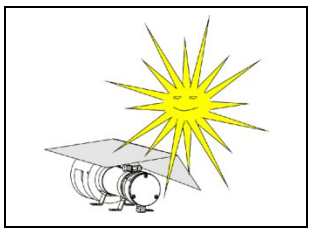


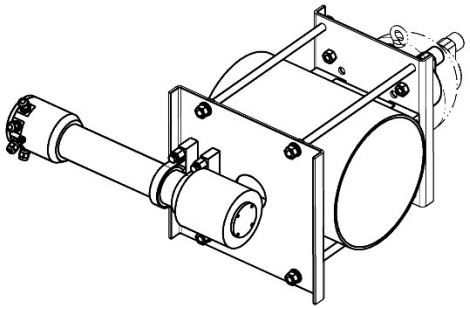
Fig. 51 Sun cover

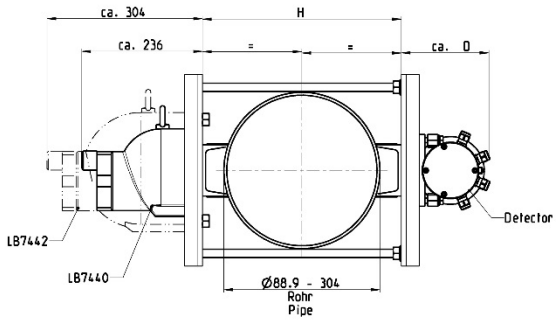
11.7 Mounting Fixtures

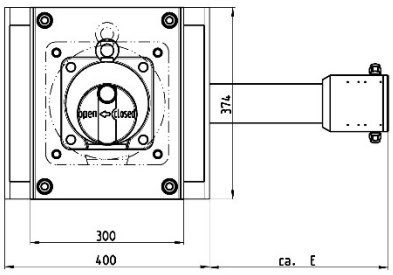
Clamping Device 90° for Pipe Diameter 88,9 ... 304 mm, Radial Irradiation
Montagevorrichtung 90° für Rohrdurchmesser 88,9 ... 304 mm Radiale Einstrahlung

Dimensions in mm
Abmessungen in mm

Material	Carbon steel Stahl St37
Painting Lackierung	Polyurethane, grey Polyurethan, grau





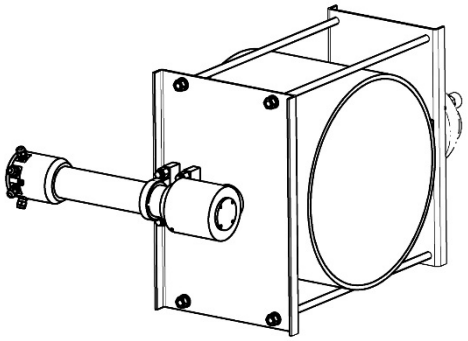


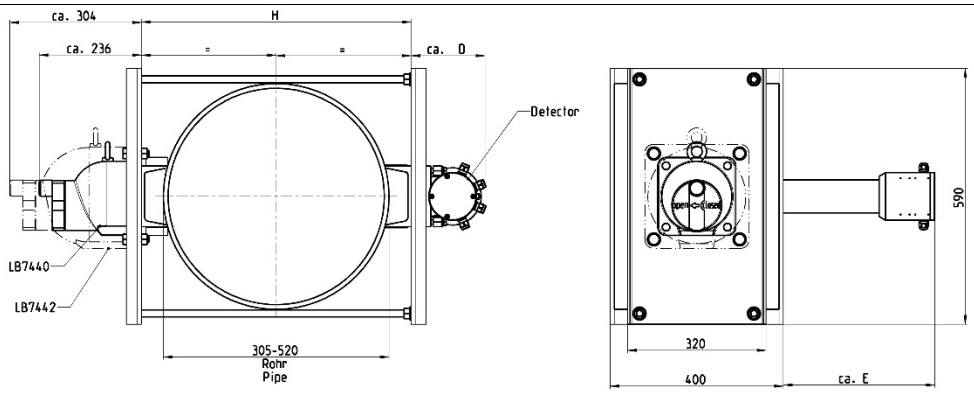
Part No. Id. Nr.	Pipe Diameter Rohrdurchmesser	D Approx./ca.	E Approx./ca.	H	Weigth of Clamping Device approx. kg Gewicht der Montagevorr. ca. kg
59296 M1	88,9 101,6 114,3 141,3 168,3 219,1 273 304	169	236.5	120 156 180 218 250 310 368 402	22

Clamping Device 90° for pipe diameter 305 ... 520 mm, radial irradiation
Montagevorrichtung 90° für Rohrdurchmesser 305 ... 520 mm, Radiale Einstrahlung

Dimensions in mm
Abmessungen in mm

Material	Carbon steel Stahl St37
Painting Lackierung	Polyurethane, grey Polyurethan, grau



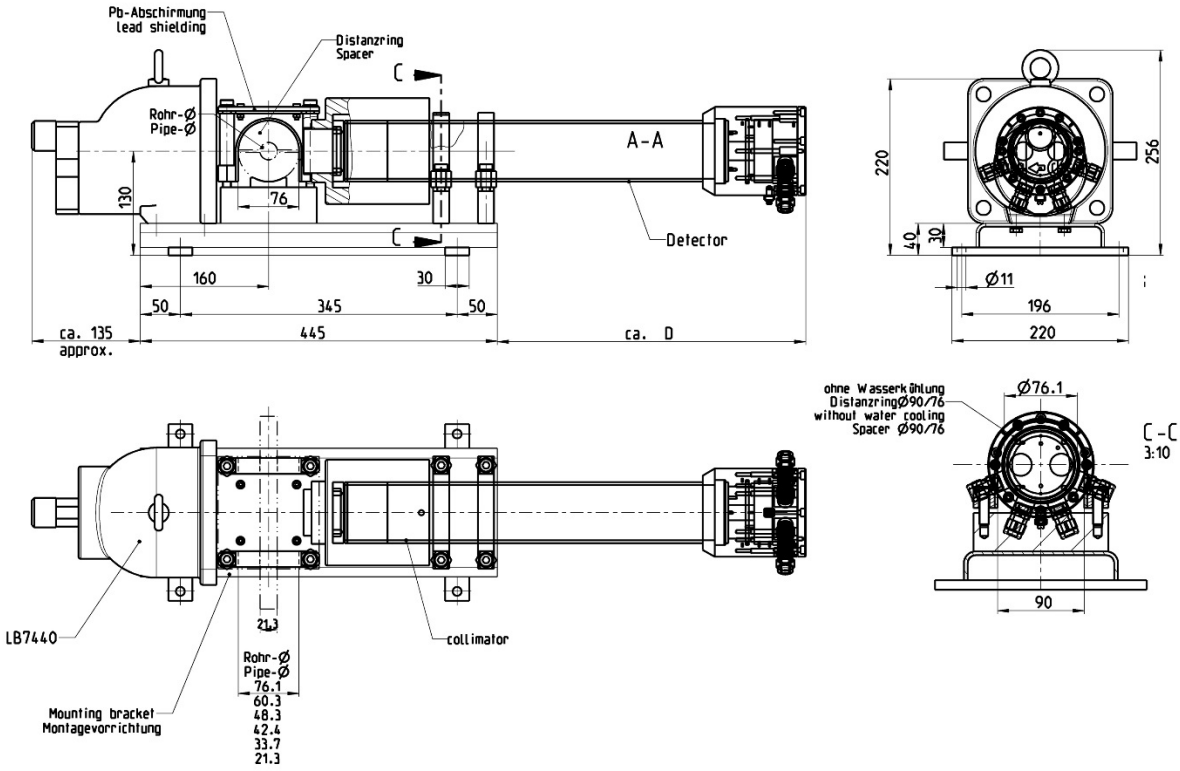


Part No. Id. Nr.	Pipe Diameter Rohrdurch- messer	D Approx./ca.	E Approx./ca.	H	Weigth of Clamping Device approx. kg Gewicht der Montagevorrichtung ca. kg
59293 M1	305 318 323,8 255,6 406,4 457,2 508 520	171	349.5	400 413 419 451 501 552 603 615	34

Clamping Device 90° for Pipe Diameter 21,3 ... 76,1 mm, Axial Irradiation
Montagevorrichtung 90° für Rohrdurchmesser 21,3 ... 76,1 mm, Axiale Einstrahlung

Dimensions in mm
Abmessungen in mm

Material	Carbon steel Stahl St37
Painting Lackierung	Polyurethane, grey Polyurethan, grau

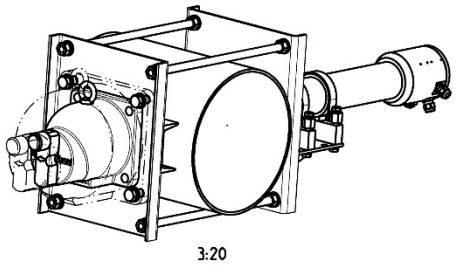


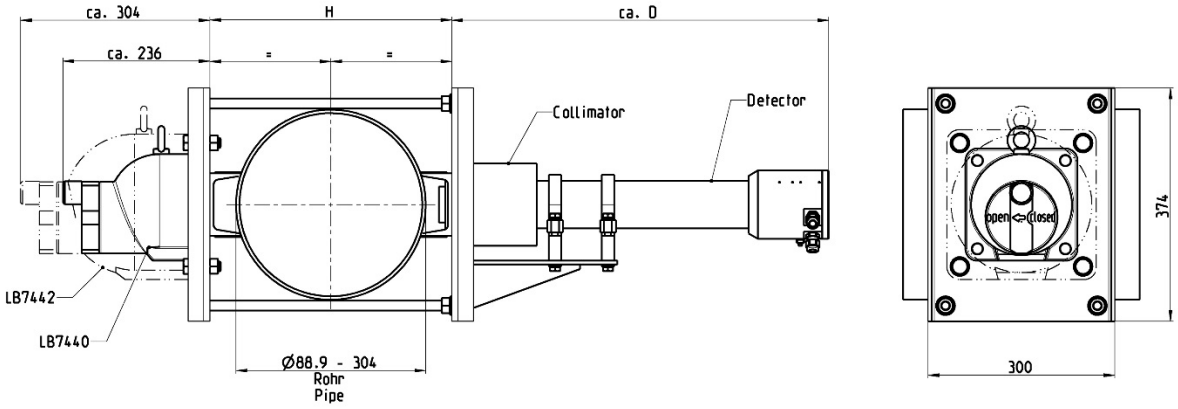
Part No. Id. Nr.	Pipe Diameter Rohrdurchmesser	D Approx./ca.	Weigth of Clamping Device approx. kg Gewicht der Montagevorrichtung ca. kg
47292 M3	21,3 33,7 42,4 48,3 60,3 76,1	278	70

Clamping Device 90° for pipe diameter 88.9 ... 304 mm, Axial Irradiation
Montagevorrichtung 90° für Rohrdurchmesser 88,9 ... 304 mm, Axiale Einstrahlung

Dimensions in mm
Abmessungen in mm

Material	Carbon steel Stahl St37
Painting Lackierung	Polyurethane, grey Polyurethan, grau



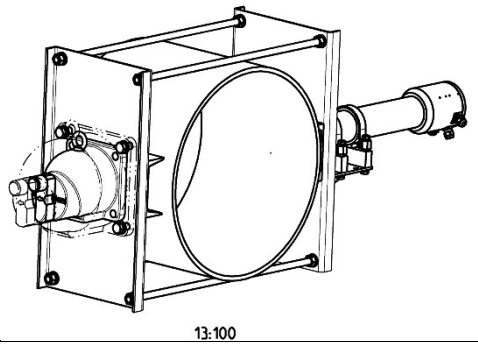


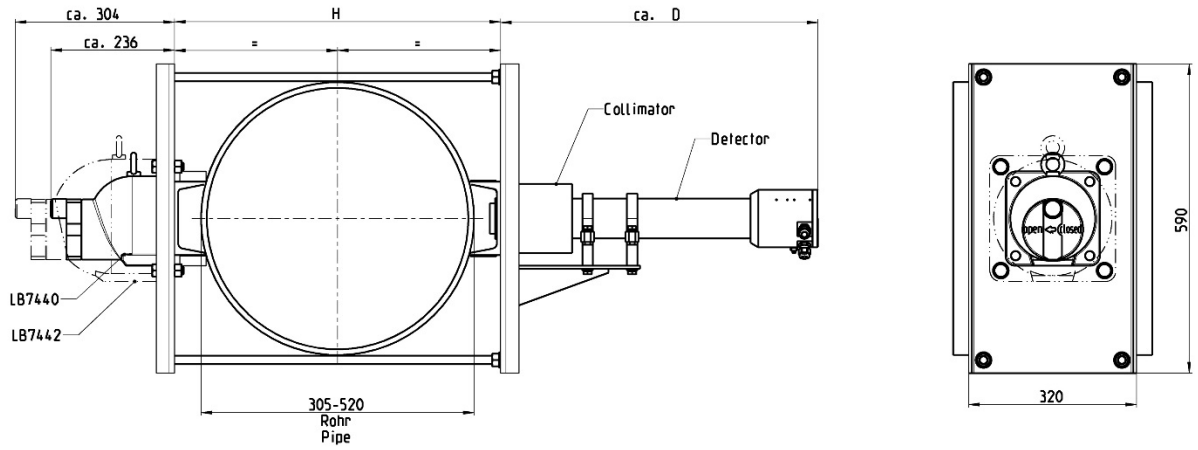
Part No. Id. Nr.	Pipe Diameter Rohrdurchmesser	D Approx./ca	H Approx./ca	Weigth of Clamping Device approx. kg Gewicht der Montagevorrichtung ca. kg
80795 M3	88,9 101,6 114,3 141,3 168,3 219,1 273 304	499	120 156 180 218 250 310 368 402	23

Clamping Device 90° for pipe diameter 305 ... 520 mm, Axial Irradiation
Montagevorrichtung 90° für Rohrdurchmesser 305 ... 520 mm, Axiale Einstrahlung

Dimensions in mm
Abmessungen in mm

Material	Carbon steel Stahl St37
Painting Lackierung	Polyurethane, grey Polyurethan, grau



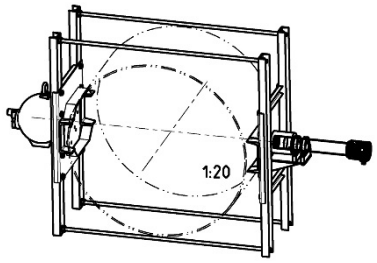


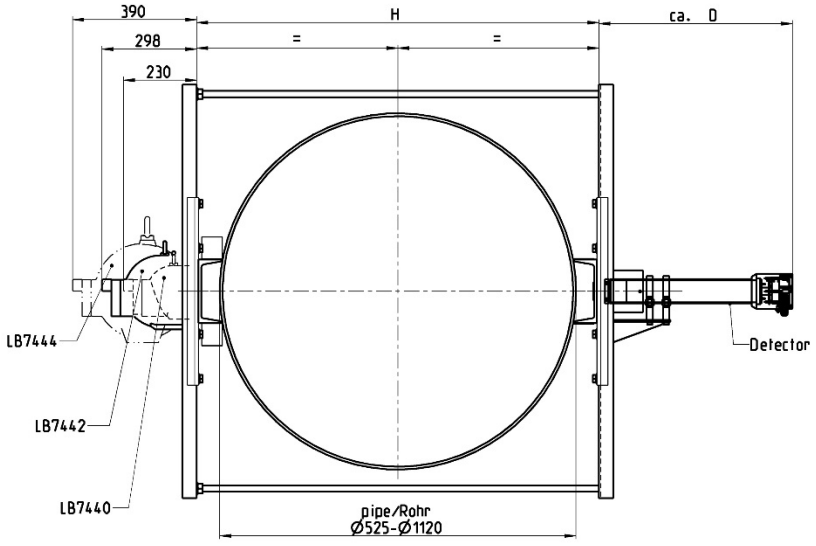
Part No. Id. Nr.	Pipe Diameter Rohrdurchmesser	D Approx./ ca.	H Approx./ ca.	Weigth of Clamping Device approx. kg Gewicht der Montagevorrichtung ca. kg
80796 M2	305 318 323,8 255,6 406,4 457,2 508 520	499	400 413 419 451 501 552 603 616	34

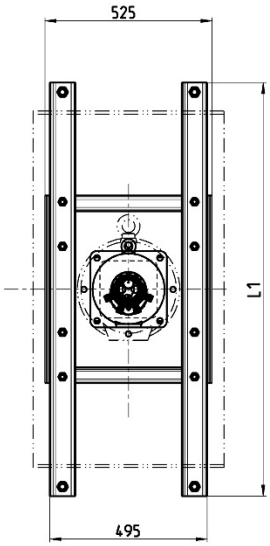
Clamping Device 90° for pipe diameter 520 ... 1120 mm, Axiale Einstrahlung
Montagevorrichtung 90° für Rohrdurchmesser 520 ... 1120 mm, Axial Irradiation

Dimensions in mm
Abmessungen in mm

Material	Carbon steel Stahl St37
Painting Lackierung	Polyurethane, grey Polyurethan, grau





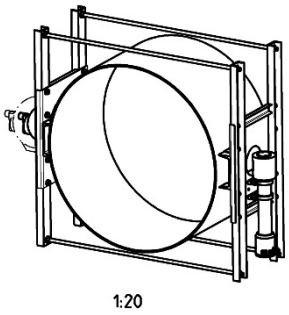


Part No. Id. Nr.	Pipe Diameter Rohrdurchmesser	Thread bar Gewinde-stange H	D Approx./ ca.	L1 Approx./ ca.	Weigth of Clamp. Device approx. kg Gewicht der Montagevorr. ca. kg
51875 M2	525 560 660 760 870 1020 1120	643 686 792 896 1009 1163 1265	735 790 890 990 1100 1250 1350	680 680 740 840 950 1200 1300	13x2 = 26 14x2 = 28 15x2 = 30 16x2 = 32 18x2 = 36 22x2 = 44 24x2 = 48

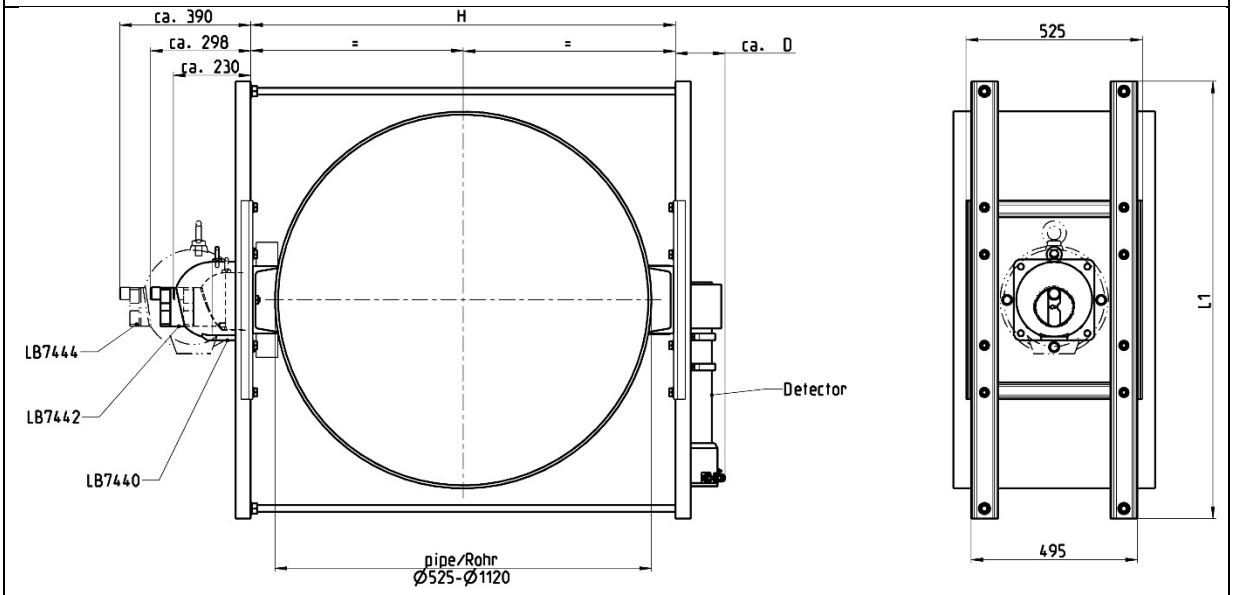
Clamping Device 90° for Pipe Diameter 525 ... 1120 mm, Lateral Irradiation
Montagevorrichtung 90° für Rohrdurchmesser 525 ... 1120 mm, seitliche Einstrahlung

Dimensions in mm
Abmessungen in mm

Material	Carbon steel Stahl St37
Painting Lackierung	Polyurethane, grey Polyurethan, grau



1:20

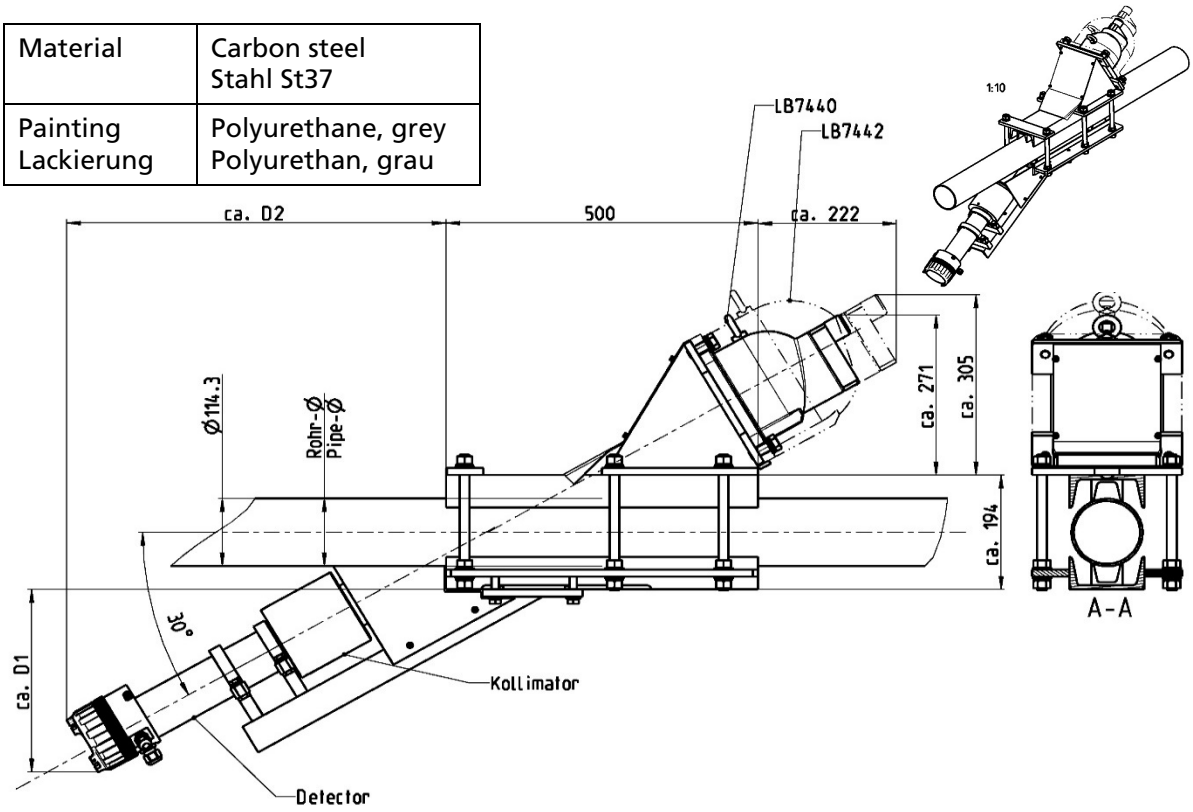


Part No. Id. Nr.	Pipe Diameter Rohrdurchmesser	Thread bar Gewinde-stange H	D Approx. ca.	L1 Approx. ca.	Weigth of Clamp. Device approx. kg Gewicht der Montagevorrichtung ca. kg
81491 M2	525 560 660 760 870 1020 1120	643 686 792 896 1009 1163 1265	143	680 680 740 840 950 1200 1300	13x2 = 26 14x2 = 28 15x2 = 30 16x2 = 32 18x2 = 36 22x2 = 44 24x2 = 48

Clamping Device 30° for pipe diameter 114,3 / St 37 mm
Montagevorrichtung 30° für Rohrdurchmesser 114,3 / St 37 mm

Dimensions in mm
Abmessungen in mm

Material	Carbon steel Stahl St37
Painting Lackierung	Polyurethane, grey Polyurethan, grau

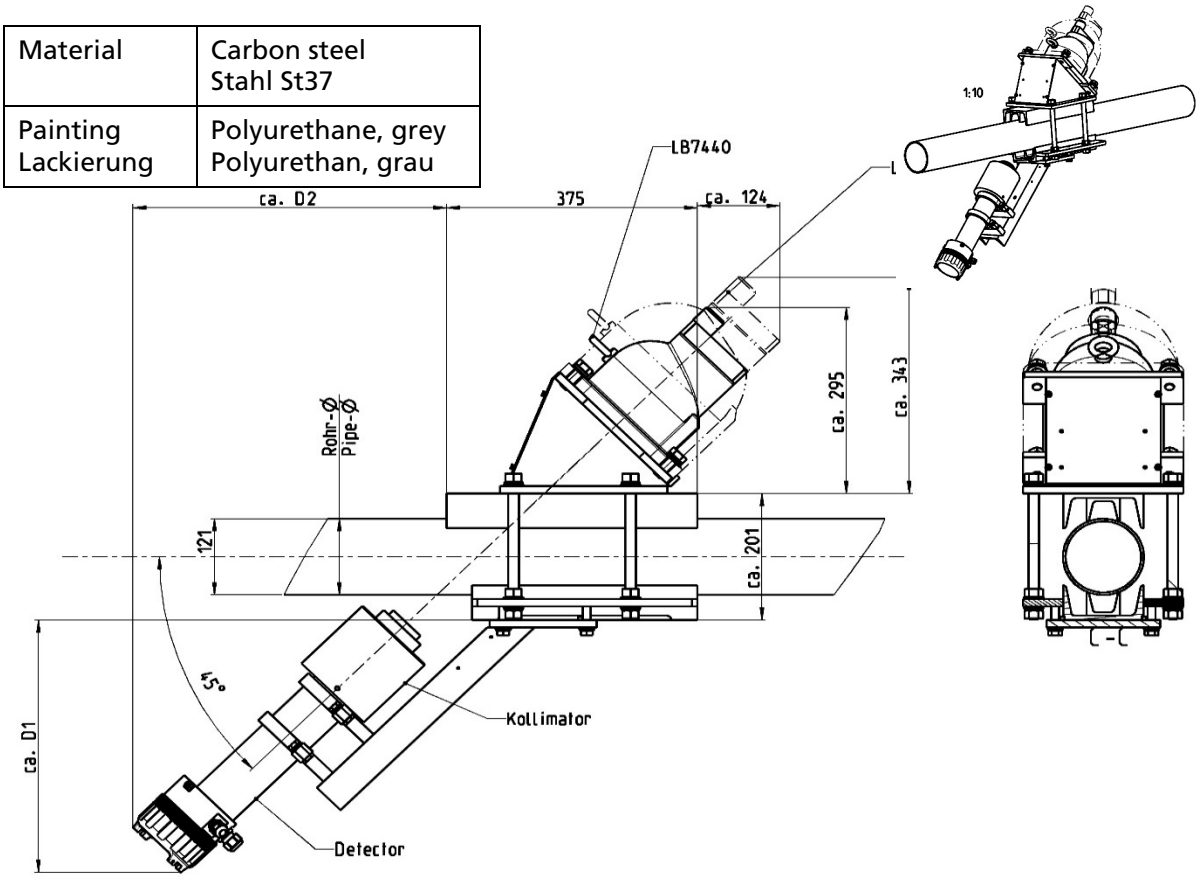


Part#, Id. Nr.	Pipe Ø, Rohr Ø	D1~	D2~	Weigth of Clamping Device, Gewicht Montagevorrichtung
25964	Ø 48,3	310	395	approx., ca. 45 kg
80792	Ø 60,3		438	
25971	Ø 63,5		445	
25972	Ø 70		460	
25973	Ø 76,1		470	
25974	Ø 82,5		485	
25975	Ø 88,9		500	
25976	Ø 95		510	
25977	Ø 101,6		522	
25978	Ø 108		534	
25979	Ø 114,3		546	
25980	Ø 121		558	
80791	Ø 127		452	
26655	Ø 133		470	
26656	Ø 139,7		490	
26657	Ø 146		506	
26658	Ø 152,4		519	
26659	Ø 159		537	
26660	Ø 165,1		551	
26661	Ø 168,3		558	
26662	Ø 171		564	
26663	Ø 177,8		580	
26664	Ø 191		608	
81246	Ø 220		625	
81485	Ø 273		630	

Clamping Device 45° for pipe diameter 60.3 ...121 mm
Montagevorrichtung 45° für Rohrdurchmesser 60,3 ...121 mm

Dimensions in mm
Abmessungen in mm

Material	Carbon steel Stahl St37
Painting Lackierung	Polyurethane, grey Polyurethan, grau

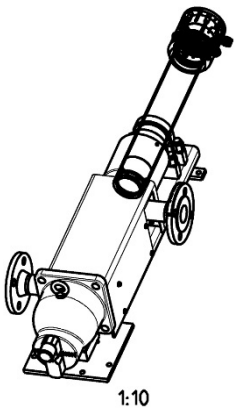


Part#, Id. Nr.	Pipe Ø , Rohr Ø	D1~	D2~	Weight of clamping device, Gewicht Montagegestell
27249	Ø 48,3	380	376	approx., ca. 45 kg
27248	Ø 60,3		376	
27250	Ø 63,5		382	
27251	Ø 70		390	
27252	Ø 76,1		396	
27253	Ø 82,5		404	
27254	Ø 88,9		412	
27255	Ø 95		418	
27256	Ø 101,6		424	
27257	Ø 108		430	
27258	Ø 114,3		438	
80794	Ø 121		445	
80793	Ø 127		384	
26997	Ø 133		395	
26998	Ø 139,7		406	
26999	Ø 146		416	
27000	Ø 152,4		424	
27001	Ø 159		434	
27002	Ø 165,1		442	
27003	Ø 168,3		446	
27004	Ø 171		450	
27005	Ø 177,8		460	
27006	Ø 191		475	
81245	Ø 220		496	
81493	Ø 273		495	

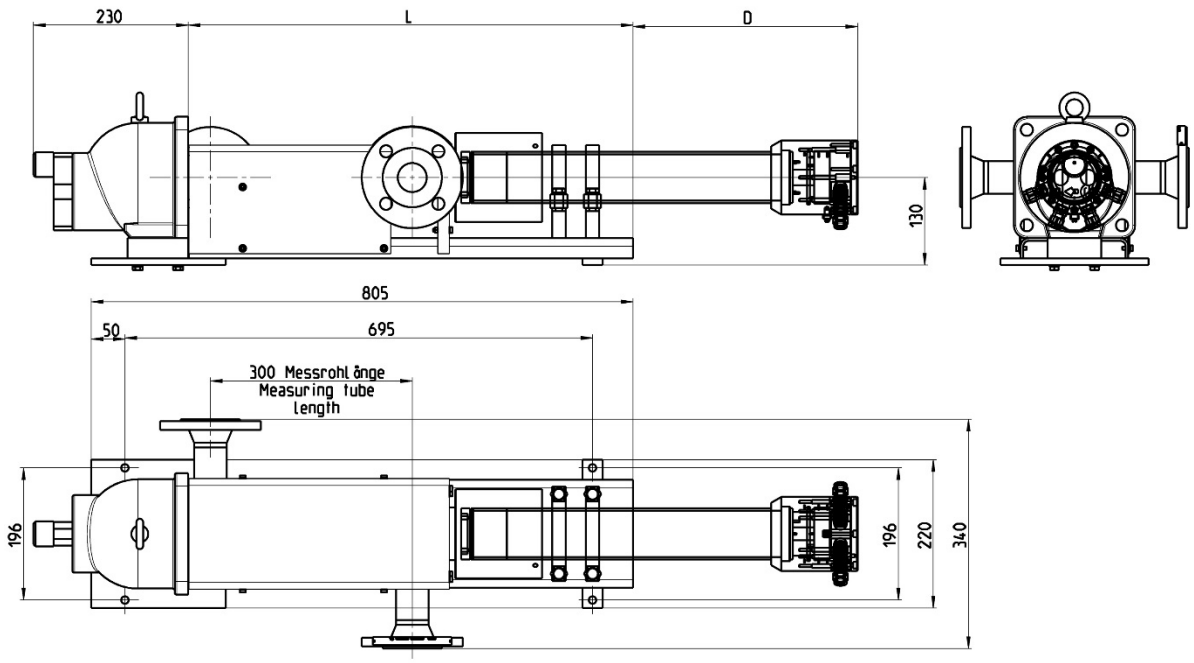
S shaped measuring path

Dimensions in mm
Abmessungen in mm

Material	Carbon steel Stahl St37
Painting Lackierung	Polyurethane, grey Polyurethan, grau



Part No. / Id. No. 21087M34



Measuring path as illustrated above	Obige Abbildung zeigt die Messstrecke in
• S shaped • DN 40 • Measuring length 300 • PN 16 • Without temperature sensor	• S-Form • DN 40 • Messweg 300 • PN 16 • Ohne Temperatur-Fühler

11.8 Certificates

CSA Group

Certificate of Compliance

Certificate: 70002079 **Master Contract:** 215040

Project: 70002079 **Date Issued:** January 6, 2014

Issued to: **Berthold Technologies GMBH & CO KG**

Calmbacher Str 22
Bad Wildbad, 75323
Germany
Attention: Karl Hoffman

The products listed below are eligible to bear the CSA Mark shown with adjacent indicators 'C' and 'US' for Canada and US or with adjacent indicator 'US' for US only or without either indicator for Canada only.

C US

J-P Laplante

Issued by: J-P Laplante, Eng.

PRODUCTS

CLASS 8721 86 - ELECTRICAL EQUIPMENT FOR LABORATORY USE - Certified to US Standards

CLASS 8721 06 - LABORATORY EQUIPMENT - Electrical

Radiation detector for radiometric measurements, Models LB41x, input rated: 100 - 240 VAC, 50/60 Hz, 8 VA or 24 Vdc, 4 W.

'X' in the model name and any following characters or figures, indicate difference in supply voltage (100 – 240 Vac or 24 Vdc) and other minor differences between the types.

Notes:

1. The above models are permanently connected, Equipment Class I, Pollution Degree 2, Installation Category II

2. Mode of operation: Continuous

3. Environmental Conditions: Extended: -40 °C to +60 °C (type with metal screw cap; -20 °C to +60 °C (type with plastic screw cap); altitude ≤ 3000 m; humidity ≤ 90 %

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Certificate:	70002079	**Master Contract:**	215040
Project:	70002079	**Date Issued:**	January 6, 2014

APPLICABLE REQUIREMENTS

CAN/CSA-C22.2 No. 61010-1-12: Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use, Part 1: General Requirements

ANSI/UL Std. No. 61010-1 (3rd Edition): Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements

CONDITIONS OF ACCEPTABILITY

1. The Models are certified for use with other equipment, where the suitability of the combination is to be determined by CSA.
2. Equipment can optionally be water cooled, however the equipment has only been tested without water cooling. Once water cooled, the ambient (outside) temperature of the equipment may exceed 60 °C under the condition that the ambient temperature inside the equipment does not exceed 60 °C
3. Equipment sub-types for use in ATEX environment are not evaluated as part of this approval.
4. Incorrect reading of the measured quantity shall not lead to a hazard. If incorrect reading is hazardous in end application, guidance to check correct operation of the equipment is required from the manufacturer
5. The equipment I/O RS-485, 4-20mA and relay contact are considered to be (indirectly) accessible in end use application. These I/O shall therefore be only connected to equipment which is safe to touch (voltage/current levels in accordance with CSA/UL 61010-1 cl 6.3 and two means of protection against hazardous live parts in accordance with cl 6.4 and 6.5)
6. The 24 Vdc type shall be supplied by a 24 Vdc voltage which is safe to touch (voltage/current levels in accordance with CSA/UL 61010-1 cl 6.3 and two means of protection against hazardous live parts in accordance with cl 6.4 and 6.5)
7. Equipment is for use in normal (PD2) environments and not for use in wet locations
8. A disconnect device, complying with 6.11.3.1 shall be provided by the installation of the end use application of the equipment
9. IP testing was not part of the approval
10. The equipment shall be connected to a mains supply with an overcurrent protective device of max 20 A

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EC-Declaration of Conformity

We, hereby declare under our sole responsibility that the design of the following products / systems / units brought into circulation by us comply with the relevant EC regulations listed below.

This declaration loses its validity should modifications or unsuitable and improper use take place without our authorisation.

Description: ***Continuous Level and Density Measurement System SmartSeries***

Type: ***LB 41x***

	EC-Regulation And Reviews	Standards and Norms	
EMC	2004/108/EG	EN 61326-1	2006
		+A1	2008
		+A2	2011
		EN 55011	2009
		+A1	2010
		Namur NE021	2011
LVD	2006/95/EG	IEC 61010-1	2010
RoHS	2011/65/EU		

This declaration is issued by the manufacturer

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

released by

Dr. Jürgen Briggmann
Head of R&D
Bad Wildbad, 27th of September, 2013

Registergericht / Court of Registration Stuttgart HRA 330991
Persönlich haftende Gesellschafter / Fully liable Associates BERTHOLD TECHNOLOGIES Verwaltungs-GmbH
Registergericht / Court of Registration Stuttgart HRB 331520
Geschäftsführer / Chief Executive Officer Horst G. Knauff
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Deutsche Steuernummer / German Tax No. 49038/08038
WEE-Reg.No. DE99468690

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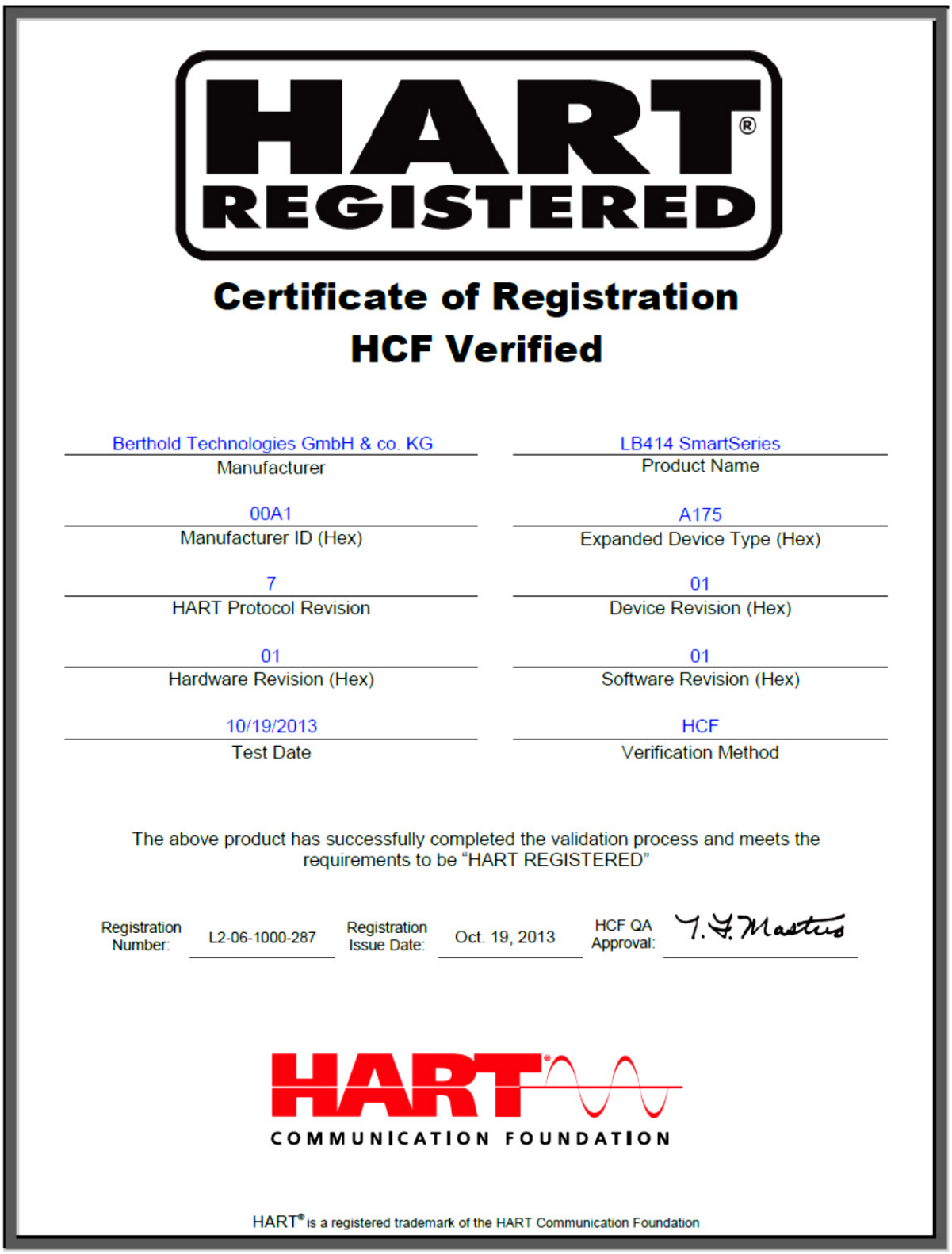
Commerzbank 75105 Pforzheim Konto/Account No. 6 511 120 (BLZ 666 800 13) SWIFT-BIC DRES DEFF 666
IBAN: DE05 6668 0013 0651 1120 00



HART REGISTERED

Certificate of Registration
HCF Verified

Berthold Technologies GmbH & co. KG Manufacturer	LB414 SmartSeries Product Name
00A1 Manufacturer ID (Hex)	A175 Expanded Device Type (Hex)
7 HART Protocol Revision	01 Device Revision (Hex)
01 Hardware Revision (Hex)	01 Software Revision (Hex)
10/19/2013 Test Date	HCF Verification Method

The above product has successfully completed the validation process and meets the requirements to be "HART REGISTERED"

Registration Number: L2-06-1000-287 Registration Issue Date: Oct. 19, 2013 HCF QA Approval: T. F. Martis

HART COMMUNICATION FOUNDATION

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Modifications due to technical advancement reserved.

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