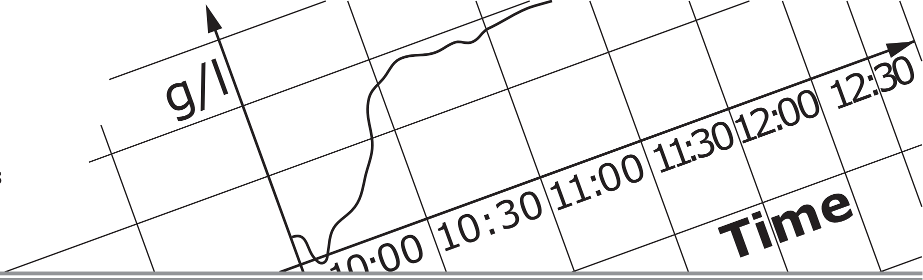
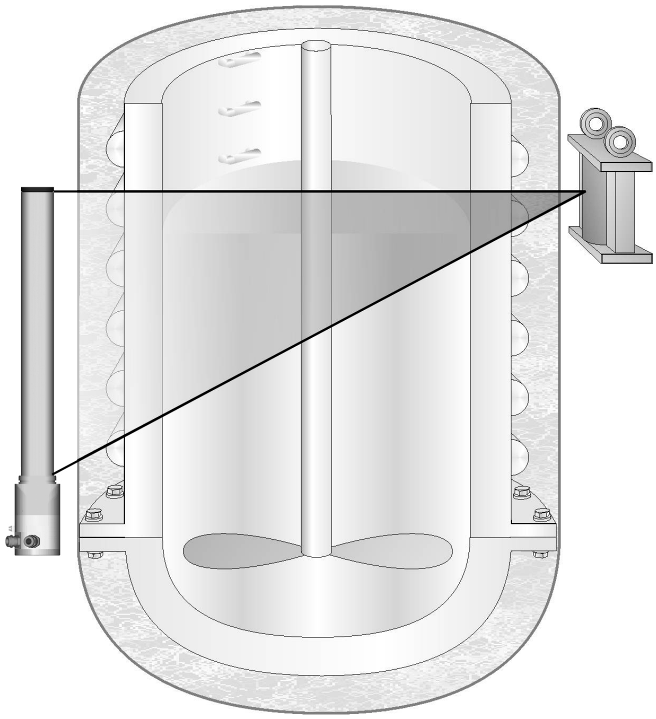


detect and identify

Process Control

sensseries LB 480

Level measurement



User's Manual

Id. No. 54733-10BA2L

Rev. No.: 05 09.2023
Embedded Soft. from Rev. 1.00.00
Device Description from Rev. 01

Volume 1: Safety Manual 1

Volume 2: Installing SENSseries 2

Volume 3: Operation with HART® Communicator 3

General Information

Dear customer

Thank you for purchasing the measuring system SENSseries LB 480 by BERTHOLD TECHNOLOGIES.

The scope of supply also includes this User’s Manual. Keep this User’s Manual on hand for reference at any time.

Please observe the warnings and safety instructions given in this User’s Manual to rule out personal injury and property damage. They are identified by the following symbols: DANGER, WARNING, CAUTION or IMPORTANT. In *Volume 1*, *"Meaning of Other Symbols Used in this Documentation"* you find an overview of the hazards to be observed and instructions on how to deal with these hazards.

Please read this User’s Manual prior to installation to get familiar with the product.

If you do encounter problems despite careful study of the User’s Manual, please do not hesitate to contact us.

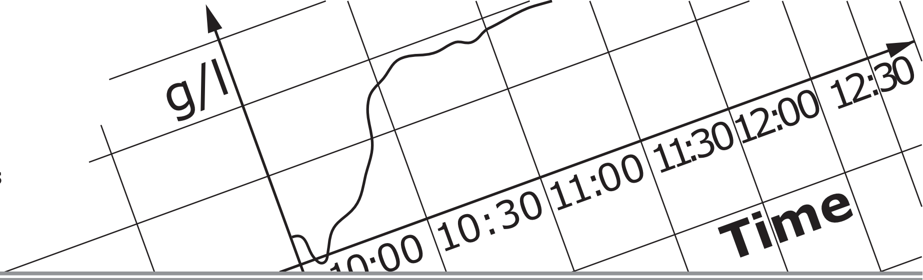
Your BERTHOLD team

Volume 1 Safety Manual

Volume 2 Installing SENSseries

Volume 3 Operation with HART® Communicator

BERTHOLD TECHNOLOGIES



Volume 1 Safety Manual

1

About this User's Manual

1.1 Typographical Conventions

The symbols and typefaces used in this User's Manual have the following meaning:

▶	prompts you to carry out an action.
1, 2, 3, …	identifies items in a graphic.
•	identifies enumerations.
italic typeface	highlights important information.
bold typeface	indicates commands or menu items.
bold italic	identifies user entries.

The term BERTHOLD TECHNOLOGIES is used in this User's Manual for the company BERTHOLD TECHNOLOGIES GmbH & Co. KG.

Please observe the warnings and safety instructions given in this User's Manual to rule out personal injury and property damage. They are identified by the following symbols: DANGER, WARNING, CAUTION or IMPORTANT.

DANGER

Indicates a direct threat of danger. The consequences will be death or most severe personal injuries.

WARNING

Indicates a possibly dangerous situation. If the situation is not avoided, death or serious bodily injury could result.

CAUTION

Indicates a possibly dangerous situation. If the situation is not avoided, minor or moderate bodily injury could occur.

NOTICE

Indicates a situation which could result in material damage if the instructions are not observed.

IMPORTANT

Paragraphs marked with this symbol provide important information on the product and on handling the product.

Tip

Includes application tips and other helpful information.

1.2 Meaning of Other Symbols Used in this Documentation

Warning: Do not step or stand under a suspended load.

Warning: Radiation

Warning: Ex-protection

Warning: Risk of crushing

Requirement: Switch off power

Requirement: Wear a hardhat

Requirement: Wear safety shoes

1.3 Meaning of Warning Signs on Detectors and Source Shieldings

Warning: Radiation
This warning is located on the source shielding.

Warning: Please read the User's Manual prior to installation
This warning is located on or in the terminal compartment of the detector.

1.4 Terms Used in this User's Manual

CrystalSENS
Standard point detector version in the SENSseries LB 480.

UniSENS
Standard rod detector version in the SENSseries LB 480.

SuperSENS
Highly sensitive detector with large volume polymer scintillator 150 x 150 mm for large pipe or tank diameter.

TowerSENS
Rod detector with an especially large potential measuring length. In contrast to multi-detector configurations, only one detector is required here.

NaI detector
NaI = sodium iodide crystal = scintillator

Scintillation detectors are very sensitive probes for gamma radiation.

Isotope
Substance of the radiation source, e.g. Cobalt 60 (Co-60) or Cesium 137 (Cs-137).

Count rate
Value for the number of pulses standardized to one second.

Background
The count rate caused by the natural environmental radiation.

Cps
Unit for the count rate: *C*ounts *p*er *s*econd.

Factory setting
In the factory setting, all parameters are preset with default values. In most cases, this makes calibration of the detector a lot easier. Nevertheless, a calibration must *always* be carried out.

mSv
Milli-Sievert: The unit indicates the dose rate (dose equivalent).

mrem
Milli-rem (roentgen equivalent in man): traditional unit for the dose rate (100 mrem = 1 mSv).

MBq
Mega Becquerel: The unit indicates the activity of a source. Each Bq corresponds to one disintegration per second, i.e. 1 MBq equals one million disintegrations.

mCi
Milli-Curie: Traditional unit for the activity of a source (1 mCi = 37 MBq).

ATEX
Atmosphère explosive: is used as a generic term for the ATEX Product Directive 94/9/EC and the ATEX Workplace Directive 1999/92/EC. The directives contain provisions for equipment and components for use in explosion hazardous areas.

FM
Factory Mutual: an American industrial property insurance company that, among other things, issues certifications in the field of explosion protection.

CSA

Canadian Standard Association: sets norms and standards that are important for Canada (and America), among other things, the Directive for Explosion Protection and Low Voltage.

PMT

Photomultiplier or only multiplier: converts the flashes of light generated by the radiation in the detector into electrical signals.

HV

HV = High voltage

The multiplier is operated at high voltage, so that flashes of light can be converted into electrical pulses.

The high-voltage control allows for measurements that are stable to temperature and aging. Each multiplier has a slightly different sensitivity, and must therefore be operated at a different high voltage.

active / passive (Source / Sink)

Depending on the detector type, the current output can be configured as a current source or current sink. The following terms are used interchangeably:

- Current source: active / Source Mode
- Current sink: passive / Sink Mode

1.5 General Information

The most important safety measures are summarized in this volume. It supplements the appropriate provisions which the staff in charge is *obliged* to follow.

Please pay attention to:

- the national safety and accident prevention regulations
- the national assembly and installation directions (for example, EN 60079)
- the generally accepted engineering rules
- the information on transport, assembly, operation, service, maintenance in this User's Manual
- the safety instructions and information in this User's Manual and the enclosed technical drawings and wiring diagrams
- the parameters, limit values and the information on operating and ambient conditions on the type labels and in the data sheets
- the labels on the device

Depending on the field of application, the corresponding chapters have to be taken into account.

2 Proper Use

The measuring system SENSseries LB 480 is a detector which, depending on its design, can be used for different measurement tasks:

- Level measurement
- Monitoring limit values
- Density measurement

The measurement system is designed for the continuous monitoring and detection of levels and limit levels of liquids and bulk solids in bins, or to determine the density of liquids in tanks and pipes. The proper use is defined in the project planning stage by BERTHOLD TECHNOLOGIES, the system delivered may be used only for this purpose.

If the detector is used in a way which is not provided for during the project planning stage and which is not described in the User's Manual, then the detector's protection is compromised and the guarantee claim becomes invalid.

BERTHOLD TECHNOLOGIES only accepts liability for / guarantees the correspondence of the systems of the SENSseries LB 480 to its published specifications. The detectors of the SENSseries may only be installed in an undamaged, dry and clean condition. Alterations and modifications to the system components are not allowed. Repairs to the detector may only be made if expressly authorized by the operating manual.

Conformity to standards

The standards and guidelines the SENSseries complies with are itemized in the CE conformity declaration.

Warning about misuse

The following use is inappropriate and has to be prevented:

- Use under other conditions and prerequisites than those specified by the manufacturer in his technical documents, data sheets, operating and assembly instructions and other specifications.
- The repair of detectors that are used in explosion hazardous areas by persons who were not authorized by BERTHOLD TECHNOLOGIES.
- Using the device in a damaged or corroded condition.
- Operation with open or inadequately closed cover.
- Operating with inadequately tightened adapters and cable fittings.
- Operation without the safety precautions provided by the manufacturer.
- Manipulating or bypassing existing safety installations.

Maintenance

The measuring system of the SENSseries LB 480 may only be installed, serviced and repaired by trained persons (see *chapter 3.2*, *page 1-20*).

Repair

Spare parts for detectors used in the Ex-area may be assembled only by the BERTHOLD TECHNOLOGIES service or by persons authorized by BERTHOLD TECHNOLOGIES. If this is not possible, you must replace the entire detector or return it to the manufacturer for repair.

Parameter settings

Never change the parameter settings without a full knowledge of this User’s Manual, as well as a full knowledge of the behavior of the connected controller and the possible influence on the operating process to be controlled!

Sources and shieldings

This measuring system uses radioactive sources. The radiation protection instructions in this User’s Manual and the relevant statutory provisions are to be observed strictly, see also *chapter 8*, *"Visual Inspection", page 1-119*.

3 Qualification of Personnel

At different parts in this User's Manual, reference is made to personnel with certain qualifications who can be entrusted with different tasks during the installation, operation and maintenance.

These three groups of people are:

1. Persons with a general knowledge, see *chapter 3.1*.
2. Experts, see *chapter 3.2*.
3. Authorized persons, see *chapter 3.3*.

The following chapters explain the meaning of these terms and the prerequisites for the particular group of people.

IMPORTANT
All work on and with the measurement systems SENSseries LB 480 must be performed by persons having at least a general knowledge; they must always be guided by an expert or an authorized person.

3.1 Persons with a General Knowledge

Persons with a general knowledge are e.g. technicians or welders who can undertake different tasks during the transportation, assembly and installation of the measuring systems SENSseries LB 480 under the guidance of an authorized person. This can also refer to construction site personnel. The persons in question must have experience in the transportation and assembly of heavy component parts.

Persons working with Ex devices must in addition have knowledge on how to work with these devices, for example, that the devices must not be subject to mechanical damage (blow, etc.).

IMPORTANT
Persons with a general knowledge must always be guided by a trained expert at the very least.
When dealing with radioactive substances, a Radiation Safety Officer must also be consulted.

3.2 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 recognized 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 User’s Manual.

3.3 Authorized Persons

Authorized persons are those who are either designated for the corresponding task due to legal regulations or those who haven been authorized by BERTHOLD TECHNOLOGIES for particular tasks. When dealing with radioactive materials, a Radiation Safety Officer must also be consulted.

4 Transport and Assembly

The weight of the source shielding may be up to several 100kg, depending on the version. Please keep in mind:

- The bearing capacity of the vessel walls or the brackets must be suitable for installation of the source with the shielding and the detector. Otherwise, system parts may fall off and cause severe injuries or bodily harm with fatal consequences.
- Make sure that the mechanical stability of the fixing devices matches the weight of the shielding.

Please keep in mind:

– Never step under hovering loads while unloading heavy system parts!

– Only use tested lifting equipment matching the transport weights.

– Maintain adequate safety margin.

– Wear hard hat and safety shoes.

– Always ensure good stability for all types of use.

– Make use of the prepared mounting options.

– Work during assembly and installation of heavy and unwieldy subassemblies should be carried out by at least two people.

– System components must be mounted vibration-free.

– Hold the housing cover firmly to prevent the housing cover from falling down when opening and closing the terminal compartment.

5 Explosion Protection

SENSseries

LB 480 - .. 1C
LB 480 - .. 2C
LB 480 - .. 3C
LB 480 - .. 4C
LB 480 - .. FA
LB 480 - .. GA

Safety Manual

Explosion Protection

for (Class I) Zone 1 / Zone 21
for Class I, II, III Division 1
ATEX / IECex / UKCA / NEC / CEC

Id.-Nr. 54733BA26

Rev.-Nr.: 07 03/2023

(bg) Инструкции за безопасност за употреба в потенциално експлозивни райони. Това ръководство за безопасност е и на разположение на официалните езици на Европейския съюз.

(cs) Bezpečnostní pokyny pro použití v oblastech, kde hrozí nebezpečí výbuchu. Tato příručka s bezpečnostními pokyny je k dispozici i v úředních jazycích Evrospké unie.

(da) Skkerhedsvejledning til brug i eksplosionsfarlige omgivelser. Denne sikkerhedsmanual findes på alle officielle sprog i det Europæiske fælleskab.

(de) Sicherheitshinweise für den Einsatz in explosionsgefährdeten Bereichen. Dieses Sicherheitshandbuch ist auch in den Amtssprachen der europäischen Gemeinschaft erhältlich.

(el) Υποδείξεις ασφάλειας για χρήση σε περιοχές με κίνδυνο έκρηξης. Αυτό το εγχειρίδιο ασφάλειας διατίθεται επίσης στις επίσημες γλώσσες της Ευρωπαϊκής Ένωσης.

(en) Safety instructions for use in potentially explosive areas. This safety manual is available also in the official languages of the European Community.

(et) Ohutusjuhised kasutamiseks plahvatusohtlikes piirkondades. Käesolev ohutuskäsiraamat on saadaval ka Euroopa Ühenduse ametlikes keeltes.

(fi) Räjähdysvaarallisilla alueilla käyttöä koskevat turvallisuusohjeet. Tämä turvaohjekirja on saatavilla myös Euroopan yhteisön virallisilla kielillä.

(fr) Consignes de sécurité relatives à une utilisation en zones explosives. Le présent manuel de sécurité est également disponible dans les langues officielles de la communauté européenne.

(ga) Treoracha sábháilteachta le haghaidh úsáide I limistéir inphléasctha Tá an lámhleabhar sábháilteachta seo ar fáil i dteangacha oifigiúla an Aontais Eorpaigh, chomh maith.

(hu) Biztonsági utasítások robbanásveszélyes területeken történő alkalmazáshoz. Ez a biztonsági kézikönyv az Európai Közösség hivatalos nyelvein is rendelkezésre áll.

(it) Istruzioni per l'impiego in ambienti a rischio di deflagrazione. Il presente manuale contiene le disposizioni di sicurezza ed è disponibile in tutte le lingue ufficiali della comunità europea.

(lt) Saugumo nurodymai naudojimui potencialiai sprogiose zonose. Šį saugumo vadovą taip pat galima gauti Europos Bendrijos oficialiomis kalbomis.

(lv) Drošības noteikumi piemērošanai jomās, kas saistītas ar sprādzienbīstamību. Šī drošības noteikumu rokasgrāmata ir pieejama arī citās Eiropas Kopienas oficiālajās valodās.

(mt) Istruzzjonijiet dwar is-sigurtà li għandhom jintużaw f'żoni potenzjalment splussivi. Dan il-manwal tas-sigurtà huwa disponibbli wkoll fl-ilsna uffiċjali kollha tal-Komunità Ewropea.

(nl) Veiligheidsinstructies voor de inzet in gebieden met gevaar voor explosies Dit veiligheidshandboek is ook in officiële talen in de EuropeseGemeenschap verkrijgbaar.

(pl) Przepisy bezpieczeństwa dotyczące użytkowania na obszarach zagrożonych wybuchem. Niniejsza instrukcja bezpieczeństwa dostępna jest również w językach urzędowych Unii Europejskiej.

(pt) Indicações de Segurança para a utilização em áreas potencialmente explosivas. Este Guia de Segurança também está disponível nas línguas oficiais da Comunidade Europeia.

(ro) Instructiuni de siguranţă pentru utilizarea în zone periculoase. Acest manual de siguranţă este de asemenea disponibil în limbile oficiale ale Comunităţii Europene.

(sk) Bezpečnostné pokyny pri použití vo výbušnom prostredí. Táto bezpečnostná príručka je k dispozícii aj v úradných jazykoch Európskej únie.

(sl) Varnostna navodila za uporabo v eksplozijsko ogroženih območjih. Ta varnostni priročnik je na voljo tudi v uradnih jezikih Evropske unije.

(sp) Instrucciones de seguridad para el uso en áreas explosibles. El presente manual de seguridad está disponible también en las lenguas oficiales de la Comunidad Europea.

(sv) Säkerhetshänvisningar till användning i områden som är utsatt för exlposionsfara. Denna handbok finns även tillgänglig i alla officiella språk av den europäiska gemenskapen.

5.1 Declaration of Conformity

5.1.1 Hazardous Environments

Berthold Technologies GmbH & Co. KG
Calmbacher Straße 22
75323 Bad Wildbad, Germany
info@berthold.com
www.berthold.com

EU-Declaration of Conformity (original) File No.: CE20023-4

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 harmonized rules of the EU.

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

Description: ***detector for radiometrical measurement system in hazardous environments***

Typ: ***LB 480-xx-ee-xx-xx-xxx-x***

e = all letters except 0 (Zero) and Z
x = all letters

	directive	applied standards	
EMC	2014/30/EU	EN 61326-1	2013
RoHS	2011/65/EG	EN 50581	2012
ATEX	2014/34/EU	EN IEC 60079-0	2018
	PTB 11 ATEX 1032 X	EN 60079-1	2018
		EN 60079-7	2018
		EN 60079-11	2012
		EN 60079-31	2014
notified body: 0102 PTB Braunschweig, Germany		IEC 61010-1	2010

This declaration is issued by the manufacturer

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

released by

Dr. J. Briggmann

Head of R&D
Bad Wildbad, 29rd of May, 2020

Registergericht / Court of Registration	Stuttgart HRA 330991
Persönlich haftende Gesellschafterin / Fully liable Associates	Berthold Technologies Verwaltungs-GmbH
Registergericht / Court of Registration	Stuttgart HRB 331520
Geschäftsführung / Management	Andreas Dobratz
USt.-Id-Nr. / VAT Reg. No.	DE813050511
Deutsche Steuernummer / German Tax No.	49038/08038
WEEE-Reg. No.	DE99468690

Bankverbindungen / Bank Details	IBAN	BLZ	Konto / Account	Swift BIC
Sparkasse Pforzheim-Calw	DE37	6665 0085	0008 0450 03	PZHSDE66
Volksbank Pforzheim	DE85	6669 0000	0000 9570 04	VBPFDE66
Commerzbank Pforzheim	DE05	6668 0013	0651 1120 00	DRESDEFF666

detect and identify

Berthold Technologies GmbH & Co. KG
Calmbacher Straße 22
75323 Bad Wildbad, Germany
Fon +49 7081 177-0
Fax +49 7081 177-100
info@berthold.com
www.berthold.com

UK Declaration of Conformity

File No.: UK20023-01

We hereby declare, under our sole responsibility, that the design of the following detector placed on the market by us complies with the relevant U.K. legislation for UKCA-marking.

Unauthorized modifications or unintended use of the product make the declaration invalid.

Product name: ***detector for radiometrical measurement system in hazardous environments***

Type / model: ***LB 480-xx-ee-xx-xx-xxx-x***

e = all letters except 0 (Zero) or Z
x = all letters

Regulation		**applied standards**
Equipment and Protective System Intended for Use in Potentially Explosive Atmospheres Regulations 2016	SI 2016/1107	EN IEC 60079-0:2018 EN 60079-1:2014 EN IEC 60079-7:2015/A1:2018 EN 60079-11:2012 EN 60079-31:2014 IEC 61010-1:2010/AMD1:2016
Electromagnetic Compatibility Regulations 2016	SI 2016/1091	EN 61326-1:2013
The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012	SI 2012/3032	

approved body / number	**measure**	**certificate**
Element Materials Technology / 0891	type examination production control	EMA21UKEX0050X

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, 15th of March 2023

Registergericht / Court of Registration	Stuttgart HRA 330991		
Persönlich haftende Gesellschafterin / Fully liable Associates	Berthold Technologies Verwaltungs-GmbH		
Registergericht / Court of Registration	Stuttgart HRB 331520		
Geschäftsführung / Management	Thomas Bogner		
USt.-Id-Nr. / VAT Reg. No.	DE813050511		
Deutsche Steuernummer / German Tax No.	49038/08038		
WEEE-Reg. No.	DE99468690		
Sparkasse Pforzheim-Calw	DE37 6665 0085	0008 0450 03	PZHSDE66XXX
Volksbank pur eG	DE37 6619 0000	0029 1282 51	GENODE61KA
Commerzbank Pforzheim	DE05 6668 0013	0651 1120 00	DRESDEFFXXX

Transforming science into solutions

5.1.2 Non Hazardous Environments

Berthold Technologies GmbH & Co. KG
Calmbacher Straße 22
75323 Bad Wildbad, Germany
info@berthold.com
www.berthold.com

EU-Declaration of Conformity (original) File No.: CE20023-6

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 harmonized rules of the EU.

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

Description: ***detector for radiometrical measurement system in non hazardous environments***

Typ: ***LB 480-xx-e0-xx-xx-xxx-x***

e = 0 or Z
x = all letters

	directive	applied standards	
EMC	2014/30/EU	EN 61326-1	2013
RoHS	2011/65/EG	EN 50581	2012
LVD	2014/35/EU	IEC 61010-1	2010

This declaration is issued by the manufacturer

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

released by

Dr. J. Briggmann

Head of R&D
Bad Wildbad, 29rd of May, 2020

Registergericht / Court of Registration Stuttgart HRA 330991
Persönlich haftende Gesellschafterin / Fully liable Associates Berthold Technologies Verwaltungs-GmbH
Registergericht / Court of Registration Stuttgart HRB 331520
Geschäftsführung / Management Andreas Dobratz
USt.-Id-Nr. / VAT Reg. No. DE813050511
Deutsche Steuernummer / German Tax No. 49038/08038
WEEE-Reg. No. DE99468690

Bankverbindungen / Bank Details	IBAN	BLZ	Konto / Account	Swift BIC
Sparkasse Pforzheim-Calw	DE37	6665 0085	0008 0450 03	PZHSDE66
Volksbank Pforzheim	DE85	6669 0000	0000 9570 04	VBPFDE66
Commerzbank Pforzheim	DE05	6668 0013	0651 1120 00	DRESDEFF666

detect and identify

5.2 General Information

This safety manual provides operating instructions in accordance with the directive 2014/34/EU, the standards mentioned in the declaration of conformity, the National Electrical Code (NEC: ANSI/NFPA 70), the Canadian Electrical Code (CEC) and the UK regulations resulting from the UKCA certificate.

National responsible authorities can claim additional requests. Please observe the instructions given in this safety manual to avoid personal injury and property damage and to ensure safe operation.

⚠ The manual must be consulted in all cases where this symbol is marked, in order to find out the nature of the potential hazards and any actions which have to be taken to avoid them.

5.3 Improper Use

Warning about misuse

The following use is inappropriate and has to be prevented:

- Use under other conditions and prerequisites than those specified by the manufacturer in his technical documents, data sheets, operating and assembly instructions and other specifications.
- The repair of detectors that are used in explosion hazardous areas by persons who were not authorized by BERTHOLD TECHNOLOGIES.
- Using the device in a damaged or corroded condition.
- Operation with open or inadequately closed cover.
- Operation with
  - inadequately sealed glands,
  - inadequately tightened or damaged screwed fittings, i.e. cable glands, adapters and sealing plugs.
- Operation without paying attention to the manufacturer's safety precautions.
- Manipulating or bypassing existing safety installations.

5.4 Safety Instructions

5.4.1 Safety Instructions for Assembly and Operating Personnel

Assembly, installation, commissioning, operation and maintenance must only be carried out by authorized and trained personnel.

Before assembly/commissioning:

- Read the safety manual
- Read the operating manual
- Provide adequate training for assembly and operating personnel
- Ensure that the contents of the safety manual and the operating manual is fully understood by the relevant personnel.

If you are unclear:

- Mit Hersteller Kontakt aufnehmen.
- Reparatur

Repair

Spare parts may solely be assembled by the BERTHOLD TECHNOLOGIES service or by persons authorized by BERTHOLD TECHNOLOGIES. If this is not possible, you must replace the entire detector or return it to the manufacturer for repair.

5.5 Application Range and Technical Data

5.5.1 Ex-Protection and Temperature Limits

Test certificates:	PTB 11 ATEX 1032 X IECEx PTB 12.0038X EMA21UKEX0050X CSA 70009819 FM16US0282X / FM16CA0144X
Protection type:	IP66 / IP68 to IEC 60529 IP69K to ISO 20653 NEMA Type 4X
Air pressure:	80 kPa (0.8 bar) to 110 kPa (1.1 bar) Oxygen content of the air, typically: 21 % (Vi/V)

5.5.2 Detector Versions and Application Range for ATEX/IECEx/UKCA/NEC/CEC

Design		LB 480-1x-xx-... CrystelSENS (point detector)			LB 480-3x-xx-... SuperSENS	
		LB 480-2x-xx-... UniSENS (rod detector)			LB 480-4x-xx-... TowerSENS	
Protection concept		**LB 480-xx-1x LB 480-xx-2x**		**LB 480-xx-3C LB 480-xx-4C**	**LB 480-xx-1x LB 480-xx-2x**	**LB 480-xx-3C LB 480-xx-4C**
Signal circuits		**not intrinsically safe**		**Intrinsically safe**	**not intrinsically safe**	**Intrinsically safe**
Ex concept						
All rooms		Ex-t				
Housing (electronics compartment)		Ex-d				
Terminal compartment		Ex-e		Ex-e[1]/Ex-i	Ex-e	Ex-e[1]/Ex-i
Ambient temperature						
min.		$T_a \geq$ -40 °C				
max.		$T_a \leq$ +80 °C	$T_a \leq$ +65 °C	$T_a \leq$ +50 °C	$T_a \leq$ +60 °C[2]	$T_a \leq$ +50 °C
Zone 1 + 2, category II 2 G Class I Zone 1		**Gas**				
Temperature class		T5	T6	T6	T6	T6
Identification	ATEX/IECEx /UKCA/CEC	Ex db eb IIC Gb		Ex db eb [ia Ga] IIC Gb	Ex db eb IIC Gb	Ex db eb [ia Ga] IIC Gb
	NEC	AEx db eb IIC Gb		AEx db eb [ia Ga] IIC Gb	AEx db eb IIC Gb	AEx db eb [ia Ga] IIC Gb
Zone 21 + 22, category II 2 D		**Dust**				
Temperature class		T95 °C	T80 °C	T80 °C	T80 °C	T80 °C
Identification	ATEX/IECEx /UKCA/CEC	Ex tb IIIC Db		Ex tb [ia Da] IIIC Db	Ex tb IIIC Db	Ex tb [ia Da] IIIC Db
	NEC	AEx tb IIIC Db		AEx tb [ia Da] IIIC Db	AEx tb IIIC Db	AEx tb [ia Da] IIIC Db
Protection principle		Ex-d/ -e/ -t		Ex-d/ -e/ -i/ -t	Ex-d/ -e/ -t	Ex-d/ -e/ -i/ -t

1) Internal IP30 protection cover 2) some detectors support $T_a \leq$ +65 °C (see nameplate)

5.5.3 Detector Versions and Application Range for Divisions according NEC/CEC

Bauform		**LB 480-1x-xx-... CrystelSENS (point detector) LB 480-2x-xx-... CrystelSENS (rod detector) LB 480-3x-xx-... SuperSENS LB 480-4x-xx-... PowerSENS**	
Schutzkonzept		**LB 480-xx-Fx-... LB 480-xx-Gx-...**	
Signal circuit		not intrinsically safe	
Schutzprinzip			
Housing (electronic compartment)		explosion Proof (XP)	
Terminal compartment		explosion Proof (XP)	
Ambient temperature			
min.		$T_a \geq$ -40 °C	
max.		$T_a \leq$ +80 °C	$T_a \leq$ +60 °C
Temperature class		T5	T6
	Class I Division 1 US, NEC 500, 501	Gas Group A, B, C, D	
	Class I Division 1 C (Canada) CEC 18	Gas Group B, C, D	
	Class II Division 1 US, NEC 500, 502 C (Canada) CEC 18	Dust Group E, F, G	
	Class III Division 1 US, NEC 500, 503 C (Canada) CEC 18	Fibers	

5.5.4 Electrical characteristics for supply and RS485

	LB 480-xx-xx-x1 3)	LB 480-xx-xx-x2
Supply (terminal 1,2 or 3,4)	U = 18 … 32 V_{DC}, 12W U_m = 250 V	U = 100 … 240 V_{AC}, 50/60 Hz, 12 VA U_m = 250 V
RS485 circuit 2) (terminals 5/5A, 6/6B)	U_m = 5 V_{DC} I_m = 20 mA	

2) Only for connection to RS485 interfaces of type LB 480

3) For NEC and CEC installations, refer to CSA Certificate (Conditions of Acceptability)

Please note that the maximum permissible ambient temperature at the detector surface should not be exceeded in case of failure of any connected water cooling.

Please refer to the technical data of the operating manual for information on the ambient temperature of the water cooling required so protect the electronics from damage by overheating.

The max. ambient temperature decreases when the detector is not mounted free-standing; the maximum surface temperature must not be exceeded.

5.5.5 Electrical safety characteristics of the associated equipment

Signal circuits	LB 480-...-3C (Sink)	LB 480-...-4C (Source)	
Current output (isolated) (Terminals 17, 18 resp. 19, 20)	**HART® / 4 ... 20 mA linear characteristic curve**		
max. output voltage		U_a = 25.2 V	
max. output current		I_a = 101 mA	
max. output rating		P_a = 635 mW	
max. input voltage	U_i = 30 V		
max. input current	I_i = 152 mA		
max. input rating	P_i = 1.14 W		
max. internal inductance	L_i = 20 µH		
max. internal capacitance	C_i = 3 nF		
Individual reactances according to EN 60079-11, Table A2, Figure A4 / A6		IIC	IIB
		L_o = 17 mH	L_o = 4 mH
		C_o = 0.82 µF	C_o = 0.107 µF
Signal output (isolated) (Terminals 11, 12)	Open collector circuit linear characteristic curve		
max. input voltage	U_i = 15 V[1)]		
max. input current[2)]	I_i = 26.6 mA		
max. input rating	P_i = 100 mW		
max. internal inductance	negligibly small		
max. internal capacitance	C_i = 11 nF		
Signal output (Terminals 15, 16)	Thermometer circuit (PT100) linear characteristic curve		
max. output voltage	U_o = 14 V		
max. output current	I_o = 27.7 mA		
max. output rating	P_o = 97 mW		
max. internal inductance	negligibly small		
max. internal capacitance	C_i = 11 nF		
Maximum permissible external values jointly acting reactances (C_i is not taken into account)	IIB		
	L_o = 0.1 mH, C_o = 4.6 µF		
	L_o = 0.5 mH, C_o = 4.0 µF		
	L_o = 1.0 mH, C_o = 3.3 µF		
Maximum permissible external values jointly acting reactances (C_i is not taken into account)	IIC		
	L_o = 0.1 mH, C_o = 0.73 µF		
	L_o = 0.5 mH, C_o = 0.71 µF		
	L_o = 1.0 mH, C_o = 0.59 µF		

1) minimum 5 V 2) Leakage current in closed state <0.01 mA

In gas atmospheres, when selecting group IIB or IIC for the intrinsically safe circuits, all intrinsically safe circuits and the LB 480 detector must be operated completely in the selected group IIB or IIC.

The probe must not be installed in zone 0 or zone 20. The protection level "ia" allows the safe use of measuring equipment that may otherwise only be used in Zone 0 or Zone 20.

5.6 Installation

- Observe the installation and safety instructions in the operating manual.
- Install according to manufacturer's instructions and applicable local standards and regulations, especially when installing other than with ATEX/IECEx regulations.
- Do not operate device outside of the electrical, thermal and mechanical characteristics.
- Install the housing cover and the screwed fittings (cable glands, adapters and sealing plugs) correctly to maintain the housing protection.
- Unused entries must be sealed with metal sealing plugs.
- Please note also the operating and assembly instructions of the screwed fittings.
- Evidence of intrinsic safety has to be provided prior to the installation of intrinsically safe circuits (see IEC 60079-14). The connection of measuring and test equipment must be considered! The installation must be carried out based on this proof.
- Connect the electrical equipment to the local potential equalization.
- With shielded cables, the shielding has to be placed on the detector side. Observe an adequate insulation >500 V between the screen and the lines.
- The current output and the open-collector circuit are each floating and have a dielectric strength of at least 500 V_{eff}. The circuit of the resistance thermometer is electrically connected to the PA port. For the supply voltage the dielectric strength is at least 1500 V_{eff}.
- Use a connection cable that is permitted and suitable for the application conditions. Observe local regulations!
- The connection cable (conductor and insulation) must be suitable for a continuous operating temperature ≥ T_a +15 K.
- Connected cables must be installed strain-relieved and fixed.
- Do not disassemble the detector housing from the detector base (see Fig. 11).
- Use the detectors exclusively for stationary installation.
- Devices that have been used under "non-Ex conditions"/Ordinary locations must not be used in the Ex-area/Hazardous Locations.
- If with intrinsically safe detectors it cannot be excluded that the intrinsically safe protective circuitry in the detector has been damaged by previous activities, the detector must no longer be used in intrinsically safe installations.
- Use a checklist to document the correctness and completeness of your work. We recommend to use the checklists in in chapter 1.9.1 and 1.9.2.

5.6.1 Increased Safety "e" in the Terminal Compartment

Housing Cover

- Take the weight (approx. 1.5 kg) of the housing cover into consideration when open and closing it so that it doesn't smash down.
- Install all four Allen screws (cylinder screws ISO 4762 M5 x 20 - A4 - 70) for the housing cover with a torque of 4 Nm. Use spring washers (DIN 127 - B5 - 1.4310) for housing covers with flat gaskets. For housing covers with O-Rings, use Nord-Lock-washers (NL5 SS from NORDLOCK®).

Screwed fittings

- Use only metallic screwed fittings and M20 x 1.5 screwed fittings suitable for the type of protection, depending on their application, but at least IP65.
- Only screwed fittings are permitted for ambient temperatures between -20 °C and +40 °C that technically meet at least the standard listed on the cover page of LB 480 EU type-examination certificate. Only screwed fittings which have been approved by BERTHOLD TECHNOLOGIES may be used outside this temperature range.
- Use only cables and fittings approved in accordance with local installation regulations. This could require special cables to prevent gas migration and, in particular, fittings with compound filling.
- Use only screwed fittings that are suitable for the type of cable (reinforced, non-reinforced, ...) and the cable cross-section.
- When using adapters for thread adjustment (e.g., thread reduction), only one adapter may be used in each entry.
- Replace the screwed fittings only by screwed fittings of the same type.

Terminals

- Permissible wire cross-section:
  - with ferrules 0.5 - 1.5 mm² (AWG 21 - 16 flexible)
  - without ferrules 0.5 - 2.5 mm² (AWG 21 - 14 flexible or solid)
- Both stranded leads as well as solid wires are permitted.
- To connect stranded leads, the following can be used: Ferrules or direct insertion of the strand into the terminal. The connection of fine-wire stranded lead class 6, according to IEC 60228, is only permitted with ferrules. Wire end sleeves according to DIN 46228 Part 1 + Part 4 are permitted.
- Tools used to manufacture crimped conductors must meet the requirements for a pull-out test according to DIN 46228 Part 4. They should withstand a pull-out force of 30 N at 0.5 mm² cross-section and 50 N at 2.5 mm² cross-section.
- Install the connecting cables in the terminal compartment so that ...
  - dirt and moisture are avoided in the terminal compartment;
  - the wires are not damaged when stripping;
  - the conductor insulation or the collar of the ferrule extends into the housing of the terminal body;
  - bare conductive parts of the lines (e.g., small wires of a strand) do not protrude from the terminal body;

- the length of the outer conductive part of the ferrule or the stripped wire must be 10 mm, so that the wire is securely held in the spring-type terminal;
- if ferrules are used, the conductor insulation extends into the collar of the ferrule.

5.6.2 Intrinsically Safe Installation Ex "i"

The sections "Screwed fittings" and "Terminals" in chapter 1.6.1 also apply to the intrinsically safe installation.

- The housing cover (metal lid) covers the entire terminal compartment (see Fig. 3).
- Take the weight (approx. 1.5 kg) of the housing cover into consideration when open and closing it so that it doesn't smash down.
- Install all four Allen screws (cylinder screws ISO 4762 M5 x 20 - A4 - 70) for the housing cover with a torque of 4 Nm. Use Nord-Lock-washers (NL5 SS from Nord-Lock®).
- Seals of the screwed fittings must be designed in such a way that the separation between intrinsically safe and non-intrinsically safe terminal room is not voided.
- The semicircular plastic cover (Ex-e cover) covers the non-intrinsically safe terminals (see Fig. 3).
- The Ex-e cover must prevent access to non-intrinsically safe circuits with IP30 protection.
- After installation, the Ex-e cover must completely cover the terminal compartment for the power supply and RS485 interface again.
- Both screws (flat head screw ISO 7045 - M3 x 8 - 4.8) for fixing the Ex-e cover must be mounted.
- The housing cover is mounted correctly only if the pin on the Ex-e cover smoothly clicks into the blind hole of the housing cover.
- With intrinsically safe versions
  - the metal cover to the terminal compartment may be opened only for a short time for testing and adjustment.
  - the semicircular cover in the terminal compartment may be opened only if the terminal compartment is no longer energized and no explosive atmosphere is present.
- Devices with intrinsically safe circuits must not be connected to intrinsically safe circuits any more if they have not been used intrinsically safe before.

5.6.3 Explosion Proof (XP)

The paragraph "Terminals" in chapter 1.6.1 is also valid in this chapter.

- The threads (cable entries 1/2" NPT and housing cover) must be protected against damage.
- The threads (cable entries 1/2" NPT and housing cover) must be protected against moisture and corrosion. Therefore, always lubricate the complete thread with grease OKS 217 in order to achieve the degree of protection NEMA Type 4X.

Housing Cover

- Take the weight (approx. 1.5 kg) of the housing cover into consideration when open and closing it so that it doesn't smash down.
- Fix the housing cover thoroughly (> 10 turns), til the O-Ring is covered. Tight the housing cover with a torque moment of 25 Nm.

Cable Glands

- Only use metallic cable glands with 1/2" NPT thread.
- Only use cable glands that correlate to the local valid standards and legal regulations.
- When using conduits, install sealing boxes direct at the cable entries.

5.6.4 Commissioning

- The HART® Communicator used must be capable of operating within the respective Ex zone.
- For intrinsically safe current output, the HART® Communicator must also be intrinsically safe. The level of protection (ia, ib, ic) of the Communicator must be at least the level of protection of the installed circuit.

5.6.5 Protection Principle Ex-d/-e/-t and XP

- Do not open the terminal compartment while voltage is applied.
- If there is an explosive atmosphere: Waiting time before opening the electronics compartment after turning off the power supply: 2 minutes.
- Continued operation is not allowed if:
  - the detector is damaged
  - threads on the housing are corroded
  - the detector housing is badly corroded
  - blanking elements are badly corroded or damaged
  - cable glands are corroded or damaged
  - adapters are badly corroded or damaged
  - seals are damaged, show visible aging, or settlement.

5.6.6 Protection Principle Ex-d/-e/-i/-t (intrinsically safe current output)

When opening the terminal compartment during operation, pleasekeep in mind:

- The housing cover may only be opened for a short time for repair and maintenance.
- The semicircular cover (Ex cover) must remain closed as long as the supply voltage is applied.
- Please proceed as described in chapter 5.2.4 if the non-intrinsically safe part of the terminal compartment is to be opened. Waiting time before opening the Ex-e cover after turning off the power supply: 2 minutes.

5.7 Control Drawing

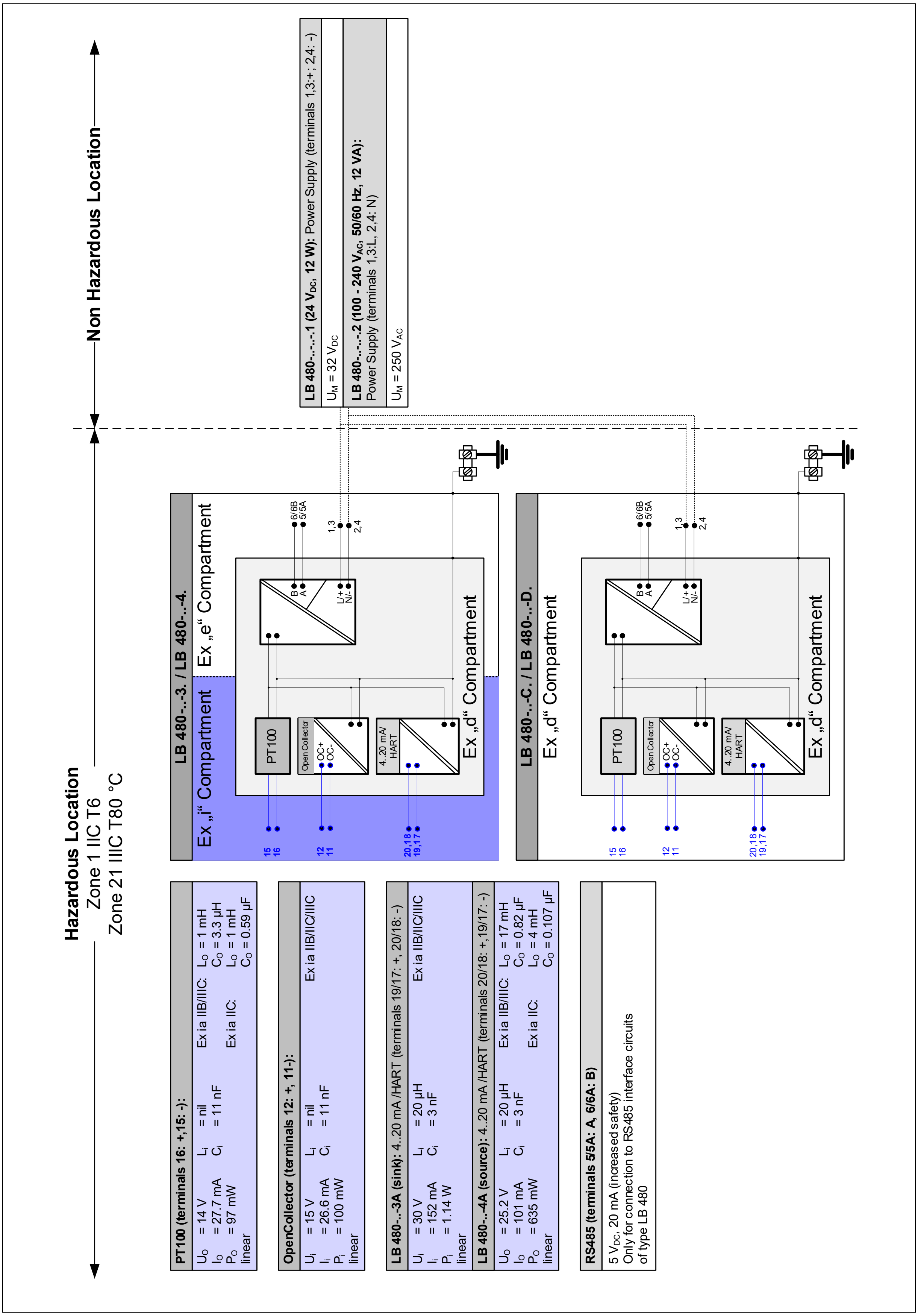
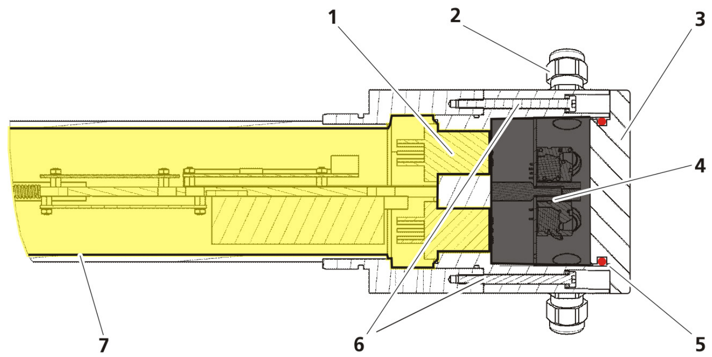


Fig. 1 Control Drawing

5.8 Ex – Concept

5.8.1 Ex-e – Concept

LB 480-xx-1C
LB 480-xx-2C



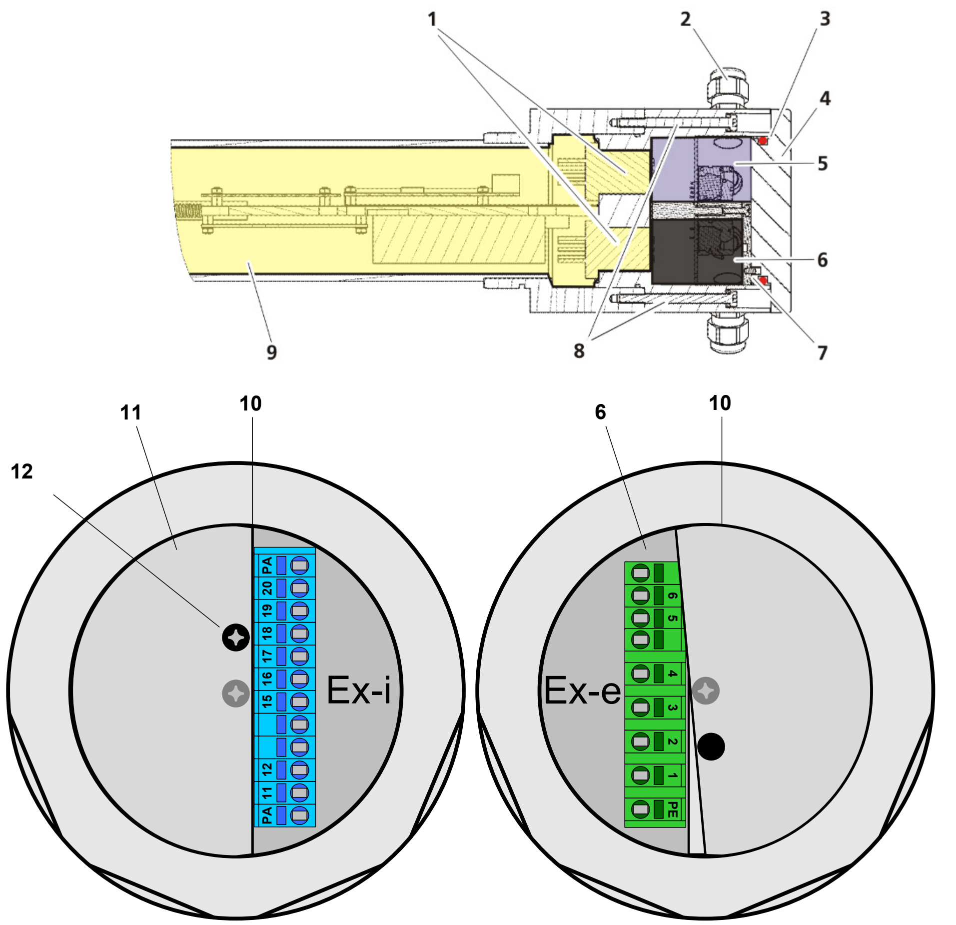
1 Pressure proofed line bushings
2 Cable glands (Ex e) max. 4
3 Lid for terminal compartment
4 Terminal compartment (Ex e)
5 Lid gasket (O-ring)
6 6 Screws **(do not loosen!)**
7 Pressure proofed housing (Ex d)

Fig. 2 Ex-e - Concept LB 480-xx-1C, LB 480-xx-2C

5.8.2 Ex-i – Concept

The RS485 connection to any connected type LB 480 interfaces is designed with increased safety.

LB 480-xx-3C
LB 480-xx-4C

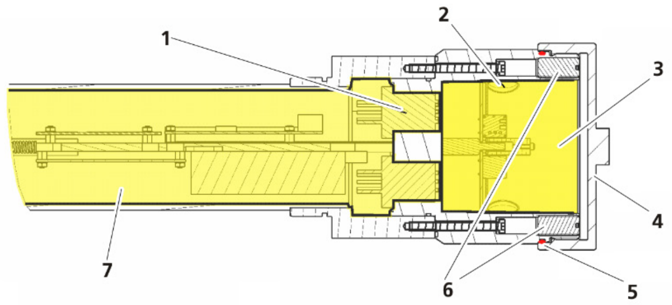


1 Pressure proofed cable bushings
2 Cable glands (Ex-e) max. 4
3 Lid gasket (O-ring)
4 Metal lid
5 Terminal compartment (Ex-i)
6 Terminal compartment (Ex-e)
7 IP 30 cover for Ex e compartment
8 6 Screws **(do not loosen!)**
9 Pressure Proofed Housing (Ex-d)
10 Master Terminal Compartment
11 Semicircular cover for Ex-e compartment with IP30 protection type
12 Unscrew to allow access to Ex-e terminal compartment after twisting of semicircu-
13 lar cover
Ex-e terminal compartment

Fig. 3 Ex-i - Concept LB 480-xx-3C, LB 480-xx-4C

5.8.3 XP – Concept

LB 480-xx-FX
LB 480-xx-GX



1 Bushings (explosion proof)
2 4x ½“ NPT cable entry
3 Terminal compartment (explosion proof)
4 Lid for terminal compartment
5 Lid gasekt (O-ring)
6 Slotted set screw (**must not be unscrewed**!)
7 Housing (explosion proof)

Abb. 4 XP - Concept LB 480-xx-FX, LB 480-xx-GX

5.8.4 Installation Plan for the Type of Protection Increased Safety "e" and Intrinsic Safety "i"

Types
LB 480-..-1
LB 480-..-2
LB 480-..-3
LB 480-..-4

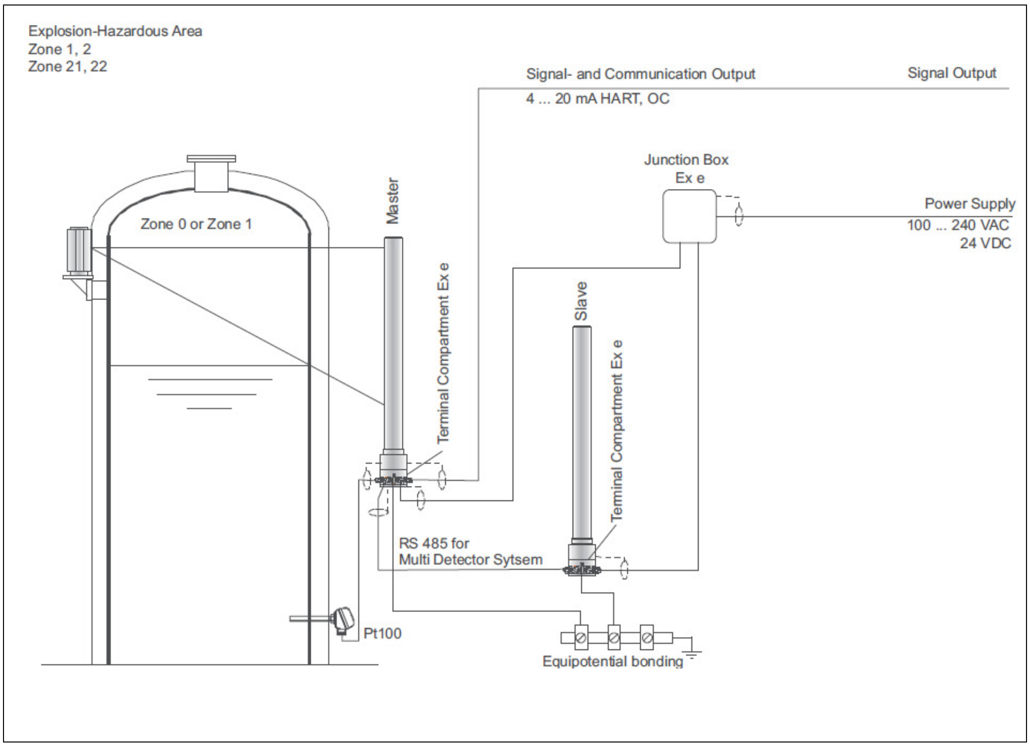


Fig. 5 Installation plan type of protection

5.8.5 Terminals

Terminal Compartment Master Ex-e and XP

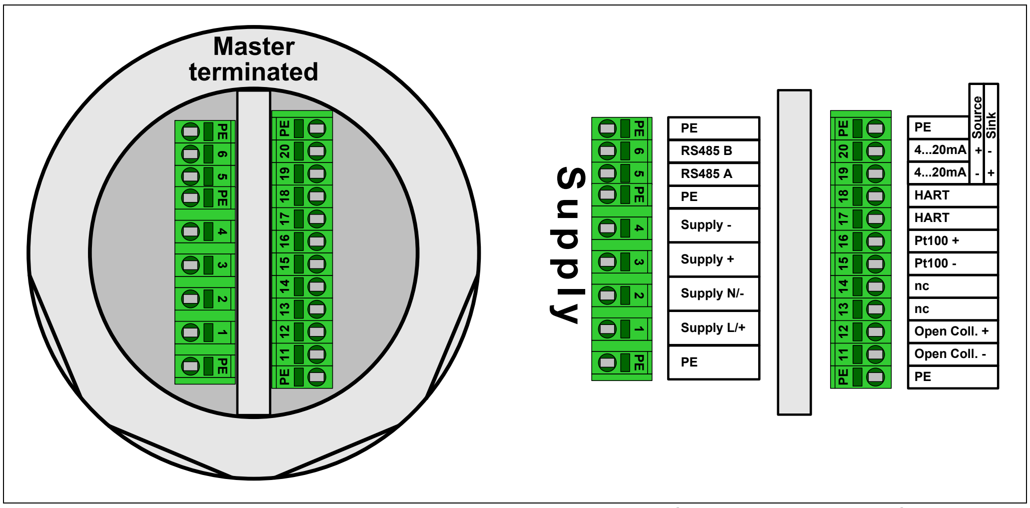


Fig. 6 Terminal Compartment Master Ex-e und XP (RS485 terminated)

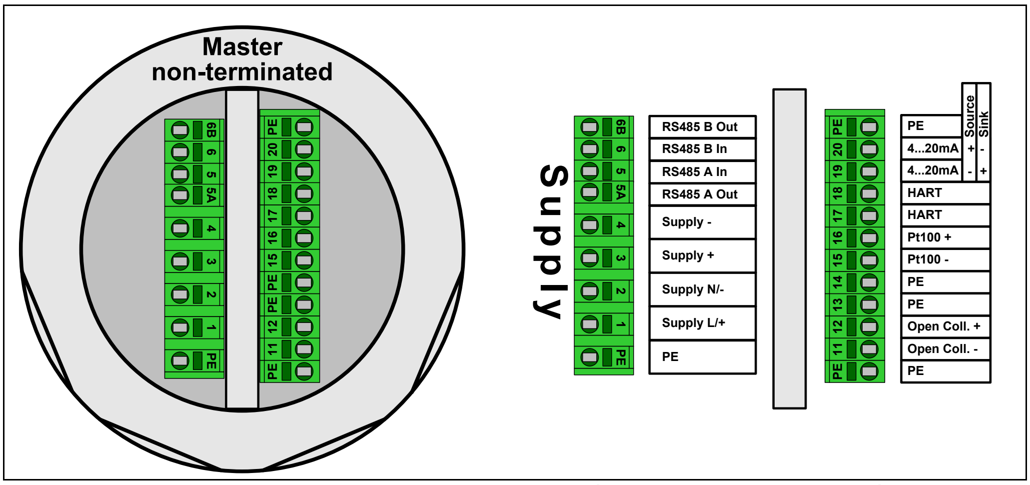


Fig. 7 Terminal Compartement Ex-e and XP (RS485 non-terminated)

Power supply

	Terminal	Labelling	
Type DC supply LB 480 - .. - .. - 11	1	Supply +	U_e = 24 V_{DC}, max. 12 W
	2	Supply -	
	3	Supply +	to forward to the next slave
	4	Supply -	
Type AC supply LB 480- .. - .. - 12	1	Supply L	U_e = 100 ... 240 V_{AC}, 50/60 Hz, max. 12 V_{AC}
	2	Supply N	
	3	Supply +	Do not use to loop through the supply!
	4	Supply -	

Do not connect any wires to the terminals "n.c.", as they are connected to the chassis ground.

Digital interface RS485

Terminal	
5/6	RS485: for multi-detector operation, connection of slave detectors or non-terminated master-detectors, service interface and for software update
5A/6B	RS485 feed through: only present in non-terminated master-detectors

Terminal Compartment Master Ex-e / Ex-i (after removing semicircular cover)

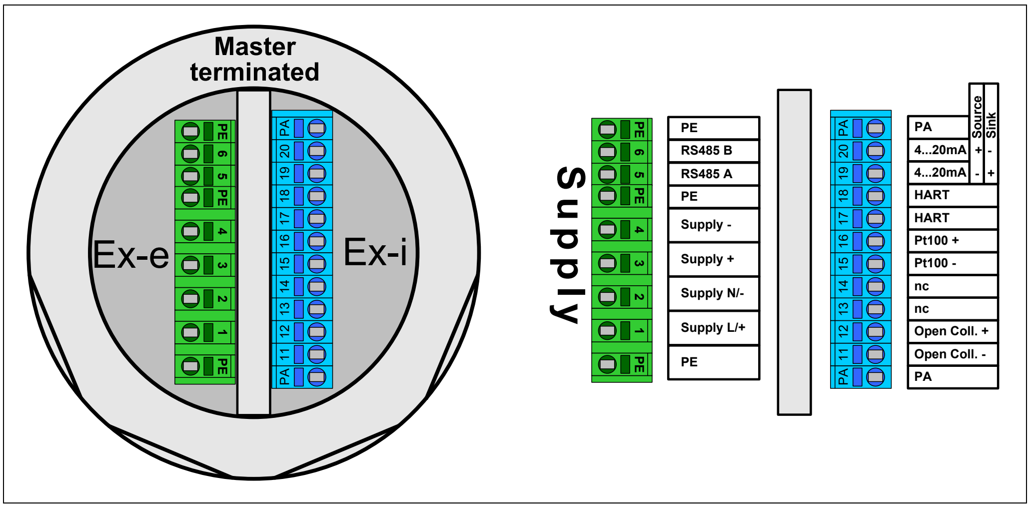


Fig. 8 Terminal compartment Ex-e / Ex-i (terminated)

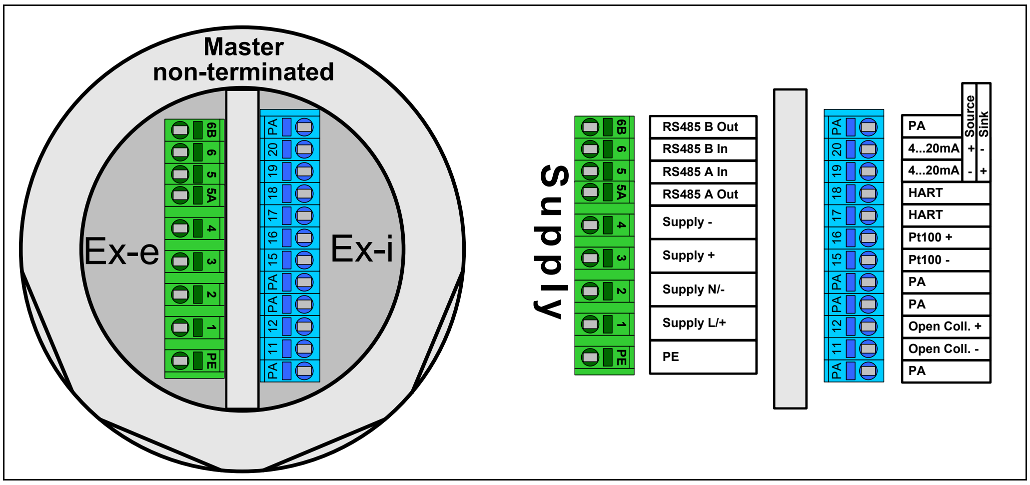


Fig. 9 Terminal compartment Ex-e / Ex-i (not-terminated)

Power Supply

	Terminal	Labelling	
Typ DC supply LB 480 - .. - .. - 11	1	Supply +	U_e = 24 V_{DC}, max. 12 W
	2	Supply -	
	3	Supply +	To forward the supply to the next slave
	4	Supply -	
Typ AC supply LB 480- .. - .. - 12	1	Supply L	U_e = 100 ... 240 V_{AC}, 50/60 Hz, max. 12 V_{AC}
	2	Supply N	
	3	Supply +	Do not use to loop through the supply!
	4	Supply -	

Do not connect any wires to the terminals "n.c.", as they are connected to the chassis ground.

Digital interface RS485

Terminal	Labelling
5/6	RS485: for multi-detector operation, connection of slave detectors or non-terminated master-detectors, service interface and for software update
5A/6B	RS485 output: only present in non-terminated master-detectors

The OC (open collector) and the current output can only be connected to an intrinsically safe repeater. Otherwise, all circuits are no longer intrinsically safe! Only a passive component may be connected as Pt100.

Slave Terminal Compartment

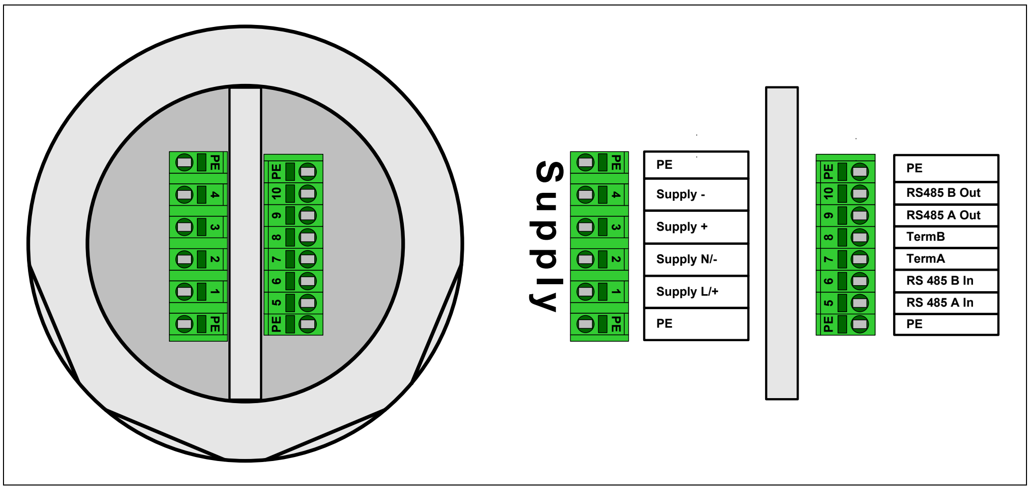


Abb. 10 Terminal compartment slave

Power supply

	Terminal	Labelling	
Typ DC supply LB 480 - .. - .. - 01	1	Supply +	U_e = 24 V_{DC}, max. 12 W
	2	Supply -	
	3	Supply +	To forward the supply to the next slave
	4	Supply -	
Typ AC supply LB 480- .. - .. - 02	1	Supply L	U_e = 100 ... 240 V_{AC}, 50/60 Hz, max. 12 VA U_m = 253 V_{AC}
	2	Supply N	
	3	Supply +	Do not use to loop through the supply!
	4	Supply -	

Digital interface RS485

Terminal	Labelling
5	RS485 A In
6	RS485 B In
9	RS485 A Out
10	RS485 B Out

Installation Instructions Cable Fittings and Dummy Plug

The cable glands are used only for the introduction of fixed cables. Please note the torques, cross sections and protection types of the screwed fittings in the following table.

The torques specified in the table below are typical values for the screwed fittings listed in the table, which essentially depend on the cable used. The pressure screw must be tightened so that the IP protection is permanently guaranteed.

Cable fittings

Type	Material	ID No.	EX labeling / Protection type	Cable cross-section for the sealing rings	A/F*	Torque / Sealant: Pressure screw	Torque / Sealant: Fitting body
Standard	Brass nickel-plated	55412	PTB 11 ATEX 1007 X IP66 / IP68 / IP69K	6 - 9 mm 9 - 14 mm	24 mm	10 Nm Silicone	
		59030	IMQ 13 ATEX 018 X IP66 / IP68 IMQ 13 ATEX 038 X IP66 / IP68	4 - 6 mm 6 - 9 mm 9 - 12 mm	22 mm	16 Nm Silicone	6 Nm Neoprene
	Stainless steel	56086	PTB 11 ATEX 1007 X IP66 / IP68 / IP69K	6 - 9 mm 9 - 14 mm	24 mm	10 Nm Silicone	
		59033	IMQ 13 ATEX 018 X IP66 / IP68 IMQ 13 ATEX 038 X IP66 / IP68	4 - 6 mm 6 - 9 mm 9 - 12 mm	22 mm	16 Nm Silicone	6 Nm Neoprene
EMC	Brass nickel-plated	56091	PTB 11 ATEX 1007 X IP66 / IP 68 / IP69K	9 - 14 mm (7 - 12 mm screen)	24 mm	10 Nm Silicone	
screen		56088	PTB 11 ATEX 1007 X IP66 / IP 68 / IP69K	9 - 14 mm (9 - 13 mm internal)	24 mm	10 Nm Silicone	
		56103		12 - 20 mm (10 - 15 mm internal)	30 mm	10 Nm Silicone	

*) A/F = across flats (wrench size)

Plugs M20 x 1.5

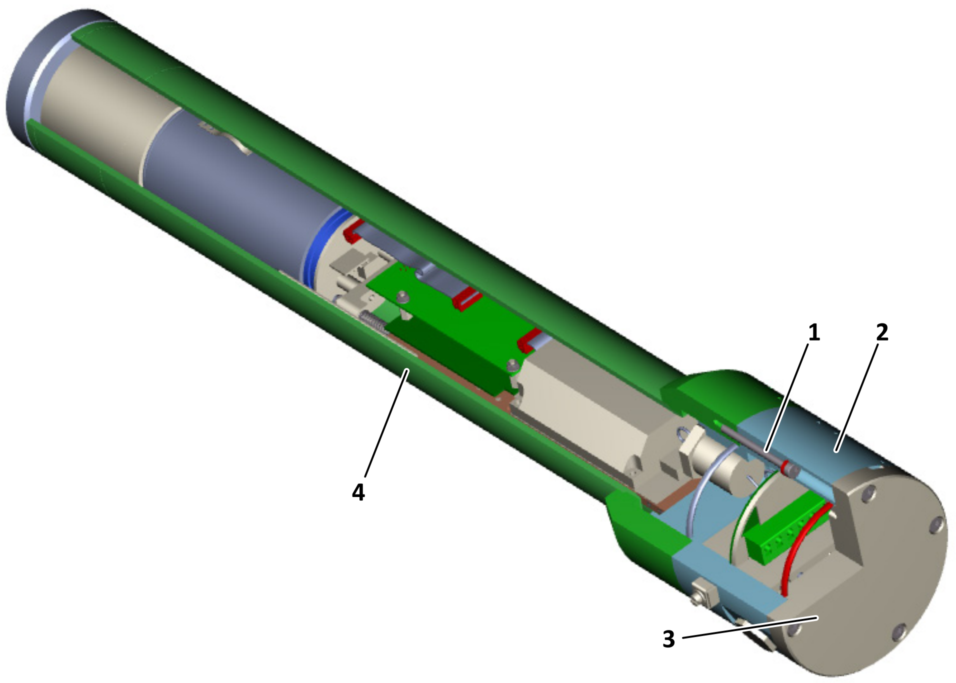
Material	ID No.	Certification No. / Protection type	A/F	Torque
Brass nickel-plated	56093	PTB 09 ATEX 1002 X IP66 / IP68 / IP69K	22 mm	10 Nm Silicone
	59031	SIRA 10 ATEX 1224 XITS 16 ATEX 101335 X IP66 / IP68 / IP69K	24 mm	6 Nm Neoprene
Stainless steel	56094	PTB 09 ATEX 1002 X IP66 / IP68 / IP69K	22 mm	10 Nm Silicone
	59032	SIRA 10 ATEX 1224 XITS 16 ATEX 101335 X IP66 / IP68 / IP69K	24 mm	6 Nm Neoprene
	68464	PTB 11 ATEX 1032 X IP66 / IP68	24 mm	10 Nm Silicone

Plugs 1/2" NPT

Material	ID No.	Certification No. / Protection type	A/F	Torque
Brass nickel-plated	33910	CSA: LR11716 UL: 10514	10 mm	30 Nm
Stainless steel 316L	66050	CSA: 2310046 IP66, NEMA 4X	10 mm	30 Nm

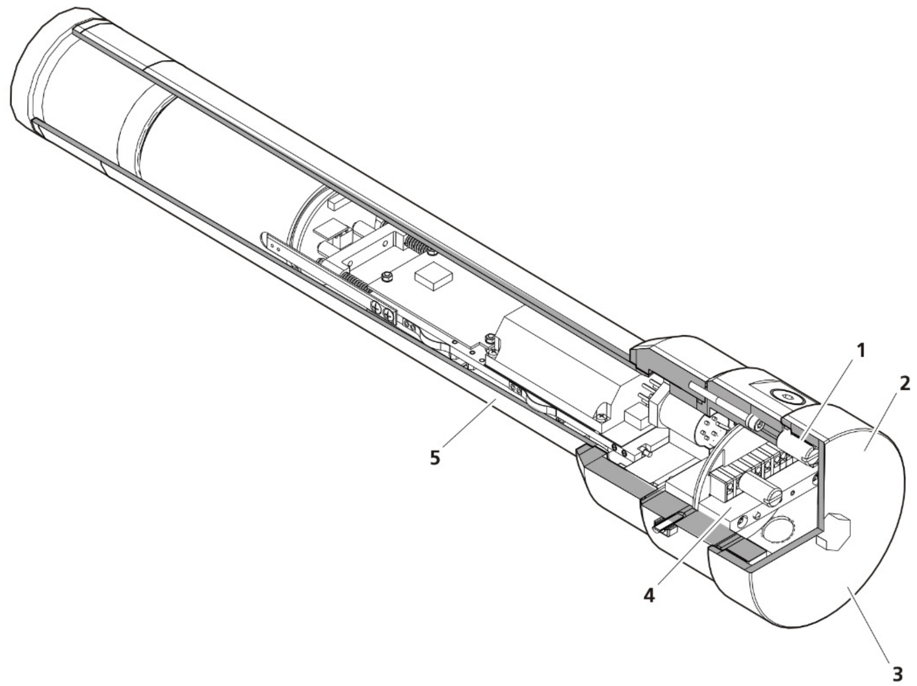
5.9 Maintenance and Visual Inspection

For detectors that are used in hazardous areas, the detector housing (Fig. 11) and thus the pressure-proof enclosure of the electronics may be opened only by the BERTHOLD TECHNOLOGIES service or by persons authorized by BERTHOLD TECHNOLOGIES.



1 6 screws **(must not be opened!)**
2 Connection head
3 Housing cover
4 Detector housing

Fig. 11 Detector housing with connection head with M20 cable entries for zone classification



1 Terminal room
2 Hosuing cover (lid)
3 Set screws* **(must not be unscrewed!)**
4 Connection head
5 Detector housing

Fig. 12 Detector housing with connection head for Class/Divisions with 1/2" NPT cable entries

*) The slotted set screws which are visible after opening the lid must not be unscrewed. Should one or more of these 6 screws be missing, the detector cannot be used in an Ex-area.

Use a checklist during commissioning, maintenance or repair to document the correctness and completeness of your work. We recommend to use the checklists in chapter 1.9.1 und 1.9.2.

Visual inspection

Carry out regular visual inspections of the SENSseries measuring system, at least once every three years. We recommend to use the checklist from chapter 1.9.1. Take appropriate actions immediately if you detect damage in the course of the visual inspection; if necessary, disconnect the detector from power supply immediately. To determine the inspection intervals for the visual inspection, take the following conditions into consideration:

- ambient conditions (temperature, humidity, corrosive atmosphere, shock and vibrations)
- operating conditions (degree of utilization, operating errors
- major changes in the overall system (e.g. changes in zoning)

Seals

If the cover or the housing is opened, the respective seals must be checked and replaced if necessary.

Cleaning

Take care not to damage the cable glands and the type plates during cleaning. Remove coarse debris with a stainless-steel wire brush. Grinding, filing or chipping away deposits with the hammer is not permitted.

5.9.1 Plan for Visual Inspection of the Detector

If you answer one of the following questions with "No", you have to record the action you have taken to remedy this deficiency in the last column. Make sure before you take the device into operation again that the provisions you have taken are correct by consulting with the person in charge of explosion protection.

Tests	YES	NO	Measures
General test			
Is the housing free of corrosion, dents, cracks, holes and warps?			
Is the housing cover of the detector firmly attached?			
Are the permissible functional and safety-related temperatures observed?			
Are the external connections of the potential equalizer in good working order?			
Is the surface of the detector free of contact with other non-alloy steel parts?			
Are the connected cables installed strain-relieved?			
Is a separator in place?			
Is the separator easily accessible for maintenance personnel?			
Test of screwed fittings (cable glands, adapters, sealing plugs)			
Were only metallic fittings used?			
Are the screwed fittings suitable for the ambient conditions?			
Are screwed fittings used for the normal ambient temperature range between -20 °C and +40 °C that at least meet the standards specified on the cover page of the EC type-examination certificate or are screwed fittings used that have been approved for use in the LB 480 by BERTHOLD TECHNOLOGIES?			
Is the permissible temperature range of the screwed fittings suitable for the temperatures encountered?			
Are the screwed fittings suitable for the required protection type (at least IP 65)?			
Are the screwed fittings free of corrosion?			

Is more than one adapter (reduction or extension piece) used?			
Is the total length of the cable glands plus any possibly used adapters less than 10 cm?			
Are the cable diameters of the cables used permitted for the cable glands?			
Are the connected cable suitable for the ambient conditions?			
Are the connected cables suitable for a temperature which is 15 °C above the maximum ambient temperature?			
Are the screwed fittings undamaged?			
Are there any doubts concerning the sealing of the screwed fittings?			
Are the cables firmly clamped in the cable glands?			
Are the screwed fittings firmly tightened?			
Are all unused openings provided with blanking plugs?			
Are the blanking plugs adequate for the required explosion group?			
Applies only to detectors with XP protection (Explosion proof)			
Is the detector cover thoroughly screwed in and is the O-ring thoroughly covered?			
Are sealing boxes at the cable entries on the housing available and are they in suitable condition?			

Date:

Name:

5.9.2 Plan for Inspection of the Terminal Compartment

If you answer one of the following questions with "No", you have to record the action you have taken to remedy this deficiency in the last column. Make sure before you take the device into operation again that the provisions you have taken are correct by consulting with the person in charge of explosion protection.

Tests	YES	NO	Measures
Test in the terminal compartment			
Is the interior (terminal compartment) in perfect order?			
Is the interior dry, clean and free of foreign material?			
Are the cables connected firmly?			
Are the terminals in perfect order?			
Is the interior free of corrosion?			
Is the insulation free of damages or trails?			
Is the mechanical fastening of the fixtures in good working order?			
Is the detector installed according to the local constructor regulations (e.g. EN 60079-14)?			
Does the cable insulation extend into the terminal compartment?			
Does the wire isolation reach into the sleeve of the terminals, respectively the sleeve of the ferrules?			
When using ferrules: Does the sleeve of the ferrule extend into the terminal sleeve?			
Are all the wires of a fine-wire strand covered by the terminal and clamped?			
Is the grounding conductor properly installed?			
Is the screened cable properly insulated electrically up to the terminal (e.g. with shrink tubing)?			
Applies only to detectors with intrinsically safe installation (Ex-i)			
Does the semicircular lid cover the terminal compartment (Ex-e)?			
Are the screws for the semicircular lid tightened?			

Has it been ensured that no wires are trapped between the semicircular cover and the underlying holder?			
Have both screws (flat head screw ISO 7045 - M3 x 8 - 4.8) of the semicircular cover been installed?			
Can the pin of the semicircular cover smoothly click into place during the assembly of the housing cover?			
Applies only to detectors with XP protection (Explosion proof)			
Are all 6 set screws are screwed in?			
Is the thread for the detector cover lubricated with grease OKS 217, in order to avoid corrosion?			
Leak test			
Is the sealing inside the screwed fittings OK?			
Is the sealing of the cover in the terminal compartment undamaged and free of cracks and settlement?			

Date:

Name:

5.10 ATEX Certificate – PTB 11 ATEX 1032 X

Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin
Nationales Metrologieinstitut

(1) **EU-TYPE-EXAMINATION CERTIFICATE**
(Translation)

(2) Equipment or Protective Systems Intended for Use in Potentially Explosive Atmospheres - **Directive 2014/34/EU**

(3) EU-Type Examination Certificate Number:

PTB 11 ATEX 1032 X **Issue: 3**

(4) Product: Scintillation measuring equipment type LB480

(5) Manufacturer: Berthold Technologies GmbH & Co. KG

(6) Address: Calmbacher Straße 22, 75323 Bad Wildbad, Germany

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

(8) The Physikalisch-Technische Bundesanstalt, notified body No. 0102 in accordance with Article 17 of the Directive 2014/34/EU of the European Parliament and of the Council, dated 26 February 2014, certifies that this product has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of products intended for use in potentially explosive atmospheres, given in Annex II to the Directive.

The examination and test results are recorded in the confidential Test Report PTB Ex 22-11191.

(9) Compliance with the Essential Health and Safety Requirements has been assured by compliance with:
EN IEC 60079-0:2018 **EN 60079-1:2014+AC:2018-09** **EN IEC 60079-7:2015+A1:2018**
EN 60079-11:2012 **EN 60079-31:2014**

(10) If the sign "X" is placed after the certificate number, it indicates that the product is subject to the Specific Conditions of Use specified in the schedule to this certificate.

(11) This EU-Type Examination Certificate relates only to the design and construction of the specified product in accordance to the Directive 2014/34/EU. Further requirements of the Directive apply to the manufacturing process and supply of this product. These are not covered by this certificate.

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

Ex **II 2 G Ex db IIC T6 Gb bzw.**
Ex **II 2 G Ex db eb IIC T5 G bzw. II 2 G Ex db eb IIC T6 Gb**
Ex **II 2 G Ex db [ia Ga] IIC T6 G bzw. II 2 G Ex db eb [ia Ga] IIC T6 Gb**
Ex **II 2 D Ex tb IIIC T95 °C Db bzw. II 2 D Ex tb IIIC T80°C Db bzw.**
Ex **II 2 G Ex tb IIIC T60°C Db**
Ex **II 2 D Ex tb [ia Da] IIIC T80 °C Db bzw. II 2 D Ex tb [ia Da] IIIC T60 °C Db**

ZSEx001e c

Konformitätsbewertungsstelle, Sektor Explosionsschutz Braunschweig, May 2, 2022
On behalf of PTB:

D. Markus

Dr.-Ing. D. Markus
Direktor und Professor

PHYSIKALISCH-TECHNISCHE BUNDESANSTALT

sheet 1/7

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

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Braunschweig und Berlin
Nationales Metrologieinstitut

(13) **SCHEDULE**

(14) **EU-Type Examination Certificate Number PTB 11 ATEX 1032 X, Issue: 3**

(15) Description of Product

The scintillation measuring equipment type LB 480 is part of a measuring system for monitoring industrial processes. It is used for continuously measuring the level in tanks or bins that contain liquid, granular, viscous or encrustation-forming media, and for measuring conveyor belt charges, and the density of liquids, suspensions, slurries and bulk solids. It is also used for continuously measuring level, weight per unit area, ash, sulphur, hydrogen and other specific application.

The measuring principle is based on the absorption of gamma rays. The radiation source does not part of the measuring equipment and not part of this certificate.

The scintillation measuring equipment consists of a scintillation detector with associated electronics in a common housing type of protection Flameproof Enclosure "d" or in type of protection Dust Protection by Enclosure "t".

The type LB 480 of measuring equipment is extended to the choice of execution as associated electrical equipment to the signal outputs OC-input, PT100 and HART current output in type of protection Intrinsic Safety "i".

The power supply and the interface RS485 are designed not intrinsically safe.

The integrated with the detector-housing connector housing is either in type of protection Flameproof Enclosure "d", or in type of protection Increased Safety "e", or in type of protection Dust Protection by Enclosure "t" or in each case in combination with the type of protection Intrinsic Safety "i "equipped.

The relevant options are listed in a new type of key and read in future as indicated below.

The relationship between variation, type of protection, temperature class and ambient temperature is re-codified and is listed in the table below.

Assignment of the ambient temperature

Protection	Temperature class	Variant	Product key	Ambient temperature
Ex db IIC Gb Ex tb IIIC Db	T6 T75 °C	A1, B1, E1	LB 480-xx-AC-xx LB 480-xx-BC-xx	-40 °C ≤ T_a ≤ +60 °C
Ex db eb IIC Gb Ex tb IIIC Db	T6 T80 °C	E2	LB 480-xx-1C-xx LB 480-xx-2C-xx	-40 °C ≤ T_a ≤ +60 °C
Ex db eb IIC Gb Ex tb IIIC Db	T6 T80 °C	A2, B2, E2	LB 480-xx-1C-xx LB 480-xx-2C-xx	-40 °C ≤ T_a ≤ +65 °C

sheet 2/7

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SCHEDULE TO EU-TYPE EXAMINATION CERTIFICATE PTB 11 ATEX 1032 X, Issue: 3

Protection	Temperature class	Variant	Product key	Ambient temperature
Ex db eb IIC Gb Ex tb IIIC Db	T5 T95 °C	A2, B2	LB 480-1x-1C-xx LB 480-1x-2C-xx LB 480-2x-1C-xx LB 480-2x-2C-xx	-40 °C ≤ T_a ≤ +80 °C
Ex db [ia Ga] IIC Gb Ex tb [ia Da] IIIC Db	T6 T80 °C	A1, B1, E1	LB 480-xx-CC-xx LB 480-xx-DC-xx	-40 °C ≤ T_a ≤ +50 °C
Ex db eb [ia Ga] IIC Gb Ex tb [ia Da] IIIC Db	T6 T80 °C	A2, B2, E2	LB 480-xx-3C-xx LB 480-xx-4C-xx	-40 °C ≤ T_a ≤ +50 °C

Type code

LB480		-	.	.	-	.	.	-	.	.	-	..-...-	Variante	Beschreibung
			1	1									Bx	Point Detector 50x50
			1	2									Bx	Point Detector 50x50 + WC
			1	..									Bx	Point Detector ...
			2	A									Ax	Rod Detector 500 mm
			2	B									Ax	Rod Detector 500 mm + WC
			2	..									Ax	..
			2	K									Ax	Rod Detector 2000 mm
			2	L									Ax	Rod Detector 2000 mm + WC
			3	1									Ex	Super-Sens
			3	2									Ex	Super-Sens + WC
			3	.									Ex	
			4	1									Ex	Tower-Sens
			4	2									Ex	Tower-Sens + WC
			4	.									Ex	
						0	0							without Ex-type approval
						1							x2	ATEX/IECEx Ex det (passive / slave)
						2							x2	ATEX/IECEx Ex det (active)
						3							x2	ATEX/IECEx Ex deit (passive)
						4							x2	ATEX/IECEx Ex deit (active)
						A							x1	ATEX/IECEx Ex dt (passive / slave)
						B							x1	ATEX/IECEx Ex dt (active)
						C							x1	ATEX/IECEx Ex dit (passive / slave)
						D							x1	ATEX/IECEx Ex dit (active)
							A							Ex-Revision
							B							Ex-Revision (1. Supplement)
							C							Ex-Revision (2. Issue)
							.							
									.					Signal Output (Slave, HART, etc.)
										1				Power supply 24 V_{DC}
										2				Power supply: 100 - 240 V_{AC}
												.		none Ex-relevant parameter
	The "x" in the "Variant" column has the function of a placeholder.													

sheet 3/7

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SCHEDULE TO EU-TYPE EXAMINATION CERTIFICATE PTB 11 ATEX 1032 X, Issue: 3

Electrical data

Power supply (Terminal 1, 2) (Terminal 3, 4)	max. 240 V, 50/60 Hz, max. 12 VA or max. 24 V (DC), max. 12 W U_m = 250 V
Interface circuit RS485 (Terminal 5, 5A, 6, 6A)	type of protection Increased Safety Ex ib IIB/IIC; 5 V (DC), 20 mA Only for connection to RS485 interface circuits other scintillation instruments LB 480 and an evaluation unit with equivalent means of protection
Thermometer circuit (PT100) (Terminal 15, 16)	type of protection Intrinsic Safety Ex ia IIB/IIC; maximum Values: U_o = 14 V I_o = 27.7 mA P_o = 97 mW Characteristic linear C_i = 11 nF L_i negligible small

Maximum permissible external values for common effective reactances (Ci is not considered).
(according to ISpark-6.2)

L_o (mH)	IIB	IIC
	C_o (µF)	C_o (µF)
0,1	4,6	0,73
0,5	4,0	0,71
1,0	3,3	0,59

The RTD circuit is electrically connected to the internal supply circuit and the earth.

Open collector circuit (Terminal 11, 12)	type of protection Intrinsic Safety Ex ia IIB/IIC; maximum Values: U_i = 15 V I_i = 26.6 mA P_i = 100 mW C_i = 11 nF L_i negligible small

The open collector circuit is safely electrically isolated from earth and all other circuits.

HART-current output (Source Mode)	type of protection Intrinsic Safety Ex ia IIB/IIC;

sheet 4/7

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SCHEDULE TO EU-TYPE EXAMINATION CERTIFICATE PTB 11 ATEX 1032 X, Issue: 3

(Terminal 17, 18)

maximum Values:
U_o = 25.2 V
I_o = 101 mA
P_o = 635 mW
Characteristic linear
C_i = 3 nF
L_i = 20 µH

Maximum permissible external values for common effective reactances (Ci is not considered). (according to ISpark-6.2)		
L_o (mH)	IIB	IIC
	C_o (µF)	C_o (µF)
0,44	0,52	0,084
0,8	0,45	0,066
1,6	0,38	0,049
13,0	0,37	-----

Single reactances to table A.2 and figure A.4 or A.6 of EN 60079-11			
IIB		IIC	
L_o (mH)	C_o (µF)	L_o (mH)	C_o (µF)
17	0.820	4	0.107

or

HART- current output (Sink Mode)
(Terminal 17, 18)

type of protection Intrinsic Safety Ex ia IIB/IIC;
Only for connection to a certified intrisically safe circuit. Maximum Values:
U_i = 30 V
I_i = 152 mA
P_i = 1.14 W
C_i = 3 nF
L_i = 20 µH

The HART current output (source mode or sink mode) of the current output module are safely electrically isolated from earth and all other circuits.

Changes in this issue with respect to further issues

1. For the mounting of the glass window, in addition to the previously used casting compound, the following materials may also be used:

3M Scotch-Weld™ DP 105
Master Bond EP41S-6
Panacol Vitralit® 2028
When the material 3M Scotch-Weld™ DP 105 is used, the maximum ambient temperature is reduced to +60 °C.

sheet 5/7

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SCHEDULE TO EU-TYPE EXAMINATION CERTIFICATE PTB 11 ATEX 1032 X, Issue: 3

2. Terminal board with modified pin assignment at the RS485 interface to allow terminated and non-terminated Master detector and connection of an evaluation unit with equivalent protection circuits..

Changes in issues 1 and 2

Electronic components were changed for new product groups.

The core material of the used current compensation chokes was exchanged.
The temperature class description in the Ex marking has been changed.
Adjustment of the special condition "X" for equipment types with intrinsically safe "ia" output circuits.

Electronic components were exchanged for new product groups with identical parameters. The components are located in the Ex-d housing.

The core material of the current compensation inductors used has been changed. The current compensation inductors are located in the Ex-d housing and are galvanically isolated from the intrinsically safe circuit section via transformers and optocouplers. The component cannot act externally via voltage and current limitations.

The temperature class designation in the Ex marking has been changed.

Adaptation of the specific conditions of use for device types with intrinsically safe "ia" output circuits.

(16) Test Report PTB Ex 22-11191

(17) Specific conditions of use

For the future the special conditions and the notes for manufacture and operation are defined as follows:

1) Due to the requirements of clause 5.1, EN 60079-1 it shall be pointed out that the joint dimensions of the flameproof enclosure deviate from the values tabulated in EN 60079-1. Repairing of flameproof joints exclusively according to the values specified in table 1 or table 2 of EN 60079-1 is not permitted and may only be carried out in accordance with the constructive specifications given by the manufacturer.

2) The interface circuit RS485 serves exclusively for intercommunication of the probes and an evaluation unit with equivalent means of protection and must not be connected to an external RS485 circuit.

3) In gas atmospheres must be fully operated in the selected group IIB or IIC in the choice of group IIB or IIC for the intrinsically safe circuits, all intrinsically safe circuits and the scintillation meter type LB 480.

4) The probe must not be installed in zone 0 or zone 20. The protection level "ia" allows the safe use of measuring equipment that may otherwise only be used in zone 0 or zone 20.

sheet 6/7

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SCHEDULE TO EU-TYPE EXAMINATION CERTIFICATE PTB 11 ATEX 1032 X, Issue: 3

(18) Essential health and safety requirements

Met by compliance with the aforementioned standards.

Konformitätsbewertungsstelle, Sektor Explosionsschutz
On behalf of PTB:

Braunschweig, May 2, 2022

Dr.-Ing. D. Markus
Direktor und Professor

sheet 7/7

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5.11 IECEx Certificate – IECEx PTB 12.0038X

IECEx Certificate of Conformity

INTERNATIONAL ELECTROTECHNICAL COMMISSION
IEC Certification System for Explosive Atmospheres
for rules and details of the IECEx Scheme visit www.iecex.com

Certificate No.:	**IECEx PTB 12.0038X**	Page 1 of 4	Certificate history:
Status:	**Current**	Issue No: 4	Issue 3 (2020-09-18) Issue 2 (2020-03-23) Issue 1 (2013-11-28) Issue 0 (2012-07-26)
Date of Issue:	2022-04-08		
Applicant:	**Berthold Technologies GmbH & Co. KG** Calmbacher Str. 22 75323 Bad Wildbad **Germany**		
Equipment:	**Scintillation measuring equipment of the LB 480 series**		
Optional accessory:	Component certificates IECEx KEM 07.0057U , IECEx EPS 13.0045U		
Type of Protection:	**Ex db eb [ia] IIC Ex tb [ia Da] IIIC**		
Marking:	Ex db IIC T6 Gb, Ex db eb IIC T5 Gb, Ex db eb IIC T6 Gb, Ex db [ia Ga] IIC T6 Gb, Ex db eb [ia Ga] IIC T6 Gb, Ex tb IIIC T95°C Db resp. Ex tb IIIC T80°C Db resp. Ex tb IIIC T60°C Db, Ex tb [ia Da] IIIC T80°C Db resp. Ex tb [ia Da] IIIC T60°C Db		

Approved for issue on behalf of the IECEx Certification Body:	**Dr.-Ing. Detlev Markus**
Position:	**Head of Department "Explosion Protection in Energy Technology"**
Signature: (for printed version)	D. Markus
Date: (for printed version)	04.05.22

1. This certificate and schedule may only be reproduced in full.
2. This certificate is not transferable and remains the property of the issuing body.
3. The Status and authenticity of this certificate may be verified by visiting www.iecex.com or use of this QR Code.

Certificate issued by:

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Bundesallee 100
38116 Braunschweig
Germany

PTB
Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin

IECEx Certificate of Conformity

Certificate No.: **IECEx PTB 12.0038X** Page 2 of 4

Date of issue: 2022-04-08 Issue No: 4

Manufacturer: **Berthold Technologies GmbH & Co. KG**
Calmbacher Str. 22
75323 Bad Wildbad
Germany

Manufacturing locations: **Berthold Technologies GmbH & Co. KG**
Calmbacher Str. 22
75323 Bad Wildbad
Germany

This certificate is issued as verification that a sample(s), representative of production, was assessed and tested and found to comply with the IEC Standard list below and that the manufacturer's quality system, relating to the Ex products covered by this certificate, was assessed and found to comply with the IECEx Quality system requirements.This certificate is granted subject to the conditions as set out in IECEx Scheme Rules, IECEx 02 and Operational Documents as amended

STANDARDS :
The equipment and any acceptable variations to it specified in the schedule of this certificate and the identified documents, was found to comply with the following standards

IEC 60079-0:2017 Edition:7.0	Explosive atmospheres - Part 0: Equipment - General requirements
IEC 60079-1:2014-06 Edition:7.0	Explosive atmospheres - Part 1: Equipment protection by flameproof enclosures "d"
IEC 60079-11:2011 Edition:6.0	Explosive atmospheres - Part 11: Equipment protection by intrinsic safety "i"
IEC 60079-31:2013 Edition:2	Explosive atmospheres - Part 31: Equipment dust ignition protection by enclosure "t"
IEC 60079-7:2017 Edition:5.1	Explosive atmospheres - Part 7: Equipment protection by increased safety "e"

This Certificate **does not** indicate compliance with safety and performance requirements other than those expressly included in the Standards listed above.

TEST & ASSESSMENT REPORTS:
A sample(s) of the equipment listed has successfully met the examination and test requirements as recorded in:

Test Report:

DE/PTB/ExTR12.0052/04

Quality Assessment Report:

DE/PTB/QAR06.0011/06

IECEx Certificate of Conformity

Certificate No.:	**IECEx PTB 12.0038X**	Page 3 of 4
Date of issue:	2022-04-08	Issue No: 4

EQUIPMENT:
Equipment and systems covered by this Certificate are as follows:

See the attached Data Sheet.

SPECIFIC CONDITIONS OF USE: YES as shown below:

1. Due to the requirements of clause 5.1, EN 60079 - 1 it shall be pointed out that the joint dimensions of the flameproof enclosure deviate from the values tabulated in EN 60079 - 1. Repairing of flameproof joints exclusively according to the values specified in table 1 or table 2 of EN 60079 - 1 is not permitted and may only be carried out in accordance with the constructive specifications given by the manufacturer.

2. The interface circuit RS485 serves exclusively for intercommunication of the probes and must not be connec ted to an external RS485 circuit.

3. In gas atmospheres must be fully operated in the selected group IIB or IIC in the choice of group IIB or IIC for the intrinsically safe circuits, all intrinsically safe circuits and the scintillation meter type LB 480

4. The probe must not be installed in zone 0 or zone 20. The protection level "ia" allows the safe use of measuring equipment that may otherwise only be used in zone 0 or zone 20.

IECEx Certificate of Conformity

Certificate No.: **IECEx PTB 12.0038X** Page 4 of 4

Date of issue: 2022-04-08 Issue No: 4

DETAILS OF CERTIFICATE CHANGES (for issues 1 and above)

1. For the mounting of the glass window, in addition to the previously used casting compound, the following materials may also be used:

3M Scotch-Weld™ DP 105

Master Bond EP41S-6

Panacol Vitralit® 2028

When the material 3M Scotch-Weld™ DP 105 is used, the maximum ambient temperature is reduced to +60 °C.

2. Terminal board with modified pin assignment at the RS485 interface to allow terminated and non-terminated Master detector and connection of an evaluation unit with equivalent protection circuits.

Attachment to Certificate
IECEx PTB 12.0038 X Issue 04

Applicant:	Berthold Technologies GmbH & Co. KG Calmbacher Straße 22, 75323 Bad Wildbad, Germany
Electrical Apparatus:	Scintillation measuring equipment type LB480

Description of equipment

The scintillation measuring equipment type LB 480 is part of a measuring system for monitoring industrial processes. It is used for continuously measuring the level in tanks or bins that contain liquid, granular, viscous or encrustation-forming media, and for measuring conveyor belt charges, and the density of liquids, suspensions, slurries and bulk solids. It is also used for continuously measuring level, weight per unit area, ash, sulphur, hydrogen and other specific application.

The measuring principle is based on the absorption of gamma rays. The radiation source does not part of the measuring equipment and not part of this certificate.

The scintillation measuring equipment consists of a scintillation detector with associated electronics in a common housing type of protection Flameproof Enclosure "d" or in type of protection Dust Protection by Enclosure "t".

The type LB 480 of measuring equipment is extended to the choice of execution as associated electrical equipment to the signal outputs OC-input, PT100 and HART current output in type of protection Intrinsic Safety "i".

The power supply and the interface RS485 are designed not intrinsically safe.

The integrated with the detector-housing connector housing is either in type of protection Flameproof Enclosure "d", or in type of protection Increased Safety "e", or in type of protection Dust Protection by Enclosure "t" or in each case in combination with the type of protection Intrinsic Safety "i "equipped.

The relevant options are listed in a new type of key and read in future as indicated below.

The relationship between variation, type of protection, temperature class and ambient temperature is re-codified and is listed in the table below.

The marking of the equipment reads in the future as follows.		
Ex db IIC T6 Gb Ex db eb IIC T6 Gb Ex db eb IIC T5 Gb	resp. resp.	
Ex db [ia Ga] IIC T6 Gb	resp. Ex db eb [ia Ga] IIC T6 Gb	
Ex tb IIIC T95°C Db	resp. Ex tb IIIC T80°C Db	resp. Ex tb IIIC T60°C Db,
Ex tb [ia Da] IIIC T80°C Db	resp. Ex tb IIIC T60°C Db	

Physikalisch-Technische Bundesanstalt (PTB)
Bundesallee 100, 38116 Braunschweig, Germany
Postfach 33 45, 38023 Braunschweig, Germany
Telephone +49 531 592-0, Telefax +49 531 592-3605

Attachment to Certificate
IECEx PTB 12.0038 X Issue 04

Assignment of the ambient temperature

Protection	Temperature class	Variant	Product key	Ambient temperature
Ex db IIC Gb Ex tb IIIC Db	T6 T75 °C	A1, B1, E1	LB 480-xx-AC-xx LB 480-xx-BC-xx	-40 °C ≤ T_a ≤ +60 °C
Ex db eb IIC Gb Ex tb IIIC Db	T6 T80 °C	A2, B2, E2	LB 480-xx-1C-xx LB 480-xx-2C-xx	-40 °C ≤ T_a ≤ +65 °C
Ex db eb IIC Gb Ex tb IIIC Db	T5 T95 °C	A2, B2	LB 480-1x-1C-xx LB 480-1x-2C-xx LB 480-2x-1C-xx LB 480-2x-2C-xx	-40 °C ≤ T_a ≤ +80 °C
Ex db [ia Ga] IIC Gb Ex tb [ia Da] IIIC Db	T6 T80 °C	A1, B1, E1	LB 480-xx-CC-xx LB 480-xx-DC-xx	-40 °C ≤ T_a ≤ +50 °C
Ex db eb [ia Ga] IIC Gb Ex tb [ia Da] IIIC Db	T6 T80 °C	A2, B2, E2	LB 480-xx-3C-xx LB 480-xx-4C-xx	-40 °C ≤ T_a ≤ +50 °C

Type code

LB480		-	.	.	-	.	.	-	.	.	-	..-	Variante	Beschreibung
			1	1									Bx	Point Detector 50x50
			1	2									Bx	Point Detector 50x50 + WC
			1	..									Bx	Point Detector …
			2	A									Ax	Rod Detector 500 mm
			2	B									Ax	Rod Detector 500 mm + WC
			2	..									Ax	..
			2	K									Ax	Rod Detector 2000 mm
			2	L									Ax	Rod Detector 2000 mm + WC
			3	1									Ex	Super-Sens
			3	2									Ex	Super-Sens + WC
			3	.									Ex	
			4	1									Ex	Tower-Sens
			4	2									Ex	Tower-Sens + WC
			4	.									Ex	
						0	0							without Ex-type approval
						1							x2	ATEX/IECEx Ex det (passive / slave)
						2							x2	ATEX/IECEx Ex det (active)
						3							x2	ATEX/IECEx Ex deit (passive)
						4							x2	ATEX/IECEx Ex deit (active)
						A							x1	ATEX/IECEx Ex dt (passive / slave)
						B							x1	ATEX/IECEx Ex dt (active)
						C							x1	ATEX/IECEx Ex dit (passive / slave)

Physikalisch-Technische Bundesanstalt (PTB)
Bundesallee 100, 38116 Braunschweig, Germany
Postfach 33 45, 38023 Braunschweig, Germany
Telephone +49 531 592-0, Telefax +49 531 592-3605

Attachment to Certificate
IECEx PTB 12.0038 X Issue 04

						D							x1	ATEX/IECEx Ex dit (active)
							A							Ex-Revision
							B							Ex-Revision (1. Supplement)
							C							Ex-Revision (2. Issue)
							.							
									.					Signal Output (Slave, HART, etc.)
										1				Power supply 24 V_{DC}
										2				Power supply: 100 - 240 V_{AC}
														none Ex-relevant parameter
	The "x" in the "Variant" column has the function of a placeholder.													

<u>Electrical data</u>

Power supply (Terminal 1, 2) (Terminal 3, 4)	max. 240 V, 50/60 Hz, max. 12 VA Or max. 24 V (DC), max. 12 W U_m = 250 V
Interface circuit RS485 (Terminal 5, 6)	type of protection Increased Safety Ex ib IIB/IIC; 5 V (DC), 20 mA Only for connection to RS485 interface circuits other scintillation instruments LB 480
Thermometer circuit (PT100) (Terminal 15, 16)	type of protection Intrinsic Safety Ex ia IIB/IIC; maximum Values: U_o = 14 V I_o = 27.7 mA P_o = 97 mW Characteristic linear C_i = 11 nF L_i negligible small

Maximum permissible external values for common effective reactances (Ci is not considered) (according to ISpark-6.2).		
L_o (mH)	**IIB**	**IIC**
	C_o (µF)	**C_o (µF)**
0,1	4,6	0,73
0,5	4,0	0,71
1,0	3,3	0,59

The RTD circuit is electrically connected to the internal supply circuit and the earth.

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Attachment to Certificate
IECEx PTB 12.0038 X Issue 04

Open collector circuit
(Terminal 11, 12)

type of protection Intrinsic Safety Ex ia IIB/IIC;
maximum Values:
U_i = 15 V
I_i = 26.6 mA
P_i = 100 mW
C_i = 11 nF
L_i negligible small

The open collector circuit is safely electrically isolated from earth and all other circuits.

HART-current output (Source Mode)
(Terminal 17, 18)

type of protection Intrinsic Safety Ex ia IIB/IIC;
maximum Values:
U_o = 25.2 V
I_o = 101 mA
P_o = 635 mW
Characteristic linear
C_i = 3 nF
L_i = 20 µH

Maximum permissible external values for common effective reactances (Ci is not considered). (according to ISpark-6.2)		
L_o (mH)	**IIB**	**IIC**
	C_o (µF)	**C_o (µF)**
0,44	0,52	0,084
0,8	0,45	0,066
1,6	0,38	0,049
13,0	0,37	-----

Single reactances to table A.2 and figure A.4 or A.6 of EN 60079-11			
IIB		**IIC**	
L_o (mH)	**C_o (µF)**	**L_o (mH)**	**C_o (µF)**
17	0.820	4	0.107

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Page 4 of 5

Attachment to Certificate
IECEx PTB 12.0038 X Issue 04

or

HART- current output (Sink Mode) (Terminal 17, 18)	type of protection Intrinsic Safety Ex ia IIB/IIC; Only for connection to a certified intrisically safe circuit. Maximum Values: U_i = 30 V I_i = 152 mA P_i = 1.14 W C_i = 3 nF L_i = 20 µH

The HART current output (source mode or sink mode) of the current output module are safely electrically isolated from earth and all other circuits.

Special conditions for safe use

For the future the special conditions and the notes for manufacture and operation are defined as follows:

1) Due to the requirements of clause 5.1, EN 60079-1 it shall be pointed out that the joint dimensions of the flameproof enclosure deviate from the values tabulated in EN 60079-1. Repairing of flameproof joints exclusively according to the values specified in table 1 or table 2 of EN 60079-1 is not permitted and may only be carried out in accordance with the constructive specifications given by the manufacturer.

2) The interface circuit RS485 serves exclusively for intercommunication of the probes and must not be connected to an external RS485 circuit.

3) In gas atmospheres must be fully operated in the selected group IIB or IIC in the choice of group IIB or IIC for the intrinsically safe circuits, all intrinsically safe circuits and the scintillation meter type LB 480.

4) The probe must not be installed in zone 0 or zone 20. The protection level “ia” allows the safe use of measuring equipment that may otherwise only be used in zone 0 or zone 20.

Physikalisch-Technische Bundesanstalt (PTB)
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5.12 UKCA Certificate – EMA21UKEX0050X

1 UNITED KINGDOM CONFORMITY ASSESSMENT

UK TYPE EXAMINATION CERTIFICATE

2 **Product or Protective System Intended for use in Potentially Explosive Atmospheres**
SI 2016:1107 (as amended) – Schedule 3A, Part 1

3 Type Examination Certificate No.: **EMA21UKEX0050X**

4 Product: **Scintillation Measuring Equipment, LB 480**

5 Manufacturer: **Berthold Technologies GmbH & Co. KG**

6 Address: **Calmbacher Strasse 22, 75323 Bad Wildbad, Germany**

7 This product and any acceptable variation thereto is specified in the schedule to this certificate and the documents therein referred to.

8 Element Materials Technology, Approved Body number 0891, in accordance with Regulation 42 of the Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations 2016, SI 2016:1107 (as amended), certifies that this product has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of products intended for use in potentially explosive atmospheres given in Schedule 1 of the Regulations.

The examination and test results are recorded in the confidential report **PTB Ex 22-11191**.

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

EN IEC 60079-0:2018 **EN 60079-1:2014** **EN IEC 60079-7:2015 + A1:2018**

EN 60079-11:2012 **EN 60079-31:2014**

Except in respect of those requirements listed at section 18 of the schedule.

10 If the sign "X" is placed after the certificate number, it indicates that the product is subject to specific conditions of use specified in the schedule to this certificate.

11 This TYPE EXAMINATION CERTIFICATE relates only to the design and construction of the specified product. Further requirements of the Regulations apply to the manufacturing process and supply of this product. These are not covered by this certificate.

12 The marking of this product shall include the following:

- Ex **II 2 G Ex db IIC T6 Gb**
- Ex **II 2 G Ex db eb IIC T5 G**
- Ex **II 2 G Ex db [ia Ga] IIC T6 G**
- Ex **II 2 D Ex tb IIIC T95 °C Db**
- Ex **II 2 G Ex tb IIIC T60 °C**
- Ex **II 2 D Ex tb [ia Da] IIIC T80 °C Db**
- Ex **II 2 G Ex db eb IIC T6 Gb**
- Ex **II 2 G Ex db eb [ia Ga] IIC T6 Gb**
- Ex **II 2 D Ex tb IIIC T80 °C Db**
- Ex **II 2 D Ex tb [ia Da] IIIC T60 °C**

This certificate and its schedules may only be reproduced in its entirety and without change. This certificate is issued in accordance with the Element Materials Technology Ex Certification Scheme.

S.P. Winsor

S P Winsor, Certification Manager

Issue date: 2023-04-14   Page 1 of 7   CSF341 4.0

Unit 1, Pendle Place, Skelmersdale, West Lancashire, WN8 9PN, United Kingdom
Element Materials Technology Warwick Ltd
Company Reg No. 02536659

UKAS PRODUCT CERTIFICATION 0178

SCHEDULE TO UK TYPE EXAMINATION CERTIFICATE

CERTIFICATE NUMBER EMA21UKEX0050X

15 Description of Product

The scintillation measuring equipment type LB 480 is part of a measuring system for monitoring industrial processes. It is used for continuously measuring the level in tanks or bins that contain liquid, granular, viscous or encrustation-forming media, and for measuring conveyor belt charges, and the density of liquids, suspensions, slurries and bulk solids. It is also used for continuously measuring level, weight per unit area, ash, sulphur, hydrogen and other specific application.

The measuring principle is based on the absorption of gamma rays. The radiation source does not part of the measuring equipment and not part of this certificate.

The scintillation measuring equipment consists of a scintillation detector with associated electronics in a common housing type of protection Flameproof Enclosure "d" or in type of protection Dust Protection by Enclosure "t".

The type LB 480 of measuring equipment is extended to the choice of execution as associated electrical equipment to the signal outputs OC-input, PT100 and HART current output in type of protection Intrinsic Safety "i".

The power supply and the interface RS485 are designed not intrinsically safe.

The integrated with the detector-housing connector housing is either in type of protection Flameproof Enclosure "d", or in type of protection Increased Safety "e", or in type of protection Dust Protection by Enclosure "t" or in each case in combination with the type of protection Intrinsic Safety "i "equipped.

The relevant options are listed in a new type of key and read in future as indicated below.

The relationship between variation, type of protection, temperature class and ambient temperature is re-codified and is listed in the table below.

Assignment of the ambient temperature

Protection	Temperature class	Variant	Product key	Ambient temperature
Ex db IIC Gb Ex tb IIIC Db	T6 T75 °C	A1, B1, E1	LB 480-xx-AC-xx LB 480-xx-BC-xx	-40 °C ≤ Ta ≤ +60 °C
Ex db eb IIC Gb Ex tb IIIC Db	T6 T80 °C	E2	LB 480-xx-1C-xx LB 480-xx-2C-xx	-40 °C ≤ Ta ≤ +60 °C
Ex db eb IIC Gb Ex tb IIIC Db	T6 T80 °C	A2, B2, E2	LB 480-xx-1C-xx LB 480-xx-2C-xx	-40 °C ≤ Ta ≤ +65 °C
Ex db eb IIC Gb Ex tb IIIC Db	T5 T95 °C	A2, B2	LB 480-1x-1C-xx LB 480-1x-2C-xx LB 480-2x-1C-xx LB 480-2x-2C-xx	-40 °C ≤ Ta ≤ +80 °C
Ex db [ia Ga] IIC Gb Ex tb [ia Da] IIIC Db	T6 T80 °C	A1, B1, E1	LB 480-xx-CC-xx LB 480-xx-DC-xx	-40 °C ≤ Ta ≤ +50 °C
Ex db eb [ia Ga] IIC Gb Ex tb [ia Da] IIIC Db	T6 T80 °C	A2, B2, E2	LB 480-xx-3C-xx LB 480-xx-4C-xx	-40 °C ≤ Ta ≤ +50 °C

SCHEDULE TO UK TYPE EXAMINATION CERTIFICATE

CERTIFICATE NUMBER EMA21UKEX0050X

Type code

LB480		-	.	.	-	.	.	-	.	.	-	..-...-	Variante	Beschreibung
			1	1									Bx	Point Detector 50x50
			1	2									Bx	Point Detector 50x50 + WC
			1	..									Bx	Point Detector ...
			2	A									Ax	Rod Detector 500 mm
			2	B									Ax	Rod Detector 500 mm + WC
			2	..									Ax	..
			2	K									Ax	Rod Detector 2000 mm
			2	L									Ax	Rod Detector 2000 mm + WC
			3	1									Ex	Super-Sens
			3	2									Ex	Super-Sens + WC
			3	.									Ex	
			4	1									Ex	Tower-Sens
			4	2									Ex	Tower-Sens + WC
			4	.									Ex	
						0	0							without Ex-type approval
						1							x2	ATEX/IECEx Ex det (passive / slave)
						2							x2	ATEX/IECEx Ex det (active)
						3							x2	ATEX/IECEx Ex deit (passive)
						4							x2	ATEX/IECEx Ex deit (active)
						A							x1	ATEX/IECEx Ex dt (passive / slave)
						B							x1	ATEX/IECEx Ex dt (active)
						C							x1	ATEX/IECEx Ex dit (passive / slave)
						D							x1	ATEX/IECEx Ex dit (active)
							A							Ex-Revision
							B							Ex-Revision (1. Supplement)
							C							Ex-Revision (2. Issue)
							.							
									.					Signal Output (Slave, HART, etc.)
										1				Power supply 24 V_{DC}
										2				Power supply: 100 - 240 V_{AC}
												.		none Ex-relevant parameter
	The "x" in the "Variant" column has the function of a placeholder.													

Electrical data

Power supply	max. 240 V, 50/60 Hz, max. 12 VA or
(Terminal 1, 2)	
(Terminal 3, 4)	max. 24 V (DC), max. 12 W, U_m = 250 V
Interface circuit RS485 (Terminal 5, 5A, 6, 6A)	type of protection Increased Safety Ex ib IIB/IIC; 5 V (DC), 20 mA Only for connection to RS485 interface circuits other scintillation instruments LB 480 and an evaluation unit with equivalent means of protection.
Thermometer circuit (PT100) (Terminal 15, 16)	type of protection Intrinsic Safety Ex ia IIB/IIC; maximum Values:

U_o	=	14	V
L_o	=	27.7	mA
P_o	=	97	mW
Characteristic linear			
C_i	=	11	nF
L_i	=	negligible small	

EMA21UKEX0050X, 2023-04-14 Page 3 of 7 CSF341 4.0

SCHEDULE TO UK TYPE EXAMINATION CERTIFICATE

CERTIFICATE NUMBER EMA21UKEX0050X

Maximum permissible external values for common effective reactances (C_i is not considered). (according to ISpark-6.2)		
L_o (mH)	IIB	IIC
	C_o (µF)	C_o (µF)
0.1	4.6	0.73
0.5	4.0	0.71
1.0	3.3	0.59

The RTD circuit is electrically connected to the internal supply circuit and the earth

Open collector circuit (Terminal 11, 12)

type of protection Intrinsic Safety Ex ia IIB/IIC;
Maximum Values:

U_i = 15 V
I_i = 26.6 mA
P_i = 100 mW
C_i = 11 nF
L_i = negligible small

The open collector circuit is safely electrically isolated from earth and all other circuits.

HART-current output (Source Mode) (Terminal 17, 18)

type of protection Intrinsic Safety Ex ia IIB/IIC;
maximum Values:

U_o = 25.2 V
I_o = 101 mA
P_o = 635 mW
Characteristic linear
C_i = 3 nF
L_i = 20 µH

Maximum permissible external values for common effective reactances (C_i is not considered). (according to ISpark-6.2)		
L_o (mH)	IIB	IIC
	C_o (uF)	C_o (uF)
0.44	0.52	0.084
0.8	0.45	0.066
1.6	0.38	0.049
13.0	0.37	----

Single reactances to table A.2 and figure A.4 or A.6 of EN 60079-11			
IIB		IIC	
L_o mH	C_o µF	L_o mH	C_o µF
17	0.820	4	0.107

EMA21UKEX0050X, 2023-04-14 Page 4 of 7 CSF341 4.0

SCHEDULE TO UK TYPE EXAMINATION CERTIFICATE

CERTIFICATE NUMBER EMA21UKEX0050X

HART- current output (Sink Mode) (Terminal 17, 18)	type of protection Intrinsic Safety Ex ia IIB/IIC; Only for connection to a certified intrinsically safe circuit. Maximum Values: U_i = 30 V I_i = 152 mA P_i = 1.14 W C_i = 3 nF L_i = 20 µH

The HART current output (source mode or sink mode) of the current output module are safely electrically isolated from earth and all other circuits.

16 Test report No. (associated with this certificate issue): None

17 Specific Conditions of Use

1) Due to the requirements of clause 5.1, EN 60079-1 it shall be pointed out that the joint dimensions of the flameproof enclosure deviate from the values tabulated in EN 60079-1. Repairing of flameproof joints exclusively according to the values specified in table 1 or table 2 of EN 60079-1 is not permitted and may only be carried out in accordance with the constructive specifications given by the manufacturer.
2) The interface circuit RS485 serves exclusively for intercommunication of the probes and must not be connected to an external RS485 circuit.
3) In gas atmospheres must be fully operated in the selected group IIB or IIC in the choice of group IIB or IIC for the intrinsically safe circuits, all intrinsically safe circuits and the scintillation meter type LB 480.
4) The probe must not be installed in zone 0 or zone 20. The protection level "ia" allows the safe use of measuring equipment that may otherwise only be used in zone 0 or zone 20.

Attention is drawn to the operating and installation instructions which may contain useful information in relation to conditions of use.

18 Essential Health and Safety Requirements (Regulations Schedule 1)

In addition to the Essential Health and Safety Requirements covered by the standards listed at item 9, all other requirements are demonstrated in the relevant test reports.

The test reports were considered to satisfy the requirements of Schedule 1 with the exception of Essential Health and Safety Requirements 5 and 6, which were separately satisfied by the content of the label drawings and the instructions.

19 Drawings and Documents

The list of controlled technical documentation is given in Appendix A to this schedule.

SCHEDULE TO UK TYPE EXAMINATION CERTIFICATE

CERTIFICATE NUMBER EMA21UKEX0050X

20 Routine Tests

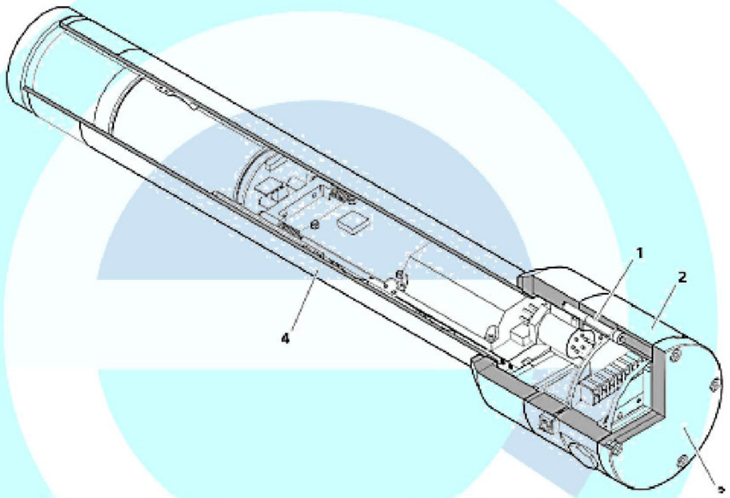
Overpressure test according to IEC 60079-1, clause 15.1 with 27.2 bar (for -60 °C) and 22.7 bar (for -20 °C) for welded enclosure.

Construction without welding is exempted from routine test as the overpressure test was performed with 4 times reference pressure.

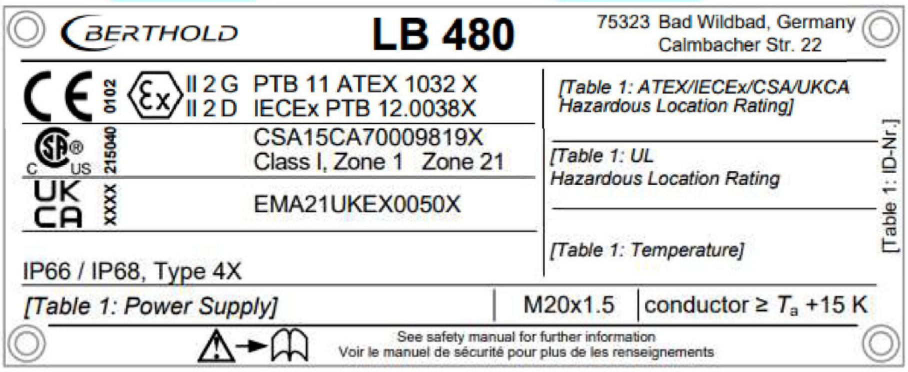
21 Specific Conditions for Manufacture

None.

22 Photographs



23 Details of Markings



EMA21UKEX0050X, 2023-04-14 Page 6 of 7 CSF341 4.0

SCHEDULE TO UK TYPE EXAMINATION CERTIFICATE

CERTIFICATE NUMBER EMA21UKEX0050X

24 Certificate History

Original certificate	2023-04-14	First issue.

This certificate is a consolidated certificate and reflects the latest status of the certification, including all variations and amendments.

25 Notes to UKCA marking

In respect of UKCA Marking, Element Materials Technology accepts no responsibility for the compliance of the product against all applicable Regulations in all applications.

26 Notes to this certificate

Element Materials Technology certification reference: TRA-054560-00 i3. (GU-BERQ-0003).

Throughout this certificate, the date format yyyy-mm-dd (year-month-day) is used.

Approved Body 0891 is the designation for Element Materials Technology Warwick Ltd.

27 Conditions for the validity of this certificate

This certificate remains valid for so long as:

(i) The equipment listed in section **4** is manufactured in accordance with the documents listed in Appendix A of this certificate.

(ii) The standards listed in section 9 of this certificate continue to satisfy the Essential Health and Safety Requirements of Schedule 1 of the Regulations SI 2016:1107 (as amended by SI 2019:696) and the generally acknowledged state of the art (e.g. as determined by the publishers of those standards).

APPENDIX A - TECHNICAL DOCUMENTS

Title:	Drawing No.:	Rev. Level:	Date:
Element list of scheduled drawings for this certificate	Scheduled drawings list for EMA21UKEX0050X	1	2023-04-13

EMA21UKEX0050X, 2023-04-14   Page 7 of 7   CSF341 4.0

5.13 CSA Certificate - 70009819

CSA GROUP™

Certificate of Compliance

Certificate: 70009819 **Master Contract:** 215040

Project: 80137855 **Date Issued:** March 03, 2023

Issued To: **Berthold Technologies GMBH & CO KG**
Calmbacher Str 22
Bad Wildbad, Baden-Württemberg, 75323
Germany

Attention: Juergen Betzelt

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

Issued by: M. Munro

M Munro

PRODUCTS

CLASS 2258 02 – PROCESS CONTROL EQUIPMENT – For Hazardous Locations
CLASS 2258 82 – PROCESS CONTROL EQUIPMENT – For Hazardous Locations – Certified according to US standards.

Ex db IIC T6 Gb
Class I, Zone 1 AEx db IIC T6 Gb

Scintillation Counter. Model LB 480 ab-cd-.e-*
-40 °C ≤ T_a ≤ +60 °C, IP66/IP68, Type 4X

Where:

a = 1 – Version Bx (Rod detectors with plastic scintillator for UniSENS detector)
2 – Version Ax (Point detectors with NaI scintillator for CrystalSENS detector)
3 – Version Ex (Detectors with glass window for SuperSENS)
4 – Version Ex (Detectors with glass window for TowerSENS)
b = Any alphanumeric character to signify sensor length and additional water cooling option.
c = A – Socket x1; Ex d (passive/slave)
B – Socket x1; Ex d (active)
d = C – Latest Ex-revision
e = 1 – (rated 24Vdc, 12W)

DQD 507 Rev. 2019-04-30 Page 1

CSA GROUP™

Certificate: 70009819
Project: 80137855

Master Contract: 215040
Date Issued: March 03, 2023

2 – (rated 100Vac-240Vac, 50/60Hz, 12VA)
* May be followed by additional alphanumeric digits, specifying features that are not relevant to certification.

Ex tb IIIC T75°C Db
Zone 21 AEx tb IIIC T75°C Db

Scintillation Counter. Model LB 480 ab-cd-.e-*
-40 °C ≤ T_a ≤ +60 °C, IP66/IP68, Type 4X

Where:
a = 1 – Version Bx (Rod detectors with plastic scintillator for UniSENS detector)
2 – Version Ax (Point detectors with NaI scintillator for CrystalSENS detector)
3 – Version Ex (Detectors with glass window for SuperSENS)
4 – Version Ex (Detectors with glass window for TowerSENS)
b = Any alphanumeric character to signify sensor length and additional water cooling option.
c = A – Socket x1; Ex t (passive/slave)
B – Socket x1; Ex t (active)
d = C – Latest Ex-revision
e = 1 (rated 24Vdc, 12W)
2 (rated 100Vac-240Vac, 50/60Hz, 12VA)
* May be followed by additional alphanumeric digits, specifying features that are not relevant to certification.

Ex db eb IIC T6 Gb
Class I, Zone 1 AEx db eb IIC T6 Gb

Scintillation Counter. Model LB 480 ab-cd-.e-*
-40 °C ≤ T_a ≤ +65 °C, IP66/IP68, Type 4X

Where:
a = 1 – Version Bx (Rod detectors with plastic scintillator for UniSENS detector)
2 – Version Ax (Point detectors with NaI scintillator for CrystalSENS detector)
3 – Version Ex (Detectors with glass window for SuperSENS)
4 – Version Ex (Detectors with glass window for TowerSENS)
b = Any alphanumeric character to signify sensor length and additional water cooling option.
c = 1 – Socket x2; Ex d, Ex e (passive/slave)
2 – Socket x2; Ex d, Ex e (active)
d = C – Latest Ex-revision
e = 1 (rated 24Vdc, 12W)
2 (rated 100Vac-240Vac, 50/60Hz, 12VA)
* May be followed by additional alphanumeric digits, specifying features that are not relevant to certification.

Ex tb IIIC T80°C Db
Zone 21 AEx tb IIIC T80°C Db

Scintillation Counter. Model LB 480 ab-cd-.e-*
-40 °C ≤ T_a ≤ +65 °C, IP66/IP68, Type 4X

DQD 507 Rev. 2019-04-30 Page 2

Certificate: 70009819
Project: 80137855

Master Contract: 215040
Date Issued: March 03, 2023

Where:
a = 1 – Version Bx (Rod detectors with plastic scintillator for UniSENS detector)
2 – Version Ax (Point detectors with NaI scintillator for CrystalSENS detector)
3 – Version Ex (Detectors with glass window for SuperSENS)
4 – Version Ex (Detectors with glass window for TowerSENS)
b = Any alphanumeric character to signify sensor length and additional water cooling option.
c = 1 – Socket x2; Ex t (passive/slave)
2 – Socket x2; Ex t (active)
d = C – Latest Ex-revision
e = 1 (rated 24Vdc, 12W)
2 (rated 100Vac-240Vac, 50/60Hz, 12VA)
* May be followed by additional alphanumeric digits, specifying features that are not relevant to certification.

Ex db eb IIC T5 Gb
Class I, Zone 1 AEx db eb IIC T5 Gb

Scintillation Counter. Model LB 480 ab-cd-.e-*
-40 °C ≤ T_a ≤ +80 °C, IP66/IP68, Type 4X

Where:
a = 1 – Version Bx (Rod detectors with plastic scintillator for UniSENS detector)
2 – Version Ax (Point detectors with NaI scintillator for CrystalSENS detector)
b = Any alphanumeric character to signify sensor length and additional water cooling option.
c = 1 – Socket x2; Ex d, Ex e (passive/active)
2 – Socket x2; Ex d, Ex e (active)
d = C – Latest Ex-revision
e = 1 (rated 24Vdc, 12W)
2 (rated 100Vac-240Vac, 50/60Hz, 12VA)
* May be followed by additional alphanumeric digits, specifying features that are not relevant to certification.

Ex tb IIIC T95°C Db
Zone 21 AEx tb IIIC T95°C Db

Scintillation Counter. Model LB 480 ab-cd-.e-*
-40 °C ≤ T_a ≤ +80 °C, IP66/IP68, Type 4X

Where:
a = 1 – Version Bx (Rod detectors with plastic scintillator for UniSENS detector)
2 – Version Ax (Point detectors with NaI scintillator for CrystalSENS detector)
b = Any alphanumeric character to signify sensor length and additional water cooling option.
c = 1 – Socket x2; Ex t (passive/slave)
2 – Socket x2; Ex t (active)
d = C – Latest Ex-revision
e = 1 (rated 24Vdc, 12W)
2 (rated 100Vac-240Vac, 50/60Hz, 12VA)
* May be followed by additional alphanumeric digits, specifying features that are not relevant to certification.

Certificate: 70009819
Project: 80137855

Master Contract: 215040
Date Issued: March 03, 2023

Conditions of Acceptability:

1) The interface circuit RS485 serves exclusively for intercommunication of the probes and must not be connected to an external RS485 circuit.
2) Repair of flameproof joints is not permitted. If repair is required, the equipment shall be returned to the manufacturer.
3) For 24Vdc models: This equipment may only be powered by a power supply unit with a limited energy electric circuit in accordance with CAN/CSA C22.2 No. 61010-1-12 and ANSI/UL 61010-1, or Class 2 as defined in the Canadian Electrical Code C22.1, Section 16-200 and/or National Electrical Code (NFPA 70), article 725.121.

Class 2258 04 – PROCESS CONTROL EQUIPMENT – Intrinsically Safe Entity – For Hazardous Locations
Class 2258 84 – PROCESS CONTROL EQUIPMENT – Intrinsically Safe Entity – For Hazardous Locations – Certified to US Standards

Ex db [ia Ga] IIC T6 Gb
Class I, Zone 1 AEx db [ia Ga] IIC T6 Gb

Scintillation Counter. Model LB 480 ab-cd-.e-*
Associated Intrinsically Safe wiring for EPL Ga, when connected per drawing 45190VP10.
-40 °C ≤ T_a ≤ +50 °C, IP66/IP68, Type 4X

Where:
a = 1 – Version Bx (Rod detectors with plastic scintillator for UniSENS detector)
2 – Version Ax (Point detectors with NaI scintillator for CrystalSENS detector)
3 – Version Ex (Detectors with glass window for SuperSENS)
4 – Version Ex (Detectors with glass window for TowerSENS)
b = Any alphanumeric character to signify specifications and features
c = C – Socket x1; Ex d, Ex i (passive)
D – Socket x1; Ex d, Ex i (active)
d = C – Latest Ex-revision
e = 1 (rated 24Vdc, 12W)
2 (rated 100Vac-240Vac, 50/60Hz, 12VA)
* May be followed by additional alphanumeric digits, specifying features that are not relevant to certification.

Ex tb [ia Da] IIIC T80°C Db
Zone 21 AEx tb [ia Da] IIIC T80°C Db

Scintillation Counter. Model LB 480 ab-cd-.e-*
Associated Intrinsically Safe wiring for EPL Da, when connected per drawing 45190VP10.
-40 °C ≤ T_a ≤ +50 °C, IP66/IP68, Type 4X

Where:
a = 1 – Version Bx (Rod detectors with plastic scintillator for UniSENS detector)
2 – Version Ax (Point detectors with NaI scintillator for CrystalSENS detector)
3 – Version Ex (Detectors with glass window for SuperSENS)

DQD 507 Rev. 2019-04-30 Page 4

Certificate: 70009819
Project: 80137855

Master Contract: 215040
Date Issued: March 03, 2023

4 – Version Ex (Detectors with glass window for TowerSENS)
b = Any alphanumeric character to signify specifications and features
c = C – Socket x1; Ex i, Ex t (passive)
D – Socket x1; Ex i, Ex t (active)
d = C – Latest Ex-revision
e = 1 (rated 24Vdc, 12W)
2 (rated 100Vac-240Vac, 50/60Hz, 12VA)
* May be followed by additional alphanumeric digits, specifying features that are not relevant to certification.

Ex db eb [ia Ga] IIC T6 Gb
Class I, Zone 1 AEx db eb [ia Ga] IIC T6 Gb

Scintillation Counter. Model LB 480 ab-cd-.e-*
Associated Intrinsically Safe wiring for EPL Ga, when connected per drawing 45190VP10.
-40 °C ≤ T_a ≤ +50 °C, IP66/IP68, Type 4X

Where:
a = 1 – Version Bx (Rod detectors with plastic scintillator for UniSENS detector)
2 – Version Ax (Point detectors with NaI scintillator for CrystalSENS detector)
3 – Version Ex (Detectors with glass window for SuperSENS)
4 – Version Ex (Detectors with glass window for TowerSENS)
b = Any alphanumeric character to signify specifications and features
c = 3 – Socket x2; Ex d, Ex e, Ex i (passive)
4 – Socket x2; Ex d, Ex e, Ex i (active)
d = C – Latest Ex-revision
e = 1 (rated 24Vdc, 12W)
2 (rated 100Vac-240Vac, 50/60Hz, 12VA)
* May be followed by additional alphanumeric digits, specifying features that are not relevant to certification.

Ex tb [ia Da] IIIC T80°C Db
Zone 21 AEx tb [ia Da] IIIC T80°C Db

Scintillation Counter. Model LB 480 ab-cd-.e-*
Associated Intrinsically Safe wiring for EPL Da, when connected per drawing 45190VP10.
-40 °C ≤ T_a ≤ +50 °C, IP66/IP68, Type 4X

Where:
a = 1 – Version Bx (Rod detectors with plastic scintillator for UniSENS detector)
2 – Version Ax (Point detectors with NaI scintillator for CrystalSENS detector)
3 – Version Ex (Detectors with glass window for SuperSENS)
4 – Version Ex (Detectors with glass window for TowerSENS)
b = Any alphanumeric character to signify specifications and features
c = 3 – Socket x2; Ex d, Ex i, Ex t (passive)
4 – Socket x2; Ex d, Ex i, Ex t (active)
d = C – Latest Ex-revision
e = 1 (rated 24Vdc, 12W)

CSA GROUP™

Certificate: 70009819 **Master Contract:** 215040
Project: 80137855 **Date Issued:** March 03, 2023

2 (rated 100Vac-240Vac, 50/60Hz, 12VA)
* May be followed by additional alphanumeric digits, specifying features that are not relevant to certification.

Conditions of Acceptability:

1) The probe must not be installed in zone 0 or zone 20.
2) The interface circuit RS485 serves exclusively for intercommunication of the probes and must not be connected to an external RS485 circuit.
3) Repair of flameproof joints is not permitted. If repair is required, the equipment shall be returned to the manufacturer.
4) For 24Vdc models: This equipment may only be powered by a power supply unit with a limited energy electric circuit in accordance with CAN/CSA C22.2 No. 61010-1-12 and ANSI/UL 61010-1, or Class 2 as defined in the Canadian Electrical Code C22.1, Section 16-200 and/or National Electrical Code (NFPA 70), article 725.121.

Entity Parameters:

Thermometer Circuit (PT100) (Terminal 15- and 16+)
Type of protection Intrinsic Safety Ex ia IIB/IIC/IIIC Maximum Values:
U_o = 14.0 V L_i = nil
I_o = 27.7 mA C_i = 11 nF
P_o = 97.0 mW
Linear

Maximum permissible external values for common effective reactance's (C_i is not considered)		
L_o (mH)	**IIB (IIIC)**	**IIC**
	C_o (µF)	**C_o (µF)**
0.1	4.6	0.73
0.5	4.0	0.71
1.0	3.3	0.59

The RTD circuit is electrically connected to the internal supply circuit and the earth.

Open Collector Circuit (Terminal 11-, 12+)
Type of protection Intrinsic Safety Ex ia IIB/IIC/IIIC Maximum Values:
U_i = 15.0 V L_i = nil
I_i = 26.6 mA C_i = 11 nF
P_i = 100.0 mW
Linear

The open collector circuit is safely electrically isolated from earth and all other circuits.

HART-current output (Source Mode) (Terminal 17/19-, 18/20+)
Type of protection Intrinsic Safety Ex ia IIB/IIC/IIIC Maximum Values:
U_o = 25.2 V L_i = 20.0 µH
I_o = 101.0 mA C_i = 3.0 nF
P_o = 635.0 mW
Linear

DQD 507 Rev. 2019-04-30 Page 6

Certificate: 70009819 **Master Contract:** 215040
Project: 80137855 **Date Issued:** March 03, 2023

Maximum permissible external values for common effective reactance's (C_i is not considered)		
L_o (mH)	**IIB (IIIC)**	**IIC**
	C_o (µF)	**C_o (µF)**
0.44	0.52	0.084
0.8	0.45	0.066
1.6	0.38	0.049
13.0	0.37	-

Single reactance's to table A.2 and figure A.4 or A.6 of 60079-11			
IIB		**IIC**	
L_o (mH)	**C_o (µF)**	**L_o (mH)**	**C_o (µF)**
17.0	0.820	4.0	0.107

Or

HART-current output (Sink Mode) (Terminal 17/19+, 18/20-)
Type of protection Intrinsic Safety Ex ia IIB/IIC/IIIC Maximum Values:
U_i = 30.0 V; L_i = 20.0 µH
I_i = 152.0 mA C_i = 3.0 nF
P_i = 1.14 W
Linear

***Note:** the HART current output (source mode or sink mode) of the current output module are safely electrically isolated from earth and all other circuits.

DQD 507 Rev. 2019-04-30 Page 7

CSA GROUP™

Certificate: 70009819
Project: 80137855

Master Contract: 215040
Date Issued: March 03, 2023

APPLICABLE REQUIREMENTS

CAN/CSA-C22.2 No. 60529:16	Degrees of protection provided by enclosures (IP Code)
CAN/CSA C22.2 No. 94.2-15	Enclosures for Electrical Equipment, Environmental Considerations
CAN/CSA C22.2 No. 61010-1-12 + AMD 1-18	Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements
CAN/CSA C22.2 No. 60079-0:2019	Explosive atmospheres. Part 0: Equipment - General requirements.
CAN/CSA C22.2 No. 60079-1:2016	Explosive atmospheres. Part 1: Equipment protection of flameproof enclosures “d”.
CAN/CSA C22.2 No. 60079-7:2016	Explosive atmospheres. Part 7: Equipment protection by Increased Safety ‘e”.
CAN/CSA C22.2 No. 60079-11:2014 (R2018)	Explosive atmospheres. Part 11: Equipment protection by Intrinsic Safety “i”.
CAN/CSA C22.2 No. 60079-31:2015	Explosive atmospheres. Part 31: Equipment dust ignition protection by enclosure “t”.
ANSI/IEC 60529-2020 *Edition 2.0*	Degrees of Protection Provided by Enclosures (IP Code)
ANSI/UL 50E-15 *Second Edition*	Enclosures for Electrical Equipment, Environmental Considerations
ANSI/UL 61010-1-2018 *Third Edition*	Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements
ANSI/UL 60079-0:2019 *Seventh Edition*	Explosive atmospheres. Part 0: Equipment - General requirements.
ANSI/UL 60079-1:2015 *Seventh Edition*	Explosive atmospheres. Part 1: Equipment protection by flameproof enclosures “d”.
ANSI/UL 60079-7:2017 *Fifth Edition*	Explosive atmospheres. Part 7: Equipment protection by Increased Safety ‘e”.
ANSI/UL 60079-11:2018 *Sixth Edition*	Explosive atmospheres. Part 11: Equipment protection by Intrinsic Safety “i”.
ANSI/UL 60079-31:2015 *Second Edition*	Explosive atmospheres. Part 31: Equipment dust ignition protection by enclosure “t”.

DQD 507 Rev. 2019-04-30 Page 8

Certificate: 70009819 **Master Contract:** 215040
Project: 80137855 **Date Issued:** March 03, 2023

MARKINGS

The manufacturer is required to apply the following markings:

- Products shall be marked with the markings specified by the particular product standard.
- Products certified for Canada shall have all Caution and Warning markings in both English and French.

Additional bilingual markings not covered by the product standard(s) may be required by the Authorities Having Jurisdiction. It is the responsibility of the manufacturer to provide and apply these additional markings, where applicable, in accordance with the requirements of those authorities.

The products listed are eligible to bear the CSA Mark shown with adjacent indicators 'C' and 'US' for Canada and US (indicating that products have been manufactured to the requirements of both Canadian and U.S. Standards) or with adjacent indicator 'US' for US only or without either indicator for Canada only.

- Manufacturer's name: "Berthold Technologies GMBH & CO KG", or CSA Master Contract Number "215040", adjacent to the CSA Mark in lieu of manufacturer's name.
- Model designation: As specified in the PRODUCTS section, above.
- Electrical ratings: As specified in the PRODUCTS section, above.
- Ambient temperature rating: As specified in the PRODUCTS section, above.
- Manufacturing date in MMYY format, or serial number, traceable to year and month of manufacture.
- Enclosure IP ratings: As specified in the PRODUCTS section, above.
- The CSA Mark, with or without the "C" and "US" indicators, as shown on the Certificate of Conformity.
- The designation "CSA 15CA70009819X"
- Method of Protection markings (Ex -- markings): As specified in the PRODUCTS section, above. The word "Class" may be abbreviated "CL", the word "Zone" may be abbreviated "ZN".
- Models appearing in Class 2258 04/84 in the PRODUCTS section shall be marked: "INSTALL PER CONTROL DRAWING 45190VP10" or equivalent.
- The following bilingual cautions: (as applicable)

Variant	Bilingual cautions
all	ISO 3864 Symbol B.3.1 ⚠ or ISO 7000 symbol 0434 ⚠ (triangle with exclamation point): "SEE SAFETY MANUAL FOR FURTHER INFORMATION", and "VOIR LE MANUEL DE SÉCURITÉ POUR PLUS DE LES RENSEIGNEMENTS"
	ISO 3864 Symbol B.3.1 ⚠ or ISO 7000 symbol 0434 ⚠ (triangle with exclamation point): "NO NOT OPEN WHILE ENERGIZED – IN AN EXPLOSIVE ATMOSPHERE, DE-ENERGIZE AND WAIT 2 MINUTES BEFORE OPENING", and "NE PAS OUVRIR SOUS TENSION – EN PRESENCE D'UNE ATMOSPHÈRE EXPLOSIVES METTRE HORS TENSION ET ATTENDRE 2 MINUTES"
x1 LB 480 ab-cd-.e-*	ISO 3864 Symbol B.3.1 ⚠ or ISO 7000 symbol 0434 ⚠ (triangle with exclamation point): "SEAL WITHIN 50mm OF ENCLOSURE",

DQD 507 Rev. 2019-04-30 Page 9

Certificate: 70009819
Project: 80137855

Master Contract: 215040
Date Issued: March 03, 2023

Where:	and
c = A, B, C, or D	"SCELLEMENT À MAXIMUM 50 mm DU BOÎTIER"

- The manufacturing location shall be identified if the equipment can be produced in more than one facility.
- ISO 60417, Symbol 5031 ⎓ adjacent to the DC input terminal rating.
- ISO 60417, Symbol 5032 ∼ adjacent to the AC input terminal rating.
- The equipment shall be marked with a specification that the field installed conductors shall be rated ≥ Ta +15 K.
- ISO 60417, Symbol 5019 ⏚ shall be permanently marked adjacent to the equipment ground (protective conductor) terminal.
- Terminals for field installed wiring shall be permanently marked on, or adjacent to, each terminal.
- The size and threadform of each wiring entry shall be permanently marked.

Notes:

Products certified under Class C225802 have been certified under CSA's ISO/IEC 17065 accreditation with the Standards Council of Canada (SCC). www.scc.ca

SCC Accredited CB-P/S
OCPS Accrédité CCN

5.14 FM Certificates

5.14.1 US Certificate Of Conformity No: FM16US0282X

CERTIFICATE OF CONFORMITY

FM Approvals
Member of the FM Global Group

1. **HAZARDOUS (CLASSIFIED) LOCATION ELECTRICAL EQUIPMENT PER US REQUIREMENTS**
2. **Certificate No:** **FM16US0282X**
3. **Equipment: (Type Reference and Name)** **LB 480 Series Scintillation Measurement Equipment**
4. **Name of Listing Company:** **Berthold Technologies GmbH & Co. KG**
5. **Address of Listing Company:** **Calmbacher Strasse 22, 75323 Bad Wildbad, Germany**
6. The examination and test results are recorded in confidential report number:

   3054263 dated 22nd September 2016
7. FM Approvals LLC, certifies that the equipment described has been found to comply with the following Approval standards and other documents:

   Class 3600:2022, Class 3615:2022, Class 3616:2022,
   Class 3810:2005, ANSI/NEMA 250:1991
8. If the sign 'X' is placed after the certificate number, it indicates that the equipment is subject to specific conditions of use specified in the schedule to this certificate.
9. This certificate relates to the design, examination and testing of the products specified herein. The FM Approvals surveillance audit program has further determined that the manufacturing processes and quality control procedures in place are satisfactory to manufacture the product as examined, tested and Approved.
10. Equipment Ratings:

    Explosionproof for Class I, Division 1, Groups A, B, C and D; Dust-ignitionproof for Class II, Division 1, Groups E, F and G; and Class III, Division 1 hazardous (classified) locations, indoors and outdoors (Type 4X) with an ambient temperature rating of -40°C to +65°C (or +80°C).

Certificate issued by:

J. E. Marquedant
J. E. Marquedant
VP, Manager - Electrical Systems

18 January 2023
Date

To verify the availability of the Approved product, please refer to www.approvalguide.com

THIS CERTIFICATE MAY ONLY BE REPRODUCED IN ITS ENTIRETY AND WITHOUT CHANGE

FM Approvals LLC. 1151 Boston-Providence Turnpike, Norwood, MA 02062 USA
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F 347 (Apr 21) Page 1 of 3

SCHEDULE

US Certificate Of Conformity No: FM16US0282X

11. The marking of the equipment shall include:

Class I Division 1, Groups A, B, C, D

Class II, III, Division 1, Groups E, F, G

T6, Ta = -40°C to +65

T5, Ta = -40°C to +80°C

Type 4X

12. **Description of Equipment:**

General - The LB 480 Series Scintillation Measurement Equipment is used as part of a measuring system for monitoring industrial processes. The equipment is used for continuously measuring the level or weight per unit area, in tanks or bins, of liquid, granular, viscous or encrustation-forming media and for measuring conveyor belt charges as well as the density of liquids, suspensions, slurries and bulk solids. The measurement principle is based on the absorption of gamma rays. The radiation source is not part of the measuring equipment and is not included in the product Approval.

Construction - The LB 480 Series Scintillation Measurement Equipment consists of a scintillation detector with associated electronics in an explosionproof/dust-ignitionproof enclosure with separate sensor and wiring compartments. The sensor and wiring compartments are separated by NRTL listed cemented feedthroughs. The sensor and housing (socket) are constructed of 304 or 316 stainless steel. The wiring compartment contains four ½-inch NPT entries and contains a threaded cover. The socket attaches to the sensor by cylindrical joint fastened with six bolts. The bolt holes terminate under the threaded cover inside the wiring compartment) and therefore contain six threaded plugs to form a valid flamepath. The equipment is available with an optional window which is cemented into the sensor.

Ratings - The equipment is rated for use in an ambient temperature of -40°C to +65°C (or +80°C). The equipment operates at 100-240 Vac (12 VA) or 24 Vdc (12 W).

LB 480-a-bA-cd-xe-0x0-x. Scintillation Measurement Equipment.
a = Sensor: 11, 12, 13, 14, 15, 16, 2A, 2B, 2E, 2F, 2I, 2J, 2K, 2L, 31, 32, 41, 42, 43 or 44.
b = Approval: F or G.
c = Signal output: 0, 1 or 2.
d = Power supply: 1 or 2.
e = Housing material: 1 or 3.
x = Options not affecting the equipment safety.

13. **Specific Conditions of Use:**

The ambient temperature range and T-code rating for the equipment is as follows:

Ambient Temperature	T-Code
-40°C to +65°C	T6
-40°C to +80°C	T5

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SCHEDULE

FM Approvals
Member of the FM Global Group

US Certificate Of Conformity No: FM16US0282X

14. **Test and Assessment Procedure and Conditions:**

    This Certificate has been issued in accordance with FM Approvals US Certification Requirements.

15. **Schedule Drawings**

    A copy of the technical documentation has been kept by FM Approvals.

16. **Certificate History**

    Details of the supplements to this certificate are described below:

Date	Description
22nd September 2016	Original Issue.
3rd August 2022	Supplement 1: Report Reference: RR233804 dated 3rd August 2022. Description of the Change: Minor documentation changes not affecting the equipment safety. Minor model code changes to add alternate terminal configuration and to remove variables with no influence on the protection method. Class 3600, 3615 and 3616 updated to the latest versions as changes between editions are non-technical.
18th January 2023	Supplement 2: Report Reference: PR460854 dated 18th January 2023. Description of the Change: Testing and examination of an alternate window cement material.

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5.14.2 Canadian Certificate Of Conformity No: FM16CA0144X

CERTIFICATE OF CONFORMITY

FM Approvals
Member of the FM Global Group

1. **HAZARDOUS LOCATION ELECTRICAL EQUIPMENT PER CANADIAN REQUIREMENTS**
2. **Certificate No:** **FM16CA0144X**
3. **Equipment: (Type Reference and Name)** **LB 480 Series Scintillation Measurement Equipment**
4. **Name of Listing Company:** **Berthold Technologies GmbH & Co. KG**
5. **Address of Listing Company:** **Calmbacher Strasse 22, 75323 Bad Wildbad, Germany**
6. The examination and test results are recorded in confidential report number:

   3054263 dated 22nd September 2016
7. FM Approvals LLC, certifies that the equipment described has been found to comply with the following Approval standards and other documents:

   CAN/CSA-C22.2 No. 0.4:R2013, CSA-C22.2 No. 0.5:2016, CSA-C22.2 No. 25:R2014, CSA-C22.2 No. 30:R2016, CAN/CSA-C22.2 No. 94:R2011, CAN/CSA-C22.2 No. 61010-1-12:2012
8. If the sign 'X' is placed after the certificate number, it indicates that the equipment is subject to specific conditions of use specified in the schedule to this certificate.
9. This certificate relates to the design, examination and testing of the products specified herein. The FM Approvals surveillance audit program has further determined that the manufacturing processes and quality control procedures in place are satisfactory to manufacture the product as examined, tested and Approved.
10. Equipment Ratings:

    Explosionproof for Class I, Division 1, Groups B, C and D; Dust-ignitionproof for Class II, Division 1, Groups E, F and G; and Class III, Division 1 hazardous locations, indoors and outdoors (Type 4X) with an ambient temperature rating of -40°C to +65°C (or +80°C).

Certificate issued by:

J.E. Marquedant
VP, Manager - Electrical Systems

18 January 2023
Date

To verify the availability of the Approved product, please refer to www.approvalguide.com

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F 348 (Apr 21)

Page 1 of 3

SCHEDULE

Canadian Certificate Of Conformity No: FM16CA0144X

11. The marking of the equipment shall include:

    Class I Division 1, Groups B, C, D

    Class II, III, Division 1, Groups E, F, G

    T6, Ta = -40°C to +65

    T5, Ta = -40°C to +80°C

    Type 4X

12. **Description of Equipment:**

    General - The LB 480 Series Scintillation Measurement Equipment is used as part of a measuring system for monitoring industrial processes. The equipment is used for continuously measuring the level or weight per unit area, in tanks or bins, of liquid, granular, viscous or encrustation-forming media and for measuring conveyor belt charges as well as the density of liquids, suspensions, slurries and bulk solids. The measurement principle is based on the absorption of gamma rays. The radiation source is not part of the measuring equipment and is not included in the product Approval.

    Construction - The LB 480 Series Scintillation Measurement Equipment consists of a scintillation detector with associated electronics in an explosionproof/dust-ignitionproof enclosure with separate sensor and wiring compartments. The sensor and wiring compartments are separated by NRTL listed cemented feedthroughs. The sensor and housing (socket) are constructed of 304 or 316 stainless steel. The wiring compartment contains four ½-inch NPT entries and contains a threaded cover. The socket attaches to the sensor by cylindrical joint fastened with six bolts. The bolt holes terminate under the threaded cover inside the wiring compartment) and therefore contain six threaded plugs to form a valid flamepath. The equipment is available with an optional window which is cemented into the sensor.

    Ratings - The equipment is rated for use in an ambient temperature of -40°C to +65°C (or +80°C). The equipment operates at 100-240 Vac (12 VA) or 24 Vdc (12 W).

    LB 480-a-bA-cd-xe-0x0-x. Scintillation Measurement Equipment.
    a = Sensor: 11, 12, 13, 14, 15, 16, 2A, 2B, 2E, 2F, 2I, 2J, 2K, 2L, 31, 32, 41, 42, 43 or 44.
    b = Approval: F or G.
    c = Signal output: 0, 1 or 2.
    d = Power supply: 1 or 2.
    e = Housing material: 1 or 3.
    x = Options not affecting the equipment safety.

13. **Specific Conditions of Use:**

    The ambient temperature range and T-code rating for the equipment is as follows:

Ambient Temperature	T-Code
-40°C to +65°C	T6
-40°C to +80°C	T5

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SCHEDULE

Canadian Certificate Of Conformity No: FM16CA0144X

14. **Test and Assessment Procedure and Conditions:**

    This Certificate has been issued in accordance with FM Approvals Canadian Certification Scheme.

15. **Schedule Drawings**

    A copy of the technical documentation has been kept by FM Approvals.

16. **Certificate History**

    Details of the supplements to this certificate are described below:

Date	Description
22nd September 2016	Original Issue.
3rd August 2022	Supplement 1: Report Reference: RR233804 dated 3rd August 2022. Description of the Change: Minor documentation changes not affecting the equipment safety. Minor model code changes to add alternate terminal configuration and to remove variables with no influence on the protection method. C22.2 No. 30 updated to the latest reaffirmed date.
18th January 2023	Supplement 2: Report Reference: PR460854 dated 18th January 2023. Description of the Change: Testing and examination of an alternate window cement material.

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5.15 Inmetro Certificate – IEX 19.0182X

IEx	**CERTIFICADO DE CONFORMIDADE** *Certificate of Conformity*	**Data de Emissão: 06/01/2020** *Issuing date*
		Data de Validade: 05/01/2029 *Validity date*
	Nº: IEx 19.0182X **Página / *Page*: 1/5**	**Revisão / *Revision***
		Nº: 2 — **Data: 06/01/2023** *Date*

Produto *Product*	**UNIDADE DE MEDIÇÃO DE CINTILAÇÃO** ***SCINTILLATION MEASURING UNIT***
Solicitante / Endereço: *Applicant / Address*	**BERTHOLD TECHNOLOGIES GmbH & Co. KG** Calmbacher Street 22 75323 - Bad Wildbad - Germany
Fabricante / Endereço: *Manufacturer / Address*	**BERTHOLD TECHNOLOGIES GmbH & Co. KG** Calmbacher Street 22 75323 - Bad Wildbad - Germany
Unidade (s) Fabril (is) / Endereço: *Production Site / Address*	**BERTHOLD TECHNOLOGIES GmbH & Co. KG** Calmbacher Street 22 75323 - Bad Wildbad - Germany
Modelo: *Model*	**LB 480**
Características Principais: *Ratings / Principal Characteristics*	**Ver Descrição do Produto / *See Product Description***
Marca / Código de barras: *Trademark / Bar Code*	**BERTHOLD**
Família de Produto: *Product's Family*	**Unidade de medição de cintilação para uso em atmosferas explosivas** ***Scintillation measuring unit for use in explosive atmospheres***
Número de Série / Lote: *Serial number / Batch number*	**N/A**
Marcação: *Marking*	**Ver Descrição do Produto / *See Product Description***
Normas Aplicáveis: *Aplicable Standards*	**ABNT NBR IEC 60079-0:2020 (corrigida 2022), ABNT NBR IEC 60079-1:2016 (corrigida 2020, ABNT NBR IEC 60079-7:2018 (corrigida 2022), ABNT NBR IEC 60079-11:2013 (corrigida 2017) & ABNT NBR IEC 60079-31:2022**
Modelo de Certificação: *Certification Model*	**Modelo 5, segundo ABNT NBR ISO/IEC 17067:2015 / Model 5**
Portaria Inmetro Nº / Escopo: *Inmetro Decree n° / Scope*	**115:2022 / Equipamentos Elétricos para Atmosferas Explosivas / Electrical Equipment for Explosive Atmospheres**
Concessão para: *Concession for*	**Uso do Selo de Identificação da Conformidade sobre o (s) produto (s) relacionado (s) neste Certificado / Use of the conformity identification seal on the product (s) listed in this certificate**

A **Associação IEx Certificações**, que é um Organismo de Certificação de Produto acreditado pela Coordenação Geral de Acreditação – Cgcre, sob o registro N° OCP-0064, confirma que o produto está em conformidade com a (s) Norma (s) e Portaria acima descritas.
Associação IEx Certificações, as a Product Certification Body accredited by Coordenação Geral de Acreditação – Cgcre, according to the register N° OCP-0064, confirms that the product (s) is (are) in compliance with the standards and Decree above mentioned.

MARCO ANTONIO BUCCIARELLI ROQUE:99815273868

MARCO ANTONIO BUCCIARELLI ROQUE:99815273868
Eu sou o autor deste documento
2023.01.16 14:41:56-03'00'
12.1.0

Marco A. Bucciarelli Roque
Signatário autorizado
Authorized signatory

Certificação do Produto — OCP 0064 — Produto certificado IEx

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IEx-FR-005, Rev.12, 21/11/2017

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IEx		Data de Validade: 05/01/2029 *Validity date*	
	Nº: IEx 19.0182X Página / *Page*: 2/5	Revisão / *Revision*	
		Nº: 2	Data: 06/01/2023 *Date*

Representante Legal / Endereço: *Legal Representative / Address*	**INSTRUMENTOS LINCE LIMITADA** Rua Luiz Ferreira, 84 21042-210 - Rio de Janeiro - RJ - Brasil CNPJ: 29.359.171/0001-93

Marca *Trade mark*	Modelo *Model*	Descrição do produto *Product descripition*	Código de Barras *Bar Code*
BERTHOLD	LB 480	Unidade de medição de cintilação para uso em atmosferas explosivas para o monitoramento de processos industriais. U_N = 15 V; P = 5 W	N/A

Descrição do Produto / *Product Description*

A unidade de medição de cintilação da série LB 480 faz parte de um sistema de medição para monitoramento de processos industriais. É utilizado para medir continuamente o nível de tanques ou silos que contenham meios líquidos, granulares, viscosos ou formadores de incrustações, ou para medir as cargas da correia transportadora, a densidade de líquidos, suspensões, lamas e sólidos a granel.

A unidade consiste em um detector de cintilação com os componentes eletrônicos de análise necessários, que estão alojados em invólucro à prova de explosão.

A unidade de medição de cintilação da série LB 480 é estendida a versões de aparelhos elétricos associados para os sinais de saídas da entrada OC, PT100 e saída de corrente HART no tipo de proteção segurança intrínseca "i".

A fonte de alimentação e a interface RS485 foram projetadas como não intrinsecamente seguras.

A relação entre variação, tipo de proteção, classe de temperatura e temperatura ambiente é recodificada e está listada na tabela abaixo.

The scintillation measuring equipment series LB 480 is part of a measuring system for monitoring industrial processes. It is used for continuous measurement of the level in tanks or bins that contain liquid, granular, viscous or encrustation-forming media, and for measuring conveyor belt charges, as well as the density of liquids, suspensions, slurries and bulk solids.

The scintillation measuring equipment consists of a scintillation detector with associated electronics in a common housing in type of protection Flameproof Enclosure.

The series LB 480 of scintillation measuring equipment is extended to versions of associated electrical apparatus for the signal outputs OC-input, PT100 and HART current output in type of protection Intrinsic Safety "i".

The power supply and the interface RS485 are designed as non-intrinsically safe.

The relationship between variation, type of protection, temperature class and ambient temperature is re-codified and is listed in the table below.

ACESSÓRIOS E OPCIONAIS / *ACCESSORIES AND OPTIONALS*:

Proteção *Protection*	Classe de Temperatura *Temperature Class*	Variação *Variant*	Código *Type Code*	Temperatura Ambiente *Ambient Temperature*
Ex db IIC Gb Ex tb IIIC Db	T6 T75 °C	A1, B1, E1	LB 480-xx-AC-xx LB 480-xx-BC-xx	-40 °C ≤ Ta ≤ +60 °C
Ex db eb IIC Gb Ex tb IIIC Db	T6 T80 °C	A2, B2, E2	LB 480-xx-1C-xx LB 480-xx-2C-xx	-40 °C ≤ Ta ≤ +65 °C
Ex db eb IIC Gb Ex tb IIIC Db	T5 T95 °C	A2, B2	LB 480-1x-1C-xx LB 480-1x-2C-xx LB 480-2x-1C-xx LB 480-2x-2C-xx	-40 °C ≤ Ta ≤ +80 °C
Ex db [ia Ga] IIC Gb Ex tb [ia Da] IIIC Db	T6 T80 °C	A1, B1, E1	LB 480-xx-CC-xx LB 480-xx-DC-xx	-40 °C ≤ Ta ≤ +50 °C
Ex db eb [ia Ga] IIC Gb Ex tb [ia Da] IIIC Db	T6 T80 °C	A2, B2, E2	LB 480-xx-3C-xx LB 480-xx-4C-xx	-40 °C ≤ Ta ≤ +50 °C

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		Data de Validade: 05/01/2029 *Validity date*
	N°: IEx 19.0182X **Página / *Page*: 3/5**	**Revisão / *Revision***
		N°: 2 | **Data: 06/01/2023** *Date*

PARÂMETROS ELÉTRICOS / *ELECTRICAL DATA*

Alimentação / *Power supply* (Terminal 1, 2) (Terminal 3, 4)	max. 240 V, 50/60 Hz, max. 12 VA; ou/*or* max. 24 V (cc/*dc*), max. 12 W Um = 250 V
RS485 *Interface circuit* (Terminal 5, 6)	5 V (cc/*dc*), 20 mA Somente para conexão com circuitos de interface RS485 de outros instrumentos de cintilação LB 480 *Only for connection to RS485 interface circuits of other scintillation instruments LB 480*
(PT100) *Thermometer circuit* (Terminal 15, 16)	Tipo de proteção Ex ia IIB/IIC *type of protection Intrinsic Safety* Valores máximos / M*aximum values*: U_o = 14 V; I_o = 27.7 mA; P_o = 97 mW; C_i = 11 nF; L_i = desprezível / *negligible*

Valores externos máximos admissíveis para reatâncias efetivas comuns (Ci não é considerado).
Maximum permissible external values for common effective reactances (Ci is not considered).

L_o (mH)	IIB	IIC
	Co (µF)	Co (µF)
0.1	4.6	0.73
0.5	4.0	0.71
1.0	3.3	0.59

O circuito RTD é eletricamente conectado ao circuito interno de alimentação e ao terra.
The RTD circuit is electrically connected to the internal supply circuit and the earth

Circuito coletor aberto / *Open collector circuit* (Terminal 11, 12)	Tipo de proteção Ex ia IIB/IIC *type of protection Intrinsic Safety* Valores máximos / M*aximum values*: U_i = 15 V; I_i = 26.6 mA; P_i = 100 mW; C_i = 11 nF; L_i = desprezível / *negligible*

O circuito coletor aberto é isolado eletricamente do terra e de todos os outros circuitos
The open collector circuit is safely electrically isolated from earth and all other circuits

Saída de corrente HART-current output (Source Mode) (Terminal 17, 18)	Tipo de proteção Ex ia IIB/IIC *type of protection Intrinsic Safety* Valores máximos / M*aximum values*: U_o = 25.2 V; I_o = 101 mA; P_o = 635 mW; C_i = 3 nF; L_i = 20 µH

Valores externos máximos admissíveis para reatâncias efetivas comuns (Ci não é considerado).
Maximum permissible external values for common effective reactances (Ci is not considered).

L_o (mH)	IIB	IIC
	Co (µF)	Co (µF)
0.44	0.52	0.084
0.8	0.45	0.066
1.6	0.38	0.049
13.0	0.37	-

Reatâncias simples para a tabela A.2 e figura A.4 ou A.6 da NBR IEC 60079-11
Single reactances to table A.2 and figure A.4 or A.6 of IEC 60079-11

IIB		IIC	
L_o (mH)	C_o (µF)	L_o (mH)	C_o (µF)
17	0.820	4	0.107

Saída de corrente HART- *current output* (Sink Mode) (Terminal 17, 18)	Tipo de proteção Ex ia IIB/IIC *type of protection Intrinsic Safety* Somente para conexão a um circuito intrinsecamente seguro certificado / *Only for connection to a certified intrisically safe circuit.* Valores máximos / M*aximum values*: U_i = 30 V; I_i = 152 mA; P_i = 1,14 W, C_i = 3 nF; L_i = 20 µH

A saída de corrente HART (Modo *Source* ou Modo *Sink*) do módulo de saída de corrente é isolada eletricamente do terra e de todos os outros circuitos.
The HART current output (source mode or sink mode) of the current output module are safely electrically isolated from earth and all other circuits.

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		Data de Validade: 05/01/2029 *Validity date*	
	N°: IEx 19.0182X Página / *Page*: 4/5	Revisão / *Revision*	
		N°: 2	Data: 06/01/2023 *Date*

Documentos / *Documents*			
Título / *Title*	**Número** / *Number*	**Revisão** / *Revision*	**Data** / *Date*
Relatório de Avaliação da Conformidade	RACT-Ex 1166.218.19B	2	05/01/2023
Relatórios de Ensaios emitido por PTB	DE/PTB/ExTR12.0052/04	4	08/04/2022
Relatórios de Ensaios emitido por PTB	DE/PTB/ExTR12.0052/03	3	18/09/2020
Relatórios de Ensaios emitido por PTB	DE/PTB/ExTR12.0052/02	2	10/03/2020
Relatórios de Ensaios emitido por PTB	DE/PTB/ExTR12.0052/01	1	28/11/2013

Documentos / *Documents*:

Os documentos da Certificação estão listados no Relatório de Avaliação da Conformidade RACT-Ex 1166.218.19B.
The certification documents are listed in the Conformity Assessment Report RACT-Ex 1166.218.19B.

Observações / *Notes*

a) Os equipamentos fornecidos ao mercado brasileiro devem estar de acordo com a definição do produto e a documentação aprovada neste processo de certificação;
The equipment provided to the Brazilian Market shall be according to the product definition and to the documentation approved in this certification process;

b) Somente as unidades fabricadas durante a vigência deste Certificado estarão cobertas por esta certificação;
Only the units manufactured during the validity of this certificate will be covered by this certification;

c) A validade deste Certificado está atrelada à realização das avaliações de manutenção e tratamento de possíveis não conformidades de acordo com as orientações da Associação IEx Certificações e previstas no RAC específico da portaria N° 115:2022 / Equipamentos Elétricos para Atmosferas Explosivas.
Para verificação da condição atualizada de regularidade deste certificado de conformidade deve ser consultado o banco de dados do Inmetro, referente a produtos e serviços certificados;
The validity of this Certificate is linked to the performance of the surveillance audits and treatment of possible nonconformities according to the guidelines of the Associação IEx Certificações and foreseen in the specific RAC of the ordinance N° 115:2022 – Electrical Equipment for Explosive Atmospheres.
In order to verify the updated condition of the regularity of this certificate of conformity, the Inmetro database for certified products and services must be consulted;

d) O Selo de Identificação da Conformidade deve ser colocado na superfície externa do equipamento, em local facilmente visível;
The Conformity Identification Seal shall be placed on the outer surface of the equipment in an easily visible location;

e) Os produtos devem ser instalados em atendimento à norma de instalações elétricas para atmosferas explosivas (ABNT NBR IEC 60079-14);
The products must be installed in compliance with the standards of electrical installations for Explosive Atmospheres (ABNT NBR IEC 60079-14);

f) Esta certificação refere-se única e exclusivamente aos requisitos de avaliação da conformidade para equipamentos elétricos para atmosferas explosivas, não abrangendo outros regulamentos eventualmente aplicáveis ao produto;
This certification refers only and exclusively to the conformity assessment requirements for electrical equipment for explosive atmospheres, not covering any other regulation applicable to the product;

g) As atividades de instalação, inspeção, manutenção, reparo, revisão e recuperação dos equipamentos são de responsabilidade dos usuários e devem ser executadas de acordo com os requisitos das normas técnicas vigentes e com as recomendações do fabricante;
The activities of installation, inspection, maintenance, repair, revision and recuperation of equipment are the responsibility of the end users and shall be performed according to the applicable technical standards requirements and according to manufacturer recommendations;

h) A letra "**X**" após o número do certificado indica as seguintes condições especiais de uso seguro do equipamento:
The letter "X" in the Certificate Number refers to the following special conditions for safe use of the product:

- Consultar o fabricante para fins de reparos. O reparo de juntas à prova de explosão não é permitido de acordo com os valores da tabela 3 da ABNT NBR IEC 60079-1.
Consult manufacturer for repairs. Repair of flameproof joints is not allowed according to values of table 3 of IEC 60079-1.
- O circuito de interface RS485 serve exclusivamente para intercomunicação das sondas e não deve ser conectado a um circuito externo RS485.
The interface circuit RS485 serves exclusively for intercommunication of the probes and must not be connected to an external RS485 circuit.
- Em atmosferas de gases para a escolha do grupo IIB ou IIC dos circuitos intrinsecamente seguros, todos os circuitos intrinsecamente seguros e o medidor de cintilação série LB 480 devem ser totalmente operados no grupo selecionado IIB ou IIC.
In gas atmospheres for the choice of group IIB or IIC for the intrinsically safe circuits, all intrinsically safe circuits and the scintillation meter LB 480 series shall be fully operated in the selected group IIB or IIC either.

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		Data de Validade: 05/01/2029 ***Validity date***
	N°: IEx 19.0182X **Página / *Page*: 5/5**	**Revisão /** ***Revision***
		N°: 2 — **Data:** ***Date*** **06/01/2023**

Observações / *Notes*
- A sonda não deve ser instalada na zona 0 ou zona 20. O nível de proteção "ia" permite o uso seguro dos equipamentos de medição que podem ser utilizados na zona 0 ou zona 20. *The probe must not be installed in zone 0 or zone 20. The protection level "ia" allows the safe use of measuring equipment that may otherwise only be used in zone 0 or zone 20.*
i) Os produtos foram ensaiados com 1,5 vezes a sua pressão de referência, devendo ser submetidos ao ensaio de rotina de sobrepressão em 100% de sua produção. *The product was approved with 1.5 times the reference pressure and 100% of production shall be submitted to the overpressure routine test.*

Histórico de Revisões / *Revision History*

Revisão / *Revision*	**Data** / *Date*	**Descrição** / *Description*
0	06/01/2020	Emissão inicial / *Initial Issue*
1	30/03/2022	Atualização de Norma e Atualizações Menores / *Standard update and Minor Updates*
2	06/01/2023	Recertificação, Atualização de Normas e Atualização de Documentos e de Materiais *Recertification, Updating of Standards, Addition of Variants and Updating Documents and Materials*

Proposta / *Proposal:* **14.0.1166.218.19, 14.0.1166.101.22 & 14.0.1166.643.22**

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6 Electrical Installation

The electrical installation may be carried out only by a qualified electrician.

Electrical hazards

WARNING

Risk of fatal injury due to electric shock!

Open the housing only to perform installation, maintenance and repair work.

When the housing is open, you may come into contact with live parts if the power supply is connected. During installation and maintenance work on the hardware of the detector you have to switch off the measuring system and all the inputs and outputs in order to avoid contact with live parts.

Never modify the installation without having thoroughly read this User's Manual.

Cable glands, adapters and dummy plugs

The screwed fittings must be suitable for the intended use (ATEX or FM/CSA).

If the detector is not used in explosion hazardous areas, the screwed fittings, adapters and dummy plugs have to be tested in accordance with at least one of the following guidelines or standards:

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

At ambient temperatures of -20 to +40° C, only metallic cable glands and metal adapters may be used to comply with the protection class IP 65. The material properties of the cable glands, adapters and dummy plugs used must be suitable for the ambient conditions existing at the measuring location.

At ambient temperatures above 40° C and below -20° C, only the cable glands tested and approved by Berthold may be used.

The tightening torques for the cable glands supplied by BERTHOLD TECHNOLOGIES are listed on *page 1-49*.

Please note that only one adapter per cable entry may be used. It is not permitted to screw together several adapters.

The total length of the cable glands, including any adapter must not exceed 10 cm.

Cable conduits that are not used must be closed by suitable, metallic dummy plugs.

Special cable glands are required for reinforced cables. The cable assembly is described in the installation instructions of the cable conduit used.

In case of doubt, we recommend using screw fittings, dummy plugs or adapters by BERTHOLD TECHNOLOGIES.

Cables and wires

Only use cables with diameters that are permitted for each cable gland. The cables must have the following wire cross-sections:

- Power cord: 1 mm^2 to 2.5 mm^2
- Signal lines: 0.5 mm^2 to 2.5 mm^2

The cables used must be suitable for at least a temperature which is 15° C above the maximum ambient temperature.

The cables must not be subjected to tensile stress, but have to be installed strain-relieved. We recommend creating a cable loop in front of the entry of the housing.

If there is a danger that the cable may be used as a stepladder, then the cables must be installed protected, for example in conduits. Also make sure that the cables that are connected to the detector are laid without abrasion or kinks.

Cable shielding Pt100

With SIL-certified detectors, shielded signal lines must be used for the Pt100.

Stranded lead

The ends of multi-strand wires or fine wire lines (strands) may not be tinned or soldered. Permitted variations are ferrules and direct connection of the strand.

IMPORTANT

When installing fine wire lines in a terminal, individual wires often get stuck at the edge of the terminal, are then pushed back and in the worst case project over the insulated edge of the terminal. Therefore, make sure that all multi-wire or fine wire lines are covered by the terminal and are clamped inside the terminal.

Grounding conductor

The grounding conductor has to be connected to the terminals marked with PE. With interconnected detectors (multi-detector operation) the PE may not be looped from one detector to another. Therefore supply lines with PE have to be guided in a star-shaped pattern from one terminal box to the individual detectors.

Potential equalization

Connect the detector to a equipotential busbar on site. The line on this bar must be as short as possible.

Separator

A separator

- must be present (regulation according to EN 61010-1)
- must be easily accessible for maintenance personnel
- has to be included in the company's internal documentation

It can be installed in the form of a circuit breaker or as a switch and must meet the requirements of IEC 947-1 and IEC 947-3. If a fuse is used, it must trigger only at a current of greater than 4 amps per unit.

General points that are important for installation

IMPORTANT

Open the terminal compartment in dry ambient conditions, not in the rain.
Moisture in the terminal compartment can both cause a short circuit with other lines or cancel the explosion protection.

- Please follow the signs on the detectors.
- Connect the cables with special care.
- The connecting cable and its installation must comply with applicable regulations.
- Make sure when installing the cables that mechanical damage to the conductor insulation from sharp edges or moving metal parts will be ruled out. If necessary, install the cable appropriately protected, for example in conduits.
- Install the connecting cables in the terminal compartment so that
  - dirt and moisture is avoided in the terminal compartment;
  - the wires are not damaged when stripping;
  - the conductor insulation or the collar of the ferrule extends into the housing of the terminal body;
  - bare conductive parts of the lines (e.g. small wires of a strand) do not protrude from the terminal body;
  - the length of the ferrule or the stripped wire can be 10 mm, so that the wire is securely held in the spring-type terminal;
  - if ferrules are used, the conductor insulation extends into the collar of the ferrule;
  - the minimum bending radii permitted for the respective cross-section are not fallen below;
  - install the cables strain-relieved and without abrasion.
- The SENSseries detectors may only be operated with fully closed housing.
- Cleaning corroded threads at the cable glands or cable conduits using abrasives or a wire brush is not allowed.

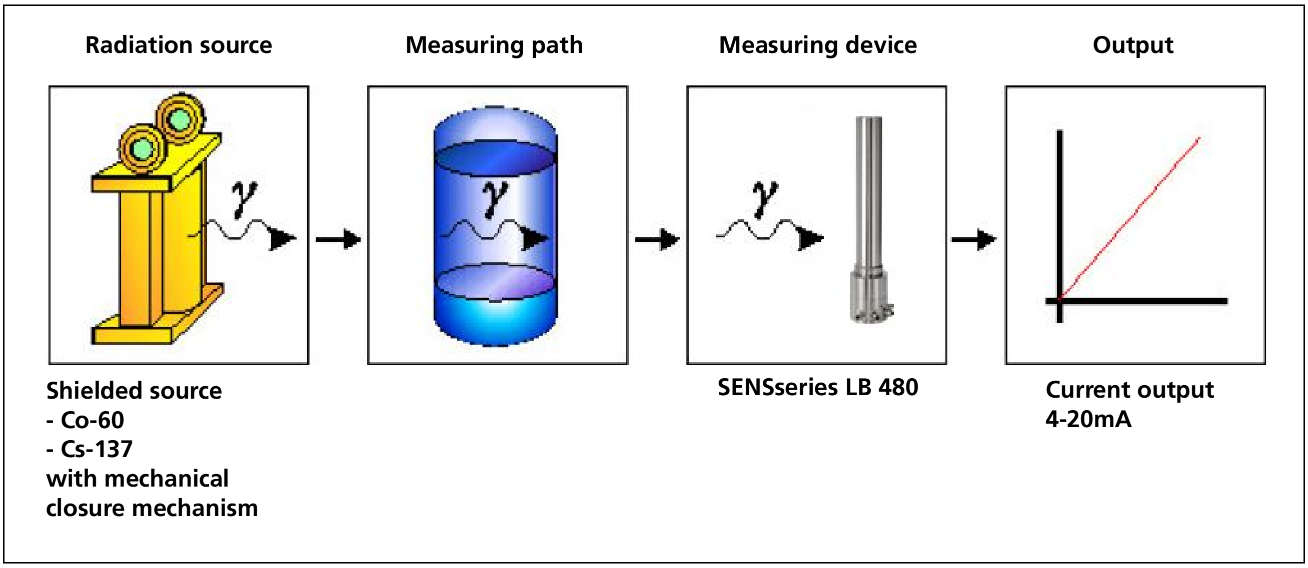
- The use of the detectors is not permitted if:
  - cable fittings are corroded or damaged;
  - threads on the housing are corroded or damaged;
  - dummy plugs are badly corroded or damaged;
  - the housing of the detector is badly corroded or damaged;
  - seals are damaged, show visible aging, or reduction.

7 Functional Safety

7.1 Scope

This safety manual applies for radiometric measurement systems consisting of a radiation source and the measuring system of the SENSseries LB 480. The measuring system can be used in the following applications:

- Level measurement (also cascaded in a master-slave arrangement)
- Level detection (as max and min limit switches)
- Density measurement



7.2 Use

The measuring device LB 480 may only be used as intended. Permissible measuring arrangements as well as the intended use are described in the operating manual.

For use in safety-related systems (Functional safety according to IEC 61508:2010 / 61511:2003) all information in this manual has to be considered.

The measuring device can be operated in the operating mode with low demand rate (low demand) or with high demand rate (high demand). For this purpose, the rules according to 7.4.5.3 of IEC 61508-2 regarding the demand rate must be observed specifically

- up to SIL 2 with one detector LB 480
- up to SIL 3 with two detectors LB 480

Any use beyond the information given in this manual shall be deemed as being not in conformity with the intended use and may result in serious injury or property damage. BERTHOLD TECHNOLOGIES GmbH & Co. KG shall not accept any liability for such injury or damage.

7.3 Other Applicable Documents and Records

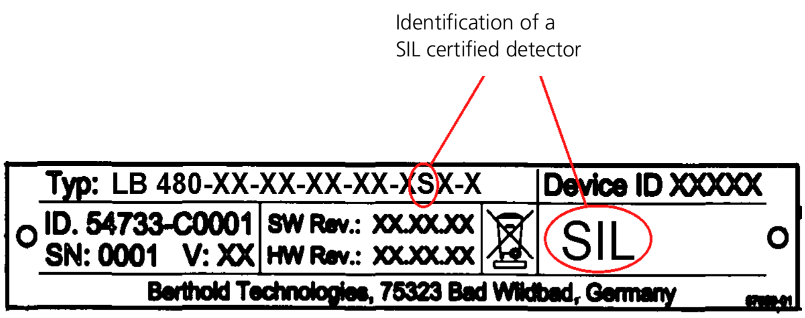
Depending on the design of the measuring system, the following documentation must be observed

Type	Operating manual
Level measurement	LB 480 Level measurement ID No. 54733-10BA1L German ID No. 54733-10BA2L English
Limit level measurement	LB 480 Limit level measurement ID No. 54733-20BA1S German ID No. 54733-20BA2S English
Density measurement	LB 480 Density measurement ID No. 54733-30BA1D German ID No. 54733-30BA2D English

The SIL conformity is certified in the attached certificate.

7.4 Detector Identification

SIL-certified detectors are marked on the nameplate with the designation "SIL" and in the LB number key in addition with an "S" (see figure below).



7.5 Project Planning

7.5.1 Safety Function

The measuring system SENSseries LB 480 is used for non-contact measurement of level, density or concentration. A gamma radiation source (Co-60 and Cs-137) generates a radiation field which is attenuated or absorbed by the product to be measured and is detected by the scintillation detector LB 480.

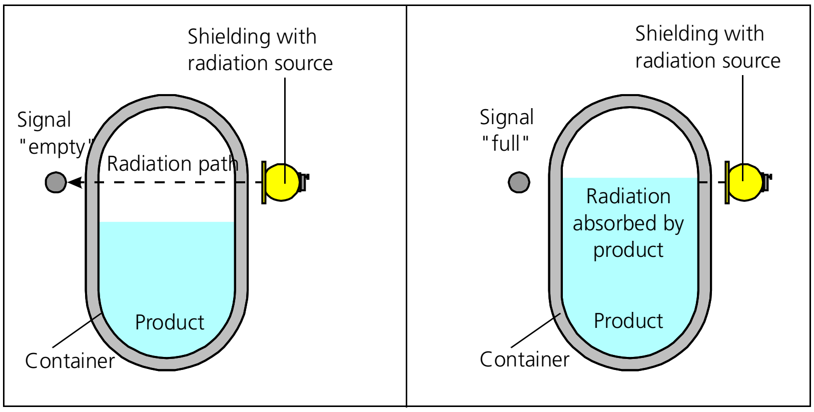
The following descriptions are exemplary for the respective application. The safety integrity, that is the non-detected measured value deviation is <2%. If TowerSENS detectors are used the deviation is <5%. Information on the accuracy of the measurement can be found in the technical data section of the operating manual.

7.5.1.1 Level detection

The measuring system consists of a detector and a radiation source. These are mechanically positioned on the filling level and trigger an alarm once this level is reached. The safety function is to monitor the fill level of the product to be monitored at a defined fill level. This can be both an overfill and underfill protection.

Principle of measurement

As long as the level is below the beam path, the detector receives radiation from the radiation source and the signals "Empty". If the level rises and reaches the height of the beam path, then the radiation is absorbed by the product. The significantly reduced radiation intensity evaluates the detector signal as a "Full" signal.



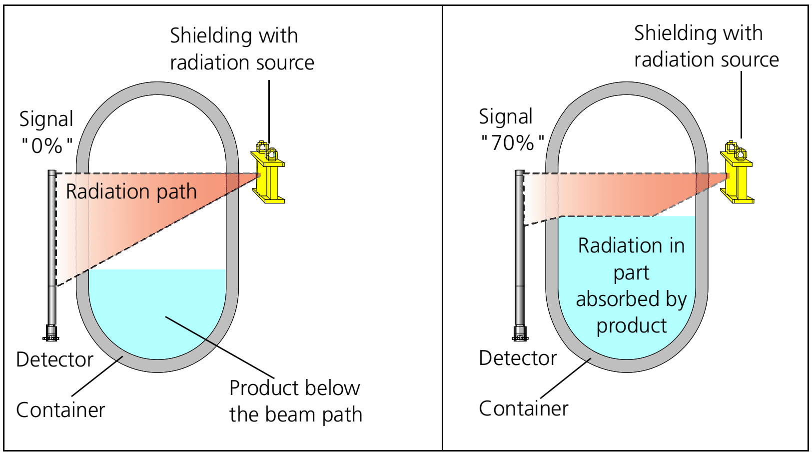
The "Empty" signal is displayed on the analog current output with 4 mA, the "Full" signal with 20mA.

7.5.1.2 Level measurement

The measuring system consists of a detector and a radiation source. Both the detector and the radiation source may be designed rod-shaped or point-shaped. These are mechanically positioned so that the desired measuring range can be covered. The safety function is to monitor the fill level of the product to be monitored within the measuring range.

Principle of measurement

As long as the level does not reach the area of the beam path, the radiation arrives unhindered at the detector. Once the level is within the measuring range, part of the radiation is absorbed. This reduced radiation intensity is indicated at the detector as rising level. The more the level rises, the more the radiation is reduced, which the detector signals as a continuous level increase from 0 to 100%.



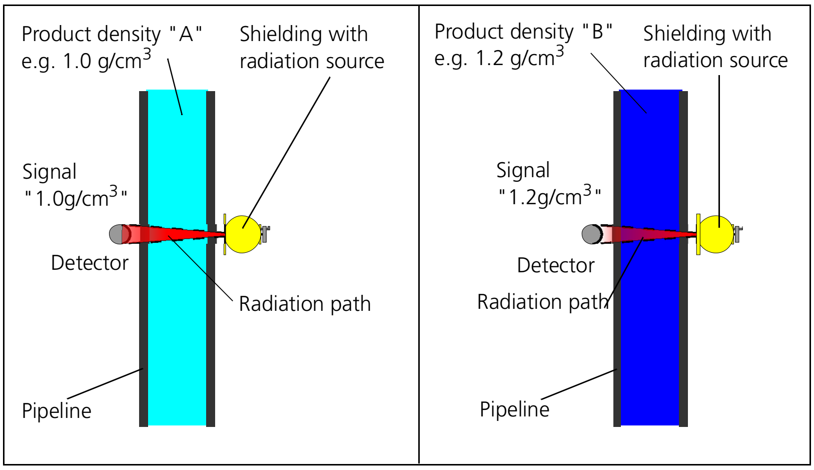
The level change from 0 ... 100% is represented by the analog current output 4 ... 20mA.

7.5.1.3 Density measurement

The measuring system consists of a detector and a radiation source. These are mechanically positioned such that the beam path runs through the product in order to detect the product density. The safety function is to monitor the fill level of the product to be monitored within a defined density measuring range.

Principle of measurement

A higher product density reduces the radiation intensity at the detector. A lower product density increases the radiation intensity at the detector. The change in radiation intensity is output in the detector as a continuous signal within the measurement range.



The detector signals the change in density via the analog current signal. The lower measuring range of the density corresponds to 4mA, the upper range corresponds to 20mA. The PT100 may be used for temperature compensation.

7.5.2 General Notes and Limitations

- The user-specific limits must be observed and the technical specifications must not be exceeded. See operating instructions.
- The container geometry on which the source-detector calculation is based must not differ from the one at the mounted measuring point. If there are any deviations, please contact BERTHOLD TECHNOLOGIES.
- Only the analog 4-20mA current output signal may be used for safety functions.
- The measuring signal may only be used by the control system when the Safety Mode is enabled.
- The RS485 interface must be used exclusively for the master-slave communication.
- The HART® multidrop mode is not allowed.
- If there are magnetic fields in the immediate vicinity of the measuring point, then you have to make sure through appropriate tests that the magnetic field intensity does not affect the measuring signal.
- Use only radiation sources with the isotope Co-60 or Cs-137.
- Only shieldings made by Berthold may be used.
- During operation, the source shielding may not be
  - closed
  - be changed in their position or removed
- It must be prevented that no additional absorber (e.g. steel plates) get into the beam path, which were not considered for commissioning.
- Any influence of adjacent radiometric measuring points should be avoided. If in doubt, the measuring point arrangement has to be discussed with BERTHOLD TECHNOLOGIES.
- Several detectors may be interconnected into a multi-detector system. In an interconnection, only one detector may be configured as a master detector.
- In a multi-detector system, the time constant must be > 2 seconds.
- The user is responsible for the validation of the safety function.
- The following types of detectors can only be used when all count rates within the measuring range are above 1000 cps.
  - LB 480-13 (CrystalSENS 40/35)
  - LB 480-14 (CrystalSENS 40/35 with water cooling)
  - LB 480-15 (CrystalSENS 25/25)
  - LB 480-16 (CrystalSENS 25/25 with water cooling)

  These detectors can be operated only with detector code "0".

- Detector code "1" has to be used for the following types of detectors: when count rates of less than 1000 cps may occur within the measuring range. In the other case detector code "0" can be used.
  - LB 480-11 (CrystalSENS 50/50)
  - LB 480-12 (CrystalSENS 50/50 with water cooling)
- The error current (Loop Alarm Type) has following setup options:
  - High: >21mA
  - Low: <3.6mA

7.5.3 Assumptions

The evaluation of the measuring device according to functional safety aspects is based on the following assumptions:

- The failure rates are constant over the lifetime.
- The environmental conditions correspond to an average industrial environment.
- The repair time (replacement of the measuring system) after an interference immune error is 72 hours. (MTTR[1]= 72h).
- The maximum operating time is limited by the average count rate and the scintillator used:

	maximum operating time	
average count rate	CrystalSENS (Point detectors with NaI crystal)	UniSENS (rod detectors) SuperSENS TowerSENS
40000 cps	10 years	10 years
80000 cps	5 years	10 years

- A temperature compensation can be used for a density measurement.

The following error cases are not considered:

- Closing or removing the source
- Failure rates of external power supplies
- Multiple errors

1. MTTR = Mean Time To Repair

7.5.3.1 Determination of the Failure Rates

The failure rates of the device were determined by an FMEDA according to IEC61508. The calculations are based on component failure rates according to SN29500. All numerical values refer to an average ambient temperature during the operating time of 40° C (104°F). For higher temperatures, the values should be corrected:

- Continuous operating temperature 50 … 60° C (122...140°F) by a factor of 1.3
- Continuous operating temperature 60 … 70° C (140...158°F) by a factor of 2.5
- Continuous operating temperature 70 … 80° C (158...176°F) by a factor of 4.5

Similar factors apply when frequent temperature fluctuations are expected.

7.6 Device Behavior during Operation

7.6.1 Device Behavior after Power On

After power on, a diagnosis phase of 15 seconds starts in which the measuring device is checked for errors. The current output changes to 24mA for 2 seconds and then to 0mA. During this time, no communication with the device is possible.

If an error is detected during the diagnosis phase, the device changes to fault current. In the other case, a current in the range between 3.8 ... 20.5 mA is output.

7.6.2 Behavior of the Current Output in Case of Error

If the measuring device detects a fault, the current output is brought to a safe condition.

Error >21mA or <3.6mA:

There is a hardware or software error.

Please refer to the operating manual for a detailed description of the error behavior.

7.6.3 Device Behavior in Case of Interference Radiation

The LB 480 is able to detect interference radiation caused, for example, by weld seam testing. If interference radiation is present, the measured value switches to fault current for the wait time set in the device. Overfilling or underfilling cannot be detected during this time. Even if the LB 480 is very sensitive when it comes to the detection of interference, one cannot rule out ultimately that specially low interference radiation influences may not be detected and the measured value is falsified. For this reason, it is generally necessary that the system operator is informed in advance and appropriate measures are taken to maintain the safe operation of the system.

7.7 Installation and Wiring

Installation and wiring is described in the relevant operating instructions.

If necessary, the following inputs can be connected and used:

- Pt100 for temperature compensation
- RS485 for cascading as a multi-detector system

The use of other inputs is not permitted in safety-related applications.

7.8 Commissioning

The following equipment may be used for commissioning:

- HART®-Communicator
- The PC-based control software LB 480-PC.

For commissioning, you should be familiar with the operating instructions (Level, Limit Level, or Density).

Carry out the following steps for commissioning:

1. Calibration (see User's Manual Volume 3, Chapter 5)
2. Enable Safety Mode

   Menu path: Device Config>Access>Safety ON

   With this setting, the security-compatible setting is checked and the detector LB 480 locked.

   The Safety Mode is maintained even if the device is turned off and then on again.
3. Check safety parameters and measured value

   Menu path: Diagnostic>Safety>Refresh Safety Status

   - First update Safety Stati.
     To do this, select parameter "Refresh Safety Status".
   - Then Safety Status 1, 2 and 3 have to show the value 0xFF.

   If not, the measurement cannot be used in a protection device. The measurement can be used in a protection device only when the settings are corrected so that 0xFF is displayed in the active "Safety Mode". If you need help, please see the brief explanation in the safety parameters in each menu of Safety Status 1, 2 and 3.

Please refer to *chapter 7.9 "Periodic Inspections"* so that the reference values for this test can be determined directly following the commissioning.

7.9 Periodic Inspections

The periodic performance test is used to check the safety function in order to detect possible non-recognizable dangerous errors and thus to test the operational capability of the measuring system at appropriate intervals. It is the responsibility of the operator to select the type of inspection.

The intervals depend on the PFD value used (see table in *chapter 7.11*).

The test has to be carried out so that the correct safety function can be established in the interaction of all components. The methods and procedures used in the tests must be stated and their suitability must be specified. The inspections have to be documented.

If the performance test is negative, the entire measuring system must be taken out of service and the process must be kept in a safe state by other measures.

The first test must be performed directly after the initial startup, so that the reference values and the general conditions are defined, and these are available in the following periodic inspections for reference.

IMPORTANT
During the test, the person performing the test must ensure the safety-related monitoring of the process by other technical and/or organizational measures.

7.9.1 Test Options

The options to test (proof-test) the measuring device as a component of the measuring system differ depending on the application the instrument is used for. The test options are listed below. Please note that this should be done under operating conditions, provided certain operating conditions have an impact on the measurement. For example, if there is a stirrer in the beam path, then the stirrer must be operated as under operating conditions. The same applies to a container under gas pressure, and to heating and cooling jackets, to name two further examples. It is the responsibility of the operator to select the type of inspection. The interval depends on the PFD used (see Table in *chapter 7.11*).

7.9.1.1 Limit Switch Application

The function in the Limit Switch application can be checked by controlling the response level in the course of a filling process. If filling is not feasible, the measuring system must be triggered to respond by an appropriate simulation of the level or the physical measuring effect.

7.9.1.2 Level Application

In the Level application, the function can be checked in the following manner:

1. Source open, container empty ⇒ it must be possible to check the zero point.
2. Source closed, container empty ⇒ measured value of the initial start-up must be reached under the same conditions.

7.9.1.3 Density Application

In the Density application, the function can be checked only by a reference liquid where we know the density. An example would be filling the measuring path with water. If this is not possible, a reference sample must be analyzed in the laboratory and its result has to be compared with the results of the measuring device.

In general, a 2-point tests leads to a higher safety level. A second point should have a fairly large distance from the first point. We recommend a difference between both points of >30% of the measuring range.

7.10 Repair

Repairs of the SENSseries LB 480 may be carried out at the manufacturer's works only.

7.10.1 Software Update

A software update must be carried out only by personnel authorized by BERTHOLD TECHNOLOGIES.

7.11 Functional Safety Data Sheet LB 480

7.11.1 SIL 2 in System Architecture 1oo1 (1-channel)

Parameter	Value
Protective function	- Limit level measurement - Level measurement - Density measurement
SIL	SIL 2 with one detector LB 480 (SIL2 SC3 FT0)
HFT	0
Device type	B
SFF	92%
MTTR, MRT	72h
λsd	0 FIT
λsu	0 FIT
λdd	2450 FIT
λdu	210 FIT
λtot	2660 FIT
PFDavg for T1 = 1 year	<1.12E-03
PFDavg for T1 = 2 years	<2.04E-03
PFDavg for T1 = 5 years	<4.79E-03
PFDavg for T1 = 10 years	<9.39E-03
PFH	<2.11E-07 1/h
MTBF	>42 years
Diagnostic test interval	<180s
Operating mode	Low Demand or High Demand
Maximale Demand Rate	= Diagnostic test interval * 100
DC	95%
Error response time*	0.5s

*) The error response time is the time between an error is detected until the moment the error current (<3.6mA or >21mA) is set.

In a cascade, the values for PFD and PFH must be multiplied with the number of detectors.

7.11.2 SIL 3 in System Architecture 1oo2 (2-channels)

Parameter	Value
Protective function	- Limit level measurement - Level measurement - Density measurement
SIL	SIL 3 with two detectors LB 480 (SIL3 SC3 FT1)
HFT	1
Device type	B
MTTR, MRT	72h
Beta	5%
PFDg for T1 = 1 year	<5.6E-05
PFDg for T1 = 2 years	<1.0E-04
PFDg for T1 = 5 years	<2.4E-04
PFDg for T1 = 10 years	<4.7E-04
PFH	<2.11E-07 1/h
MTBF	>19 years
Operating mode	Low Demand or High Demand
Response time	10sec
DC	95%

In a cascade, the values for PFD and PFH must be multiplied with the number of detectors.

7.12 Attachments

7.12.1 Test Log

Identification	
Company/Auditor	
Date	
Measuring point	
Product	
Order no.	
Isotope, source no., activity	
Detector type, detector size	
High voltage	
Date of last function test	

Device parameters of the safety function	
Operating mode	☐ Limit switch max
	☐ Limit switch min
	☐ Level
	☐ Density
lower measuring range (unit)	
upper measuring range (unit)	

Test	
Measured value 1 (unit)	
Measured value 2 (unit)	

Safety Status	
Safety Status 1	☐ 0xFF
Safety Status 2	☐ 0xFF
Safety Status 3	☐ 0xFF

Date: ________ Signature: ____________________

7.12.2 Definition of Terms

SIL	Safety Integrity Level
HFT	Hardware Fault Tolerance
SFF	Safe Failure Fraction
PFD_{AVG}	Average Probability of Dangerous Failure on Demand
PFH	Average Probability of Dangerous Failure on Demand
FMEDA	Failure Mode, Effects and Diagnostics Analysis
FIT	Failure in Time (1 FIT = 1 failure/109h)
λsd	Rate for safe detected failure
λsu	Rate for safe undetected failure
λs	λs = λsd + λsu
λdd	Rate for dangerous detected failure
λdu	Rate for dangerous undetected failure
DC	Diagnostic Coverage
T1	Proof Test Interval
MTBF	Mean Time Between Failure
MTTR	Mean Time To Repair
IBN	Commissioning

7.13 Functional Safety Certificate

ZERTIFIKAT ◆ CERTIFICATE ◆ 認證證書 ◆ СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFICAT

Product Service

CERTIFICATE

No. Z10 047128 0002 Rev. 00

Holder of Certificate:	**Berthold Technologies GmbH & Co. KG** Calmbacher Str. 22 75323 Bad Wildbad GERMANY
Certification Mark:	
Product:	**Sensors** **Measuring System**
Model(s):	**SENSseries LB 480**
Parameters:	Architecture 1oo1: SIL2, SC3 Architecture 1oo2: SIL3, SC3 Degree of Protection: IP66 / IP68 The report to the certificate and the user documentation in the currently valid revision are mandatory parts of this certificate.
Tested according to:	IEC 61508-1:2010 IEC 61508-2:2010 IEC 61508-3:2010

The product was tested on a voluntary basis and complies with the essential requirements. The certification mark shown above can be affixed on the product. It is not permitted to alter the certification mark in any way. In addition the certification holder must not transfer the certificate to third parties. This certificate is valid until the listed date, unless it is cancelled earlier. All applicable requirements of the testing and certification regulations of TÜV SÜD Group have to be complied. For details see: www.tuvsud.com/ps-cert

Test report no.:	BB99553C
Valid until:	2028-09-10

Date, 2023-09-12

Peter G. Weiß

(Peter Weiß)

Page 1 of 1
TÜV SÜD Product Service GmbH • Certification Body • Ridlerstraße 65 • 80339 Munich • Germany

Zertifiziervertrag

Grundlage für die Zertifikatserteilung ist die Prüf- und Zertifizierordnung von TÜV SÜD Product Service.

Mit Erhalt des Zertifikates erkennt der Zertifikatsinhaber die jeweils gültige Fassung der Prüf- und Zertifizierordnung an (www.tuev-sued.de/ps_regulations) und wird somit Partner im Zertifiziersystem von TÜV SÜD Product Service.

Prinzipielle Voraussetzung für die Gültigkeit des Zertifikates:

– Gültigkeit der zitierten normativen Prüfgrundlage(n) ist gegeben

und zusätzlich bei Zertifikaten mit Berechtigung zur Verwendung eines Prüfzeichens bzw. bei Zertifikaten für QM-Systeme:

– Voraussetzungen für vorschriftsmäßige Fertigung werden eingehalten.

– Die Fertigungs- bzw. Betriebsstätten werden regelmäßig überwacht.

Certification contract

Certification is based on the TÜV SÜD Product Service Testing and Certification Regulations.

On receipt of the certificate the certificate holder agrees to the current version of the Testing and Certification Regulations (www.tuev-sued.de/ps_regulations) and thus becomes partner in the TÜV SÜD Product Service Certification System.

Requirements for the validity of the certificate in principle:

– Validity of the quoted test standard(s)

In addition for certificates with the right to use a certification mark and for QM certificates:

– Conditions for an adequate manufacturing are maintained

– Regular surveillance of the facility is performed

Akkreditierungen / Benennungen (Status 25.02.2010) /
Accreditations / notifications (as of 2010-02-25)

Deutschland / Germany

Geräte- und Produktsicherheitsgesetz (GPSG) /
Equipment and Product Safety Act (GPSG)

Europa / Europe

- Niederspannungsrichtlinie 2006/95/EG
- Spielzeugrichtlinie 2009/48/EG
- Richtlinie für aktive medizinische Implantate 90/385/EWG
- Richtlinie für Medizinprodukte 93/42/EWG
- Richtlinie für In-vitro-Diagnostika 98/79/EG
- Richtlinie für Gasverbrauchseinrichtungen 90/396/EWG
- Richtlinie für persönliche Schutzausrüstungen 89/686/EWG
- EMV-Richtlinie 2004/108/EG
- Richtlinie für Sportboote 94/25/EG + 2003/44/EG
- Richtlinie für Maschinen 2006/42/EG
- Richtlinie für Ex-Schutz Geräte 94/9/EG

- Low Voltage Directive 2006/95/EC
- Toys Directive 2009/48/EC
- Directive for Active Implantable Medical Devices 90/385/EEC
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- Directive for Machinery 2006/42/EC
- Directive for Ex Safe Equipment 94/9/EC

- ENEC Agreement for luminaires and IT equipment

USA

- Nationally Recognized Testing Laboratory (NRTL) to 29 CFR 1910.7 by OSHA
- Accredited for FDA 510(k) Third Party Review
- Conformity Assessment Body to the MRA for Medical Devices; FDA QSReg Inspections, FDA 510(k) Third Party Review

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- Recognized Certification Body to Electrical Products (Safety) Regulation; Hong Kong
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Weltweit / Worldwide

- NCB im CB-Scheme des IECEE / NCB in the CB Scheme of IECEE
- ExCB im IECEx-Scheme des IECEE / ExCB in the IECEx Scheme of IECEE
- TÜV SÜD Product Service Mark für Produkte / TÜV SÜD Product Service Mark for products DAP-ZE-1213.00
- Zertifizierung von QMS / Certification of QMS TGA-ZM-08-93-00
- Zertifizierung von QMS gemäß / Certification of QMS according to (DIN) EN ISO 13485 / ISO 13485

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- Directive for Personal Protective Equipment 89/686/EEC
- EMC Directive 2004/108/EC
- Directive for Recreational Craft 94/25/EC + 2003/44/EC
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8

Visual Inspection

Regular visual inspections of the measuring system SENSseries have to be carried out, at least every three years. To do this, use the visual inspection plan on *page 1-53*. Take appropriate actions immediately if you detect damage in the course of the visual inspection; if necessary, disconnect the detector from power supply immediately.

To determine the inspection intervals for the visual inspection, take the following conditions into consideration:

– Ambient conditions (outdoor, rain, sunlight, heat and cold).

– Operating conditions (utilization of system, operating errors)

– Measuring system is operated within or outside of an explosion hazardous zone.

Carry out a visual inspection before first commissioning and after any repair that requires opening of the detector cover and check the terminal compartment. Please use the visual inspection plan (*Volume 1*) on *page 1-53* and the plan for checking the terminal compartment on *page 1-55*.

9 Radiation Protection

9.1 General Information and Guidelines

In order to prevent adverse health effects caused by working with radioactive substances, limits for the maximum permissible radiation exposure of operating personnel have been agreed upon on an international level. Appropriate measures in designing the shieldings and arranging the measuring system at the measuring site will ensure that the radiation exposure of the personnel will remainbelow the maximum permissible value of 1mSv (100mrem) per year.

To ensure safe operation and compliance with the legal regulations, the company has to appoint a Radiation Safety Manager who is responsible for all questions relating to radiation protection. The Radiation Safety Officer will monitor handling of the radiometric measuring system and, if necessary, formalize the safeguards and any special precautions applicable to a given establishment in formal procedural instructions, which in special cases may serve as a basis for radiation protection guidelines. Radiation protection zones outside the shielding must be – if they are accessible – marked and guarded. These instructions should also include checks of the shutter device of the shielding and actions in case of accidents – such as fire or explosion. Any special event has to be reported to the Radiation Safety Manager immediately. He will then investigate any damage and immediately take suitable precautions if he detects defects that may adversely affect the safe operation of the system.

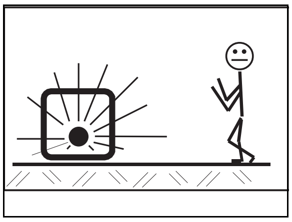
The Radiation Safety Manager has to make sure that the provisions of the Radiation Protection Regulations are observed. In particular, his duties include instructing the staff on the proper precautions when working in the vicinity of radioactive substances.

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

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

The total sum of the radiation dose absorbed by a body is determined by three factors. On the basis of these factors, certain fundamental radiation protection rules can be derived: Distance, time and shielding.

Distance

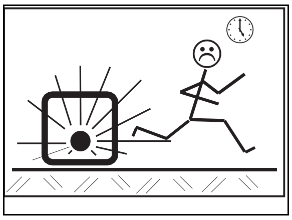


This means the distance between the radioactive source and the human body. The radiation intensity (dose rate) decreases – like light – in proportion to the square of the distance, i.e. doubling the distance to the source reduces the dose rate to one quarter.

Conclusion:

Maximum distance should be maintained when working in the vicinity of equipment containing radioactive material. This is especially true for persons that are not directly involved in this work.

Time

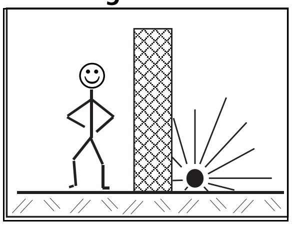


The total time a person stays in the vicinity of a radiometric measuring system and the body is exposed to radiation. The effect is cumulative and increases therefore with the duration of the radiation exposure.

Conclusion:

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

Shielding



The material surrounding the source provides the shielding effect. As the shielding effect depends, following an exponential function, on the product of thickness multiplied by the density, it follows that materials with a high specific weight are to be used for shielding purposes. The device designer usually calculates suitable dimensions.

Conclusion:

Before mounting or dismounting the shielding, make sure that the radiation exit channel is *locked* in the closed position.

During use

Installation, dismantling, relocation, maintenance, testing involving the radioactive source and its shielding shall ONLY be performed under the supervision of the Radiation Safety Officer.

For more information please contact BERTHOLD TECHNOLOGIES.

9.2 Mounting the Shielding

9.2.1 Safety Instructions

The shielding container consists of a lead-filled, stable cast housing. A rotary shutter is installed to close the radiation exit channel. Operation is carried out from behind by a T-handle, which is secured by a padlock in open as well as in closed position. The locking prevents that the radiation path can be closed or opened by unauthorized persons. Also is prevents that unauthorized persons can remove the source.

Radiation exposure during installation

To keep the radiation exposure of the assembling personnel as low as possible, only licensed personnel who have been trained on how to handle radioactive substances are allowed to assemble or disassemble the shielding with the source. The work is performed according to the instructions and under the supervision of the Radiation Safety Manager. It has to be ensured that the lock of the shielding is closed and secured, so that no unshielded radiation can exit. Make sure the shielding is not modified or damaged.

Vibrations

Constant vibrations can loosen the lead in the shielding and grind up lead in extreme cases. In this case, the shielding effect and the function of the shielding are no longer guaranteed. In the worst case, the radioactive substance may leak out. Also, constant vibrations can loosen the source holder or the source, which also would impair both the function and the shielding effect.

A corrosive atmosphere requires an additional protective covering made from a suitable material, such as stainless steel sheet, or the shielding itself must be made from a suitable stainless steel. Corresponding versions are available on request from BERTHOLD TECHNOLOGIES.

NOTICE

Depending on the operation conditions, the function check has to be repeated at appropriate intervals, at least once a year.

9.2.2 Radiation Exposure during Installation of the Shielding

The shieldings of measuring systems are usually designed such that the limit of the control area is in a given distance (in most cases less than one meter) around the shielding, and it does not matter whether point or rod sources are being used and how high their activity is. A simplified calculation of the radiation exposure during installation of the shielding is possible with sufficient accuracy using the dose rate data printed on the type plate, measured in 1 m distance from the shielding. The radiation exposure D can be calculated according to the following formula:

$$D = DR \times t \times 4$$

D = accumulated dose during assembly in Sv
DR = dose rate on the type plate of the shielding in μSv/h
t = time needed for the installation with shielding in h

If the work process is prepared well, you may expect a working time of less than 20 minutes to perform work such as installation of the shielding or operating the shutter.

Calculation example

DR = 3μSv
t = 20min (1/3h)

D = 3 x 1/3 x 4 = 4μSv/h

If we compare this dose with the permissible annual dose of 1 mSv for persons who are not exposed to radiation on their job, this work may be carried out 250 times per year by one and the same person.

1

9.2.3 Radiation Dose Calculations

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

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

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

$$\text{Dose D} = \frac{A \times k \times T}{r^2 \times s}$$

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

Nuclide	k	Dimensions
Co-60	0.35	$\frac{\mu Sv \times m^2}{h \times MBq}$
Cs-137	0.09	

Calculation example

Calculate the dose in a distance of 50 cm from a Co-60 source with an activity of 350 MBq and a time of 30 minutes. The source is installed in a shielding with a shielding factor of 30:

$$\text{Dose D} = \frac{350 MBq \times 0.35 \mu Sv \times m^2 \times 0.5 h}{(0.5 m)^2 \times h \times MBq \times 30} = 8.2 \mu Sv$$

9.3 Testing the Shutter Mechanism

The Radiation Protection Ordinance requires that regular functional testing and maintenance are carried out on the shielding and the inspection is documented. In establishing the testing interval for periodic functional testing and maintenance of the source shielding, the ambient and operating conditions of the measuring device, the legal regulations and the permit conditions must be considered. The functional checks and maintenance have to be carried out, however, at least once a year.

The functional test is to ensure that the locking mechanism is working properly. It must be ensured that:

- the closure moves easily and freely
- the locking mechanism does not get jammed at any point in the range of rotation
- the beam path can be closed completely

If you notice a failure or you have doubts, please contact the BERTHOLD TECHNOLOGIES service department.

9.4 Safety Measures

When designing the installation of radiometric measuring systems, the possibility that a fire breaks out must be considered. Flammable substances must not be stored in the proximity of radioactive substances. They should be covered and protected properly to prevent a possible spreading of the fire to the radioactive sources. It is mandatory to coordinate all preventive measures against fire with the local authorities, primarily with the fire department, which must be informed about the type, scope and place of application of the radioactive substances used, in order to be prepared in the event of fire.

When devising alarm plans, possible special features of the radiometric measuring system have to be mentioned; the Radiation Safety Manager to be notified in the event of an emergency has to be included in those plans as well, and also the address and phone number of the regulatory authority.

9.5 Protection against Theft

Radioactive substances or facilities containing radioactive substances must be secured against unauthorized use. Fixed installations are, by their nature, protected against unauthorized use.

If facilities working with radiometric measuring systems are taken out of service for a longer or indefinite period of time, the radioactive sources together with their shieldings should be dismantled and secured until the facility is taken into operation again.

Portable measuring systems, on the other hand, have to be protected by keeping them under constant supervision, or, if they are not in operation, by keeping them in a locked room or container which can be guarded against unauthorized access.

This is especially true for low activity test sources which are used, for example, to check the function of dose rate measuring instruments.

In the event that radioactive substances are lost, the Radiation Safety Manager and the regulatory authority have to be notified immediately.

In case of theft, the police must be informed as well.

9.6 Accidents, Loss, Damage, Fire, Theft

Remember the principles of health and safety in such situations: Time, distance, and shielding (see also *page 1-120*). In case of one of the above situations:

- Limit access to the area
- Report the incident to the authorities.
- Inform BERTHOLD TECHNOLOGIES.

Proper handling and disposal of possibly leaking radioactive sources or contaminated parts of the equipment must be coordinated with the supervisory authority.

9.6.1 Malfunctions and Accidents

The Radiation Protection Ordinance defines malfunction as an event which for safety reasons prohibits continuation of the operation of the facility.

Malfunction

Malfunction means, that a device necessary to guarantee safe operation of the facility, e.g. the seal of the active radiation beam of the shielding, no longer functions properly.

Accident

An accident is an event which could expose persons to a radiation dose which exceeds the permissible limits, or could cause contamination by radioactive substances.

In terms of safety, malfunctions and accidents are very serious events and appropriate steps must be taken immediately to prevent hazards to persons as well as facilities, or to reduce them as much as possible.

It is therefore important that the personnel is aware of preventive measures and is prepared for possible accidents or malfunctions of the facilities, so that dangerous consequences can be ruled out as far as possible by a proper reaction of the personnel.

In any case, the Radiation Safety Manager who checks the situation at site and takes all necessary steps to prevent unnecessary radiation exposure of the personnel must be notified immediately.

The Radiation Safety Manager will then take appropriate measures and will inform the official authority concerned, and, if necessary, get further information from the manufacturer.

IMPORTANT

The recovery of shieldings and sources after incidents and accidents may only be carried out in accordance with the instructions by the authorities.

The necessary steps should be taken in the following order:

- Locate source.
- Check function of shielding
- Check effectiveness of shielding by measuring the dose rate
- Guard and mark controlled areas.
- Secure source and shielding.
- Document the incident and assess possible radiation exposure of personnel.

In case the source capsule is damaged, the following points have to be considered:

- Avoid contamination.
- Handle source with tools (e.g. pincers or tweezers) and put both (source and tool) in a plastic bag.
- Stay behind auxiliary shielding (e.g. concrete, steel, or lead plate).
- Check if vicinity is free of contamination
- Secure radioactive waste properly (deposit at governmental collection site or return to manufacturer).

If the source is leaking and the dose rate might possibly be exceeded, the regulatory authority (e.g. trade board) has to be notified immediately.

In case of an accident or malfunction or any other event which affects the safety, the regulatory authority has to be informed and also, if necessary, the authority in charge of public safety. Please contact BERTHOLD TECHNOLOGIES if you need any further information.

9.7 Shielding and Source

Shieldings do not include any wearing parts or mechanically moving parts that under normal operating conditions require maintenance. For safety reasons, however, it should be possible any time to lock the useful beam. A functional check has to be performed in appropriate intervals of max. one year (see *chapter 9.3*). The Radiation Safety Manager has to be informed immediately if any faults on the shielding or a sluggish locking mechanism are detected. If the problem cannot be solved simply by cleaning, you have to stop working with the system until it has been repaired.

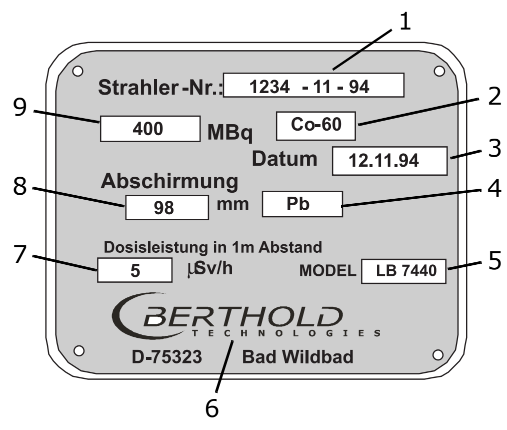
As long as the shielding does not show any significant mechanical damage or strong corrosion, the built-in source will be protected. Please observe the radiation protection guidelines when checking or replacing the source.

The radioactive sources used and the function area of the measuring system typically permit a service life of more than 10 years. The useful life of radioactive sources should be based on the period of use recommended in the leak test certificate. A source may have to be replaced earlier if the statistical variations which increase in the course of time become intolerably high and any compensation by increasing the time constant is not acceptable any more, e.g. for control-engineering reasons.

IMPORTANT

Empty calibration has to be performed any time a source is replaced!

For information on the design of source and shielding please refer to the technical documentation and the identity plate (*Fig. 9-1*).



1 Source number
2 Isotope
3 Source manufacture date
4 Shielding material
5 Type of shielding
6 Shielding manufacturer
7 Dose rate in 1 m distance
8 Effective shielding thickness
9 Activity

Fig. 9-1 Identity plate

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

1234 - 11 - 94

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

9.8 Leak Test

Depending on the stipulations of the regulatory authority responsible for the sources employed in their territory, regularly recurring leak tests have to be carried out. These tests have to be carried out by approved experts, or in consultation with the regulatory authority, by the manufacturer. The appropriate documents on the source have to be provided in order to carry out this test.

9.8.1 Required Documents

- Inventory of the sources to be tested with information on the previous leak tests
- Source certificate including the following information:
  - Nuclide, activity, purchase date, physical-chemical form
  - Description of capsule and type of sealing
  - Resistance against mechanical and thermal influences or classification of the source design
- Information on location, intended use as well as on the typical operational maximum mechanical and thermal stress.
- If the sources are installed in an appliance, a drawing has to be enclosed which clearly shows the position of the source and of all parts that are essential for its protection against external influences. Proposals for the best test method should beavailable, e.g. through information on alternative test areas and, if necessary, the required manipulations, how the test canbe carried out without adversely affecting the workability of the system or appliance.
- Certificate on an acceptance test by the manufacturer.

Alternative test areas

For point source shieldings with rotary shutter:

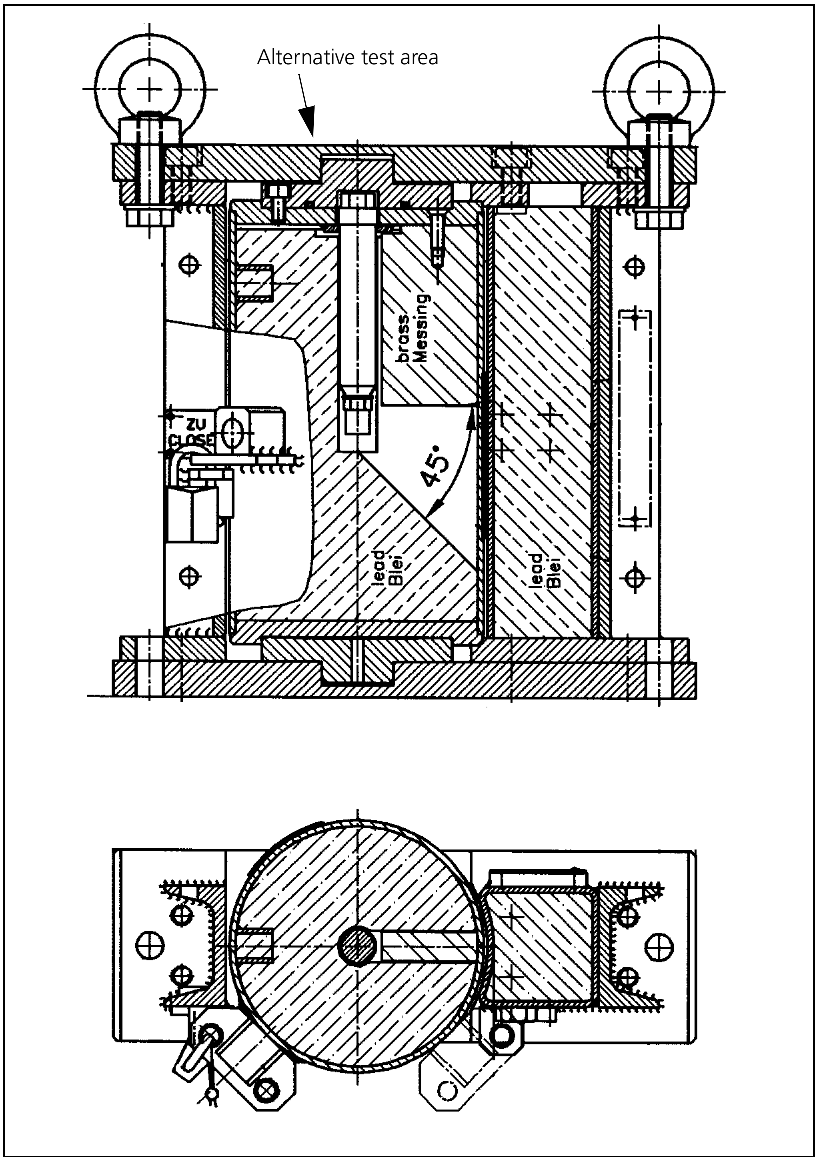


Fig. 9-2 Alternative test area on point source shieldings:

The alternative test area is the visible part on the head of the shielding cylinder.

For rod source shieldings

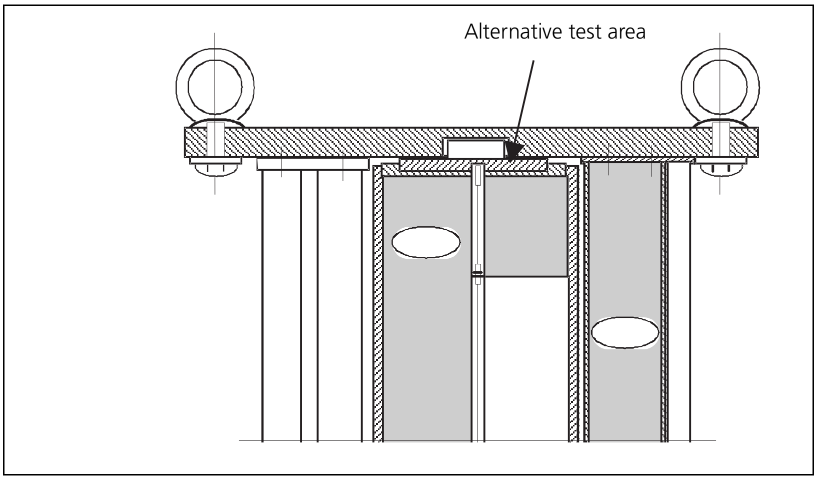


Fig. 9-3 Alternative test area on rod source shieldings

The alternative test area is the visible part on the head of the shielding cylinder.

For point source shieldings with rotary shutter:

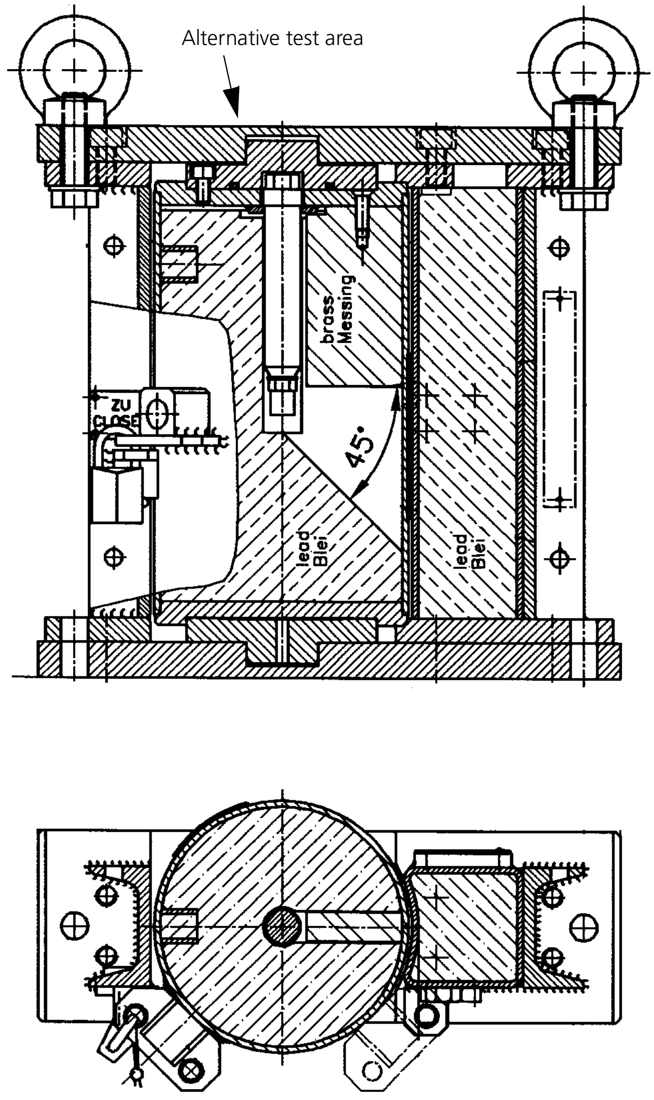


Fig. 9-4 Alternative test area on point source shieldings:

The alternative test area is the visible part on the head of the shielding cylinder.

For point source shieldings LB 744X

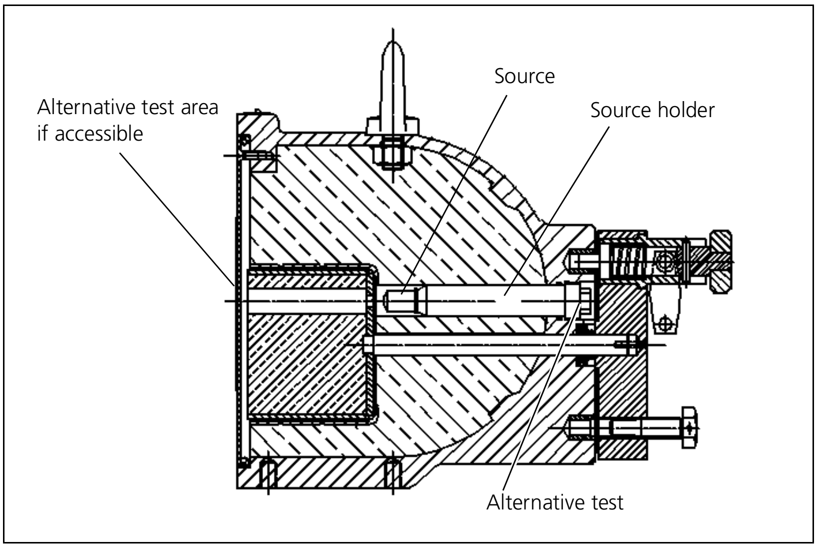


Fig. 9-5 Alternative test area on point source shieldings:

Turn lever to horizontal position for inspection.

The alternative test area is the head of the visible edge of the source holder. If the cover is also accessible then you have to wipe there as well.

10 Source Replacement

IMPORTANT
Radioactive sources may be replaced only by a competent firm that has a service license to handle radioactive materials.

10.1 Radiation Exposure during Source Replacement

It is important to calculate the possible radiation exposure even before mounting or dismantling rod sources. An exact calculation is possible using the equation described in chapter 9.2.3.

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

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

Dose $D = A \times 0.15$ for Co-60

Dose $D = A \times 0.04$ for Cs-137

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

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

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

Calculation example

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

$$D = 400 \times 0.15 = 60 \mu Sv$$

The radiation exposure in the vicinity of the shielding was previously calculated to be 10 μSv. The total radiation exposure including mounting and dismantling can then be estimated as being 70 μSv for a single part source.

If the above assumptions do no apply, the calculations have to be corrected accordingly. Actually, it can only be another working time which has a proportional effect on the result of the calculated dose rate.

10.2 Point Source Replacement on Rotary Cylinder Shielding

In this section we will describe the replacement of point sources on shieldings with the following ID no:

- Type 80
- Type 100
- Type 120
- Type 150
- Type 200
- Type 270

When replacing a source, you have to work with the unshielded source for a short time.

The exchange of radioactive sources must be performed in accordance with applicable regulations under the supervision of the Radiation Safety Officer.

CAUTION

Health hazards due to radiation!

When replacing a source, you have to work with the unshielded source for a short time. An increased dose of radiation is harmful to health.

You have to carry a pocket dosimeter during work to measure the personal dose and to document the actual radiation exposure. Moreover, work has to be coordinated with the competent Radiation Safety Manager.

IMPORTANT

For Germany you have to keep in mind:
Source replacement by the customer is possible only if:
1) the appropriate technical qualification is guaranteed
2) the work to be done to replace the source has been approved explicitly by the regulatory authority. Your “License to Handle Radioactive Substances” states whether you are in possession of such a license.

Prerequisite for this work is detailed knowledge of the design of the shielding; appropriate drawings must therefore be available.

Preparation

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

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

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

Prepare a suitable, clean space, if possible with an auxiliary shielding (shielding vessel, lead bricks, concrete stones, etc.) and place the source holder and the source there on a piece of paper to protect it against dirt.

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

If you are working with several sources, make sure that the sources cannot be mixed up.

10.2.1 Source Replacement Procedure

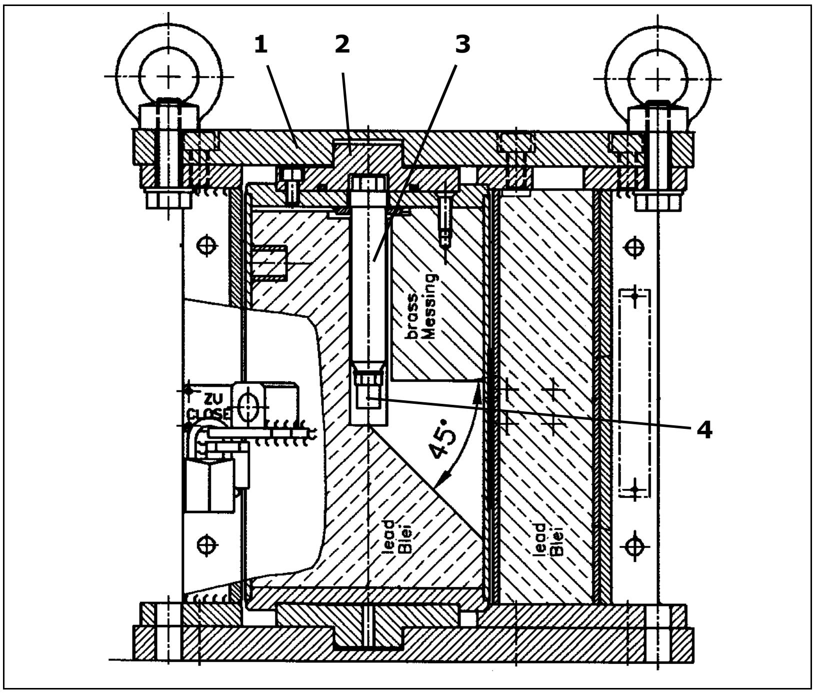


Fig. 10-1 Dismantling rotary cylinder point source shielding

Dismantling the shielding

- Unscrew the head flange **(1)** using a suitable Allen key.
- Open the locking cover **(2)**.

CAUTION

Health hazards due to radiation!

Do not remove the source from the shielding!

Do not touch the source to prevent a high partial body dose. Touch the source only with a tool that allows you to hold the source easily and safely, for example, with a pipe wrench. Do not press the pipe wrench too hard to avoid damage to the source. Keep the source far away from your body and set it down behind an auxiliary shielding.

- Unscrew the source holder **(3)** with the source **(4)** from the shielding. Use a size 12 socket wrench.

Remove source from shielding

- Unscrew the source from the source holder using a socket wrench (size 10 mm). Hold the source holder using a second socket wrench (size 12 mm).

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

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

IMPORTANT
Make sure the source is not mixed up with the new or another source.

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

Install new source

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

Assemble shielding again

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

Replace the type label

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

IMPORTANT
The special regulations regarding labeling and transport of the shielding back to the manufacturer have to be observed. If in doubt, please contact BERTHOLD TECHNOLOGIES's Source Transport Manager.

This completes the source replacement.

10.3 Rod Source Replacement

In this section we will describe the replacement of rod sources on shieldings with the following ID no:

- Type 80
- Type 100
- Type 120
- Type 150
- Type 200
- Type 270

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

CAUTION

Health hazards due to radiation!

When replacing a source, you have to work with the unshielded source for a short time. An increased dose of radiation is harmful to health.

You have to carry a pocket dosimeter during work to measure the personal dose and to document the actual radiation exposure. Moreover, work has to be coordinated with the competent Radiation Safety Manager.

IMPORTANT

For Germany you have to keep in mind:
Source replacement by the customer is possible only if:
1) the appropriate technical qualification is guaranteed
2) the work to be done to replace the source has been approved explicitly by the regulatory authority. Your "License to Handle Radioactive Substances" states whether you are in possession of such a license.

Prerequisite for this work is detailed knowledge of the design of the shielding; appropriate drawings must therefore be available.

Preparation

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

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

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

Prepare a suitable, clean space, if possible with an auxiliary shielding (shielding vessel, lead bricks, concrete stones, etc.) and place the source holder and the source there on a piece of paper to protect it against dirt.

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

IMPORTANT

Check that the sources are installed in the proper position. Note the respective marking rings on the source (top = 1 ring; bottom = 2 rings (see Fig. 10-2).

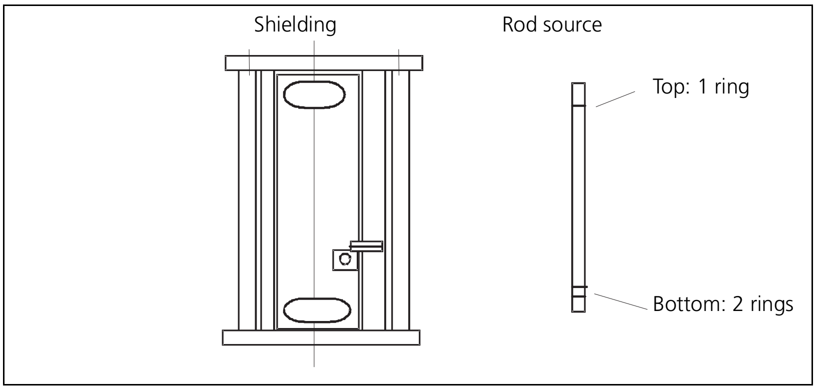


Fig. 10-2 Markings on shielding and rod source

When working with several sources, make sure that the sources cannot be mixed up. Multi-part sources must be set up in the proper order. The installation pattern of multi-part sources is indicated by the letters A, B, C etc. from top to bottom (*Fig. 10-3* on *page 1-145*).

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

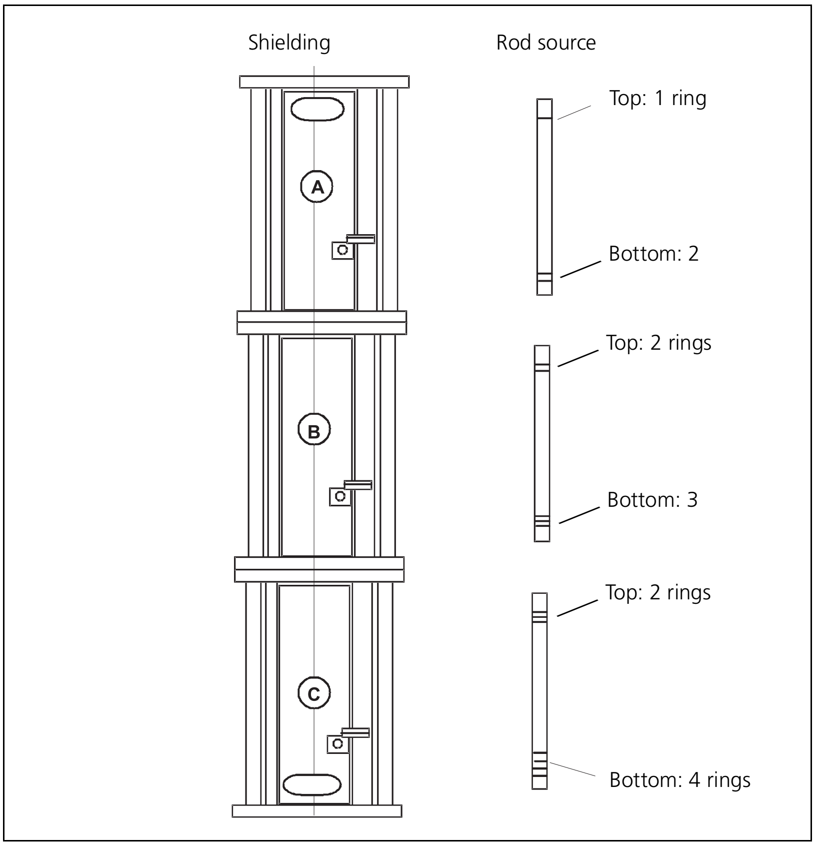


Fig. 10-3 Markings on multi-part sources and shieldings

10.3.1 Source Replacement Procedure

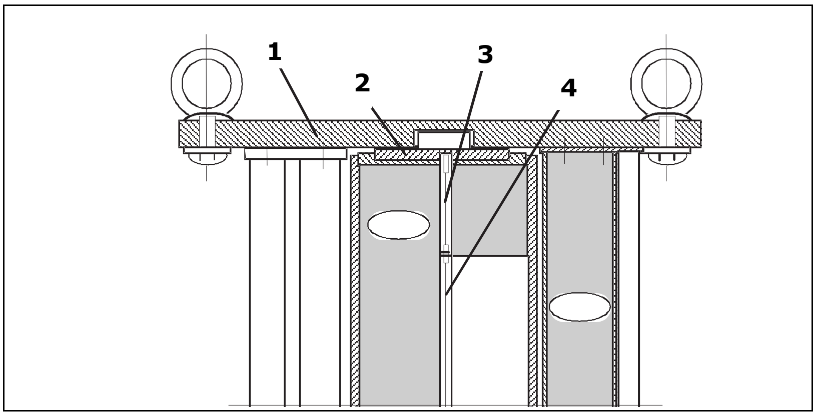


Fig. 10-4 Dismounting rod source shielding

- Unscrew the head flange **(1)** using a suitable Allen key.
- Open the locking cover **(2)**.

⚠ CAUTION

Health hazards due to radiation!

Do not remove the source from the shielding!

Do not touch the source to prevent a high partial body dose. Touch the source only with a tool that allows you to hold the source easily and safely, for example, with a pipe wrench. Do not press the pipe wrench too hard to avoid damage to the source. Keep the source far away from your body and set it down behind an auxiliary shielding.

Remove source from shielding

- Pull out the rod source **(4)** using the brass extension bar **(3)**, hold it with two pairs of pliers and insert it into a transport-shielding. Unscrew the extension bar**(3)** first using two pairs of pliers.
- If necessary, clean and grease the thread on the source holder and the shielding.
- Pull the new source out of the transport shielding so much that the brass extension bar can be fixed at the top with screws. Make sure not to mix up the parts, especially when working with multi-part sources.

IMPORTANT
Make sure the source is not mixed up with the new or another source.

Install new source

- Using a pair of pliers, take the new source out of the transport shielding and place it into the operating shielding.
- Attach the brass cover **(2)** again after you have checked if the O-ring seal is clean and undamaged.
- Attach head flange again and carefully secure it with screws.
- Check the proper ON/OFF function.
- Carefully close the transport shielding again, after you have put the old source into the transport shielding.
- Set up the operating shieldings as planned. With multi-part shieldings be sure to observe the correct order.

Replace the type label

- Replace the type label on the shielding or attach the new source number.
- For multi-part rod source shieldings, an additional label has to be attached to the bottom shielding showing the overall activity.

IMPORTANT
The special regulations regarding labeling and transport of the shielding back to the manufacturer have to be observed. If in doubt, please contact BERTHOLD TECHNOLOGIES's Source Transport Manager.

This completes the rod source replacement.

10.4 Point Source Replacement on LB 744x Shieldings

In this chapter we will describe how to replace point sources on the following shieldings:

- LB 7440
- LB 7442
- LB 7444
- LB 7445
- LB 7446

The exchange of radioactive sources must be performed in accordance with applicable regulations under the supervision of the Radiation Safety Officer.

⚠ CAUTION

Health hazards due to radiation!

When replacing a source, you have to work with the unshielded source for a short time. An increased dose of radiation is harmful to health.

You have to carry a pocket dosimeter during work to measure the personal dose and to document the actual radiation exposure. Moreover, work has to be coordinated with the competent Radiation Safety Manager.

IMPORTANT

For Germany you have to keep in mind:
Source replacement by the customer is possible only if:
1) the appropriate technical qualification is guaranteed
2) the work to be done to replace the source has been approved explicitly by the regulatory authority. Your "License to Handle Radioactive Substances" states whether you are in possession of such a license.

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

Prerequisite for this work is detailed knowledge of the design of the shielding; appropriate drawings must therefore be available.

Preparation

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

- Allen keys in the required sizes.
- 2 pairs of pliers to take hold of source and source holder (e.g. a pair of combination pliers or multigrip pliers).

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

If sufficient space is available, the source can be replaced in the shielding installed at the measuring site. Move the new source in its transport shielding close to the installation site.

Prepare a suitable, clean space, if possible with an auxiliary shielding (shielding vessel, lead bricks, concrete stones, etc.) and place the source holder and the source there on a piece of paper to protect it against dirt.

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

Source Replacement Procedure

▶ Open the lock (2) of the shielding (1).

▶ If necessary, pull out the locking screw (5) from the lever.

▶ Pull the knob (3) and turn the lever (4) by 90° to the right to the center position between OPEN and CLOSED

Now the hex screw head of the source holder is visible.

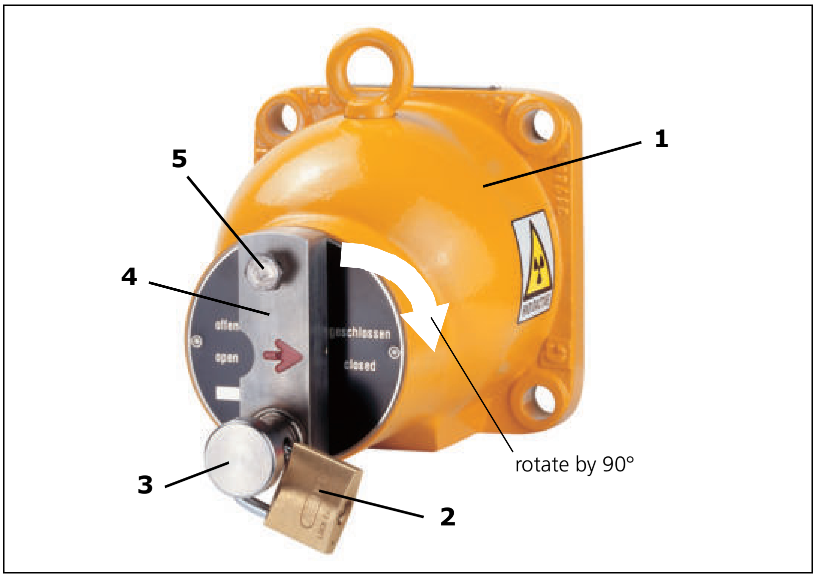


Fig. 10-5 Point source shielding, beam path closed

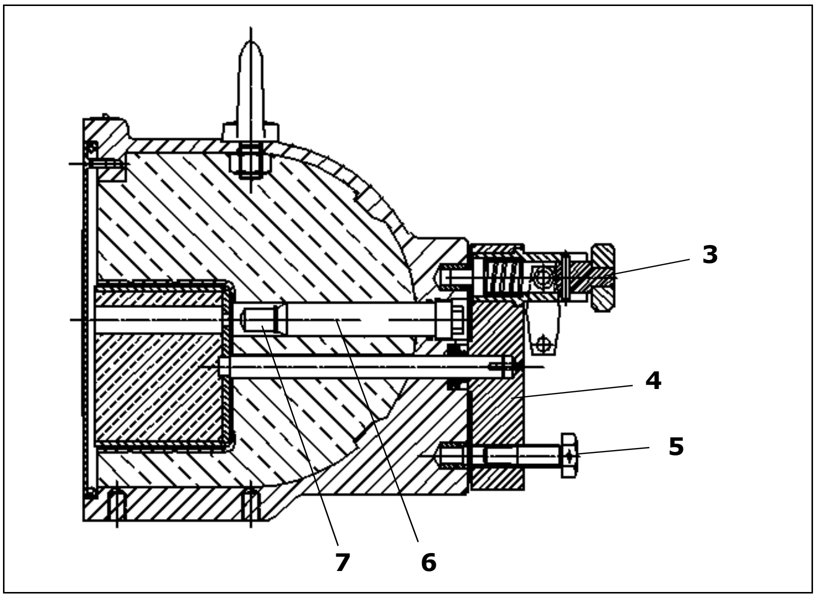


Fig. 10-6 Sectional drawing of source holder, beam path open

CAUTION

Health hazards due to radiation!

Do not remove the source from the shielding!

Do not touch the source to prevent a high partial body dose. Touch the source only with a tool that allows you to hold the source easily and safely. Keep the source far away from your body and set it down behind an auxiliary shielding.

- Screw the source holder (6) together with the source (7) using a socket wrench (size 12 mm).

Remove source from shielding

- Unscrew the source from the source holder using a socket wrench (size 10 mm). Hold the source holder using a second socket wrench (size 12 mm).

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

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

IMPORTANT
Make sure the source is not mixed up with the new or another source.

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

Install new source

- Using a pair of pliers, take the new source out of the transport shielding and firmly fix it onto the source holder together with the locking washer (torque: 3.5Nm).
- Put the source holder with the source again into the shielding and fix it using the socket wrench (torque: 44Nm).
- Check the proper ON/OFF function.
- Carefully close the transport shielding again, after you have put the old source into the transport shielding.

Replace the type label

- Replace the type label on the shielding or attach the new source number.
- Calibrate the system new (see *Volume 3*)

IMPORTANT

The special regulations regarding labeling and transport of the shielding back to the manufacturer have to be observed. If in doubt, please contact BERTHOLD TECHNOLOGIES's Source Transport Manager.

This completes the point source replacement.

11 Source Disposal

In general, each country has a collection site for radioactive material.

However, if you would like to return radioactive material to us for disposal, **the international regulations, ADR and GGVSE**, for transport, labeling and dose rates of the radioactive material have to be complied with, as well as the regulations of each country. It is the full responsibility of the sender to make sure these regulations are complied with.

Please keep in mind:

- Dose rate on the surface of the packing: <2000µSv/h.
- Dose rate in a distance of 1 m from the surface of the packing: <100µSv/h.
- Attach the UN number with the symbol for dangerous cargo on each package
- Shipping documents with correct description of the contents and accident procedures sheet in conformance with the ADR regulations are required.
- Packaging must comply with the valid ADR regulations.

For all questions on source transport or source return please contact our sales force, or our representative.

IMPORTANT

In many countries the transport of radioactive materials is subject to approval by the authorities. The source may be returned only after prior order confirmation and release confirmation by BERTHOLD TECHNOLOGIES.

Please keep in mind:

- Radioactive materials and their shieldings may not be damaged in any way and must have a valid seal test certificate. The seal test certificate may not be older than six months at the time of arrival in Germany. An exception is possible if a PTB certificate is available which confirms that the validity of the test dates has been extended.
- If you plan to return radioactive sources with isotope Am-241 or Cm-244, you have to include the *Special Form* certificate.
- It is indispensable that radioactive material that is returned to us is adequately labeled with your name and address.
  If you have received a quotation from us, please include our quotation number as well.
- Radioactive material can be returned only after you have received permission from BERTHOLD TECHNOLOGIES. We would be happy to send you a quotation on the costs to be expected for returning a source.
- BERTHOLD TECHNOLOGIES has to be informed in advance about the return transport. Radioactive material that is shipped to BERTHOLD TECHNOLOGIES without prior notice will not be accepted by BERTHOLD TECHNOLOGIES. Any warehouse expenses will be charged to the supplier.
- The source return declaration and the seal test certificate have to be sent to BERTHOLD TECHNOLOGIES together with your order documents. You will get the form for the source return declaration from BERTHOLD TECHNOLOGIES on request.

Notes:

Subject to change in the course of further technical development.

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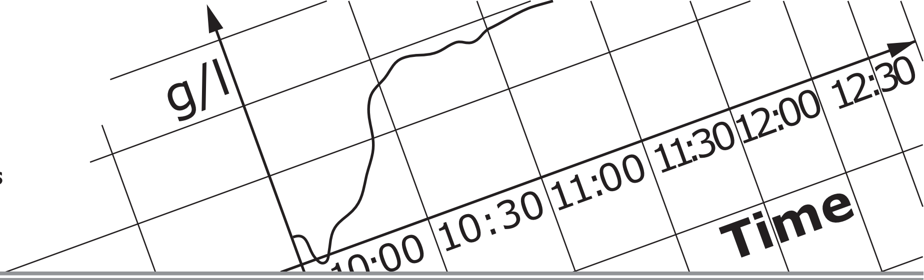


Volume 2 Installing SENSseries

1 System Description

1.1 Measuring System

1.1.1 Basic Measuring Configuration

The measuring system SENSseries LB 480 is a detector which, depending on its design, can be used for different measurement tasks:

- Level measurement
- Monitoring limit values
- Density measurement

The measuring system SENSseries LB 480 comes in the following versions:

- Point detector CrystalSENS (NaI 50/50)
- Point detector SuperSENS (scintillator 150/150)
- Rod detector UniSENS (length 0.5 to 2m in 50cm increments)
- Rod detector TowerSENS (length 3 to 8m in 1m increments)

The measuring system utilizes the radiometric measuring method, i.e. the absorption of Gamma radiation passing through the product being measured. In order to obtain an optimum measuring effect at minimal source activity, the ideal measuring geometry is calculated for each measuring site and the source is designed accordingly.

The measuring system SENSseries LB 480 is a compact detector, including the required components scintillation counters, power supply and the entire evaluation electronics, in one device.

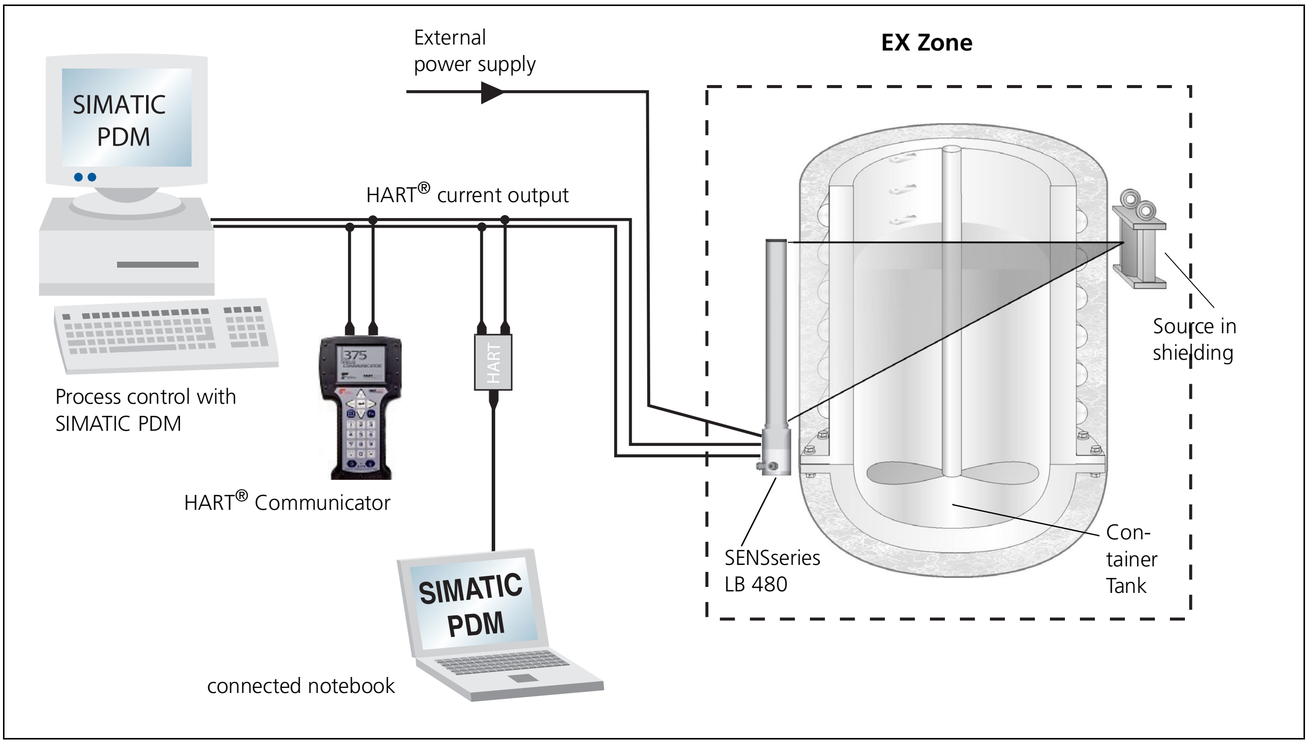


Fig. 1-1 Basic measuring configuration

1.1.2 Detector communication

Communication with the PCS[1]

The communication with display, evaluation and control devices takes place via a 2-wire HART® current interface with modulated digital current signal (FSK-modulation of the current signals according to the Standard Bell-202).

The level data are supplied as isolated 4-20 mA current signal to the process control system PCS.

Configuration and monitoring

Configuration, parameter setting and calibration of the detectors, as well as the output and display of the digital units of measure are carried out either:

- via a hand-held terminal, e.g. the 375 Field Communicator by Emerson Process Management GmbH & Co. OHG, or
- via PC and a suitable user interface for the detector, e.g. the SIMATIC PDM software.

Volume 3 describes the Operation with HART® Communicator.

1. PCS = process control system

1.1.3 Measuring Geometries

The hardware and software of the measuring system SENSseries LB 480 allow for an easy adaptation of the system to different measuring geometries and measuring tasks. Therefore, the settings and parameters of the measuring device have to be defined with care during commissioning for the particular measuring task.

Commissioning log

Important parameters may not be changed during operation. The system must be taken into operation and settings changed only by persons who know how to work with the device. Therefore, all users should read these User's Manual carefully. BERTHOLD TECHNOLOGIES, therefore, recommends documenting all settings in a setup protocol.

Project planning

The best system configuration is selected for each measuring task in the planning stage. Therefore, the specific project documentation has to be observed and followed.

1.2 SENSseries Hardware

1.2.1 Detector

The measuring system SENSseries LB 480 comprises one detector and the evaluation unit, both accommodated in a sturdy stainless steel housing.

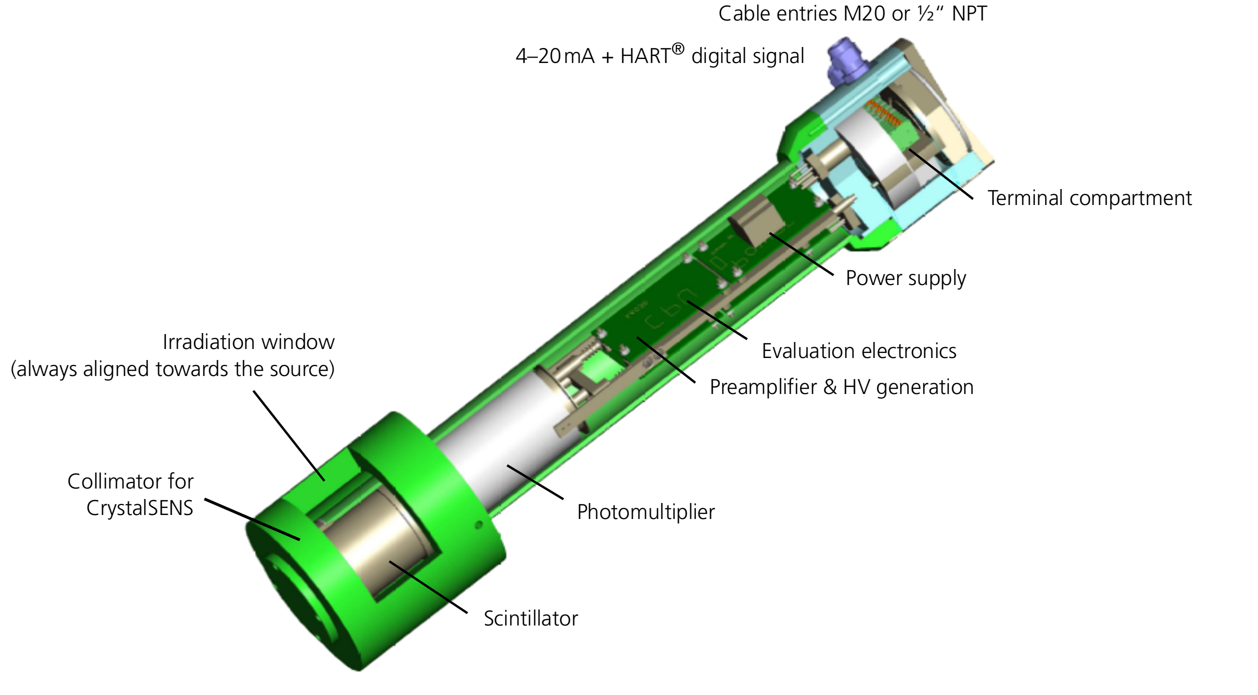


Fig. 1-2 Design of the SENSseries LB 480

Component	Description
Scintillator	Detecting Gamma radiation.
Photomultiplier, preamplifier, HV generation and evaluation electronics	Conversion of the flashes of light into electrical signals, conversion to liquid level, density or limit value.
Power supply	Power supply unit in two versions: 100V to 240V_{AC} 24V_{DC}
Terminal compartment	Includes all terminals which are necessary for the installation of the detector. For detailed information please see in *chapter 3* on *page 2-225*.
Thread of the cable entries	4 pcs M20 (ATEX) or 4 pcs ½" NPT (FM/CSA) for feedthrough of the connection cable.

Evaluation electronics

Control and processing of the signals are carried out by the evaluation electronics. The 4-20 mA measuring signal is passed through a 2-wire cable to the PCS (terminals 15 and 16).

Detector Communication

The measuring system SENSseries LB 480 uses the HART® protocol for communication. Configuration, parameter setting and calibration of the detectors, as well as the output and display of the digital units of measure are carried out either:

- via a hand-held terminal, e.g. the *375 Field Communicator* by Emerson Process Management GmbH & Co. OHG, or
- via PC with FDT frame application or
- via PC and the *SIMATIC PDM* software.

Access to electronics

At the top, the detector is closed by a detachable housing cover which can be removed by unscrewing the Allen screws.

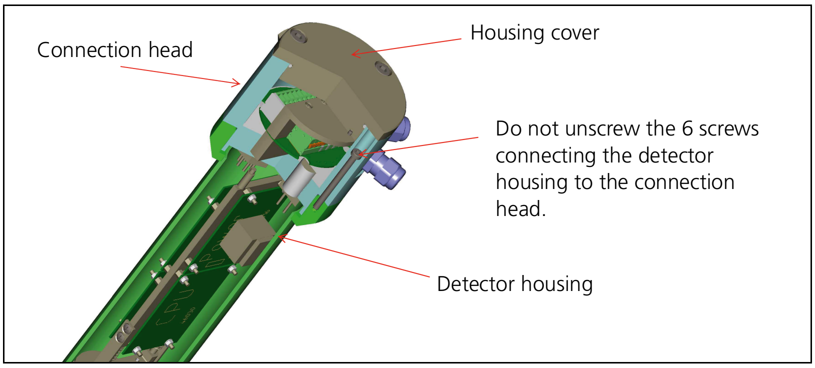


Fig. 1-3 Detector housing with connection head

Decay compensation

For automatic decay compensation, the detector is equipped with a capacitor-buffered real-time clock. The capacitor buffers the real-time clock for about one week. If the buffering is lost, the real-time clock starts with the last saved date the detector was supplied with power. A message informs you that the date has to be updated.

1.2.2 Sources

Sources are not part of the SENSseries LB 480 measuring system. They can be purchased separately through BERTHOLD TECHNOLOGIES together with the respective shieldings and holding devices.

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

The following radiation sources are used for measurement:

- *Co-60* emits Gamma radiation with an energy of 1.17 or 1.33 MeV. It is available as rod or point-shaped source. The influence of interferences due to gas density fluctuations and varying wall deposits is lower than with Cs-137. The half-life period of Co-60 is 5.27 years.
- *Cs-137* emits Gamma radiation with an energy of 0.66 MeV. Typically, it is delivered as a point-shaped source, occasionally as a rod-shaped source. The half-life period of Cs-137 is about 30 years.

1.3 Measuring Principle

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

The mathematical correlation is as follows:

$$I = I_0 \times e^{-\mu \times \rho \times d}$$

The equation shows that with a given source and the respective mass attenuation coefficient *μ* the measuring effect is dependent only on the product density *ρ* and the measuring path *d*.

Since the measuring path is constant and possible product density changes at a certain measuring path due to exponential reasons do not have any effect any more, this measuring method is not affected by any chemical and virtually no physical properties of the product being measured. For this reason, the radiometric measuring principle ensures high reliability and low maintenance.

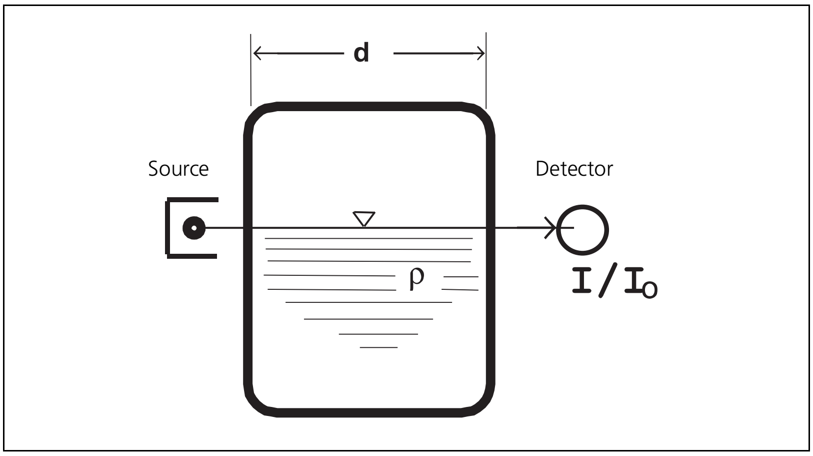


Fig. 1-4 Measuring Principle

1.4 Measuring Arrangements

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

Which of these arrangements is chosen depends on the size of the measuring range and on the measuring geometry resulting from the measuring task. Moreover, constructional circumstances and customer-specific requirements may have an effect on the device selection.

The respective selections are made during the planning stage and must be observed during assembly and commissioning.

1.4.1 Rod Source Arrangement

Fig. 1-5 shows a basic arrangement with *rod-shaped source and point-shaped detector (CrystalSENS, SuperSENS)* as well as the respective characteristic curve. The length of the rod source is adapted to the size of the required measuring range. The non-linearities resulting from the measuring geometry and the dissemination and absorption conditions of the radiation are compensated for by means of a non-linear activity distribution along the rod source, including the critical zone around the bottom end of the measuring range.

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

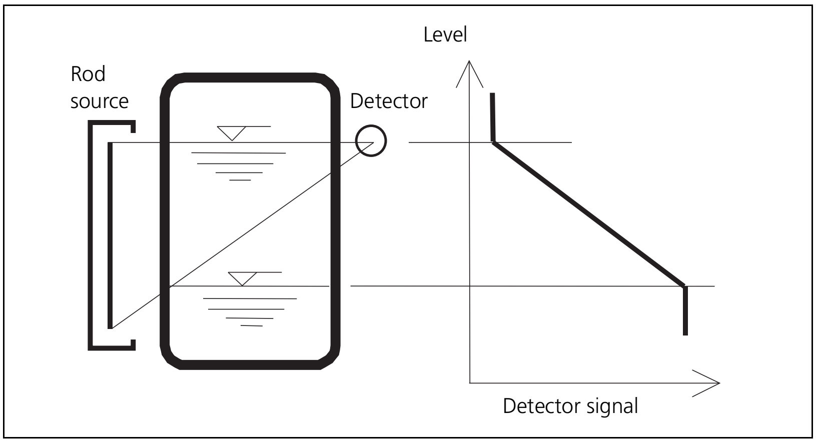


Fig. 1-5 Rod source arrangement

1.4.2 Rod Detector Arrangement

Fig. 1-6 shows an arrangement with *rod-shaped detector (Uni-SENS) and point source*. The length of the rod detector determines the length of the measuring range; for larger measuring ranges it is possible to work with several UniSENS rod detectors or one Tower-SENS.

For unfavorable measuring geometries one can also work with two point sources. As the characteristic curve shows, the measuring geometry results in non-linearities which are compensated for by a correction line that is adjusted to the measuring site and stored in the evaluation electronics.

The required tag-specific calculations will be provided by BERTHOLD TECHNOLOGIES.

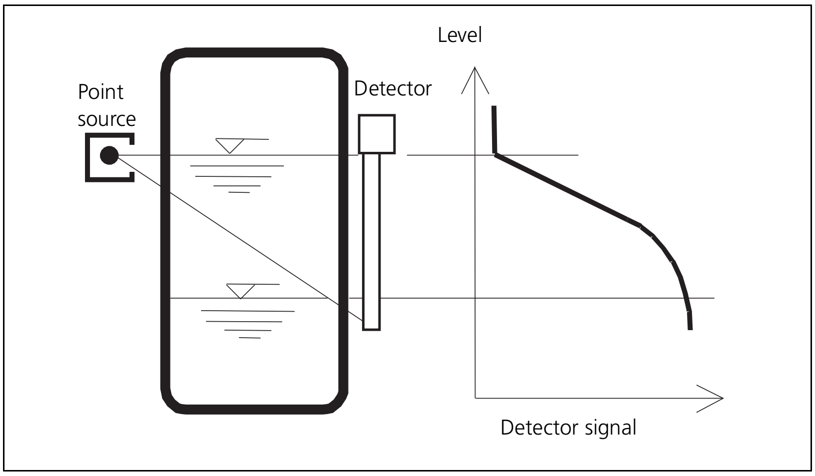


Fig. 1-6 Rod detector arrangement

1.4.3 Rod Source / Rod Detector Arrangement

For measuring geometries with an unfavorable ratio between measuring range and the source - detector distance or with very thick container walls, one can choose an arrangement with *rod source and rod detector* to reduce the source activity (see *Fig. 1-7*). In this case, the lengths of source and detector have to be adjusted to the size of the measuring range to be covered.

The non-linearities obtained in the upper range of the characteristic curve are compensated for by means of a correction line adjusted to the measuring site and stored in the evaluation electronics. The required tag-specific calculations will be provided by BERTHOLD TECHNOLOGIES.

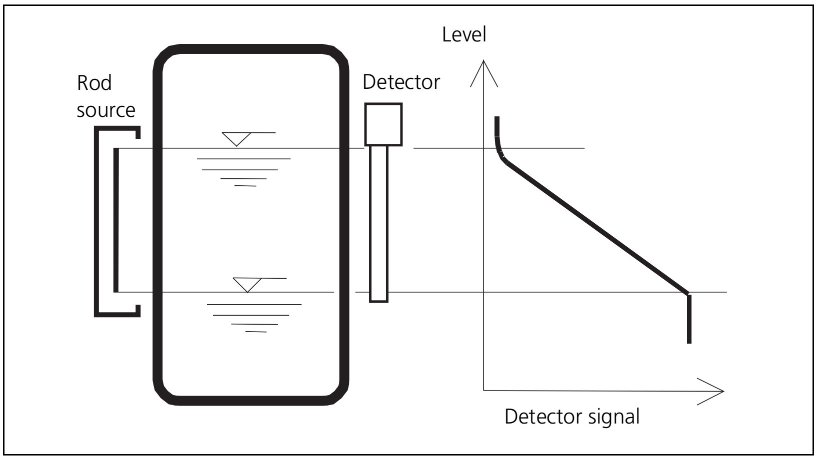


Fig. 1-7 Rod source / Rod detector arrangement

1.4.4 Point Source / Point Detector arrangement

In exceptional cases with little space and a very small measuring range, you can also choose an arrangement with *point source and point detector* (see *Fig. 1-8*). The resulting exponential non-linearities in this arrangement can be linearized automatically using a mathematical function provided by the evaluation unit. The required tag-specific calculations will be provided by BERTHOLD TECHNOLOGIES.

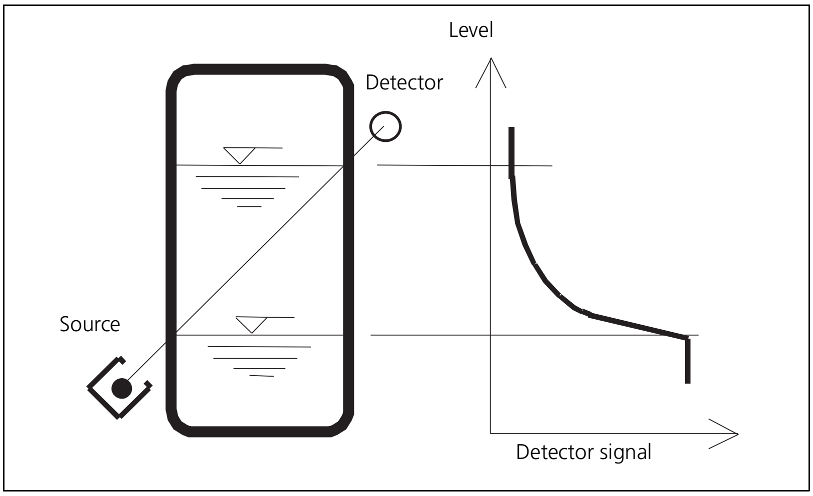


Fig. 1-8 Point source / Point detector arrangement

1.4.5 Point source / Point detector arrangement for limit switches

The arrangement shown in *Fig. 1-9* is used for limit measurements, for example to avoid overflowing when filling a container.

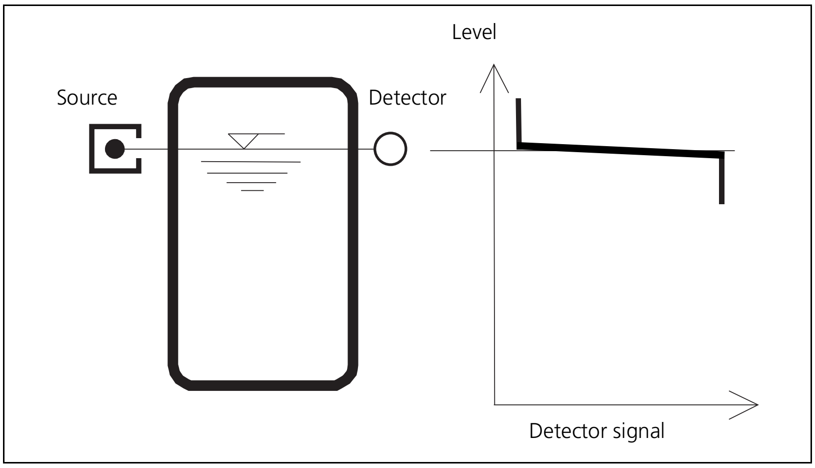


Fig. 1-9 Point source / Point detector arrangement for limit switches

1.5 Technical Data

If you are working under different operating conditions, please contact BERTHOLD TECHNOLOGIES.

Ambient temperature for "non-Ex" areas

	Operating temperature		Storage temperature
	uncooled	with water cooling	
CrystalSENS (Point detector)	-40 to +60° C	to +100° C	-40 to +60° C
UniSENS (Rod detector) SuperSENS TowerSENS	-40 to +60° C	to +100° C	-40 to +60° C

Ambient temperature in Ex-areas

Limited temperature ranges can apply for use in explosion hazardous areas. Please note the maximum ambient temperature values for explosion protection in the Safety Manual. Keep devices in a dry (no condensation), dark (no direct sunlight), clean and lockable room. Stay within the temperature range for storage.

General ambient conditions for explosion protection to CSA

Pollution Degree: 2
Overvoltage Category: III
Altitude: up to 4000m
Humidity: 90% or less

The approvals listed on the type plate of the each detector are valid.

IP protection type

according to IEC 60529: IP66 and IP68
according to ISO 20653: IP69K
according to NEMA Standard Publ. 250: 4X and 6

Vibration, mechanical shock

Vibration: 1.9g
mechanical shock: 30g
according to DIN EN 60068-2-6 and 60068-2-27

EMC

Interference emission to EN 61326-1, Equipment Class A
Resistance to interference to EN 61326-1, NAMUR NE21 and EN 61326-3-1 (SIL)

Housing

Material stainless steel 1.4301/304; other stainless steels on request.

Weight

see *Volume 2, chapter 5*.

Water cooling

Stainless steel 1.4301/304; maximum 6 bar, hose connection R1/4" or 10 mm dia.

2

Current output

HART current output 4 ... 20 mA, floating

passive or active (Source or Sink mode)

Resolution better than 6 µA

Impedance range active: 120 ohms to 500 ohms

Passive impedance range: up to 250 ohms at 12V, 500 ohms at 24V.

For safe HART® communication you need at least 250 ohms.

The maximum cable length of the HART® loop depends on the connected impedance as well as on the capacity and inductivity of the cable.

Max. cable length with BERTHOLD cable # 32024:

- 3300 m at 120 ohms
- 1600m at 250 ohms
- 800m at 500 ohms

The current output itself is monitored continuously and, in case of malfunction, signals 24 mA constantly via a redundant current path. The digital HART® communication remains in effect even on the redundant current path.

Current output		
passive	**active**	**Signal output**
LB 480-xx-0x	LB 480-xx-Zx	Non-Ex
LB 480-xx-1x	LB 480-xx-2x	Ex-e
LB 480-xx-3x	LB 480-xx-4x	intrinsically safe

For intrinsically safe signal output see *Volume 1, chapter 5, "Explosion Protection".*

Power supply

Nominal voltages (depending on version):

100V to 240V_{AC}±10%, 50/60Hz, max. 8VA or
24V_{DC} (18 to 32V_{DC}), max 8W

Cable conduits

4 cable conduits with M20 (ATEX) or ½" NPT (FM/CSA) for process connection, closed with dummy plugs. The screw fittings which are not needed for the installation must be closed with sealing plugs that are suitable for the type of protection, see *page 2-296*.

Cable glands

The screw fittings supplied by BERTHOLD TECHNOLOGIES match the protection type IP66, IP68 and IP69K. The permitted cable cross-section of the screw fittings is listed in our offer or our order confirmation.

The screw fittings are enclosed for each specific order, and, depending on the type, they may be nickel-plated brass (standard) or stainless steel.

Cable cross-section The cable cross-section is dependent on the cable glands used.

Wire cross-section for spring-type terminals $0.5mm^2$ to $2.5mm^2$; stripped length 10mm

Scintillators

Type	Scintillator	Dose Rate (typic) for CS-137 in µSv/h for 1000 Ips	Temperature stability	Weight in kg	Weight in kg with water cooling
CrystalSENS (Point detector)	NaI (Tl) 50*50mm NaI (Tl) 40*35mm NaI (Tl) 25*25mm NaI (Tl) 44*5mm	0,8µSv/h 1,6µSv/h 5,4µSv/h (Am-241)	≤0.002%/° C	11 (w/o collim.) 20.5 (with collim.)	14.5 (w/o collim.) 24 (with collim.)
UniSENS (Rod detector)	Polymer scintillator 500mm	0,17µSv/h	≤0.01%/° C	14	21
	Polymer scintillator 1000mm	0,09µSv/h		18	28
	Polymer scintillator 1500mm	0,06µSv/h		22	35.5
	Polymer scintillator 2000mm	0,04µSv/h		27	44
TowerSENS (Rod detector)	Polymer scintillator 1000mm	0,1-0,15µSv/h per m	≤0.02%/° C	27	-
	Polymer scintillator 2000mm		≤0.02%/° C	41	-
SuperSENS (Point detector)	Polymer scintillator 150*150mm	Cs-137: 0,14µSv/h Co-60: 0,2µSv/h	≤0.01%/° C	60	61

High voltage generation Voltage range of control 300V to 1300V (error message below 300V and above 1300V)

Voltage range external setting 300V to 1300V

Sensitivity changes due to temperature variation or due to ageing are automatically compensated for by an automatic high voltage control.

Counter Rate max. 1,000,000 cps

Automatic decay compensation For Cs-137, Co-60 and a universally configurable isotope

Digital output (not Ex)	Open Collector, electrically isolated; max. 100mA at 5 to 35V_{DC}; R_{max} 10kOhm; max. 2V voltage drop, leakage current in closed state <0,01mA; at inductive load a freewheeling diode is required The output can be used either for: – Error signal – Stop signal – Max. alarm – Min. alarm – Detector temperature – Interfering radiation For intrinsically safe signal output see *Volume 1, chapter 5, "Explosion Protection".*
RS-485	For software updates and the cascading of up to 16 slaves. For a software update, all slaves must be logged off from the master first.
Detector temperature sensor	Two independent temperature sensors Measurement deviation: -25° C to 100° C: ±2K -55° C to 125° C ±3K
Connection to PCS	Via current interface 4–20mA with optional HART® protocol according to Standard BELL-202 FSK.
Pt100	– measurable temperature range -30° C ... 180° C – monitored temp limits – Accuracy: +/-0.2° C – maximum connectable cable length: 30m

1.6 Detector Codes

The detector codes are used for automatically adjusting the operating point of the high voltage and have already been set by the manufacturer. They only have to be checked or adapted when the electronics has been exchanged.

Detector type	LB-No.	Scintillator	Detector code	Restrictions
CrystalSENS	LB 480-11 LB 480-12	50x50 NaI	0	with count rates in the measuring range of >1000cps
	LB 480-11 LB 480-12	50x50 NaI	1	with count rates in the measuring range of <1000cps
	LB 480-13 LB 480-14	40x35 NaI	0[1]	
	LB 480-15 LB 480-16	25x25 NaI	0[1]	
	LB 480-17 LB 480-18	44x5 NaI	2[1]	
UniSENS	LB 480-2A LB 480-2B	500	22	
	LB 480-2E LB 480-2F	1000	13	
	LB 480-2I LB 480-2J	1500	10	
	LB 480-2K LB 480-2L	2000	10	
SuperSENS	LB 480-31 LB 480-32	150x150	23	
TowerSENS	LB 480-4.	1000 mm	31	
		2000 mm	32	
		3000 mm	33	
		4000 mm	34	
		5000 mm	35	
		6000 mm	36	
		7000 mm	37	
		8000 mm	38	

1 The count rates in the measuring range must be greater than 1000cps.

2

1.7 Nomenclature of the SENSseries LB 480

LB480 - 1 1 - 1[ ] - 1 1 - r 1 - 0 0 - L

		Scintillator
1	1	CrystalSENS 50/50
1	2	CrystalSENS 50/50 + WC
1	3	CrystalSENS 40/35
1	4	CrystalSENS 40/35 + WC
1	5	CrystalSENS 25/25
1	6	CrystalSENS 25/25 + WC
1	7	CrystalSENS 44/5
2	A	UniSENS 500
2	B	UniSENS 500+ WC
2	E	UniSENS 1000
2	F	UniSENS 1000 + WC
2	I	UniSENS 1500
2	J	UniSENS 1500 + WC
2	K	UniSENS 2000
2	L	UniSENS 2000 + WC
3	1	SuperSENS 150x150
3	2	SuperSENS 150x150 + WC
4	1	TowerSENS 1000
4	2	TowerSENS 1000 + WC
4	3	TowerSENS 2000
4	4	TowerSENS 2000 + WC

	Approval; Supply/Signal
1[ ]	Zones (ATEX/IECEx/NEC/CEC) Ex-d/e/t; passive or slave
2[ ]	Zones (ATEX/IECEx/NEC/CEC) Ex-d/e/t; active
3[ ]	Zones (ATEX/IECEx/NEC/CEC) Ex-d/e/i/t; passive
4[ ]	Zones (ATEX/IECEx/NEC/CEC) Ex-d/e/i/t; active
A[ ]	Zones (ATEX/IECEx/NEC/CEC); Ex-d; passive or slave
B[ ]	Zones (ATEX/IECEx/NEC/CEC); Ex-d; active
C[ ]	Zones (ATEX/IECEx/NEC/CEC); Ex-dit; passive or slave
D[ ]	Zones (ATEX/IECEx/NEC/CEC); Ex-dit; active
F[ ]	Divisions (NEC/CEC); XP; passive or slave
G[ ]	Divisions (NEC/CEC); XP; active

[ ] = Ex-Revision A, B,...

LB480 - 1 1 - 1[ ] - 1 1 - r 1 - 0 0 0 - L	
0 0	without Ex-approval, passive, M20 socket
Z 0	without Ex-approval, active, M20 socket
	Signal output
0	Slave detector
1	HART® (RS-485 terminated)
2	HART® (RS-485 not terminated)
	Power supply
1	$24V_{DC05}$
2	100V to $240V_{AC}$
	Collimator
0	without
a	axial
r	laterally positioned or laterally 66° for SuperSENS
f	axial 316L
s	lateral 316L
	Housing material
1	1.4301 (Standard)
3	316L
	I/O extensions
0	without
	Special approvals
0	none
S	SIL
	Special version
0	none

LB480 - 1 1 - 1[ ] - 1 1 - r 1 - 0 0 0 - L

	Application
0	Slave LK1
S	Switch LK1
T	Switch LK2
U	Switch LK3
V	Switch LK4
W	Switch LK5
L	Level LK2
M	Level LK3
N	Level LK4
O	Level LK5
D	Density LK3
E	Density LK4
F	Density LK5
G	SWITCH SPEEDSTAR LK4
H	SWITCH SPEEDSTAR LK5
J	LEVEL SPEEDSTAR LK4
P	LEVEL SPEEDSTAR LK5
K	DENSITY SPEEDSTAR LK5

(LK = License Key)

IMPORTANT

In case of CrystalSENS and UniSENS:
An optional water cooling that is mounted on the detector at the factory, bears the following marking on an additional type plate: LB 480-AA-xx-xx-xx-xxx-x. The placeholder "AA" replaces the corresponding characters on the type plate on the detector.

2

Installation

Please pay attention to:

– the national safety and accident prevention regulations
– the national assembly and installation directions (for example, EN 60079)
– the generally accepted engineering rules
– the information on transport, assembly, operation, service, maintenance in this User’s Manual
– the safety instructions and information in this User’s Manual and the enclosed technical drawings and wiring diagrams
– the parameters, limit values and the information on operating and ambient conditions on the type labels and in the data sheets
– the labels on the device

CAUTION

Health hazards due to radiation!
Radiometric measuring devices utilize radioactive substances.

Danger due to radioactivity may occur if persons are exposed to radiation as a result of improper working with the measuring system.

Only persons who are trained in the handling of radioactive materials and possess the necessary know-how and skills are allowed to work with these measuring systems, see *Volume 1*, *chapter 3, "Qualification of Personnel"*, *page 1-19*. Construction site personnel with experience in transporting heavy components may also be commissioned to carry out the installation. This construction site personnel, however, has to be guided by qualified persons; the Radiation Safety Officer has to be consulted for transportation and installation of the source.

Careful conformance to these regulations ensures that no hazard exists for persons using the devices.

Please be sure to comply with the Radiation Protection Guidelines applicable in your country and observe the Radiation Protection Instructions in *chapter 9, page 1-121*.

Storing the shieldings

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

⚠ WARNING

Risk of injury!

The weight of the source shielding may be up to several 100kg, depending on the version.

Make sure that the mechanical stability of the mounting devices matches the weight of the shielding and that the operating staff is wearing hard hats and safety shoes whenever doing any work on the shielding.

Take the shielding out of the box just prior to installation. Up to that time, store the shielding with the radioactive source in a location that is guarded against unauthorized access, see *chapter 2.1.4* on *page 2-182*.

Detector

Damaged cable glands must be replaced immediately. Under no circumstances should the detector be operated with damaged cable glands. If moisture has penetrated, you have to dry the terminal compartment.

Detectors which are used in hazardous areas must not be put into operation again following a mechanical shock or drop, as the explosion protection is no longer guaranteed. If this happens, the detector must be examined by a person authorized by BERTHOLD TECHNOLOGIES. If this is not possible, you have to replace the entire detector or return it to the manufacturer for inspection.

Corrosion resistance

The housing of the detector is made of stainless steel 1.4301 (304) and is therefore well protected from corrosion. The protection provided by stainless steels consists of a passive oxide layer on the surface, which is formed by oxidation with oxygen. However, if the surface gets damaged by unalloyed steel and particles of the unalloyed steel remain on the surface (ferrous contamination), then the surface may corrode at this contact point. Make sure, therefore, that neither during installation nor during operation other metal parts made of non-alloyed steel come into contact with the housing surface of the detector.

Mounting position

Size and position of the measuring range to be covered are determined in the projection phase for the measuring site and defined by drawings, sketches or details in writing. For assembly, these specifications have to be observed closely, since deviations may cause malfunctions of the measuring system.

Using the drawings of the shielding and taking into account the circumstances at the measuring site, carefully install the mounting brackets and fixtures.

2.1 Transport to the Installation Site

⚠ **WARNING**

Risk of injury!

- Never step under hovering loads while unloading heavy system parts!
- Only use tested lifting equipment matching the transport weights.
- Maintain adequate safety margin.
- Wear hard hat and safety shoes.

Transportation may also be carried out by construction site personnel with experience in transporting heavy components. However, this construction site personnel has to be guided by authorized persons; the Radiation Safety Officer has to be consulted for transportation of the source.

2.1.1 Transporting Detector and Evaluation Unit

NOTICE

Risk of damage!

System parts may get damaged during transport.

Transport the detector and evaluation unit in the original packaging and protect the parts from vibrations.

2.1.2 Transporting Shielding with Source

Please observe the Radiation Protection Guidelines. Radioactive substances may be transported on public traffic routes only by persons in possession of the proper transport license!

⚠ **CAUTION**

Health hazards due to radiation!

A source may be transported only in its shielding. The shielding must be closed during transportation and installation.

The shielding with the source inside can be lifted onto a palette by a fork-lift and transported to its destination. If the system parts are provided with eyebolts for transportation, they have to be used for lifting, unless the system parts are transported in their original packaging.

2.1.3 Temporary Storage of Sources

The operator has to take suitable provisions for temporary storage of sources at the place of installation between the period from source delivery to the start of the installation work.

Sources will be stored in their shieldings. A source may be stored only in a lockable room which is identified accordingly. Accessible controlled areas have to be identified and, if necessary, secured.

2.1.4 Installation Sites

⚠ WARNING

Risk of injury!

Heavy system parts may fall down if not installed properly.

The bearing capacity of the vessel walls or the brackets must be suitable for installation of the source with the shielding and the detector.

Free space must be foreseen at the installation site for:

- Freedom of motion for delivery of shielding, detector and evaluation unit.
- The electrical installation of the detector.
- Servicing and repair work, to install and dismantle parts.

The fixture for the assembled system components must not transfer any vibrations to the detector or the shielding. Likewise, it has to be ruled out that too high temperatures can be transferred to the system components.

The source with shielding and the detector are horizontally installed on the designated position on the outside of the vessel and outside a possibly installed heat insulation. The exact position for your system parts is stated on the calculation documents and the technical information prepared by BERTHOLD TECHNOLOGIES.

2.1.5 Unpacking and Cleaning System Parts

After unpacking, compare all parts with the packing list and check if the shipment is complete and shows any sign of damage. If necessary, you may have to clean parts.

If you detect any damage, notify the forwarder and the manufacturer immediately.

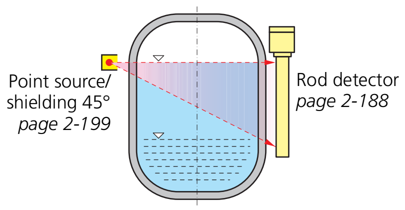
2

2.2 Source Detector Arrangements

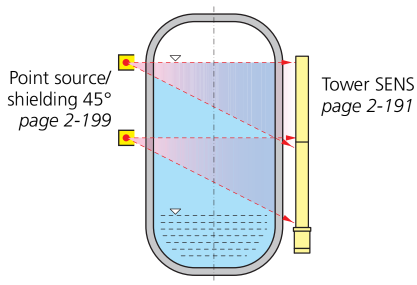
BERTHOLD TECHNOLOGIES offers a large number of options for your particular measurement setup. The schematic drawings below show examples of different arrangements which will guide you to the respective installation instructions. Since other arrangements are also possible, the installation of the detector side and the source side will be explained separately. For this reason, you may find the installation instructions for the detector in another setup example than the instructions for the source.

Continuous level measurement

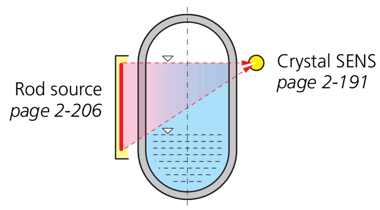
Point source with shielding 45° and rod detector



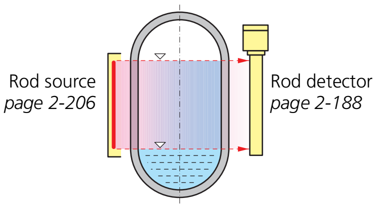
Point source with shielding 45° cascaded and Tower-Sens



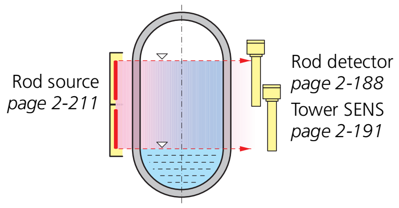
Rod source with shielding and point detector NaI 50/50 or Super-Sens



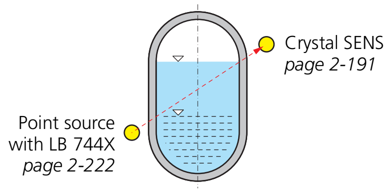
Rod source with shielding and rod detector



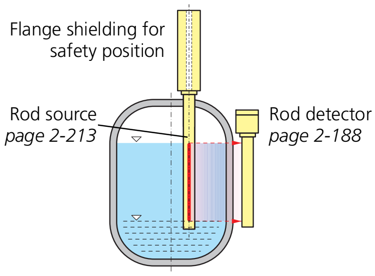
Rod source with shielding cascaded and rod detector cascaded or Tower-Sens



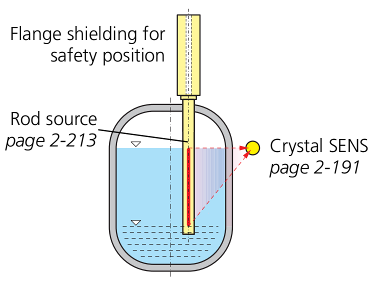
Point source with shielding LB744X and point detector NaI 50/50 or Super-Sens



Rod source in dip tube and rod detector

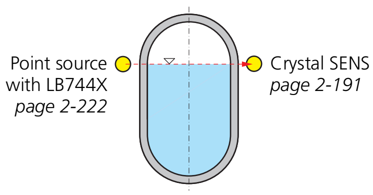


Rod source in dip tube and point detector NaI 50/50 or Super-Sens



Limit switch

Point source with shielding LB744X and point detector NaI 50/50 or Super-Sens



The limit switch differs from the continuous level measurements in that the exceeding of the level is specifically detected at a certain position and reported. This position is physically fixed by the mechanical arrangement and is highly reliable to prevent over- and underfilling.

IMPORTANT

If a suitable arrangement example should be missing for your special application, you will receive special documents in advance. Please contact us if you did not receive these documents. By means of the source number which you find on the shielding it is easily possible to provide you with the suitable information on this measuring site.

2.3 Detector Protection

NOTICE

Risk of damage!

The detector may be damaged due to strong mechanical stress, vibrations and high temperatures.

Prevent heat transfer from the detector holder to the detector by using a suitable heat-insulation spacer.

2.3.1 Cooling

The ambient temperature must not exceed the values specified in the technical data (see *Volume 2*, *chapter 1.5*, *page 2-170*). If temperatures exceeding 50° C are expected, you have to use a detector with water cooling jacket (see *page 2-195*). The cooling water cycle has to remain in operation even when the detector is turned off, if the maximum operating temperature is likely to be exceeded.

NOTICE

Risk of overheating!

A failure of the water cooling or insufficient flow can overheat and thus destroy the detector.

The maximum ambient temperatures are listed in the technical data in *chapter 1.5*, *page 2-170*. In addition:

- To prevent freezing, the water cooling system must be drained.
- Polluted cooling water may clog the water cooling system, which may result in the detector getting overheated and destroyed. It is therefore essential to use clean cooling water.
- The water pressure in the cooling jacket must not exceed 6 bar.

Water cooling in Ex-areas

The information in the Safety Manual regarding the ambient temperature for explosion protection also apply to the operation of a water cooling on detectors that are used in hazardous areas.

Detector temperature monitoring

The detector includes an internal temperature measurement which can be used to trigger a pre-alarm if higher temperatures are measured. The temperature switching point can be adjusted (see *Volume 3, chapter 2.32*). The alarm can be picked up at the digital output. If you operate the water cooling so that the temperature at the detector remains below 40° C, you could switch off the detector on exceeding a temperature limit of e.g. 50° C prematurely to protect the detector against overtemperature.

Cooling water curves

The required amount of cooling water is dependent on the possible heat transmission, the cooling water temperature and the detector type. You find the cooling water curves and further information in the technical specifications on *page 2-249*.

Connecting the water cooling

Water is always supplied from the bottom to prevent air pockets that can drastically reduce the cooling effect. Therefore, the detector has to be aligned so that the water exits at the highest point (see illustration on page *page 2-256*).

2.3.2 Sun Protection

If the detector is installed outdoors, it should be protected against exposure to direct sunlight by a weather protection roof.

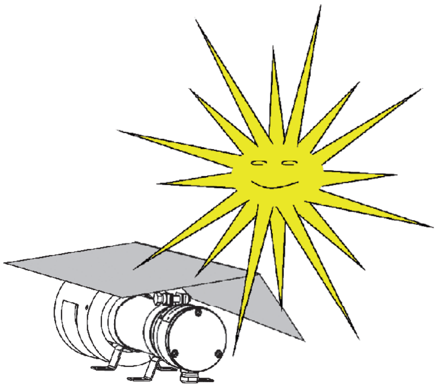


Fig. 2-1 Sun protection

2.3.3 Heavy-Duty Environments

When selecting the installation site, keep in mind that the detector should not be affected by mechanical stress or heavy vibrations, in order not to restrict its service life. If the measuring system is used in a heavy-duty environment, the detector and the shielding should be provided with an additional protective cover.

2.3.4 Precautions against Vibrations

Excessive vibrations or shocks on the detector shorten the service life. Mount the detector on a vibration-free support; you may also dampen possibly occurring vibrations or shocks using appropriate vibration absorbers.

2.3.5 Magnetic Fields

The detector is provided with an internal shielding that protects the photomultiplier against magnetic fields. Nevertheless, strong magnetic fields in close proximity to the detector may impair its function. In this case, the detector can be protected by an additional thick-walled steel tube, or the measuring point has to be relocated to another suitable position. In these cases BERTHOLD TECHNOLOGIES would be happy to help you.

2.3.6 Cleaning

Take care not to damage the cable glands and the type plates during cleaning. The detector may be cleaned with water or gasoline. Remove coarse deposits with a wire brush. Grinding, filing or chipping away at deposits with the hammer is not permitted.

2.4 Detector Assembly

Make sure that

– the detector or the source fixtures do not obstruct the beam path.

– there are no pipes, flanges, stirrers or other installations in the beam path.

Only installations that have already been taken into account in planning the measurement configuration are permitted. Otherwise, the curve is no longer linear; there may even be sections in the measurement range where the measured values do not change.

2.4.1 Rod Detector with and without Water Cooling

The rod detector is mounted vertically on the outside of the vessel. The top point of the effective detector length is marked by a marking groove, which also defines the top point of the measuring range that can be covered. Please note the dimensional drawings of the rod detector (*page 2-251*).

As shown in *Fig. 2-2*, the rod detector is mounted *outside* the marking grooves, with one fixing clamp each at the top and at the bottom. The distance from the center of the detector to the surface of the vessel or the surface of a thermal insulation is about 100 mm. The clamps have to be arranged so that no heat is transferred to the detector.

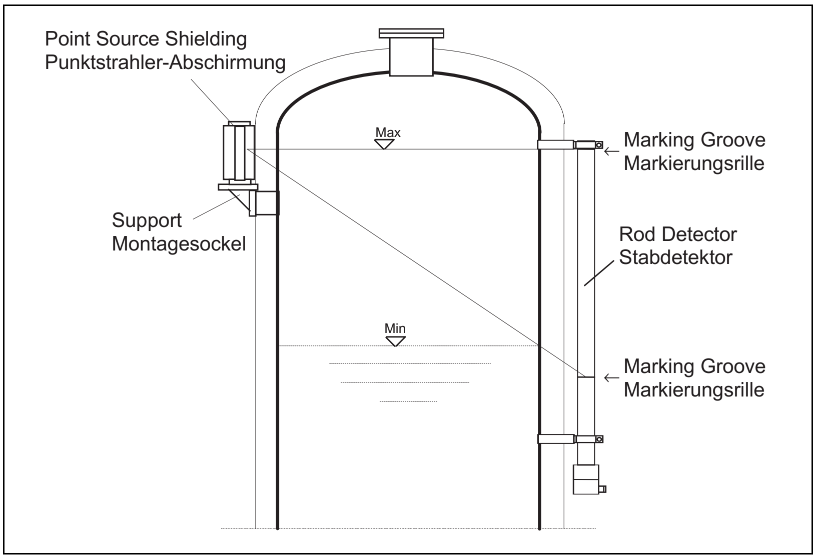


Fig. 2-2 Rod detector installation, example with point source

Rod detector with detector shielding (collimator), with and without water cooling

Due to the weight of the collimator, a mounting foot has to be used which will carry the detector with collimator. In addition, an anti-tipping device has to be installed at the upper flange. Otherwise, the installation has to be carried out as shown in *Fig. 2-2*.

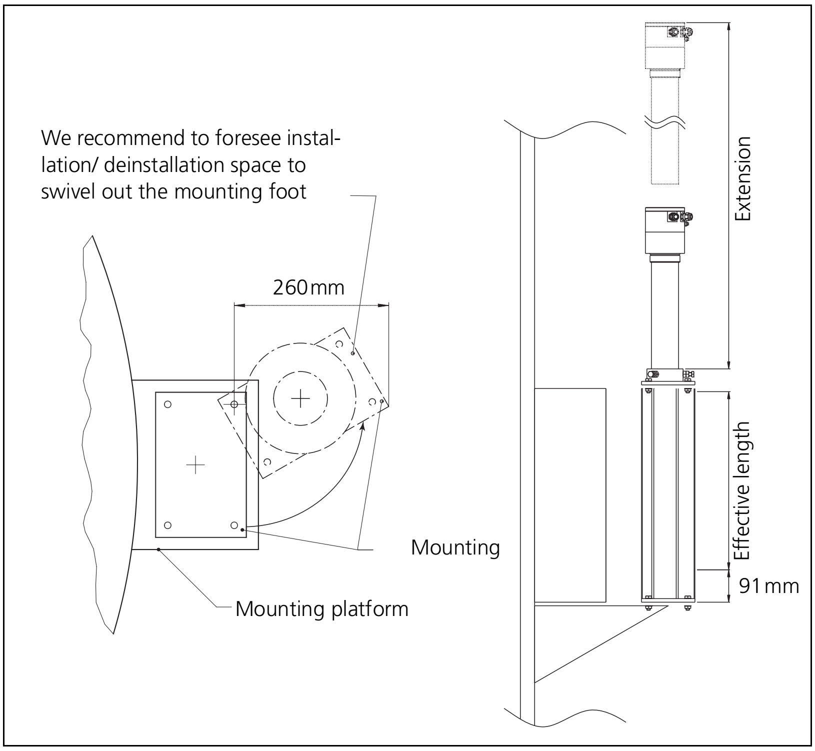


Fig. 2-3 Installation proposal for rod detector with collimator

For details on how to position the collimator please see the technical drawings.

Multi-detector arrangement

Several detectors are necessary to cover detector lengths of more than 2m (alternative: Tower-Sens). The detectors are arranged such that the sensitive areas of the detector overlap seamlessly. The detectors are slightly offset on the side (*Fig. 2-4*). The sensitive areas are marked by grooves, see also *Fig. 2-22* on *page 2-205*.

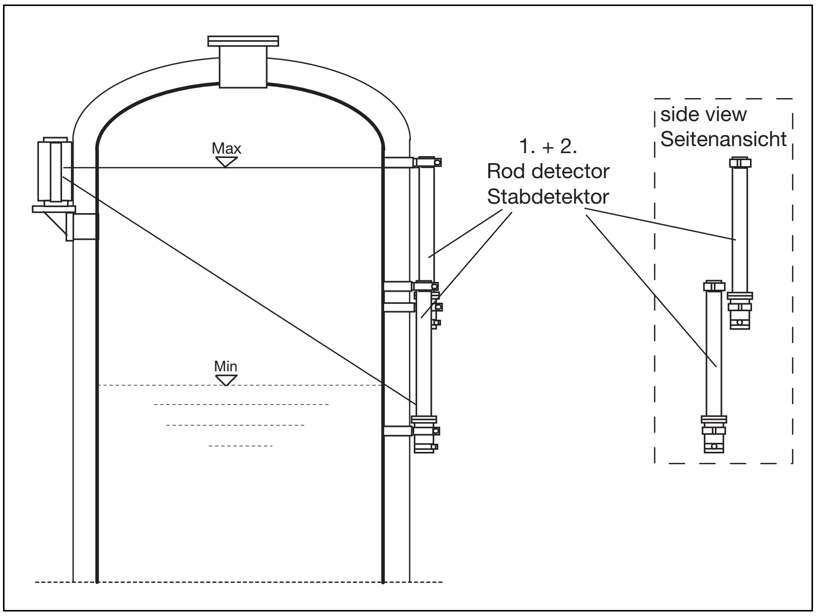


Fig. 2-4 Multi-detector arrangement

For installation details see the technical drawing (see *page 2-249*).

2.4.2 TowerSENS

See *chapter 5.2, "TI LB 480 TowerSENS"* on *page 2-284*.

2.4.3 CrystalSENS (Point Detector)

With point source

The combination of CrystalSENS and point source is typically used to measure the limit level (*Fig. 2-5*). The detector is aligned on the same height relative to the source.

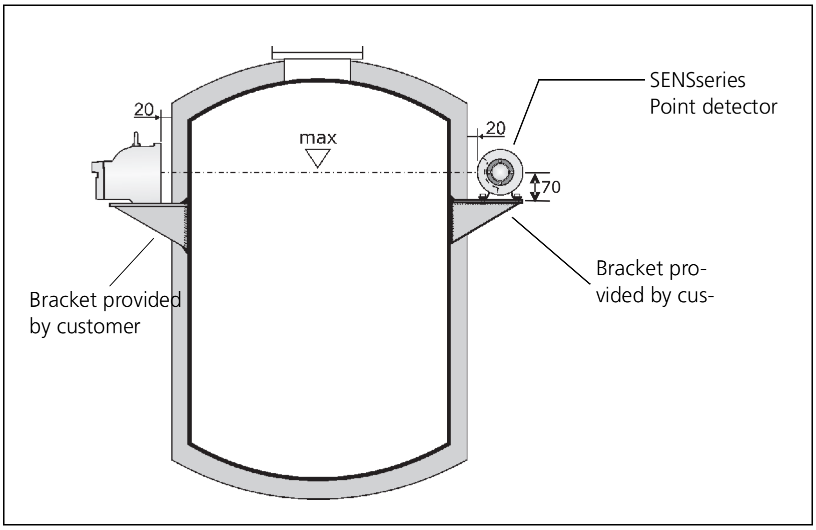


Fig. 2-5 Limit level measurement

With rod source

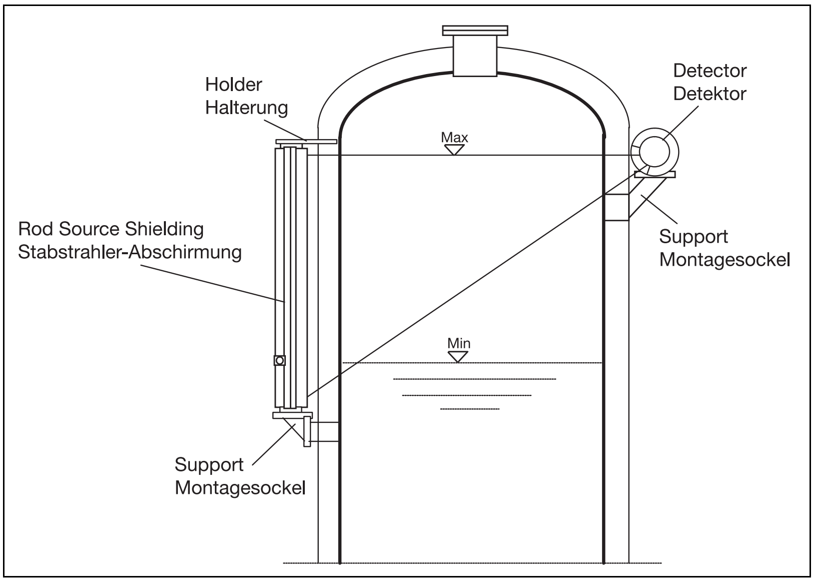


Fig. 2-6 Continuous level measurement

As shown in *Fig. 2-6*, the size of the measurement range for continuous level measurement is defined by the radiation field received by the detector; this radiation field has to be taken into account during installation of detector and shielding. The installation situation is illustrated in the project drawings, sketches and descriptions.

IMPORTANT
When installing the CrystalSENS, please pay attention to the correct alignment relative to the source. The lateral opening (beam window) in the collimator releases the sensitive area of the detector and must be directed at the source.

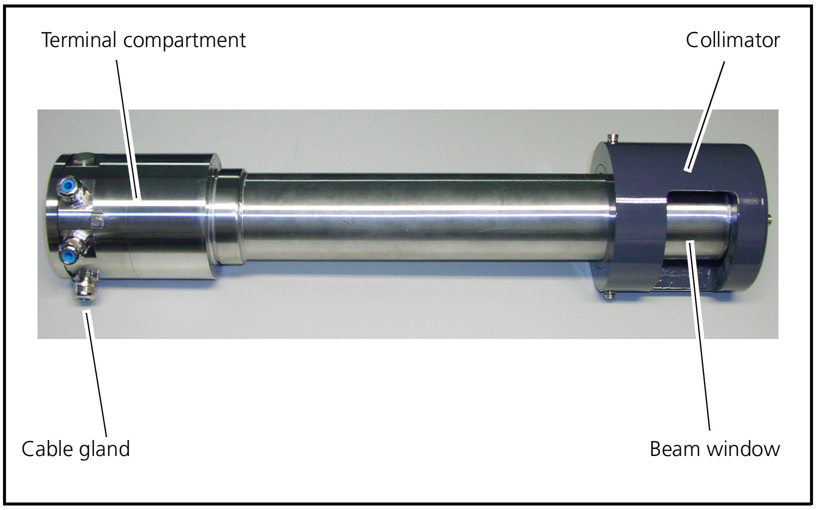


Fig. 2-7 CrystalSENS

The CrystalSENS is installed on the container using a fixture that is provided by the customer. The distance to the surface of the vessel or the surface of a thermal insulation should be about 100 mm.

Clamps (see *chapter 2.4.4*) or an installation kit (see *chapter 2.4.5*) are used for installation of the detector on a bracket.

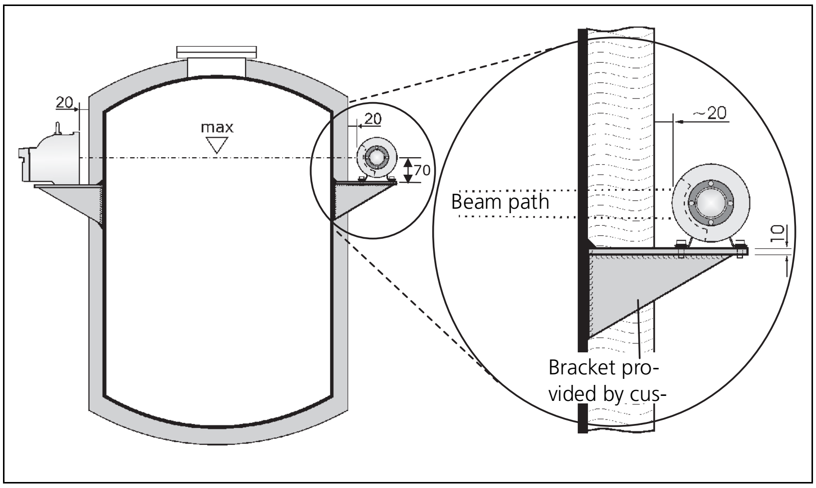


Fig. 2-8 Installing the CrystalSENS

If the bracket cannot be mounted on the container, then it has to be mounted on a support in the vicinity.
Fig. 2-9 shows three further alternative proposals (A, B, C) to mount the detector.

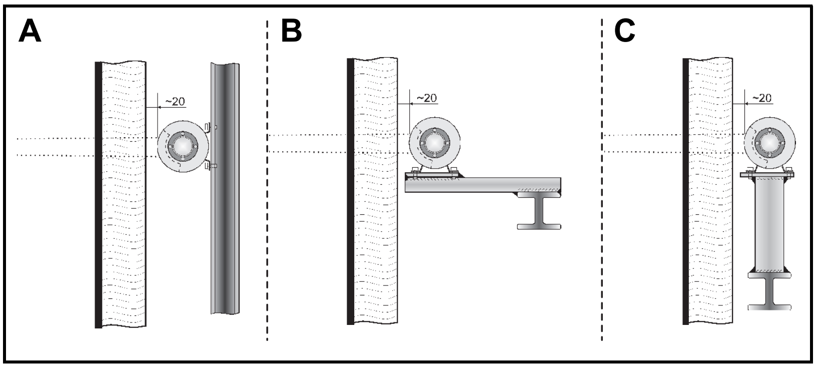
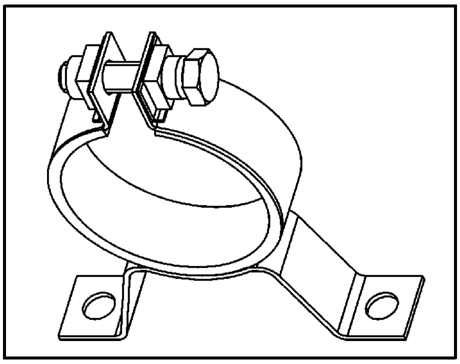


Fig. 2-9 Alternative installations

The technical drawings for CrystalSENS and its accessories can be found in *chapter 5, "Technical Informationen",* on *page 2-249*.

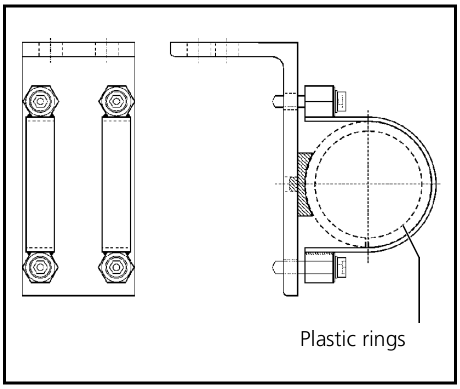


2.4.4 Installation Procedure using Fastening Clamps

Stainless steel clamps are available for the installation of the detector.

Clamps for CrystalSENS without water cooling	Clamps for CrystalSENS with Water cooling
ID No. 31346 (1 set = 2 clamps)	ID No. 31347 (1 set = 2 clamps)

1. Make a suitable bracket for the container according to the drawing on *page 2-258*.
2. Mount the bracket either directly on the container or on a stable support.
3. Mount the detector with the clamps on the bracket (see *chapter 5.1, "TI LB 480 Level"*).



2.4.5 Installation Procedure with Mounting Kit

A robust stainless steel holder is available instead of the clamps.

The holder consists of an angle on which two clamps are already mounted. You can bolt or weld the holder on a bracket.

For detectors without water cooling system you have to use the plastic rings shown with dashed lines in the drawing to the left for installation. They compensate for the difference in diameter between detectors with or without water cooling. Thus, the same bracket can be used for detectors with and without water cooling.

All metal parts of this holder are made of stainless steel. You find the technical drawing with dimensions in *chapter 5* on *page 2-249*.

Mounting Kit for CrystalSENS
ID No. 39246

1. Make a suitable bracket for the container according to the drawing on *page 2-259*.
2. Mount the bracket either directly on the container or on a stable support.
3. Mount the holder with the detector on the bracket.

2.5 Water Cooling

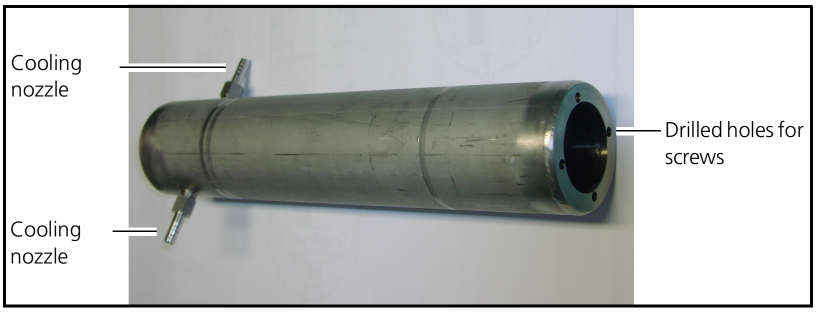


Fig. 2-10 Water cooling

If you have ordered the detector together with the water cooling, the water cooling is already mounted.

If you order the water cooling later, then you have to install it according to the following instructions.

Installing the water cooling

1. Remove the four front screws and pull the collimator from the detector.

NOTICE

To attach the collimator and the water cooling later to the detector again, you need four screws that are 5 mm longer than the original screws (not included).

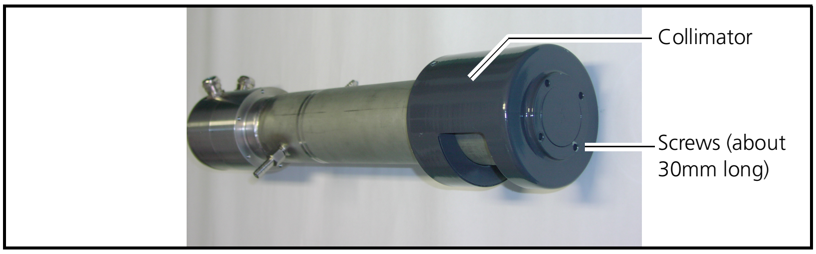


Fig. 2-11 Mounting screws for collimator

2. Slide the cooling jacket over the detector.

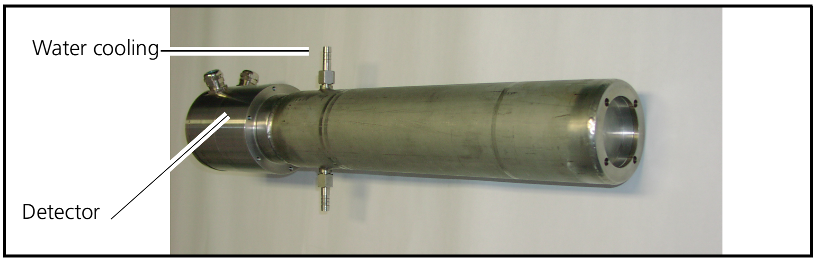


Fig. 2-12 Detector with water cooling

3. Remove the plastic ring from the collimator by opening the screws on the side of the collimator.

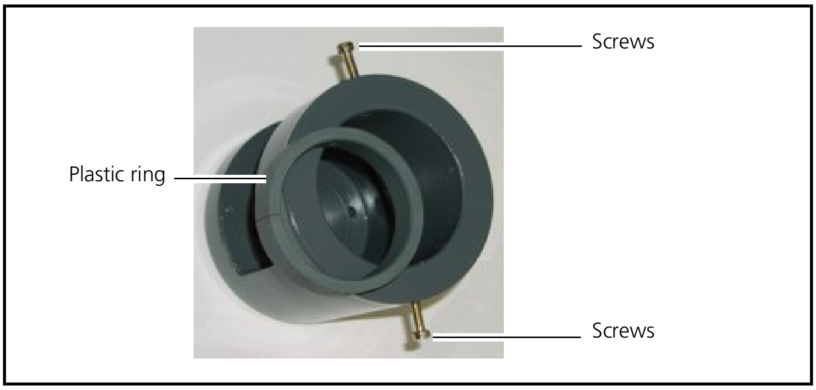


Fig. 2-13 Collimator for detector

4. Slide the collimator over the water cooling system, so that the beam window is facing the source. Position the collimator and water cooling relative to the pitch circle of the detector. Make sure that the position of the cooling nozzle is arranged so that later you have unhindered access to the installation of the water supply.

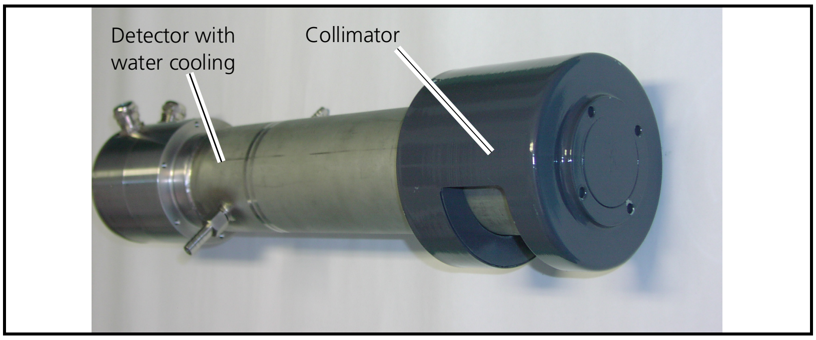


Fig. 2-14 Detector with water cooling and collimator

Please read the information on the water cooling on *page 2-186*.

2.6 Shielding

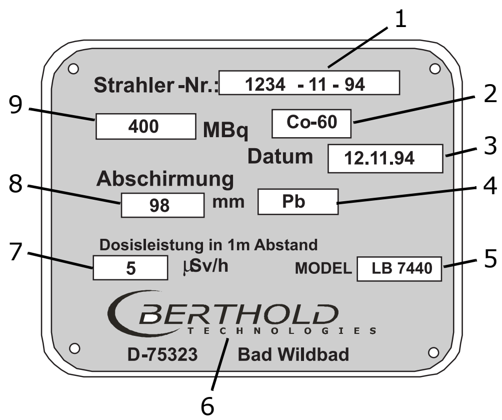
Shielding, source type, isotope and activity for each measurement configuration will be selected together with the customer to ensure compliance with the local dose rate limits. Co-60 or Cs-137 point sources are used which are tightly welded into a capsule made of titan or stainless steel. Therefore, no radioactive material can escape, provided the source is intact, and contaminations are ruled out.

For point source shieldings, the capsule with the source is fixed on a source holder and installed in the shielding. For rod source shieldings, a rod source is placed into the existing borehole of the shielding. The shielding matches the length of the source.

The distance from the source shieldings to the vessel surface is designed such that reaching into the beam channel with the hand is prevented (reference value approx. 20 mm). For shieldings with a rotary cylinder (vertically standing cylinder) make sure that the cylinder can be rotated on the vessel surface without friction.

Apart from a few exceptions, all shieldings are filled with lead to keep the dose rate on the surface with small construction sizes as low as possible. Therefore, the shieldings are quite heavy. The weights are listed in the technical drawings in *chapter 5* on *page 2-249*.

For information on the design of source and shielding please refer to the technical documentation and the type plate (*Fig. 2-15*).



1 Source number
2 Isotope
3 Source manufacture date
4 Shielding material
5 Type of shielding
6 Shielding manufacturer
7 Dose rate in 1 m distance
8 Effective shielding thickness
9 Activity

Fig. 2-15 Identity plate

Please observe the safety instructions in *Volume 1* on *page 1-121*. A source may be transported only in its shielding. Keep the source shielding closed during storage, transportation and installation.

The arrangement of the sources is defined during the planning stage and entered in a drawing or defined in writing. These details must be observed carefully to ensure correct linearization data. Detailed information about the design and function of each shielding being used can also be found in the drawings, which are included in the documentation.

2.6.1 Point source shielding 45°

The radiation warning sign identifies the start of the controlled area, provided the controlled area is *outside* the shielding. If the controlled area is *inside* the shielding, then the radiation warning sign attached on the shielding suffices.

Fig. 2-16 Radiation warning sign

CAUTION

Increased radiation dose due to open beam channel!

A too high dose of radiation may be harmful to your health.

A source may be transported only in its shielding. The shielding must be closed during transportation and installation.

The shielding has a fan-shaped exit channel which emits radiation towards the front and downward up to an angle of 45°. This allows the shielding to be mounted vertically which simplifies the construction of the fixing bracket and the installation the shielding, since the fixture need not be inclined at a certain angle, but is placed vertically onto the bracket. During installation, the shielding and thus the useful beam must be aligned such that they point exactly towards the detector.

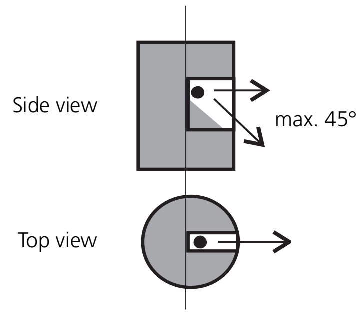


Fig. 2-17 Point source shielding 45°

2

NOTICE

Function failure due to damage

The detector fixture must not transfer any vibrations or heat onto the shielding; otherwise the locking mechanism may be damaged and the shielding effectiveness may be adversely affected.

Therefore, install the fixture on a vibration-free support or attenuate possible vibrations using vibration absorbers. Prevent heat transfer by using suitable insulating materials.

Install shielding 45°

IMPORTANT

Before installing the source shielding or the source, you have to determine the background (see Volume 3, chapter 7.1).

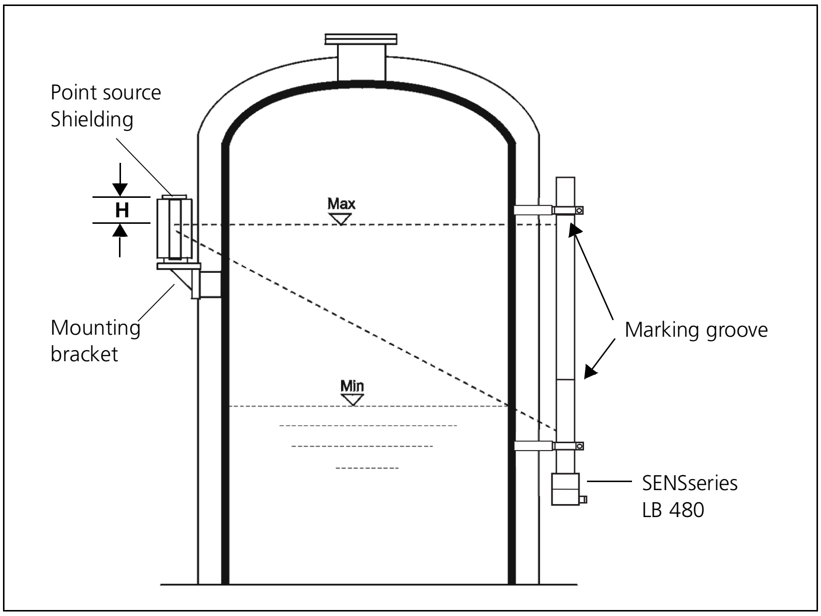


Fig. 2-18 Point source with rod detector

The standard arrangement (*Fig. 2-18*) shows the mounting position of the shielding with point source; *H* indicates the topmost point of the measuring range that can be covered. The shielding must be mounted on a suitable fixture that is provided by the customer in the appropriate height, so that the upper edge of the shielding is positioned above the measuring range offset by the size *H*.

Size H for various shielding types

Shielding type	Size H (in mm)
100	115
150	115
200	155
270	200

The distance from the source shieldings to the vessel surface is designed such that reaching into the beam channel with the hand is prevented (reference value approx. 20mm).

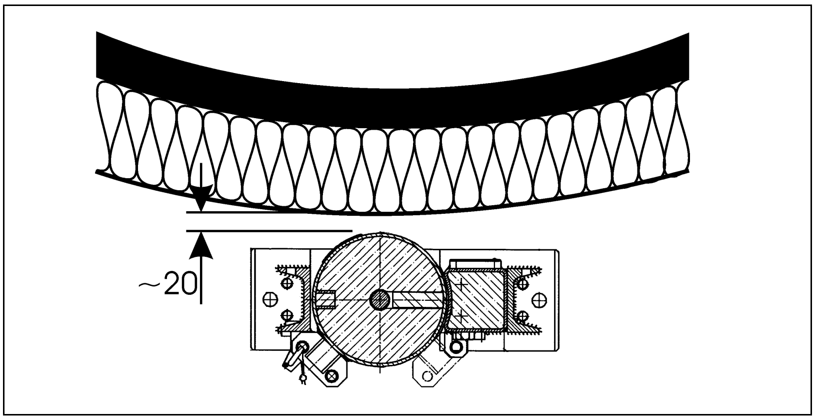


Fig. 2-19 Distance of the source shielding from the vessel surface

See "Technical Information" in *chapter chapter 5* for the dimensions of the various shieldings.

Fig. 2-20 shows a proposal for a mounting bracket for the source shielding. The size and rigidity of the mounting bracket has to match the size and weight of the shielding. The bracket has to be mounted in the appropriate height, if possible, directly on the vessel or on another supporting structure.

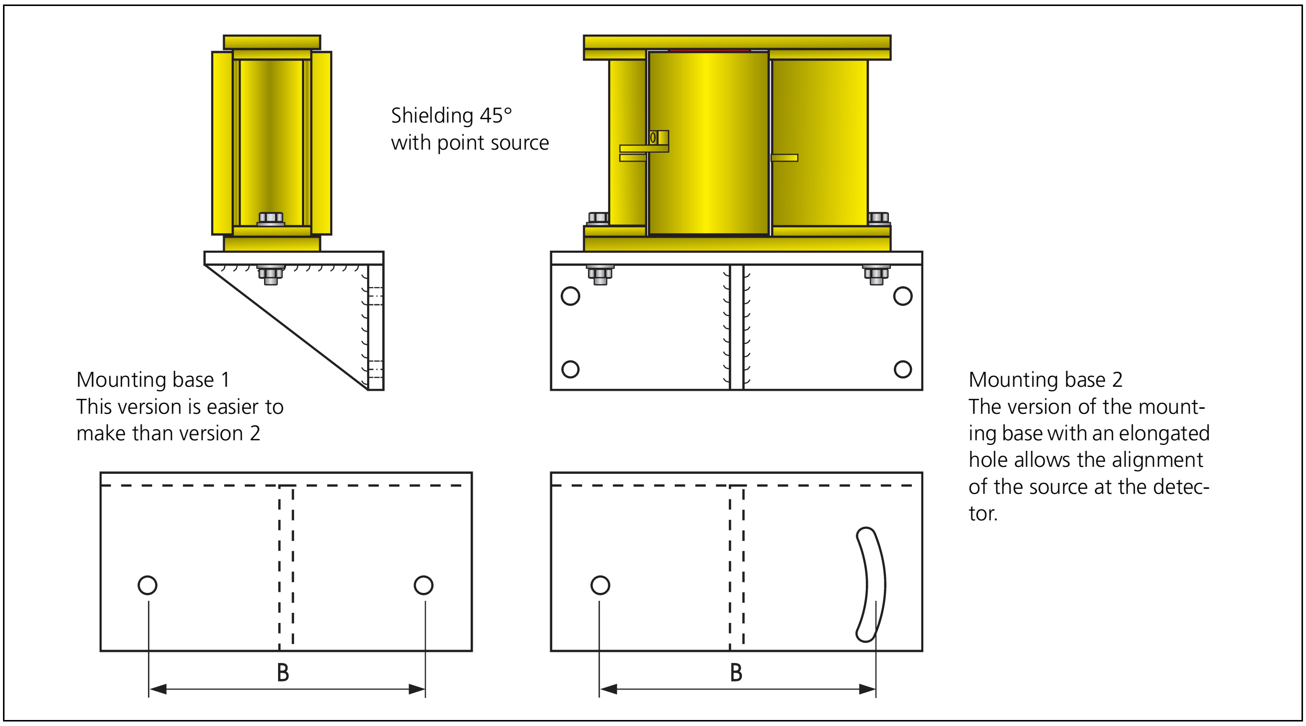


Fig. 2-20 Installation proposal shielding; size B see "Technical Information" in chapter 5

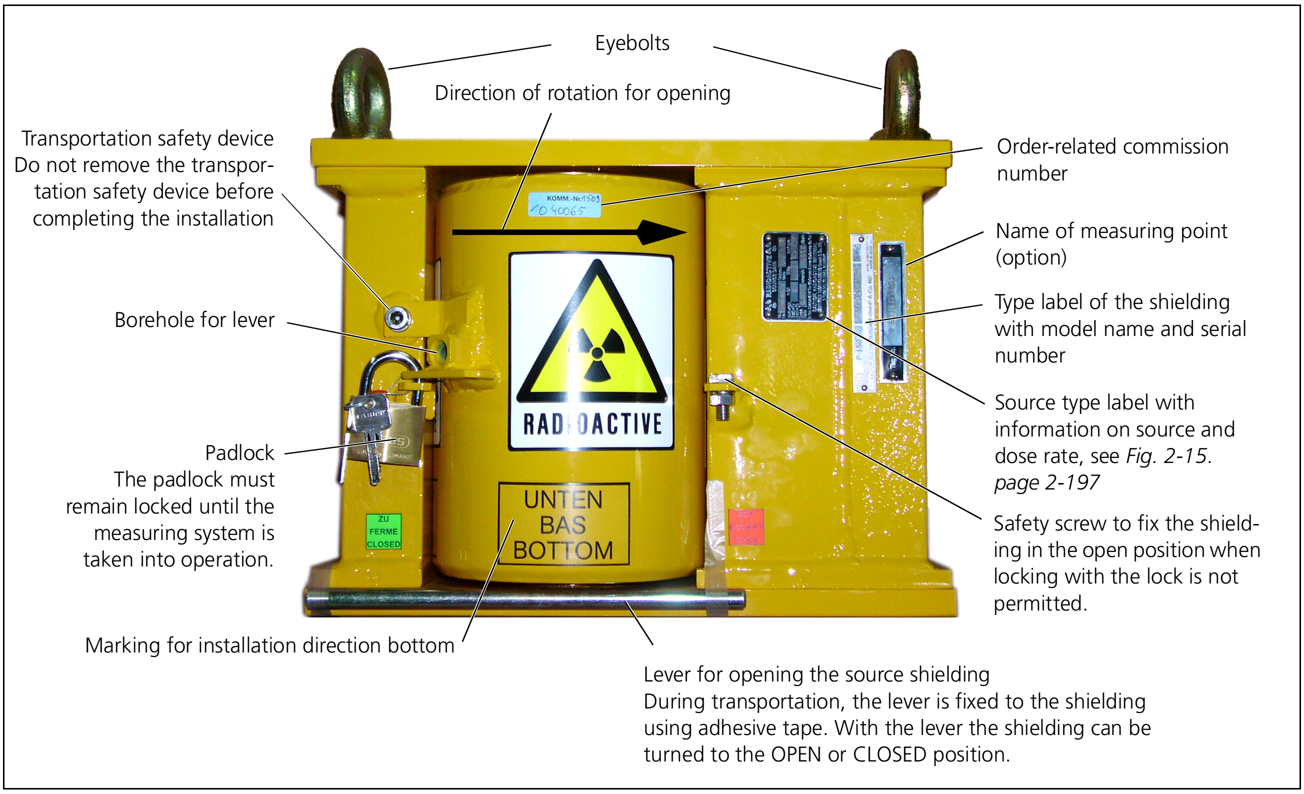


Fig. 2-21 Shielding closed, view from operator's side; the opposite side is facing the vessel or the detector

IMPORTANT

Following installation of the shielding, the function of the locking mechanism has to be tested. The function check has to be carried out every six months and recorded.

Open shielding

After the shielding has been installed, it may be opened only for commissioning. Open the transportation safety device and open the lock. Now use the lever fixed to the base with adhesive tapes and plug it into the borehole for the locking mechanism. Open the beam channel by turning the lever to the right up to the right limit stop.

This position can now be locked again with the padlock to prevent inadvertent closing of the beam channel during operation. If locking with the lock should not be permitted, you may also fix the position with the supplied screws.

Pneumatic actuator

Point source shieldings may as an option be supplied with a pneumatic actuator. You find the technical data in *chapter 5*.

⚠ **CAUTION**

Risk of crushing!

The cylinder rotates automatically! Fingers may get jammed on the strap or on the locking piece.

Never change the factory-adjusted setting for attenuation on the pneumatic actuator. This pre-setting ensures that the cylinder rotates slowly and the risk of crushing is low.

2.6.2 Point Source 45° Cascaded

For large measurement ranges or containers with small internal diameter, it may be necessary or beneficial to use two point source inside the measuring range to minimize the total activity and to improve the linearization options. *Fig. 2-22* shows the appropriate measuring geometry. The shieldings are installed below each other in a distance of size *X*. For detailed information on the size *X* please see the respective documentation. Depending on the size of the measuring range, this arrangement can be realized with one or several detectors.

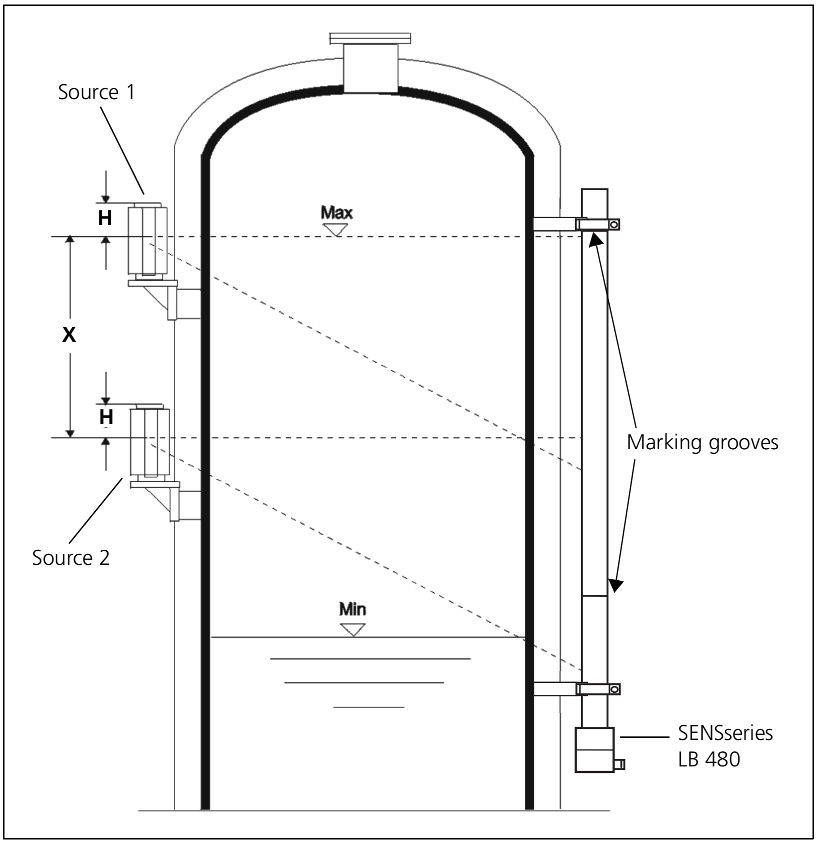


Fig. 2-22 Multi-detector arrangement

2.6.3 Rod source

CAUTION

Increased radiation dose due to open beam channel!

A too high dose of radiation may be harmful to your health.

A source may be transported only in its shielding. The shielding must be closed during transportation and installation.

Rod source shielding

For rod sources, cylinder-shaped shieldings having the length of the source are used which are provided with a source exit channel (see *Fig. 2-23*).

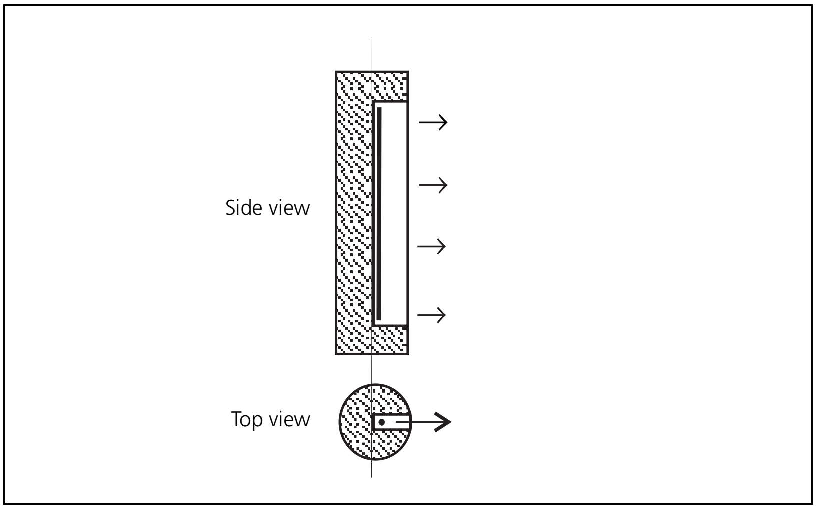


Fig. 2-23 Rod source shielding

These shielding are placed on a suitable bracket at the measuring site. For larger measuring ranges several parts are mounted on top of each other. Robust construction, especially of the moving parts of the rotating shutter, ensures reliable performance even in heavy-duty environments.

NOTICE

Function failure due to damage

The detector fixture must not transfer any vibrations or heat onto the shielding; otherwise the locking mechanism may be damaged and the shielding effectiveness may be adversely affected.

Therefore, install the fixture on a vibration-free support or attenuate possible vibrations using vibration absorbers. Prevent heat transfer by using suitable insulating materials.

Installing the rod source shielding

IMPORTANT

Before installing the source shielding or the source, you have to determine the background (see Volume 3, chapter 7.1).

Size and position of the measuring range to be covered are determined in the projection phase for the measuring site and defined by drawings, sketches or details in writing. For assembly, these specifications have to be observed closely, since deviations may cause malfunctions of the measuring system. *Fig. 2-24* shows a standard arrangement.

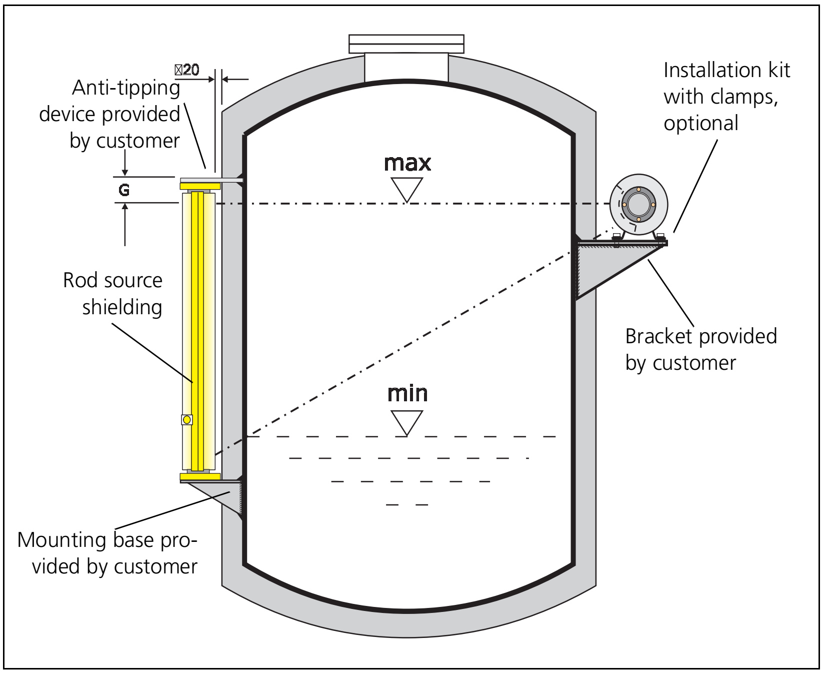


Fig. 2-24 Rod Source Arrangement

The shielding must be mounted at the measuring site, so that the top point of the rod source (size *G*) and the center of the detector are on a horizontal line, which defines the upper point of the measuring range (Max).

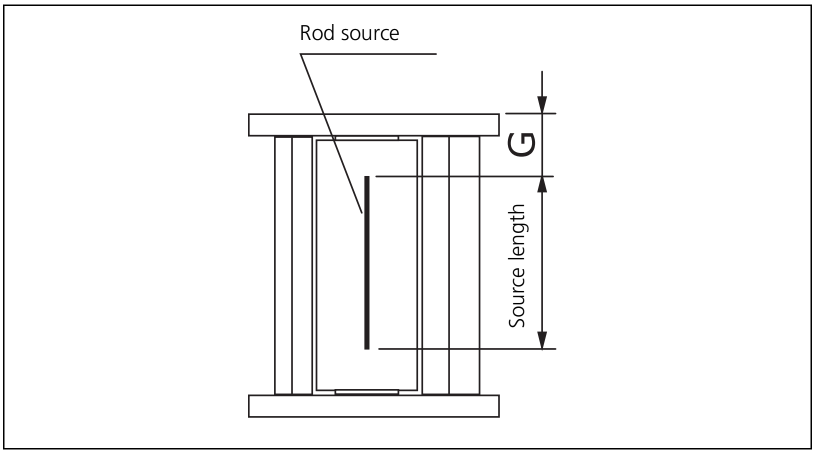


Fig. 2-25 Rod source arrangement, see also next table

Shielding diameter (in mm)	G (in mm)
100	92
150	132
200	169
270	202

The installation height of the supporting structure that is to be provided by the customer has to be measured using the dimensional drawings of the shielding.

The size and stability of the supporting structure or another suitable mounting device for the shielding has to match the size and total weight of the shielding. For safety reasons, every rod source shielding should in addition be secured against tipping over by a support bracket (see also *Fig. 2-28* on *page 2-212*). For information on dimensions and the weight, for which the fixtures are designed, please see the technical drawings of the shielding in *chapter 5*.

Single part shieldings for rod sources have to be marked *top* and *bottom* to rule out any side-inverted installation (see *Fig. 2-26*). The shielding should be installed fairly close to the vessel surface (or the surface of a thermal insulation), so that the measuring range covered is not diminished and it is not possible to reach into the useful beam, which must be prevented for radiation protection reasons. *Fig. 2-26* shows the operator's side, the opposite side must face the vessel.

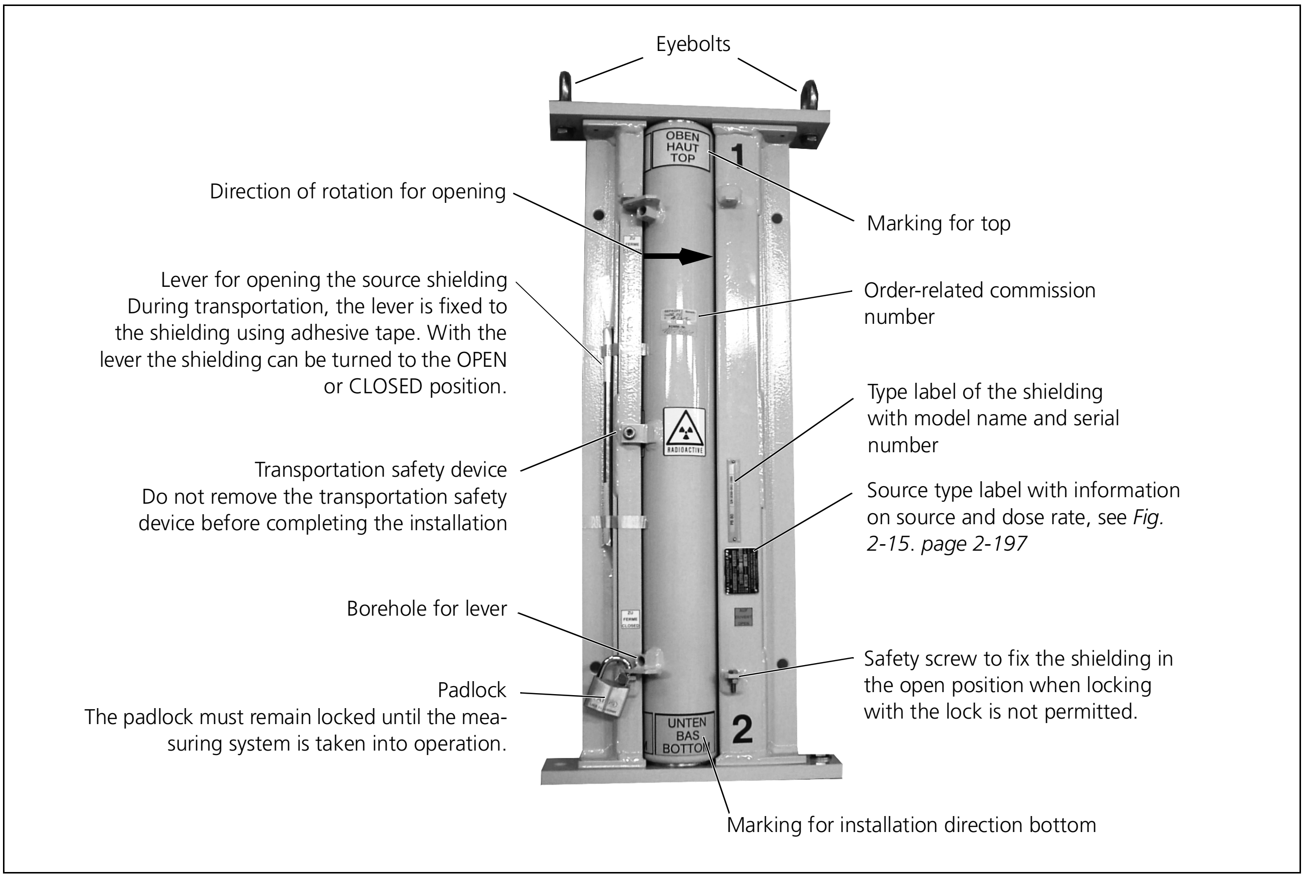


Fig. 2-26 Shielding closed, view from operator's side; the opposite side is facing the vessel or the detector

IMPORTANT

Following installation of the shielding, the function of the locking mechanism has to be tested. The function check has to be carried out every six months and recorded.

Open shielding

After the shielding has been installed, it may be opened only for commissioning. Open the transportation safety device and open the lock. Now use the lever fixed to the base with adhesive tapes and plug it into the borehole for the locking mechanism. Open the beam channel by turning the lever to the right up to the right limit stop.

This position can now be locked again with the padlock to prevent inadvertent closing of the beam channel during operation. If locking with the lock should not be permitted, you may also fix the position with the supplied screws.

Pneumatic actuator

Rod source shieldings may as an option be supplied with a pneumatic actuator. You find the technical data in *chapter 5*.

⚠ CAUTION

Risk of crushing!

The cylinder rotates automatically! Fingers may get jammed on the strap or on the locking piece.

Never change the factory-adjusted setting for attenuation on the pneumatic actuator. This pre-setting ensures that the cylinder rotates slowly and the risk of crushing is low.

2.6.4 Rod Source Cascaded

If several rod sources are needed, the individual parts are arranged directly on top of each other and fixed with screws.

Multi-part shieldings are in addition marked by the letters *A*, *B*, *C* etc. from top to bottom (see *Fig. 2-27*).

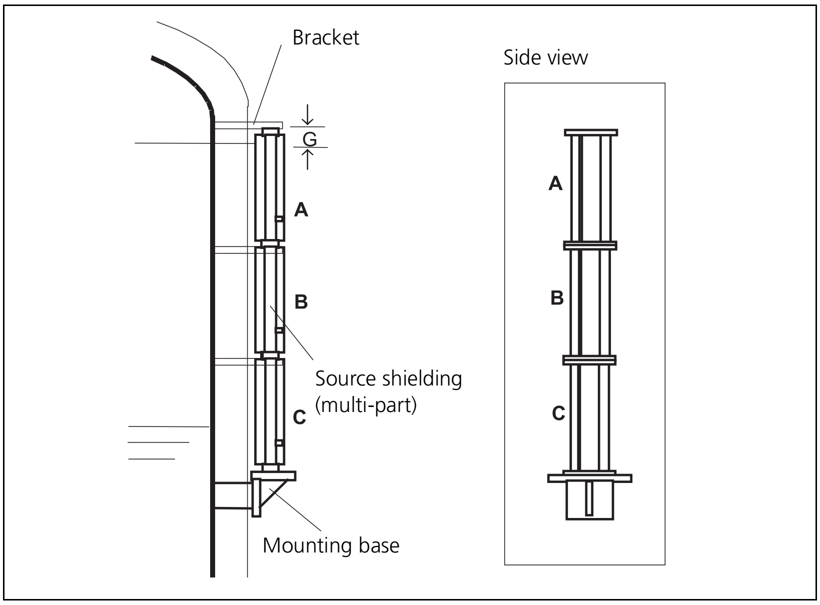


Fig. 2-27 Rod source arrangement (multi-part)

Each part must be secured adequately, e.g. by using a flat iron as anti-tipping device (*Fig. 2-28*).

IMPORTANT
Following installation of the shielding, the function of the locking mechanism has to be tested. The function check has to be carried out every six months and recorded.

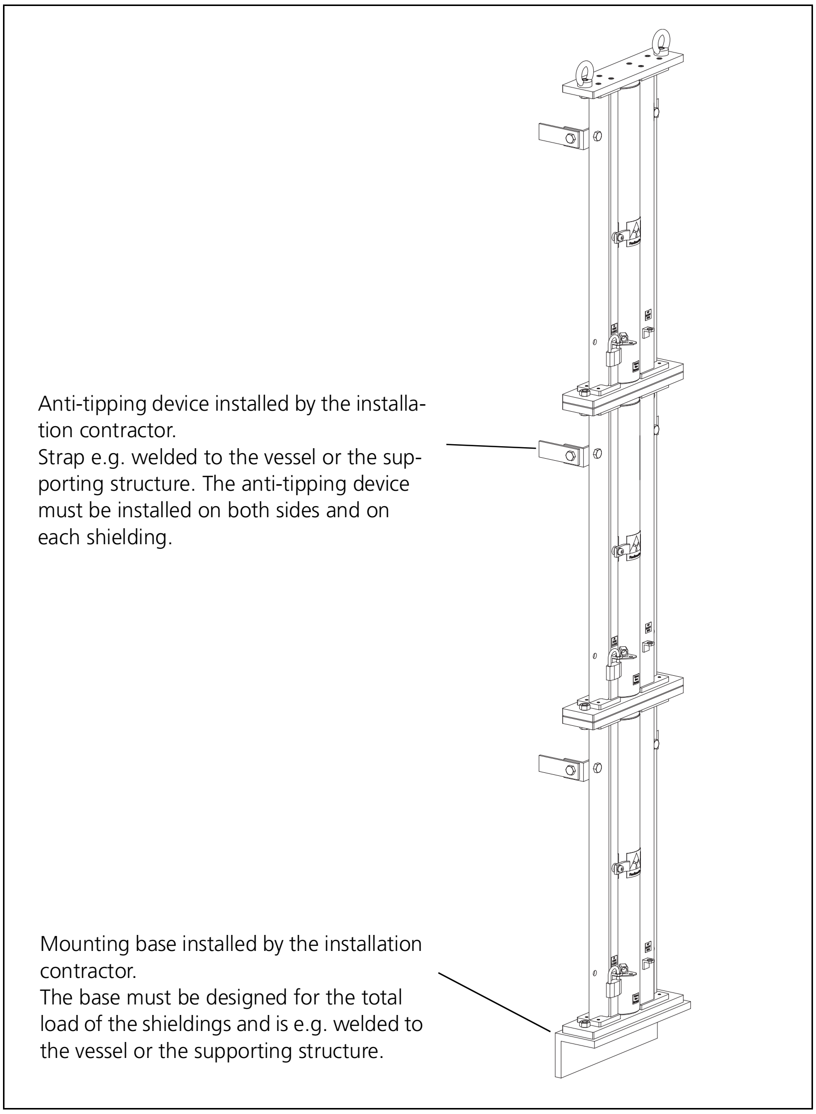


Fig. 2-28 Installation of multi-part rod source shieldings

Open shielding

After the shielding has been installed, it may be opened only for commissioning. Open the transportation safety device and open the lock. Now use the lever fixed to the base with adhesive tapes and plug it into the borehole for the locking mechanism. Open the source by turning the lever right up to the right limit stop.

This position can now be locked again with the padlock to prevent inadvertent closing of the beam channel during operation. If locking with the lock should not be permitted, you may also fix the position with the supplied screws.

2.6.5 Flange Shieldings in the Dip Tube

CAUTION

Increased radiation dose due to open beam channel!

A too high dose of radiation may be harmful to your health.

A source may be transported only in its shielding. The shielding must be closed during transportation and installation.

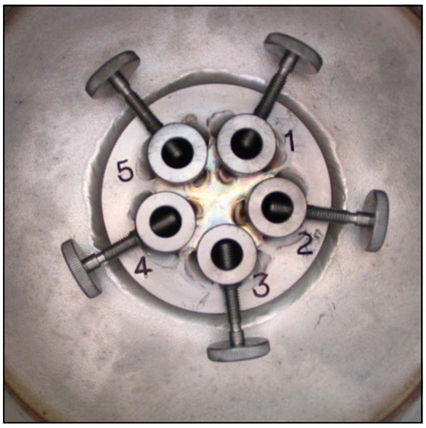
Special vessel constructions may require installation of the source inside the vessel. Essentially, this does not change the function and the basic arrangement, as shown in *Fig. 2-30*. Due to the shorter distance between source and detector and due to the fact that only one vessel wall has to be irradiated, the required source activity can be reduced significantly. For this arrangement, the source is often delivered in a so-called flange shielding which can be placed onto the flange of the protective tube. If the shielding is installed on the vessel from above, then the source is lowered into the protective pipe via a steel rope. For installation of the shielding in a vessel from below or from the side, a shaft core is used to insert the source into the protective pipe.

Fig. 2-29 Flange shieldings for rod source and point source

Versions for flange shieldings

- Rod source with steel cable, one-part or multi-part
- Rod source with shaft core, one-part or multi-part
- Point source with steel cable, one-part
- Point source with shaft core, one-part

Multi-part rod source flange shieldings can be designed such that they can be loaded with up to 5 rod sources. Signs are attached on each steel cable or each shaft core. The signs contain information on



1. the length of the cable for source positioning, if known
2. the source number, e.g. 1860/1-10-08

the source number consists of several components:

1860 is a consecutive serial number

/1 describes the location of the source in the shielding and thus allows correlation between steel cable or shaft core and source. The number is to be found on the sign and also on the head of the shielding (see illustration to the left).

-10-08 indicates the month and year of production (-MM-YY).

The customer has to provide the protection tube for the source; it should be installed such that the source can be withdrawn any time without interrupting the production process. The stability of the protection tube must match the potential mechanical and chemical stress.

Depending on the dip tube, it may be necessary to adapt the flange using a flange adapter. If required and ordered, such an adapter will be included with the shipment. You find the adapter dimensions in the "Technical Information" in *chapter 5*. Screws and sealings are not part of the delivery.

In certain applications it is essential that damage to the dip tube is detected immediately, so that the source can be secured in time. *Fig. 2-30* and *Fig. 2-31* show installation proposals which meet the highest safety standards. A double-walled protection tube is used; the space between both walls is filled with protection gas. Any damage or leak is signaled immediately by a pressure control switch.

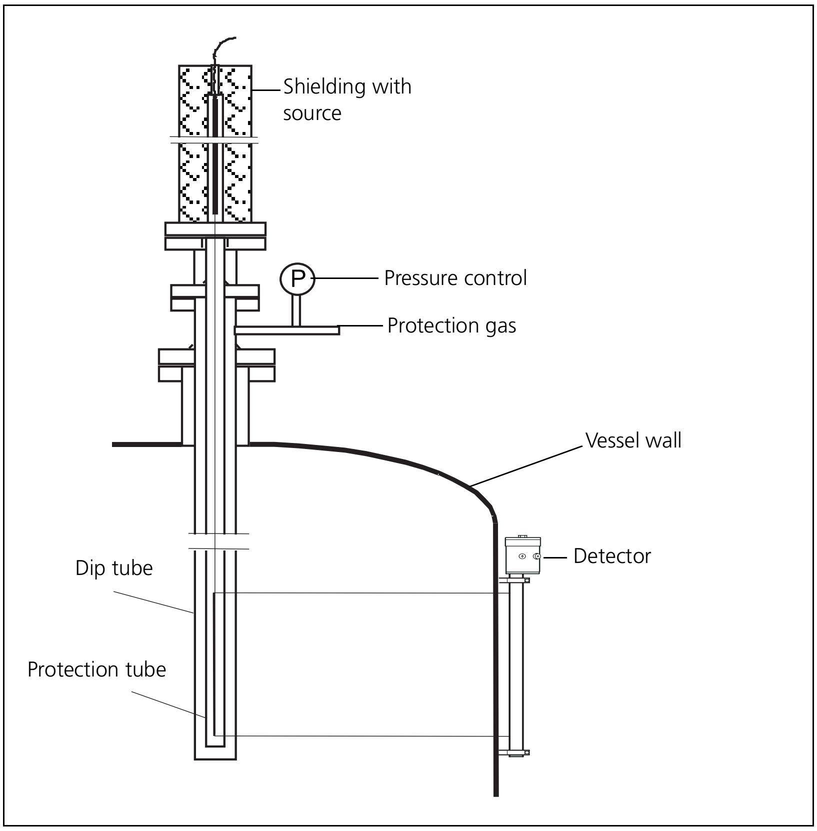


Fig. 2-30 Dip tube installation with rod source and rod detector

One or up to five rod sources can be installed in a shielding, depending on type (see "Technical Information" in *chapter 5*). With several rod sources, the individual sources are positioned in different heights in order to cover the measurement range completely. The shieldings can be adapted to your vessel flange using various flange adapters.

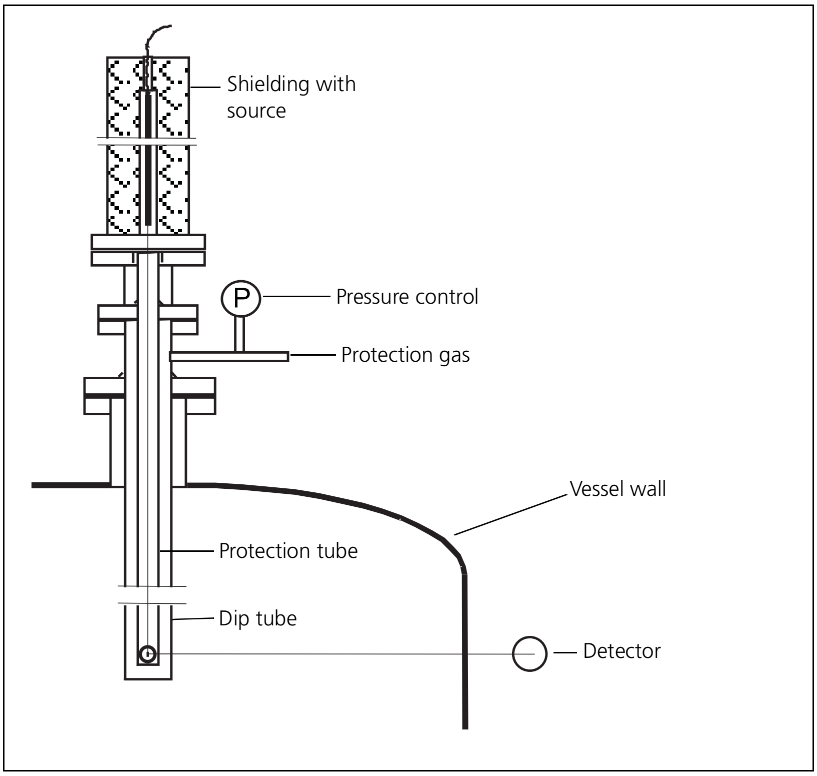


Fig. 2-31 Dip tube installation with point source and point detector

NOTICE

If the shieldings are employed in aggressive atmospheres, the steel cable or the shaft core and the latch mechanism have to be checked for corrosion in regular intervals. The intervals between the checks have to be defined by the operator such that a malfunction of the mechanism due to corrosion is ruled out.

Version with shaft core

Instead of a steel cable, a shaft core is installed which consists of a spring wire. This allows you to install flange shieldings to the vessel from below or from the side and to insert the source from there into the dip tube and to position it. The shaft core is inserted completely into the shielding to position the source. The immersion depth of the source is then fixed by a clamping screw, not with the positioning screw. In exceptional cases, it may be necessary, with point sources, to determine the position accurate to the millimeter to make sure that the beam path does not hit any vessel installation.

Operating a flange shielding with steel cable

A steel cable for positioning of the rod source is supplied for each source.

NOTICE

When opening the shielding, the source may fall into the dip tube.

If the source drops into the dip tube during applications where the flange shielding has been installed onto the vessel from above, it can be recovered again only with a lot of work and under the supervision of the Radiation Safety Officer.

Therefore, never open the source locking mechanism and the set-screw before you have latched all sources at the head end into the steel cable or the shaft core.

2

Fig. 2-32 shows how to move a source to the measurement position.

▶ Couple cable to source.

First, take off the cover. Below the cover you see the source end piece(s) to which the steel cable has to be latched.

The three illustrations on the following page show how to latch the cable into the clutch at the source. The clutch includes a snap-action mechanism that prevents that the connection will become undone on its own.

▶ Define source position in vessel.

To define the position of the source in the vessel, determine the required cable length and adjust it using the positioning screw on the cable.

▶ Insert source in dip tube:

- Make sure that the latch clicks into place correctly and can be set vertical to the source.
- Open the locking mechanism.
- Pull the source back using the cable and open the respective clamping screw.
- Slowly lower the rod source on the cable into the dip tube.

NOTICE

When closing the shielding, the steel rope may be cut and the source may fall into the dip tube.

If the source drops into the dip tube during applications where the flange shielding has been installed onto the vessel from above, it can be recovered again only with a lot of work and under the supervision of the Radiation Safety Officer.

Therefore, never close the source locking mechanism as long as not all rod sources are again in the shielding. Otherwise, the steel cable may be kinked or even cut.

Fig. 2-32 Flange shielding with steel cable

Move source again to the shielding position

- Pull the source back into the shielding using the steel cable or the shaft core.
- Fix the source with the clamping screw at the head piece.

If it is a shielding with several sources, then the order in which the source is pulled back into the shielding is important to rule out a twisting of the cable lines:

- The source hanging at the highest position has to be pulled back into the shielding first and secured with the clamping screw.
- Then pull the source at the second highest position into the shielding, etc.
- Connect the locking mechanism to the shielding.
- Finally, put the cover over the shielding. It may be necessary to unlatch the steel cables or the shaft core.

Operating the flange shielding with shaft core

- Open the lock (padlock or safety screw).
- Remove the covering cap.

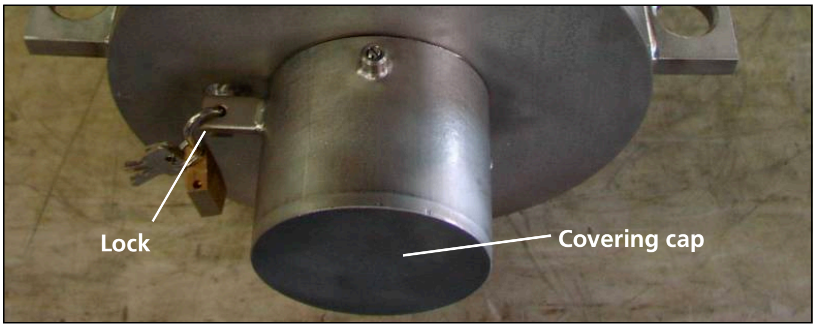


Fig. 2-33 Lock and covering cap

- Connect the shaft core with the source end piece.

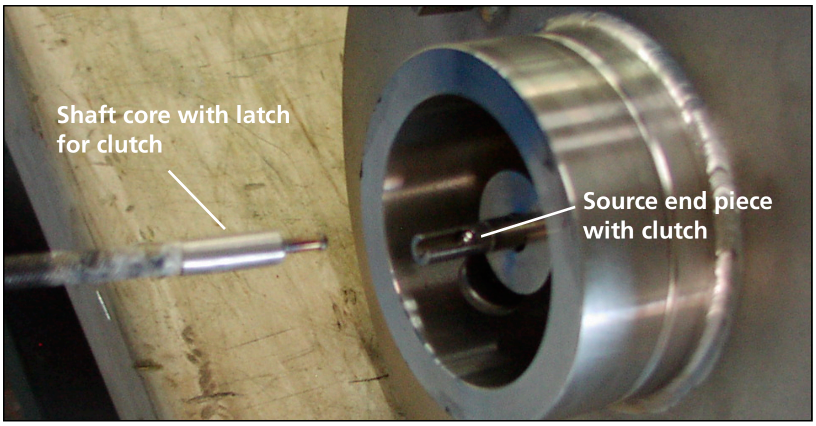


Fig. 2-34 Shaft core and source end piece

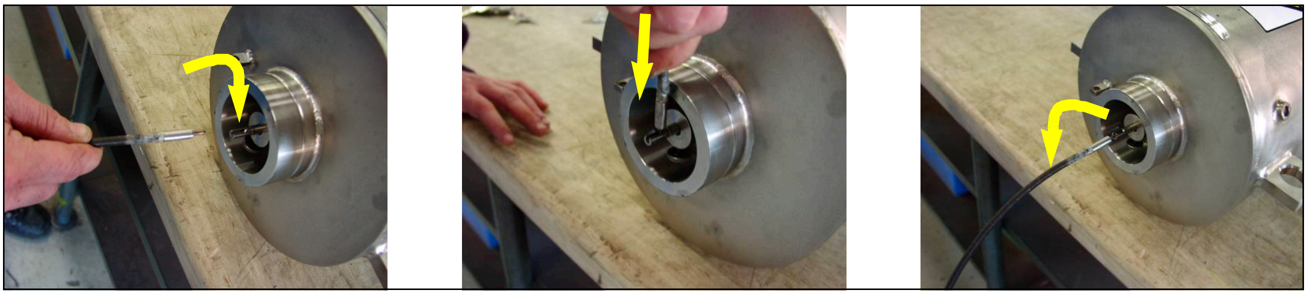


Fig. 2-35 Connect shaft core and source end piece

▶ Open the fixing screw at the head piece.

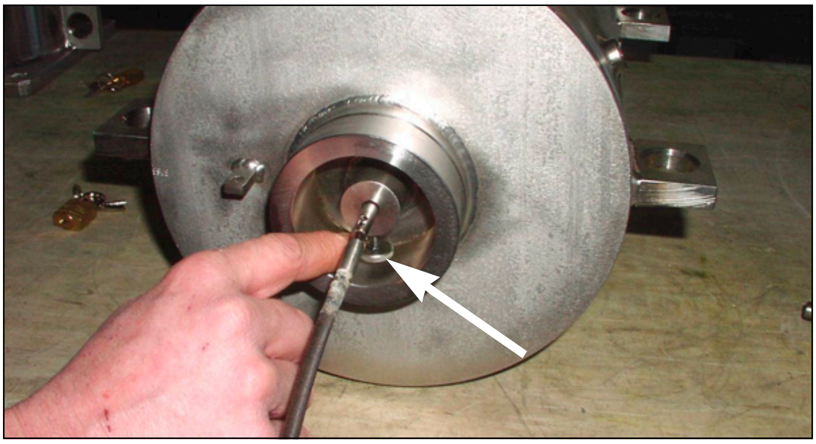


Fig. 2-36 Open fixing screw

▶ Open the source shielding.

Fig. 2-37 Open source shielding

▶ Push the shaft core in up to the limit stop.

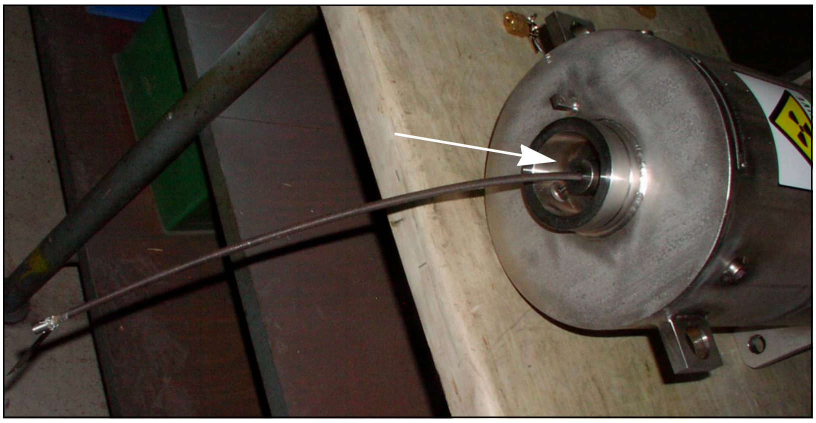


Fig. 2-38 Push the shaft core in

- Fix the position with the fixing screw at the head piece.
- Attach the covering cap again.
- Secure the lock with a padlock or the safety screw.

The source is now installed.

2.6.6 Point Source Shielding LB744X

The radiation warning sign identifies the start of the controlled area, provided the controlled area is *outside* the shielding. If the controlled area is *inside* the shielding, then the radiation warning sign attached on the shielding suffices.

Fig. 2-39 Radiation warning sign

CAUTION

Increased radiation dose due to open beam channel!

A too high dose of radiation may be harmful to your health.

A source may be transported only in its shielding. The shielding must be closed during transportation and installation.

The radiation exit is cone shaped with an angle of about 10°. During installation, the shielding and thus the useful beam must be aligned such that they point exactly towards the detector.

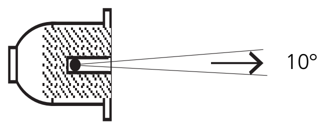


Fig. 2-40 Point source shielding

The shielding consists of a lead cylinder with source exit channel (7), surrounded by a steel jacket (*Fig. 2-41*). The locking core (6) is firmly connected with a lever (4). The "OPEN" and "CLOSED" positions are secured and the removal of the sources by unauthorized persons is prevented by a padlock (3).

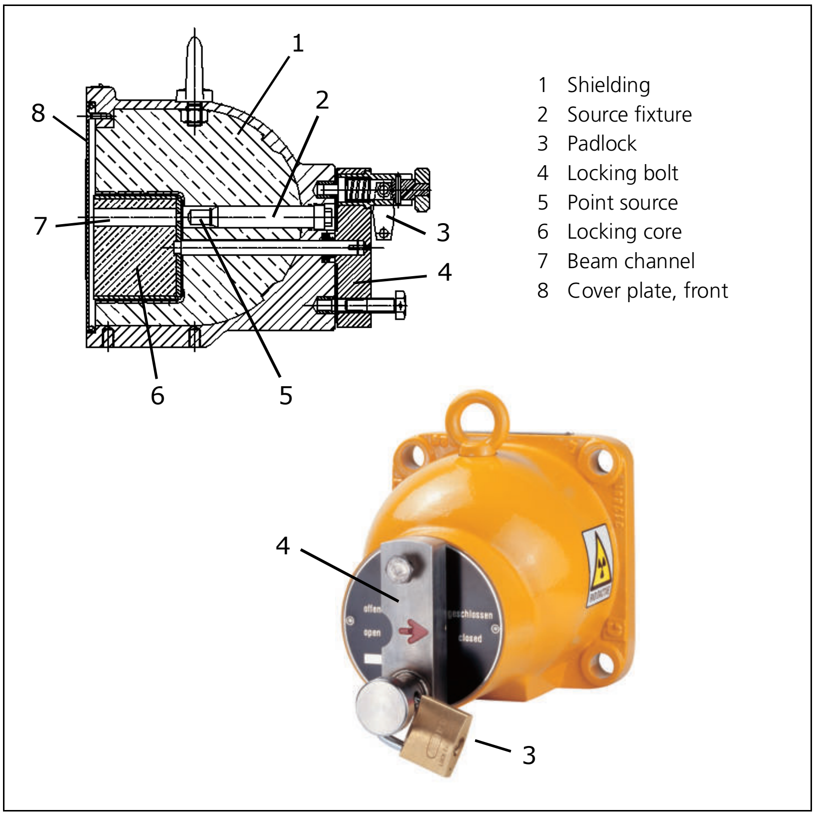


Fig. 2-41 Cross-section drawing and photo of the point source shielding, top: beam channel open, bottom: beam channel closed

Turning the lever (4) will also rotate the locking core and open the source exit channel towards the detector. The arrow on the lever is pointing to "OPEN".

The source exit channel must be closed during transportation, during installation and while carrying out work on the vessel. The arrow on the lever is pointing to "CLOSED". In the "OPEN" and "CLOSED" position, the lever or the locking core are protected by a padlock.

NOTICE

Function failure due to damage

The detector fixture must not transfer any vibrations or heat onto the shielding; otherwise the locking mechanism may be damaged and the shielding effectiveness may be adversely affected.

Therefore, install the fixture on a vibration-free support or attenuate possible vibrations using vibration absorbers. Prevent heat transfer by using suitable insulating materials.

Installing the shielding

The shielding can either be installed on a bracket or on a flange. Size and position of the measuring range to be covered are determined in the projection phase for the measuring site and defined by drawings, sketches or details in writing. For assembly, these specifications have to be observed closely, since deviations may cause malfunctions of the measuring system.

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

3

Electrical Installation

Installation should only be performed by a qualified electrician (competent person).

The safe operation of the detector is only guaranteed you if follow the safety instructions described in *Volume 1*, *chapter 6*.

3.1 Cable Entries

2

Depending on the model, the detectors are provided either with M20 (ATEX) or with ½" NPT cable entries (FM/CSA), through which the electrical cables are be installed according to regulations. Conduits or cable glands can be screwed into the cable entries. They have to be licensed for the respective type of protection and have to be installed carefully in accordance with regulations! Cables and cable conduits have to be aligned such that water cannot flow into the bushing along the cable. Also make sure that all cables that are installed are not subject to abrasion, strain or kinks.

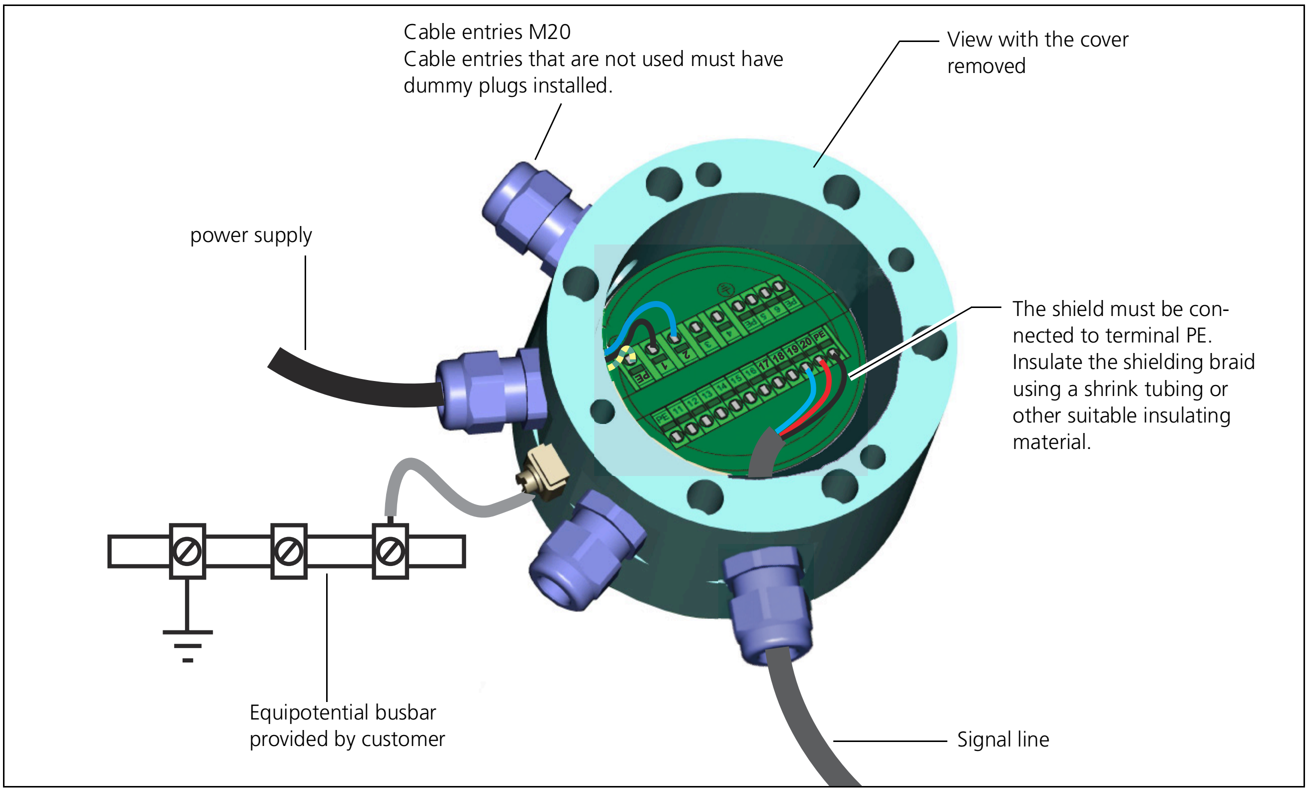


Fig. 3-1 Detector housing open - top view

Cable entries that are not used must have dummy plugs installed.

3.1.1 Multi-detector Operation

Refer to the connection diagrams in the Technical Information.

3.1.2 ATEX Connection Type

Follow the safety instructions in *chapter 5*, *"Explosion Protection", Volume 1*.

3.1.3 FM/CSA Connection Type

A stopping box (conduit seal) has to be installed on each cable entry used directly behind the detector housing.

3.1.4 Replacing a Detector or Using it at another Measuring Point

Detectors which are used in non-hazardous areas are not subject to the supervision and maintenance of Ex-protection experts; therefore, it is not guaranteed that, for example, for repair or assembly, the necessary care is taken which is required for the detectors in Ex-areas. The Ex-protection safety is therefore no longer guaranteed. The same applies to the intrinsic safety of detectors. Therefore:

- Detectors that are used in the non-Ex area may not be used in an Ex area.
- Intrinsically safe detectors, whose intrinsically safe signals are connected to non-intrinsically safe circuits must not be connected to intrinsically safe circuits any more.

3.2 Terminals

3.2.1 Master Terminal Compartment

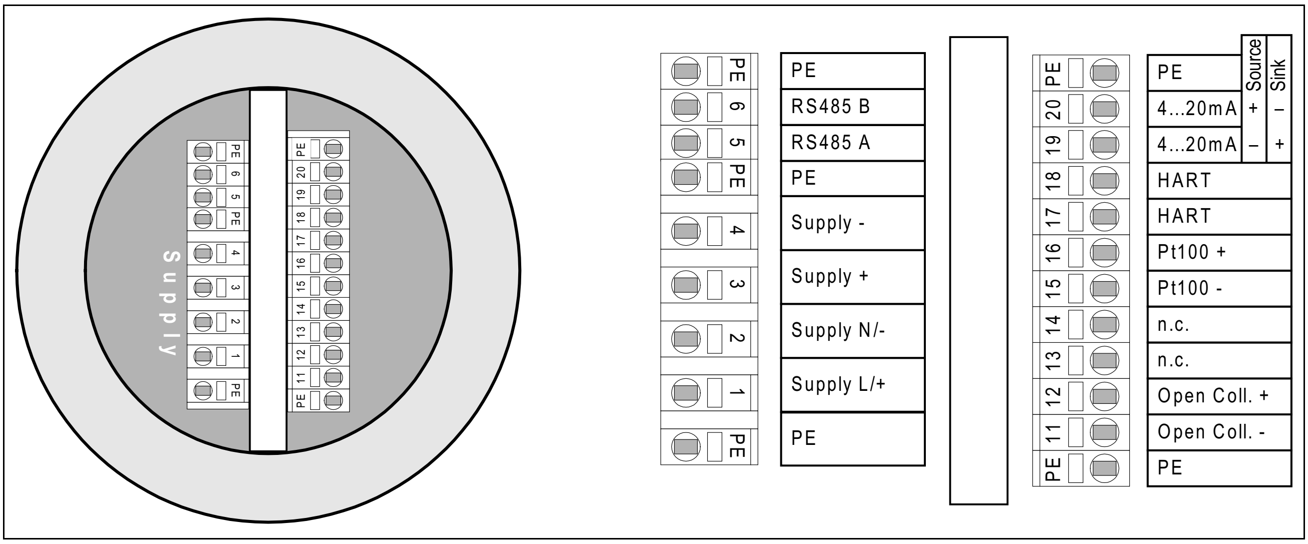


Fig. 3-2 Master Terminal Compartment (example terminated version)

Permissible conductor cross-section for terminals:

- with ferrules 0.5 - 1.5 mm² (AWG 21 - 16 flexible)
- without ferrule 0.5 - 2.5 mm² (AWG 21 - 14 flexible or solid)

Terminal description

Terminals	Master
	HART®
PE (5 x)	Ground connection and screen
1 - 2	Power supply: 100V to 240V_{AC} or 24V_{DC}, depending on version
3 - 4	Like terminals 1 - 2: additional terminal pair for transmission (loop through) the supply voltage to the next slave (only permitted for supply of 24 V_{DC})
5 - 6	RS-485: for Multi-detector operation, connection for slave detector or not-terminated master detector, service interface and software update
5A / 6B	Only present on non-terminated master detectors.

Terminals	Master
	HART®
11 - 12	Open collector signal output with reverse voltage protection ALARM: no current flowing NORMAL: Current flowing The supply voltage for the open collector must be between 5 and 36V. The maximum current that may flow through the open collector is 100mA. Depending on the supply voltage, this leads to the following resistance values which must be connected: 5V: ≥30Ω 12V: ≥100Ω 24V: ≥220Ω 36V: ≥340Ω If the resistance value is not reached, the open collector may be damaged.
13 - 14	Reserved for optional I/Os
15 - 16	Pt100 for temperature compensation, only for density measurement
17 - 18	Like terminal 19 - 20: additional terminal pair for parallel connection of a HART® Communicator
19 - 20	HART® current output: 4-20 mA current output for measured value output and parameterization. This current output is used for the continuous transfer of the measured value and for display of the error status via the adjustable fault current: – 4–20 mA for current measured value. – Adjustable fault current from 3.5 to 24 mA in case of error. The current output is continuously monitored and in case of failure signals the fault current set via the software through a redundant current path. The digital HART® communication remains in effect even on the redundant current path. – Max. cable length with BERTHOLD cable # 32024: – 1600m at 250Ω – 800m at 500Ω – Depending on the type, the current output is operated in the Sink or Source mode. Source mode (active current output) – Impedance region: 250 ... 500Ω Sink mode (passive current output) – Supply voltage: 18 ... 32V_{DC} – max. impedance: 500Ω

Signal cable with shielding

We recommend using a screened cable for the signal lines. The screen has to be connected to the detector on the PE terminal in the terminal compartment of the detector, or better, to suitable EMC cable glands.

3.2.2 Slave Terminal Compartment

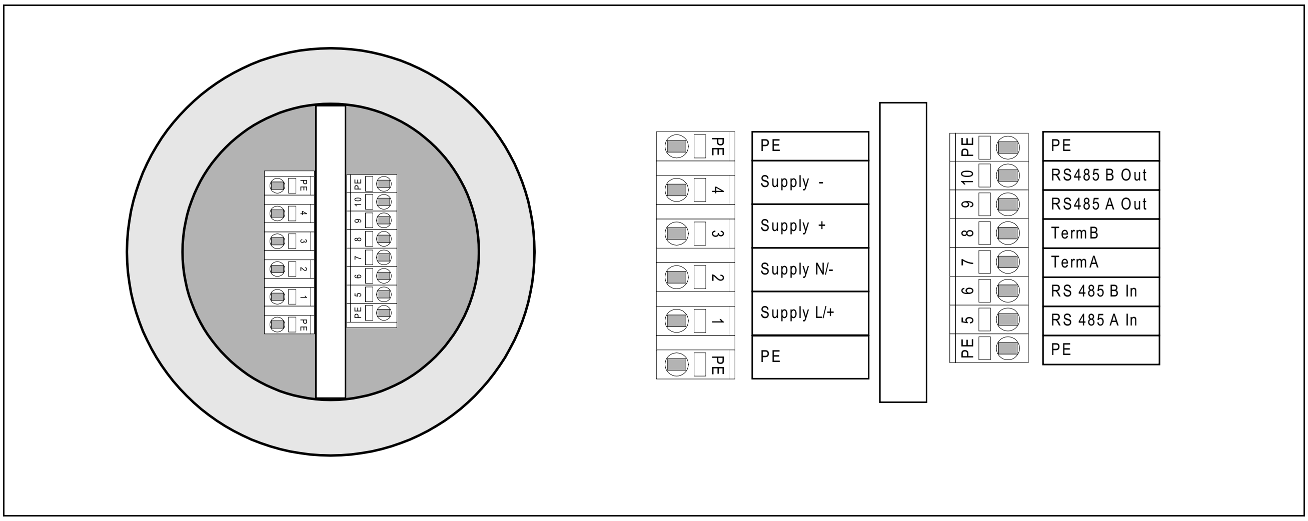


Fig. 3-3 Slave Terminal Compartment

Permissible conductor cross-section for terminals:

- with ferrules 0.5 - 1.5 mm² (AWG 21 - 16 flexible)
- without ferrules 0.5 - 2.5 mm² (AWG 21 - 14 flexible or solid)

Terminal description

Terminals	Slave
	HART®
PE (5 x)	Ground connection and screen
1 - 2	Power supply: 100V to 240V_{AC} or 24V_{DC}, depending on version
3 - 4	Like terminals 1 - 2: additional terminal pair for transmission (loop through) the supply voltage to the next slave (only permitted for supply of 24 V_{DC})
5 - 6	RS-485: for Multi-detector operation, connection to the master or previous slave, service interface and software update
7	Connect the last slave to terminal 9
8	Connect the last slave to terminal 10
9 - 10	RS 485: Connection to the next slave detector

Signal cable with shielding

We recommend using a screened cable for the signal lines.

The screen has to be connected to the detector on the PE terminal in the terminal compartment of the detector, or better, to suitable EMC cable glands.

3.3 Connecting the Detector

If lines are already connected to the detector, keep in mind:

⚠ WARNING

Explosion hazard!

As long as the detector is supplied with power, do not open the terminal compartment cover if there is a potentially explosive atmosphere.

⚠ WARNING

Risk of fatal injury due to electric shock!

If the terminal compartment cover is open, you are at risk of getting an electric shock when you touch the terminals. Do not connect or disconnect any wires as long as the device is supplied with line voltage.

Depending on the type of detector, the detector is supplied with 110/230 V_{AC} or 24 V_{DC}. With the version with 110/230 V_{AC} and with the line voltage switched, please pay attention to adequate protection against accidental contact.

Always follow the safety instructions for "Electrical Installation" on *page 2-225* and if applicable for *Explosion Protection* on *page 1-23*.

IMPORTANT

Open the terminal compartment only in dry ambient conditions, never in the rain.
Moisture in the terminal compartment can both cause a short circuit with other lines or cancel the explosion protection.

Hereinafter, it is assumed that no cables have been connected yet. Otherwise, make sure that the detector is not live.

As the intensity of electromagnetic interference on the cables is very different in the systems, we recommend using a shielded cable. Signal cables must not be laid parallel to power lines. This is especially important for master lines and lines with high current load: Keep a minimum distance of 50 cm.

Cable shields can be placed on the terminals marked with PE. If EMC cable glands are used, the shield must be placed directly in the cable gland. Screened cables must be connected at one end to the detector. Even with a multi-detector application, put on the shield of the RS-485 connection cable on one side only.

For the following activities, use the checklists in *chapter 5.9.1* on *page 1-53* and *chapter 5.9.2* on *page 1-55* to document the accuracy and completeness of your work.

For detectors that are used in hazardous areas, the detector housing (*Fig. 3-4*) and thus the pressure-proof enclosure of the electronics may be opened only by the BERTHOLD TECHNOLOGIES service or by persons authorized by BERTHOLD TECHNOLOGIES.

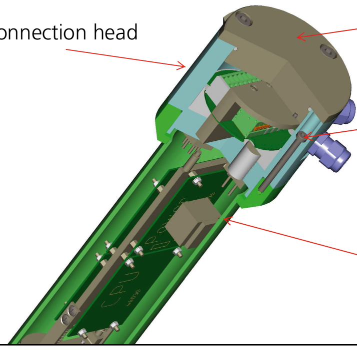


Fig. 3-4 Detector housing with connection head

Connecting cables

- Unscrew the housing cover (M5 and M8 Allen wrench).
- Remove the sealing plug on the bushings that you need for your cable entry.
- Install the screwed cable gland or for FM/CSA a conduit system with a conduit seal before the cable entry into the terminal compartment.

IMPORTANT
In Ex-protected areas, use only cable glands that are approved for your explosion protection.

- Pull the connection cables with the complete external insulation through the cable entry into the terminal compartment.

  Make sure that the cable diameter of the cable used is suitable for the screw connection.
- Make sure when installing the cables that mechanical damage to the conductor insulation from sharp edges or moving metal parts will be ruled out.
- Keep the cable length long enough to create a cable loop for strain relief before the housing inlet.

- Install the connecting cables in the terminal compartment so that
  - dirt and moisture is avoided in the terminal compartment;
  - the wires are not damaged when stripping;
  - the conductor insulation extends into the terminals when stripping;
  - the minimum bending radii permitted for the respective conductor cross-section are not fallen below.
- Stranded leads have to be stripped 10 mm, and may be introduced only when the spring-type terminal was opened by a suitable tool (screwdriver with a blade width of about 3 mm). Make sure that all wires of the stranded lead are completely trapped and no small wires project from the terminal. The insulation of the wire must extend into the terminal insertion opening.
- Connect the wires according to the wiring diagram in *chapter 3.1* and *chapter 3.2* to the terminal strip of the detector. Use at least the following terminals:
  - Signal output: Terminals 19 and 20
  - Power supply: Terminals 2 and 3 and the PE terminal for the grounding conductor connection.
- Place the cable shields on the terminals marked with PE. Place the cable shield directly inside the screw fitting, if you are using EMC screw fittings.
- Make sure that the wires sit securely in the terminals.
- Connect the terminal for potential equalization to the outside of the detector housing using the equipotential busbar.
- With cable glands: Tighten the hexagon nuts of the cable entries so much that the tightness of the terminal compartment and the strain relief protection of the connection points are secured. The tightening torques can be found on *page 1-49*.
- Remove any loose metal particles, dirt and traces of moisture from the terminal compartment.
- Only with Ex-protection FM/CSA: When installing pipework in a hazardous area, encapsulate the conduit seal using a suitable filler.
- Make sure that the cover seal is undamaged and the snap rings or Nordlock discs are placed on all the cover screws.
- Close the housing carefully with the cover seal and the housing cover. To do this, put the housing cover with the sealing on the housing and tighten the Allen screws using the specified torque: depending on the version, M5 with 4 Nm or M8 with 17 Nm (standard values).

- Create cable loops with the connected lines in front of the housing entrance and provide for an appropriate strain relief of the connected cables. If there is a danger that the cable may be used as a stepladder, then the cables must be installed protected, for example in conduits.
- Now you may turn on the line voltage.

After completing work, use the *"Plan for Inspection of the Terminal Compartment"* on *page 1-55*.

4

Repair, Maintenance and Upkeep

IMPORTANT

Spare parts for detectors used in the Ex-area must be mounted solely by the BERTHOLD TECHNOLOGIES service or by persons authorized by BERTHOLD TECHNOLOGIES. If this is not possible, you must replace the entire detector or return it to the manufacturer for repair.

2

For devices that are *NOT* used in an Ex-area, the following parts may be replaced at your own risk and taking into account a loss of any existing warranty by BERTHOLD TECHNOLOGIES:

- the complete detector electronics
- the complete connection head
- the crystal at the CrystalSENS
- the multiplier (PMT)
- the multiplier crystal combination
- the detector housing

BERTHOLD TECHNOLOGIES recommends to have detectors repaired solely by the BERTHOLD TECHNOLOGIES service or by persons authorized by BERTHOLD TECHNOLOGIES.

Only original spare parts by BERTHOLD TECHNOLOGIES may be used.

Please follow the instructions in the Safety Manual (*Volume 1*) and the instructions in *chapter 3*, *"Electrical Installation", page 2-225*.

After every repair, maintenance or upkeep, please use the checklists on *page 1-53* and *page 1-55*.

4.1 Safety Instructions

Observe the legal provisions that apply in your country!

Repair and maintenance work on the detectors must be performed by competent personnel, see *Volume 1*, *chapter 3*, *"Qualification of Personnel", page 1-19*. If in doubt, return the entire detector for repair to BERTHOLD TECHNOLOGIES.

Also note the following points:

- Repairs to electronic circuits on the board of your SENSseries detector must be carried out exclusively by the manufacturer.
- Any time you are working on electrical components, you have to observe the relevant safety regulations. Please refer to the safety instructions at the beginning of this User’s Manual. Turn off the detector and disconnect all inputs and outputs.

CAUTION

Danger due to radiation!
Radiometric measurement devices use radioactive materials.

The source emits radiation through the source exit channel. There may be a danger arising from radioactivity when people are exposed to this radiation.

Always keep the source exit channel of the shielding closed during assembly work.

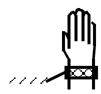
Any work in the direct vicinity of the shieldings containing the radioactive source may be performed only following proper training and under professional guidance, see *Volume 1*, *chapter 3*, *"Qualification of Personnel"*. Repairs performed by untrained persons may result in the loss of explosion protection.

Corrosion protection

If non-alloyed steel comes into contact with a stainless steel surface, the surface can corrode at this point. Make sure, therefore, that neither during installation nor during operation other metal parts made of non-alloyed steel come into contact with the housing surface of the detector.

ESD protective measures

The electronics of this measuring system contains electrostatic highly sensitive components. We recommend that you wear an ESD wrist strap during installation or repair work. Connect this wrist strap to the ground conductor.



4.2 Replacing the Complete Detector

Reuse of detectors

Detectors that are used in the non-Ex area may not be used in an Ex area.

Intrinsically safe detectors, whose the intrinsically safe signals are connected to non-intrinsically safe circuits must not be connected to intrinsically safe circuits any more.

Explanation:

Detectors which are used in non-hazardous areas are not subject to the supervision and maintenance of Ex-protection experts; therefore, it is not guaranteed that, for example, for repair or assembly, the necessary care is taken which is required for the detectors in Ex-areas. The Ex-protection safety is therefore no longer guaranteed. The same applies to the intrinsic safety of detectors.

Replacing the detector

Proceed as follows to replace the detector:

- Write down all software parameters of the installed detector.
- Disconnect the detector from power.
- Turn off any peripherals connected and all inputs and outputs.
- Unscrew the housing cover (M5 and M8 Allen wrench).
- Open wiring on digital board and on the terminals.

Tip

If the wires are not marked, we recommend marking the individual wires before disconnecting them.

NOTICE

After you have disconnected the wires and cables, reattach the housing cover with sealing immediately, so that the parts cannot be damaged during the mechanical removal.

- Dismantle the old detector from the fixture.
- Mount the new detector onto the fixture.
- Unscrew housing cover of the old detector.
- Connect the wires.
- Close the housing carefully with the housing cover. To do this, put the housing cover with the sealing on the housing and tighten the Allen screws using the specified torque: depending on the version, M5 with 4 Nm or M8 with 17 Nm (standard values).
- Turn on power.

- Enter the previously documented parameters of the detector *with the exception of the parameter HV-Default* via the HART® Communicator or an alternative user interface.
- Perform a new calibration (see *Volume 3, chapter 5*).

Now the detector is ready for operation again.

4.3 Replacing the Electronics Module

WARNING

EX

Explosion hazard!

For detectors used in the Ex-area, the electronics module must be replaced solely by the BERTHOLD TECHNOLOGIES service or by persons authorized by BERTHOLD TECHNOLOGIES. If this is not possible, you must replace the entire detector or return it to the manufacturer for repair.

IMPORTANT

Removal and installation of parts of the SENSseries detector should be carried out in a clean workshop environment.

The electronics module has to be dismantled if one of the following parts has to be exchanged:

- Electronics module (see *page 2-239*)
- Crystal-multiplier combination for CrystalSENS (see *page 2-242*)

The electronics in the CrystalSENS is dismantled together with the crystal-multiplier assembly. In the SuperSENS the electronics is dismantled together with the multiplier.

4.3.1 Dismantling the Electronics Module

IMPORTANT

Since all detector parameters are stored on the electronics module, you have to enter all the parameters again after you have exchanged the electronics. If you still have access to the detector parameters before the exchange, write them down so you can then enter them into the new electronics. Otherwise, you have to re-configure and re-calibrate the detector again. Please see the appropriate volume for instructions.

To replace the electronics module, you have to dismantle the detector housing tube from the connection head.

You may carry out the activities described below only if the detector is not used in an Ex-area.

- ▶ Write down all software parameters of the installed detector.
- ▶ Disconnect the detector from the power and switch off the detector and any connected peripherals.

⚠ WARNING

Risk of fatal injury due to electric shock!

When the housing is open, you may come into contact with live parts if the power supply is connected.

Make sure when you open the cover that no supply voltage is applied to the terminals. Use a voltmeter.

- ▶ Unscrew the housing cover (M5 and M8 Allen wrench).
- ▶ Unscrew the six screws that connect the detector housing to the connection head (Torx T25).

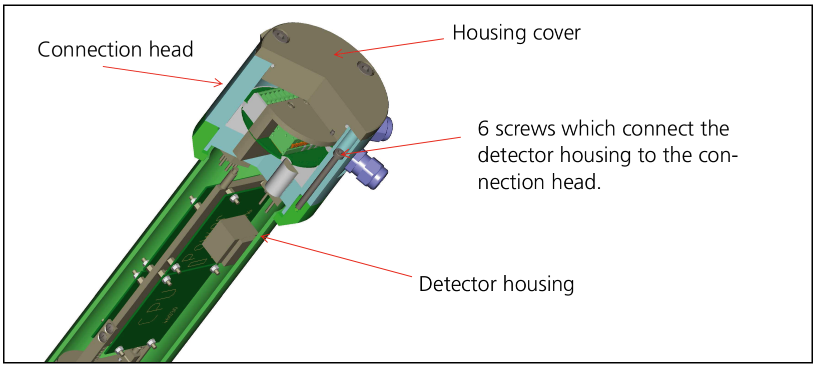


Fig. 4-1 Dismantling the detector electronics

- ▶ Carefully pull out the electronics module together with the crys-tal-multiplier assembly.
- ▶ Remove the overtube with the multiplier (SuperSENS) or the crystal-multiplier assembly (CrystalSENS) from the electronics.
- ▶ Loosen the connecting wires between connection head and electronics.
- ▶ Remove the electronics from the connection head by opening the four stud screws on the side of the metal plate of the PCB holder.
- ▶ Now you can replace the entire electronics module.

4.3.2 Installing the Electronics Module

Reassemble the electronics module in reverse order.

- Connect the wires between connection head and electronics correctly.
- Check that the wires sit firmly in the terminals.
- Replace the O-ring that seals the housing.
- Make sure that neither moisture nor metal chips are present in the connection box.
- Carefully insert electronics module with the crystal-multiplier assembly again into the housing.
- Attach the connection head to the detector housing again. Tighten screws evenly alternating between screws.
- Close the housing carefully with the housing cover. To do this, put the housing cover with the sealing on the housing and tighten the Allen screws using the specified torque: depending on the version, M5 with 4 Nm or M8 with 17 Nm (standard values).

If you have installed a new electronics module:

- Place the supplied sticker over the number of the Dev. ID on the type plate.
- Turn on the power supply of the detector again.
- Set the software parameters again using the list you have noted down at the beginning. See also *Volume 3* on *page 3-305*.

  Separate User's Manuals are available for user interfaces such as SIMATIC PDM or FOUNDATION™ Fieldbus.

This completes the replacement of the electronics module.

2

4.4 Replacing the Crystal-Multiplier Assembly (for CrystalSENS)

WARNING

Explosion hazard!

For detectors used in the Ex-area, the crystal-multiplier assembly must be replaced solely by the BERTHOLD TECHNOLOGIES service or by persons authorized by BERTHOLD TECHNOLOGIES. If this is not possible, you must replace the entire detector or return it to the manufacturer for repair.

Replacing the crystal-multiplier assembly can cause a change in sensitivity of the detector for gamma radiation. Therefore, check the calibration after the replacement and possibly perform a new calibration.

You may carry out the activities described below only if the detector is not used in an Ex-area.

- ▶ Remove the electronics module as described on *page 2-239*.
- ▶ Dismantle the crystal: loosen and remove the sleeve nut on top of the overtube of the multiplier tube (PMT). Then pull the crystal off the multiplier.
- ▶ Remove the PMT overtube from the PCB holder.
- ▶ Pull the multiplier from the base of the electronics.
- ▶ Plug the new multiplier into the socket. Please observe the encoding nose.
- ▶ Install the electronics module into the detector as described on *page 2-241*.

IMPORTANT

The replacement of the multiplier requires a readjustment of detector code and HV parameters. Please read also Volume 2, chapter 1.6, "Detector Codes", page 2-174, and Volume 3, chapter 2.42, "Plateau Measurement", page 3-379.

- ▶ Check the function of the measurement. If you detect any deviations, carry out a new calibration, see *Volume 3*, *chapter 5*, on *page 3-401*.

  Separate User's Manuals are available for user interfaces such as SIMATIC PDM or FOUNDATION™ Fieldbus.

This completes the exchange of the crystal-multiplier assembly.

4.5 Checking the Detector

Scintillation counters do not include any wearing parts and their service life is not limited, provided they are used under normal operating conditions. Malfunctions or aging in the scintillation detector can only be caused by excessive mechanical or thermal stress.

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

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

The flashes of light are converted into electrical signals in a *photomultiplier* (PMT), which is optically coupled to the detector.

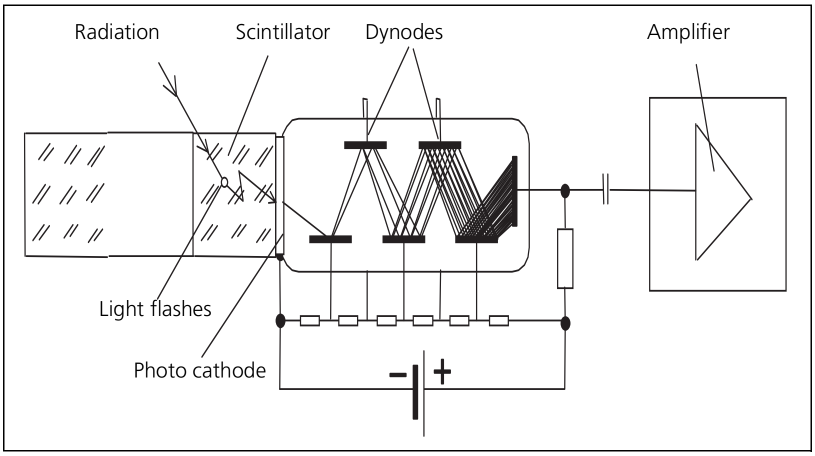


Fig. 4-2 Scintillation detector

The *point detector* CrystalSENS uses a 50/50 NaI crystal as a scintillator, the SuperSENS detector uses a 150/150 scintillator.

4.5.1 Checking the NaI Point Detector (CrystalSENS)

Malfunctions of the scintillation counter are not always indicated by a missing pulse rate; it is also possible that the specific Gamma sensitivity appears to have changed or obvious instabilities are apparent. These errors can be detected only by means of a plateau check. The detectors of the SENSseries include a function for automatic plateau recording. The check can be performed using the source at the measuring site or better a test source. Plot the measurement results in a curve (*Fig. 4-3*). The detector works perfect when you get a clearly visible plateau; the position of the plateau within the high voltage range does not matter. The plateau is recorded automatically. See also *page 3-414*.

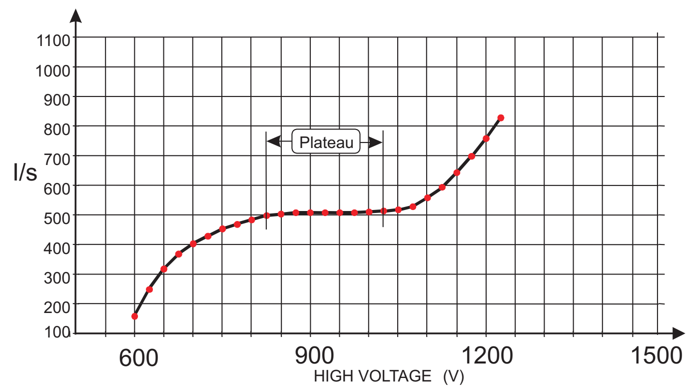


Fig. 4-3 Plateau curve of NaI detector

If the count rate changes by more than 5% per 100 V high voltage, or if the plateau is shorter than 50V, the scintillation counter will be unstable. In this case the complete detector or the crystal-multiplier assembly should be replaced.

IMPORTANT

The radiation conditions must be constant while recording the plateau!

4.5.2 Checking the Crystal-Multiplier Assembly

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

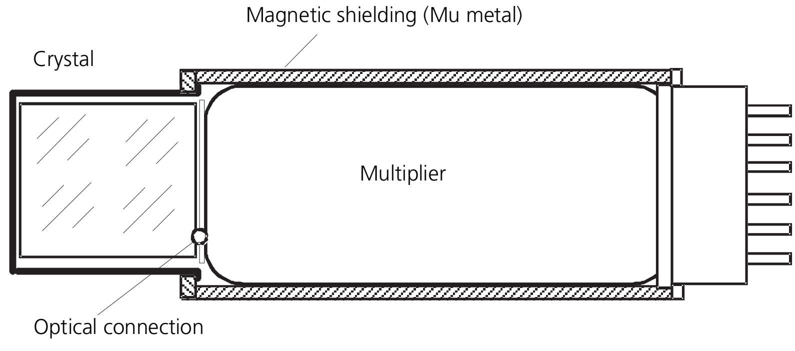


Fig. 4-4 Crystal-multiplier assembly

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

The multiplier window is coated with a vapor-deposited layer acting as photo cathode. This layer gives the window a brownish tint similar to smoked glass. If this layer is no longer present or if it is stained, then the photo-cathode has been destroyed (e.g. by overheating, glass breakage, or incident light). The multiplier must be replaced. Faults caused by damage to the dynode systems (e.g. by excessive vibration) cannot be identified by appearance. If in doubt, replace the multiplier.

Before re-assembly, apply a drop of pure silicon oil (Berthold Id.-Nr. 18844) between crystal and multiplier, and distribute it evenly by gentle rubbing to ensure a sound optical connection between the two components. Using the adhesive tape, replace the Mu-metal screen, making sure that it is only under light tension.

4.6 Customer Service

Customer service for BERTHOLD TECHNOLOGIES measuring systems is available in many countries outside Germany. For further information please visit our website www.Berthold.com.

If you do not know the phone number of your local service engineer, please call one of the following numbers at BERTHOLD TECHNOLOGIES:

+49 (0) 7081 177-111 (phone)
+49 (0) 7081 177-339 (fax)
+49 (0) 7081 177-0 (switchboard))

e-mail: Service@Berthold.com

To get efficient help you have to provide the following information:

- Detector type or "LB" number, e.g. LB 480
- Information on the error
- Information on the application
  - Product being measured
  - Installation situation
  - Measuring system, e.g. limit switch, point source with CrystalSENS
- Parameter listing
- Source number and/or BERTHOLD TECHNOLOGIES commission number
- Contact person and phone number

4.7 Repair, Return Shipping

4.7.1 Electronics, Detector

If you intend to return parts or complete detectors for repair, please provide the following information:

- Detector type or "LB" number, e.g. LB 480
- Information on the error
- Delivery address
- Billing address
- Your order number (if necessary)
- Preferred mode of transportation (if necessary)
- Customs value (for cross-border shipment)

Delivery address of BERTHOLD TECHNOLOGIES:

BERTHOLD TECHNOLOGIES GmbH & Co. KG
Service Department
Calmbacher Str. 22
D-75323 Bad Wildbad

4.7.2 Source and Shielding

If source and/or shieldings have to be returned for repair, please contact the Supervisor of Transportation at BERTHOLD TECHNOLOGIES to clarify details:

+49 (0) 7081 177-219 (phone)

Please provide the following information:

- Name, address and telephone number of the Radiation Safety Officer
- Number of sources
- Source number(s)
- Isotope and activity
- Date of the last leak test
- State of the source(s) and the shielding(s)
- Information on the type of shielding, with which the source is to be transported (if available)
- Proforma invoice for the source and the shielding in which the source is returned (for customs purposes and only for cross-border transport)

The shipment is carried out either by a forwarder trained specifically for source transport or by air freight.

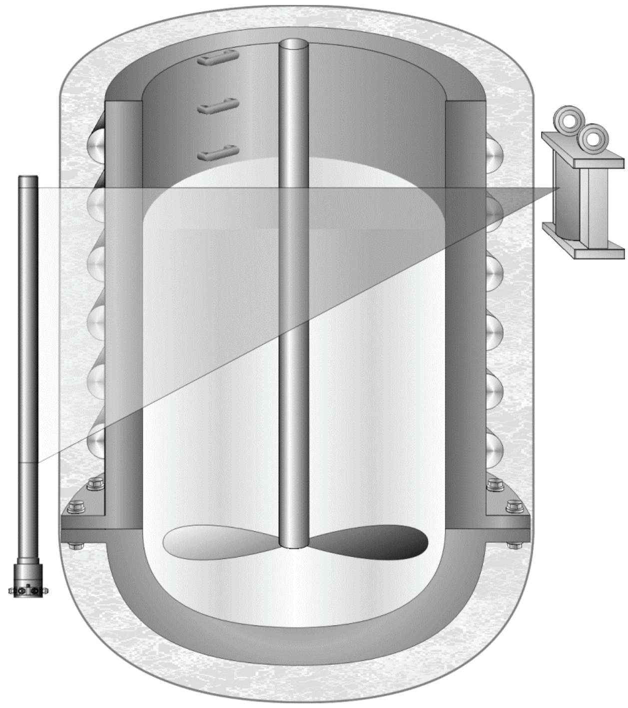
5 Technical Information

5.1 TI LB 480 Level

Technical Information
Level LB 480

Level Gauge
Füllstandmessung

Field mounted components
Messstellen-Komponenten

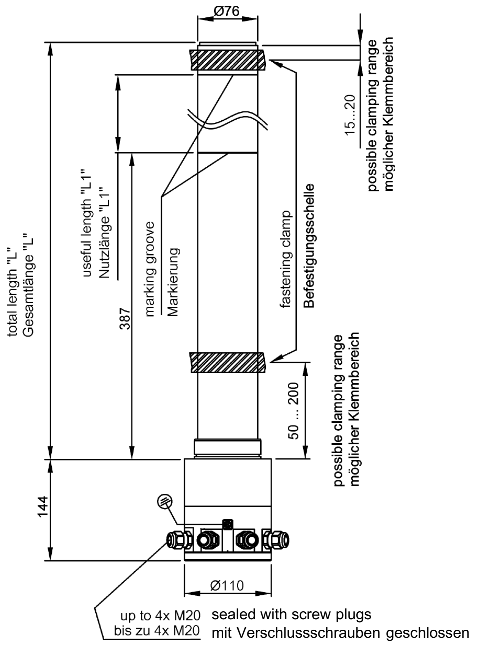


LB 480

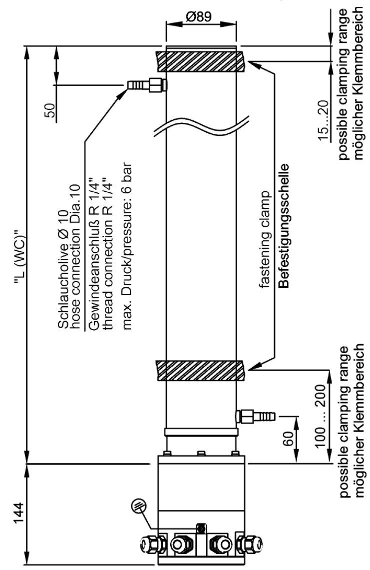
Dimensions in mm
Abmessungen in mm

1. UniSENS (Version f. Zone 1/2)

LB 480-2.-0.
LB 480-2.-1.
LB 480-2.-2.
LB 480-2.-Z.



with water cooling
mit Wasserkühlung

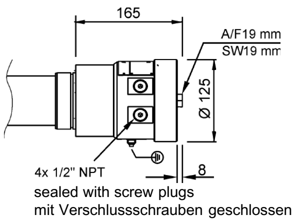


All other dimensions see left hand.
Aller anderen Maße siehe links.

1.1 UniSENS (Version f. Divisions 1/2)

LB 480-2.-F.
LB 480-2.-G.

Weight = Detector Weight +1.5kg
Gewicht = Detektorgewicht +1.5kg



The detector version for divisions (NEC/CEC) differs only in the terminal housing, compared to the standard version illustrated above. The dimensions of this terminal housing are illustrated in this drawing.

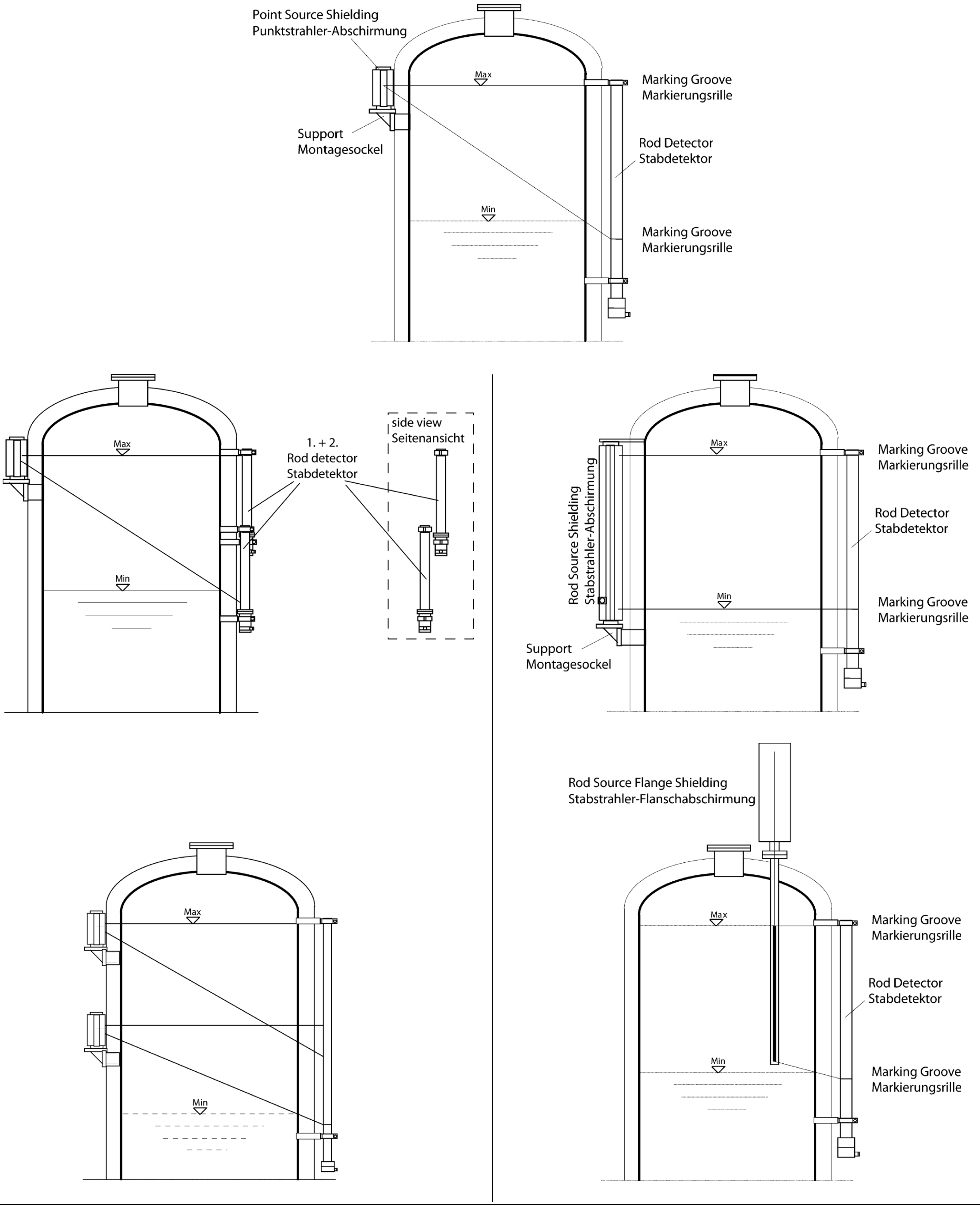
Die Detektor-Version mit Ex-Zulassung für Divisions (NEC/CEC) unterscheidet sich ausschließlich im Anschlusskopf, verglichen mit der oben aufgeführten Standardvariante. Die Abmessungen für den Anschlusskopf sind aus dieser Zeichnung zu entnehmen.

Type Typ	L	L (WC*)	L1	Weigth (kg) Gewicht (kg)	Weigth with WC* (kg) Gewicht mit WK* (kg)	Weigth with WC* + Water (kg) Gewicht mit WK* + Wasser (kg)
LB 480-2A	929		500	16,0		
LB 480-2E	1429		1000	20,5		
LB 480-2I	1929		1500	25,0		
LB 480-2K	2429		2000	29,5		
LB 480-2B		933	500		25.0	25.5
LB 480-2F		1433	1000		32.0	33.0
LB 480-2J		1933	1500		39.5	40.0
LB 480-2L		2433	2000		48.0	50.0

* WC/WK = Water Cooling / Wasserkühlung

LB 480

1.2 Examples for Measurement Arrangements with Rod Detector
Beispiele für Messanordnungen mit Stabdetektor



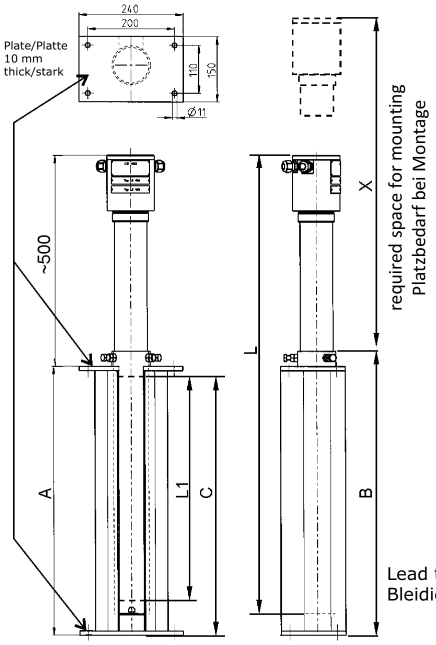
2

LB 480

Dimensions in mm
Abmessungen in mm

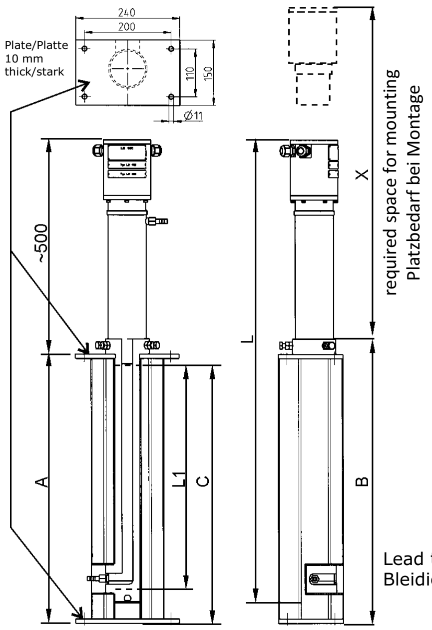
1.3 Collimator for Rod Detector
Kollimator für Stabdetektor

for Detectors without Water Cooling
für Detektoren ohne Wasserkühlung

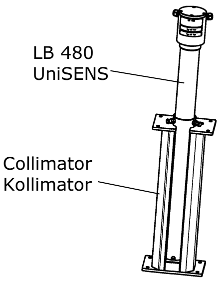


Lead thickness
Bleidicke: 36 mm

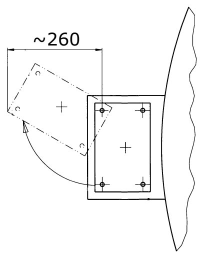
for Detectors with Water Cooling (WC)
für Detektoren mit Wasserkühlung (WK)



Lead thickness
Bleidicke: 30 mm



For installation/deinstallation, space for swiveling the collimator is recommended
Empfohlener Installations-/Deinstallationsraum zum Ausschwenken des Kollimators



Part No. Id No.	for WC für WK	L1 sensitive length empfindliche Länge	A	B	L detector length Detektorlänge	C	X	Weight Gewicht (kg)
59957-050 59957-100 59957-150 59957-200	-	500 1000 1500 2000	620 1120 1620 2120	655 1155 1655 2155	1073 1573 2073 2573	590 1090 1590 2090	1100 1600 2100 2600	110 195 280 365
60085-050 60085-100 60085-150 60085-200	✓	500 1000 1500 2000	620 1120 1620 2120	655 1155 1655 2155	1077 1577 2077 2577	590 1090 1590 2090	1100 1600 2100 2600	100 180 255 330

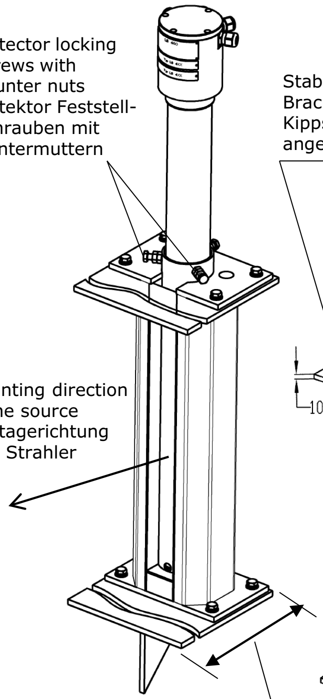
LB 480

Dimensions in mm
Abmessungen in mm

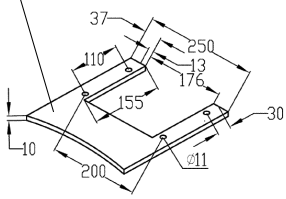
1.4 Examples for Mounting Devices and the Installation at the Collimator
Beispiele für die Halterung und Montage des Kollimators

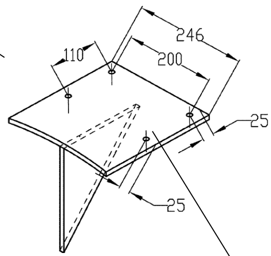
Detector locking screws with counter nuts
Detektor Feststell-schrauben mit Kontermuttern

mounting direction to the source
Montagerichtung zum Strahler



Stabilizer against tilting, installed by customer. Bracket e.g. welded to the vessel or a special support.
Kippsicherung installiert vom Errichter. Lasche z.B. angeschweißt am Behälter oder einer Tragekonstruktion.

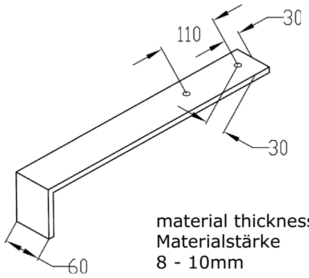




dimension depends on the on-site conditions, e.g. insulation thickness
Maß abhängig von örtlichen Gegebenheiten, z.B. Isolationsstärke.

Assembly platform installed by customer; must carry the total load of the collimator and the detector. It is e.g. welded to the vessel or on a special support
Montage-Plattform installiert vom Errichter; sie trägt das komplette Gewicht des Kollimators und des Detektors. Sie ist z.B. angeschweißt am Behälter oder einer Tragekonstruktion.

Alternative to the stabilizer against tilting in the drawing on the left, you can use a one-sided mounted angle bracket as a stabilizer too.
Alternative zur in der neben stehend dargestellten Kippsicherung, kann auch ein einseitig anmontierter Winkel als Kippsicherung montiert werden.

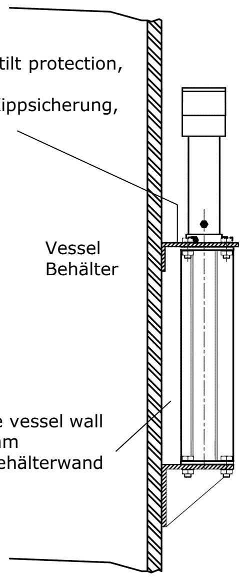


material thickness
Materialstärke
8 - 10mm

angle bracket as tilt protection, welded
Winkeleisen als Kippsicherung, angeschweißt

Vessel
Behälter

distance to the vessel wall approx. 100 mm
Abstand zur Behälterwand ca. 100 mm



BERTHOLD

2

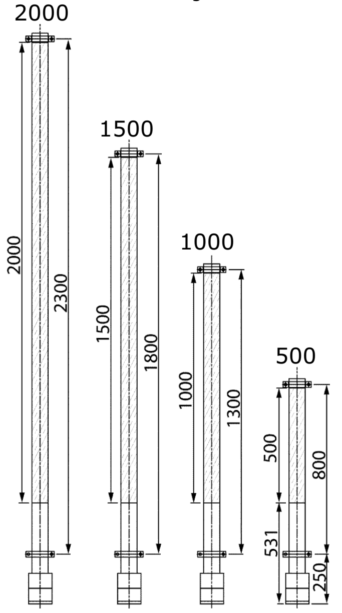
LB 480

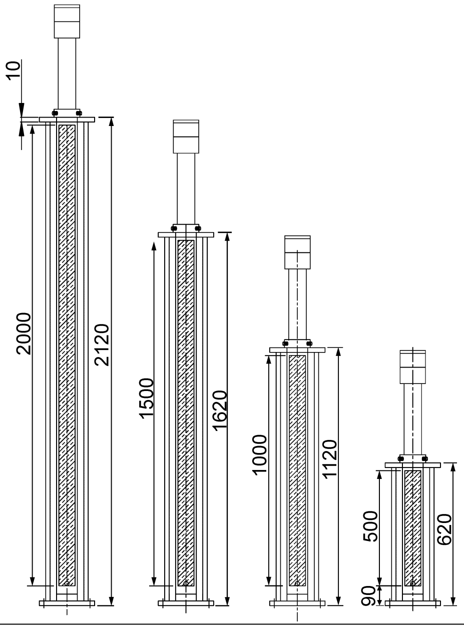
Dimensions in mm
Abmessungen in mm

1.5 Clamping Position for Rod Detectors
Klemmenposition für Stabdetektoren

1.6 Mounting Position for Rod Detector Shieldings
Klemmenposition für Stabdetektorabschirmungen

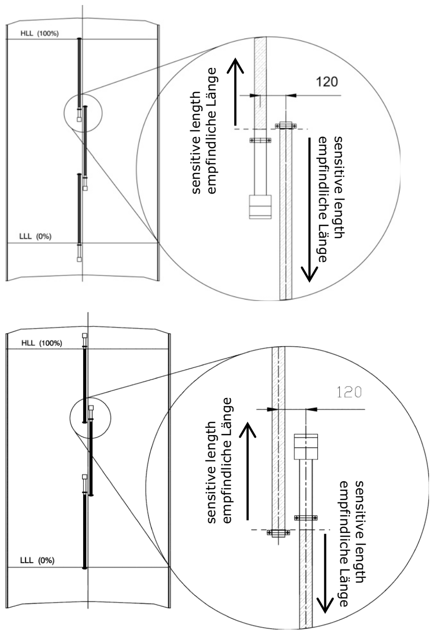
The drawings on this page are valid for Detectors with and without water cooling jacket.
Die Zeichnungen auf dieser Seite sind gültig für Detektoren mit und ohne Wasserkühlung.

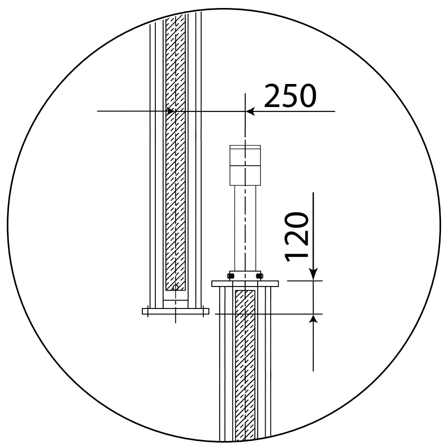




1.7 Clamping Position for Multi Detector Arrangement
Klemmenposition für Multidetektor-Anordnung

1.8 Mounting Position for Rod Detector Shieldings
Klemmenposition für Stabdetektorabschirmungen





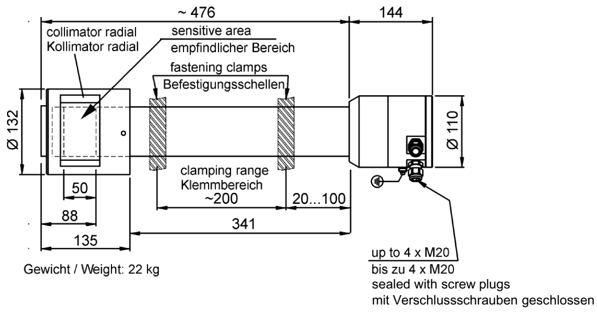
LB 480

Dimensions in mm
Abmessungen in mm

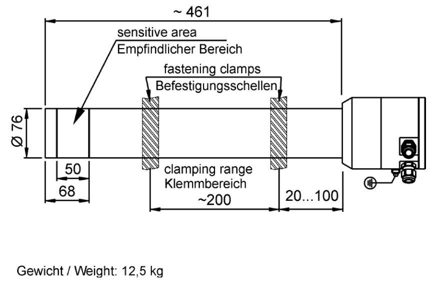
2.0 CrystalSENS (Version f. Zone 1/2)

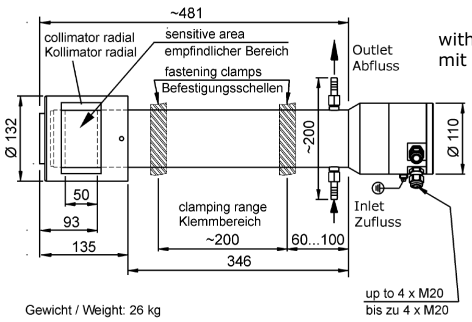
LB 480-1.-0.
LB 480-1.-1.
LB 480-1.-2.
LB 480-1.-Z.

LB 480-1.-.. -..-r.-

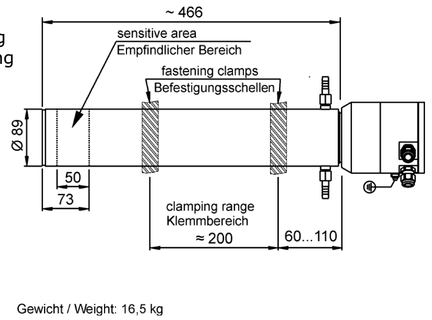


LB 480-1.-.. -..-0.-



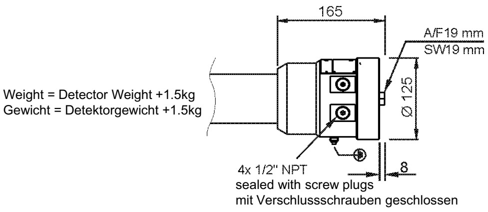


with water cooling
mit Wasserkühlung



2.1 CrystalSENS (Version f. Divisions 1/2)

LB 480-1.-F.
LB 480-1.-G.



The detector version for divisions (NEC/CEC) differs only in the terminal housing, compared to the standard version illustrated above. The dimensions of this terminal housing are illustrated in this drawing.

Die Detektor-Version mit Ex-Zulassung für Divisions (NEC/CEC) unterscheidet sich ausschließlich im Anschlusskopf, verglichen mit der oben aufgeführten Standardvariante. Die Abmessungen für den Anschlusskopf sind aus dieser Zeichnung zu entnehmen.

2.2 CrystalSENS Scintillator Size / Szintillatorgröße

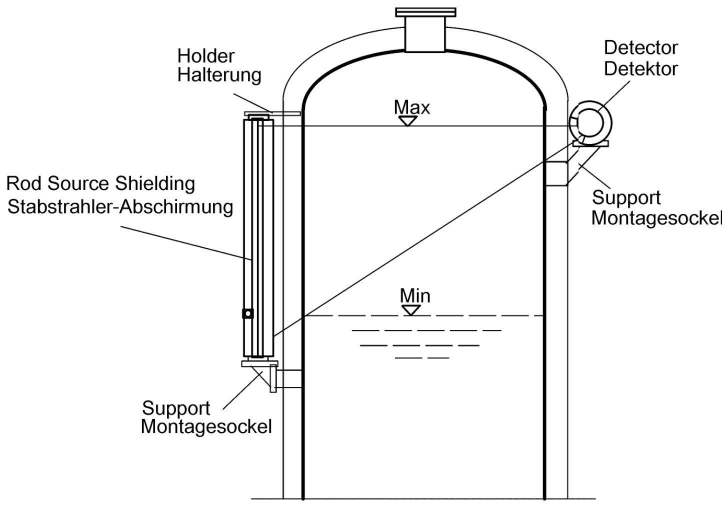
Type Typ	Scintillator Size (Ø/h) Szintillatorgröße	Water cooling Wasserkühlung
LB 480-11	50/50	-
LB 480-12	50/50	✓
LB 480-13	40/35	-
LB 480-14	40/35	✓
LB 480-15	25/25	-
LB 480-16	25/25	✓

BERTHOLD

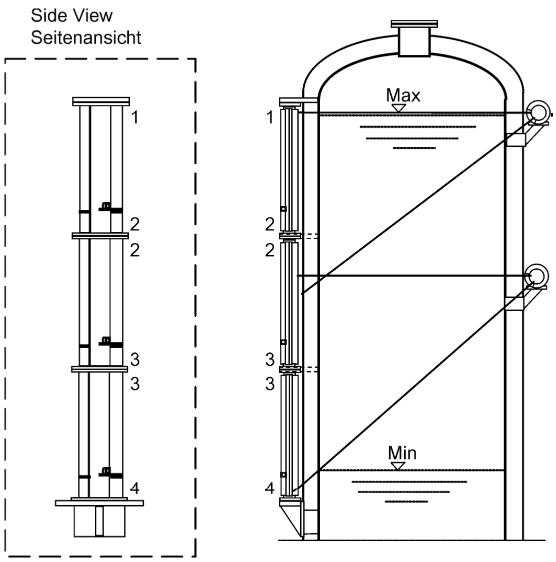
2

LB 480

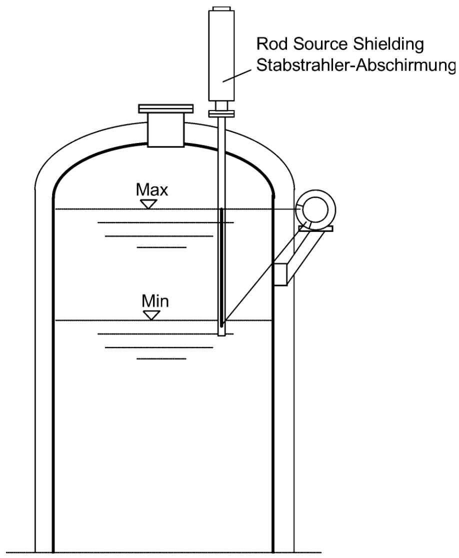
2.3 Point Detector Installation Examples
Punktdetektor Installationsbeispiele



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



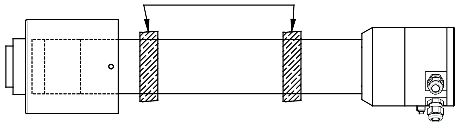
Application with dip pipe
Anordnung mit Tauchrohr



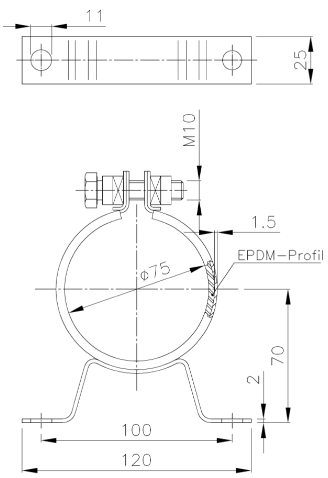
LB 480

Dimensions in mm
Abmessungen in mm

2.4 Mounting Clamps for Detector
Befestigungsschellen für Detektor



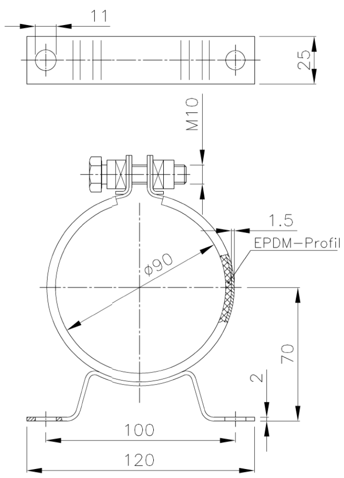
for Detectors without water cooling
für Detektoren ohne Wasserkühlung



Id. Nr. 31346 (1 set = 2 clamps)
Id. Nr. 31345 (single clamp)

Material
316Ti
1.4571

for Detectors with water cooling
für Detektoren mit Wasserkühlung



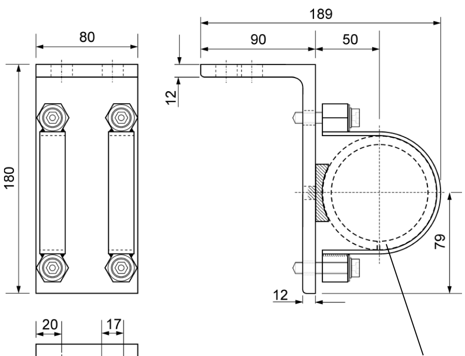
Id. Nr. 31347 (1 set = 2 clamps)
Id. Nr. 31344 (single clamp)

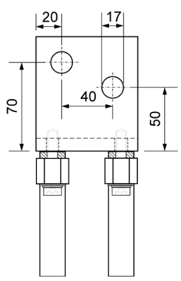
position for the clamps, see detector drawing
Position für die Schellen-Befestigung siehe Detektor-Zeichnung

---

Heavy Duty Detector Holder (stainless steel)
Robuste Detektor Halterung (Edelstahl)

Part No. Id. Nr.	for Detector für Detektor
39246	without water cooling ohne Wasserkühlung
39247	with water cooling mit Wasserkühlung





Remove the plastic ring for detectors with water cooling.

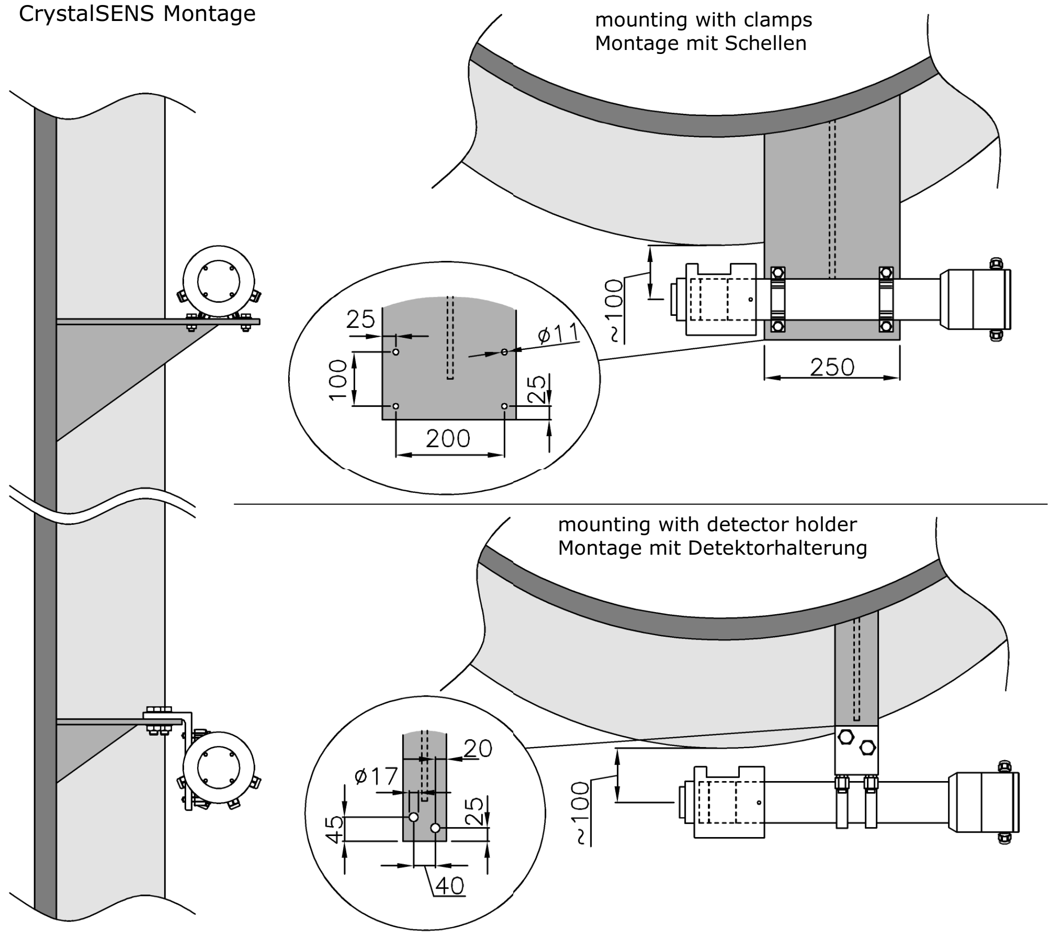
Kunststoffring bei Detektoren mit Wasserkühlung entfernen.

BERTHOLD

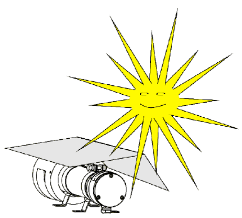
LB 480

Dimensions in mm
Abmessungen in mm

2.5 CrystalSENS Mounting
CrystalSENS Montage



2.6 Sun Roof against Strong Sun Radiation
Sonnendach gegen starke Sonneneinstrahlung



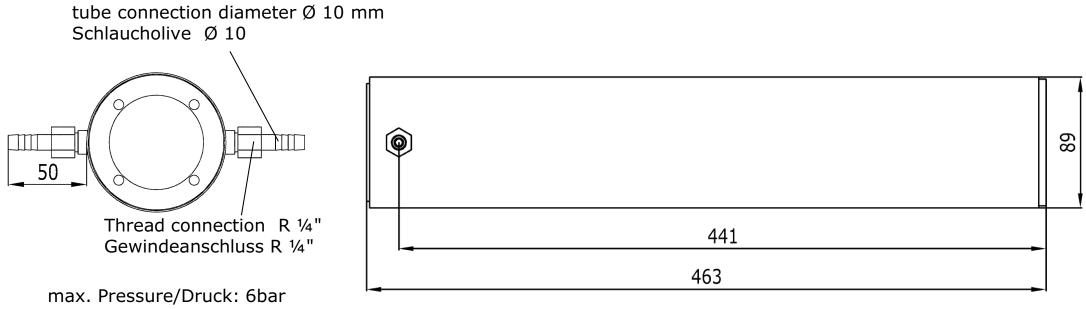
Direct sun radiation can overheat the detector. If the detector temperature can reach more than 50°C, a suitable sun roof must be installed.
The heating of the detector by thermal radiation from the vessel can also be moderated by a thermal sheet, e.g. by a thin metal plate.
For each detector a water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

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

LB 480

Dimensions in mm
Abmessungen in mm

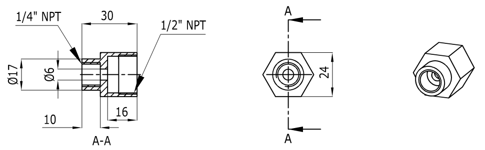
2.7 CrystalSENS Water Cooling Jacket and Adaptor Fittings
CrystalSENS Wasserkühlung und Adapter Anschlussstücke



max. Pressure/Druck: 6bar

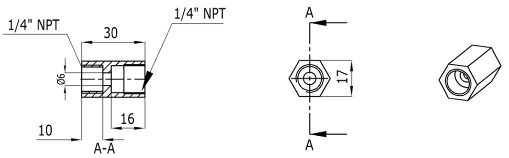
Fitting adaptor for standard water cooling Rp ¼" → ½" NPT
stainless steel 304, part no: 47189

Adapter für Standard Wasserkühlung Rp ¼"→ ½" NPT
Edelstahl 1.4301, Id. Nr.: 47189



Fitting adaptor for standard water cooling Rp ¼> ¼" NPT
stainless steel 304, part no: 46743

Adapter für Standard Wasserkühlung Rp ¼> ¼" NPT
Edelstahl 1.4301, Id. Nr.: 46743



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

Weitere Adapter für die Standard-Wasserkühlung:
Rp ¼"> ½" NPT Außengewinde, 1.4301, Id. Nr.: 06352
Rp ¼"> ¼" NPT Außengewinde, 1.4301, Id. Nr.: 06349

The above mentioned water cooling jackets and adaptor fittings offers following connection versions:
Die oben aufgeführten Wasserkühlungen und Adapter ermöglichen folgende Anschlussvarianten:

Fitting Connection	**Anschluss-Stutzen**	**part no. (material)** **Id.Nr. (Werkstoff)**
R ¼" pipe connection, male European standard Whitworth pipe thread	R ¼" Außengewinde für Rohrverschraubung europäisches Standard Whitworth-Rohrgewinde	21326 (304/1.4301) 38055 (Carbon Steel St37)
10 mm hose connection for water hose connection ID 10 mm	Schlauchstutzen für Schlauch- Innendurchmesser 10 mm	21326 (304/1.4301) 38055 (Carbon Steel St37)
fitting adaptor ½" NPT female	Adapter mit ½" NPT Innengewinde	47189 (304/1.4301)
fitting adaptor ¼" NPT female	Adapter mit ¼" NPT Innengewinde	46743 (304/1.4301)
fitting adaptor ½" NPT male	Adapter mit ½" NPT Außengewinde	06352 (304/1.4301)
fitting adaptor ¼" NPT male	Adapter mit ¼" NPT Außengewinde	06349 (304/1.4301)

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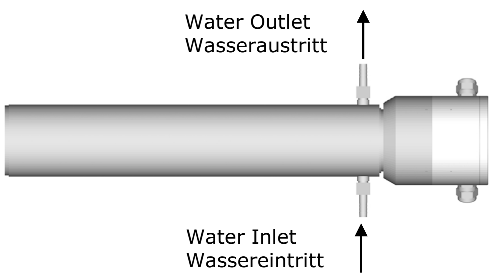
LB 480

2.8 Water Cooling Installation Instruction
Anweisung zur Installation der Wasserkühlung

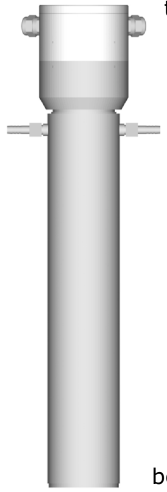
Horizontal Detector Installation
Horizontale Detektor Installation



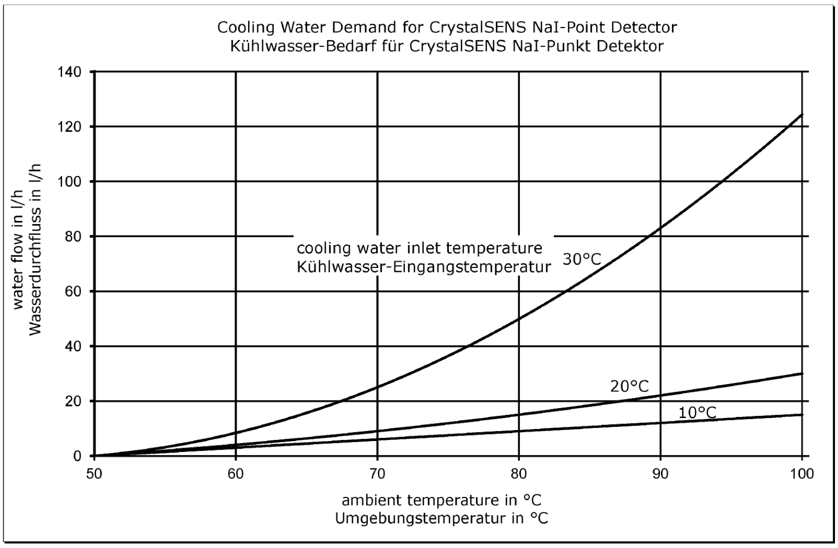
In order to fill the entire water cooling jacket, incoming water must enter from the bottom.
Damit sich die Wasserkühlung vollständig mit Wasser füllt, muss der Wasserzufluss von unten erfolgen.

Vertical Detector Installation
Vertikale Detektor Installation

Install the Detector with the connection at the top.
Installieren Sie den Detektor mit dem Anschlussgehäuse oben.



2.9 Detector Cooling Water Demand
Detektor Kühlwasserbedarf



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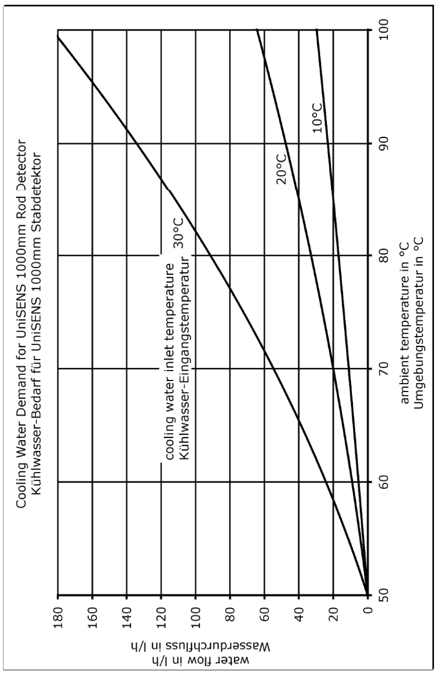
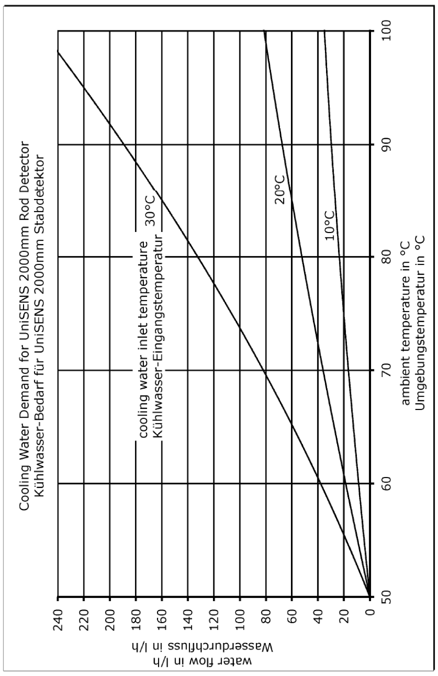
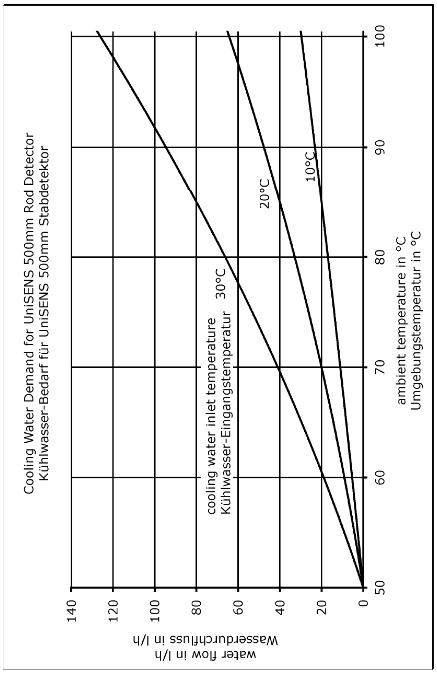
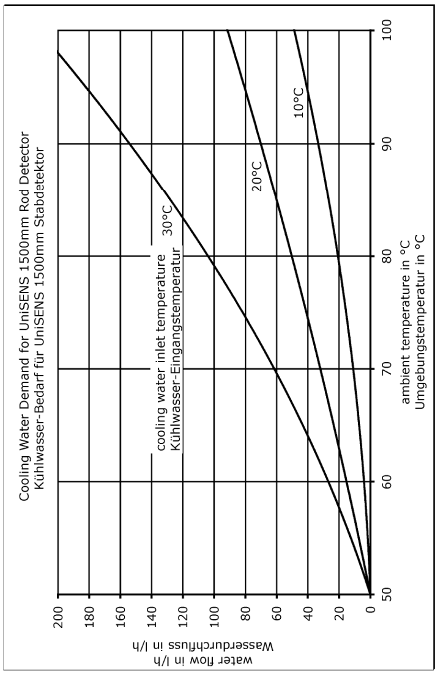
LB 480









BERTHOLD

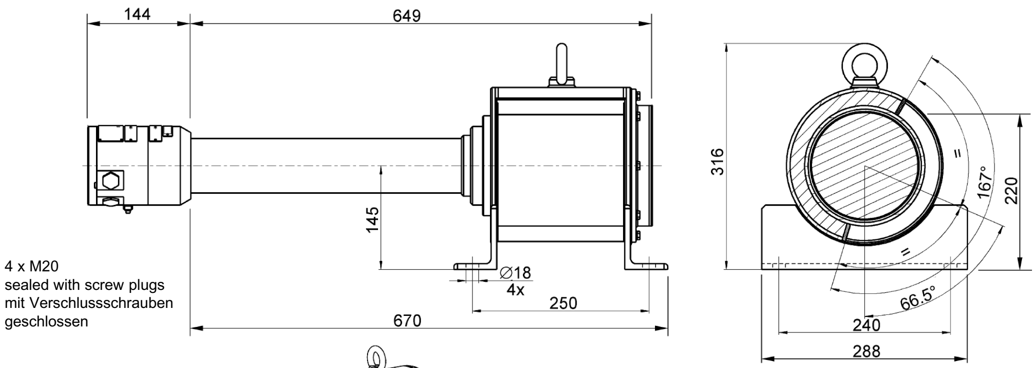
LB 480

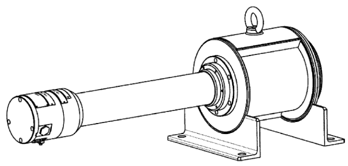
Dimensions in mm
Abmessungen in mm

3. SuperSENS (Version f. Zone 1/2)

LB 480-3.-0.
LB 480-3.-1.
LB 480-3.-2.
LB 480-3.-Z.

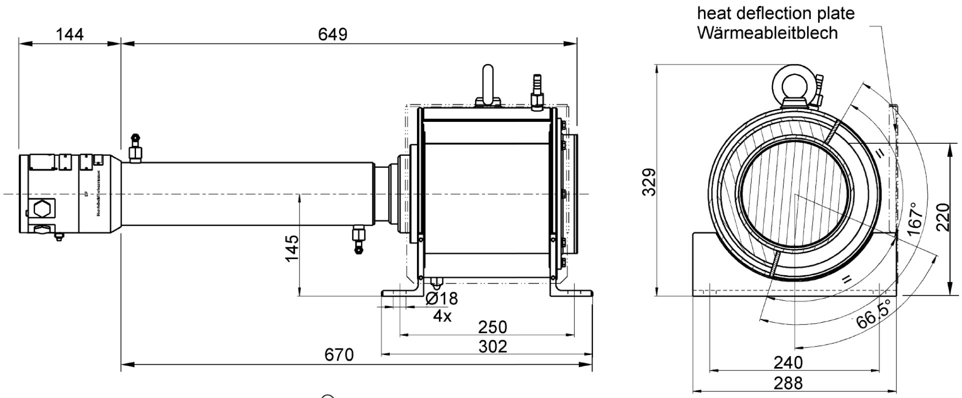
3.1 with Side Irradiation
mit seitlicher Einstrahlung
LB 480-31-..-..-r.

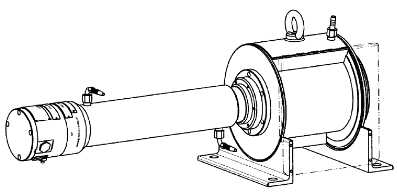




Weight/Gewicht 52 kg

3.2 with Side Irradiation and Water Cooling
mit seitlicher Einstrahlung und Wasserkühlung
LB 480-32-..-..-r.





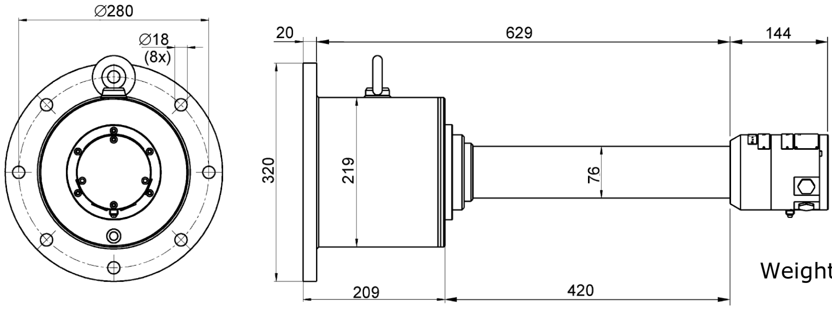
Weight/Gewicht 59 kg

BERTHOLD

LB 480

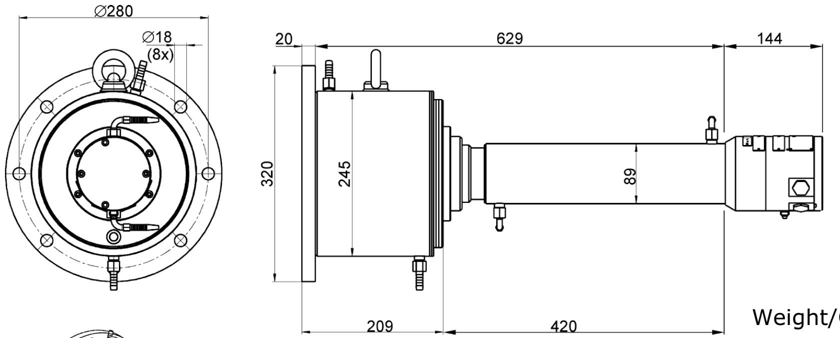
Dimensions in mm
Abmessungen in mm

3.3 with Axial Irradiation
mit frontaler Einstrahlung
LB 480-31-..-..-a.

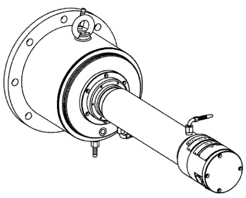


Weight/Gewicht 62 kg

3.4 with Axial Irradiation and Water Cooling
mit frontaler Einstrahlung und Wasserkühlung
LB 480-32-..-..-a.

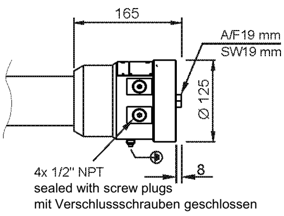


Weight/Gewicht 69 kg



3.5 SuperSENS (Version f. Divisons 1 + 2)

LB 480-3.-F.
LB 480-3.-G.



Weight = Detector Weight +1.5kg
Gewicht = Detektorgewicht +1.5kg

The detector version for divisions (NEC/CEC) differs only in the terminal housing, compared to the standard version illustrated above. The dimensions of this terminal housing are illustrated in this drawing.

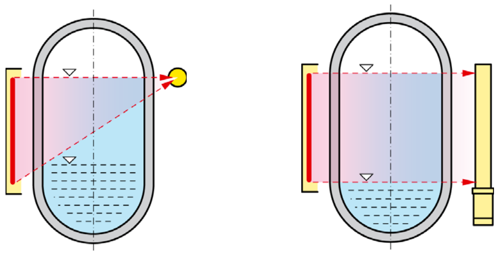
Die Detektor-Version mit Ex-Zulassung für Divisions (NEC/CEC) unterscheidet sich ausschließlich im Anschlusskopf, verglichen mit der oben aufgeführten Standardvariante. Die Abmessungen für den Anschlusskopf sind aus dieser Zeichnung zu entnehmen.

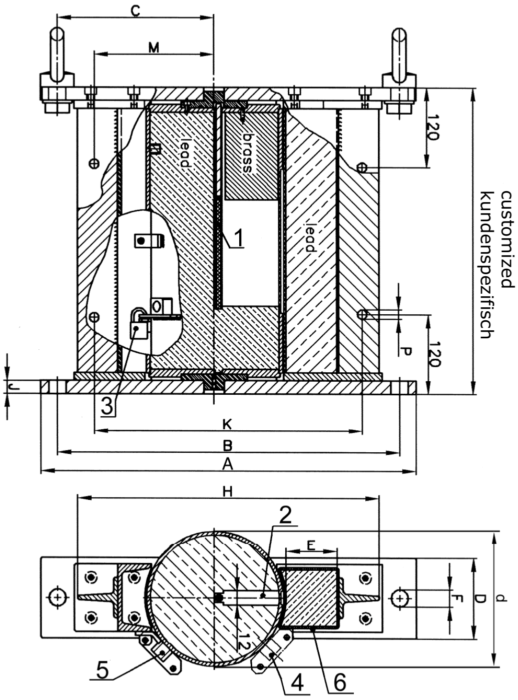
BERTHOLD

LB 480

Dimensions in mm
Abmessungen in mm

4. Shielding for Rod Source
Abschirmung für Stabstrahler





1	rod source	Stabstrahler
2	radiation channel	Strahlenaustritt
3	pad lock	Vorhängeschloss
4	position open	Stellung auf
5	position closed	Stellung zu
6	name plate	Typenschild

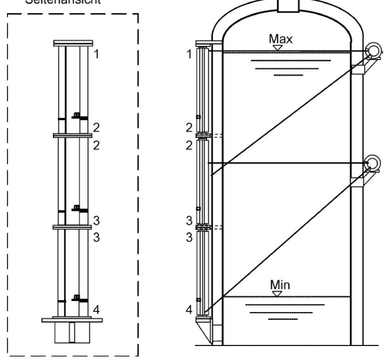
Multiple Arrangement of Rod Sources
Mehrteilige Anordnung von Stabstrahlern

Holes for tilt protection
Bohrungen für Kippsicherung

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

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

Side View
Seitenansicht

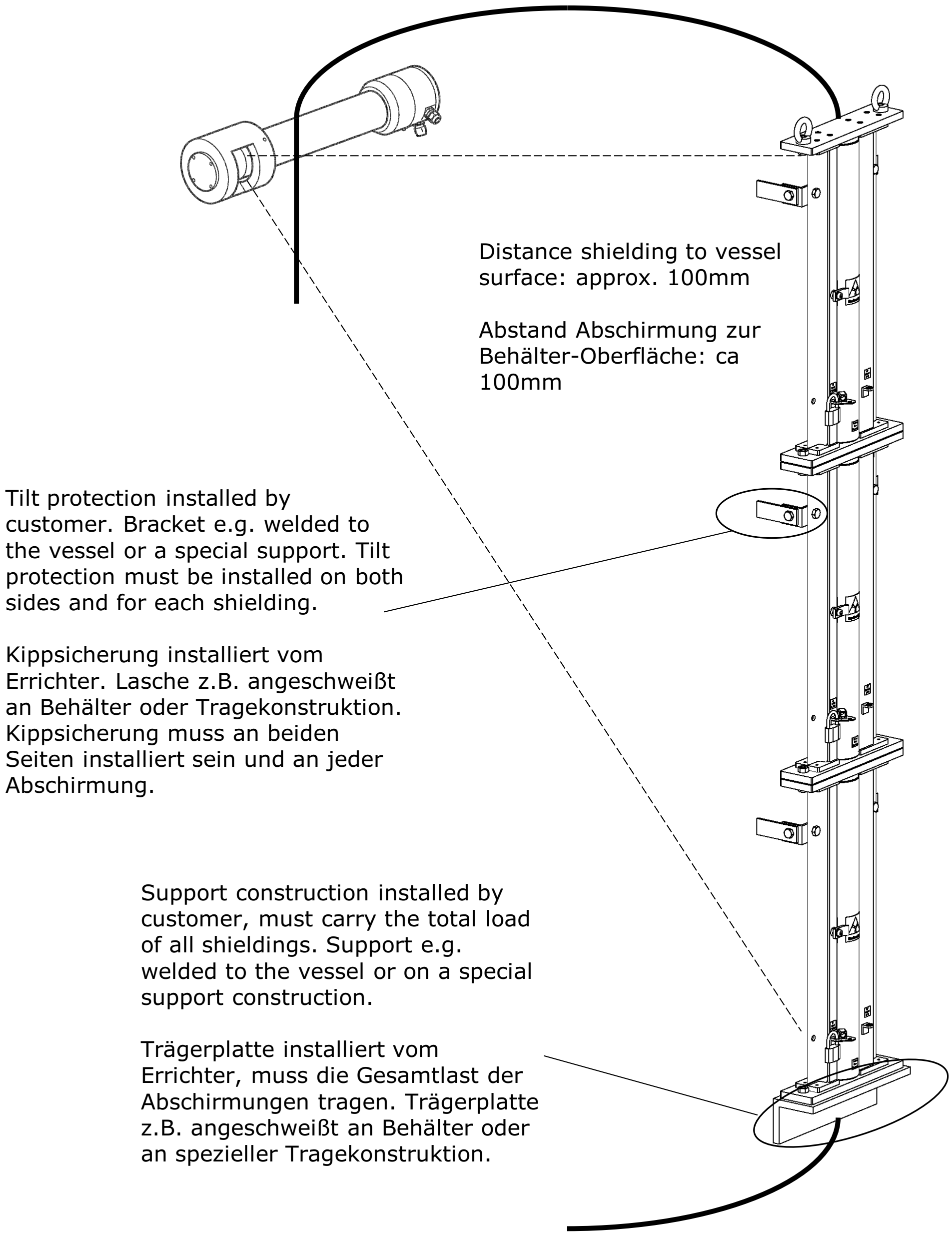


Type Typ	d	kg/m approx	A	B	C	D	E	F	H	J	K	M	P
80	85	100	320	285	130	80	41	14	235	15	204.5	90	11.5
100	105	130	340	305	140	80	41	14	255	15	224.5	100	11.5
120	127	190	400	360	165	80	47	18	310	20	270	120	11.5
150	159	300	465	425	195	100	65	18	375	20	334	150	14
200	203	450	560	510	235	120	75	25	450	25	400	180	14
270	267	780	580	510	230	125	100	26	545	25	503	222.5	14

BERTHOLD

LB 480

4.1 Multipart Installation of Rod Source Shieldings
Mehrteilige Installation von Stabstrahler-Abschirmungen



2

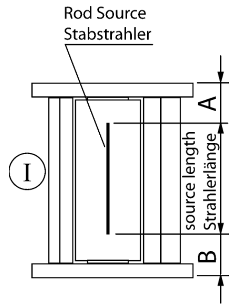
LB 480

Dimensions in mm
Abmessungen in mm

4.2 Single Part Arrangement for Rod Source Shieldings
Einteilige Anordnung von Stabstrahler-Abschirmungen

For single part rod source arrangement only the shielding with the "arrangement I" is necessary

Eine einteilige Stabstrahler-Anordnung benötigt lediglich die Abschirmung mit der Montageart I.



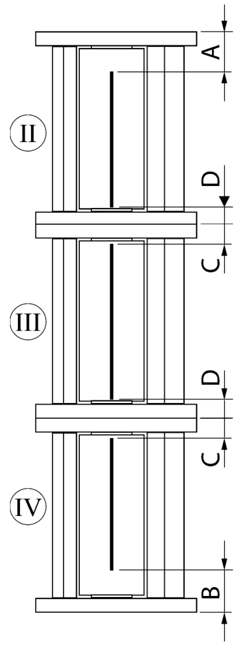
4.3 Multipart Arrangement for Rod Source Shieldings
Mehrteilige Anordnung von Stabstrahler-Abschirmungen

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

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

2-part arrangement: II + IV
3-part arrangement: II + III + IV
4-part arrangement: II + III + III + IV
etc.

Anordnung mit 2 Abschirmungen: II + VI
Anordnung mit 3 Abschirmungen: II + III + IV
Anordnung mit 4 Abschirmungen: II + III + III + IV
etc.



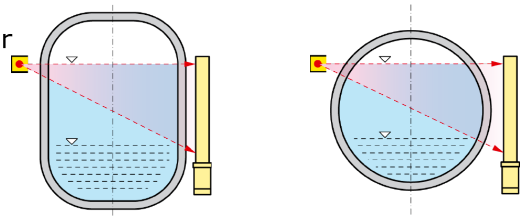
Shielding / Abschirmung		**A**	**B**	**C**	**D**
Ø	**drawing no. Zeichnungs-Nr.**				
80	21156.000-000	78	78	18	24
100	21157.000-000	92	92	18	24
120	21158.000-000	113	89	23	30
150	21159.000-000	132	106	21	32
200	21160.000-000	169	132	26	37
270	21161.000-000	202	140	30	40

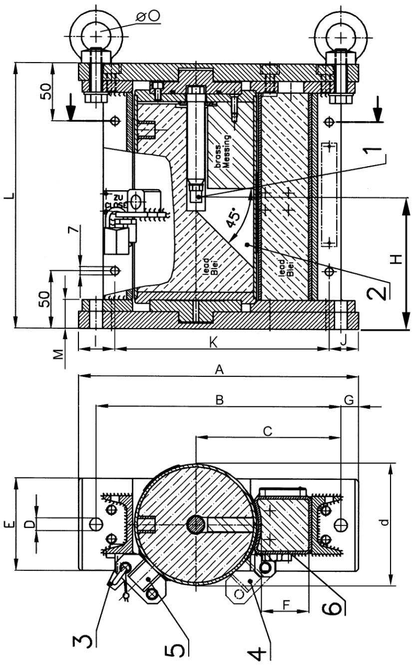
BERTHOLD

LB 480

Dimensions in mm
Abmessungen in mm

5. Shielding for Point Source
Abschirmungen für Punkt Strahler



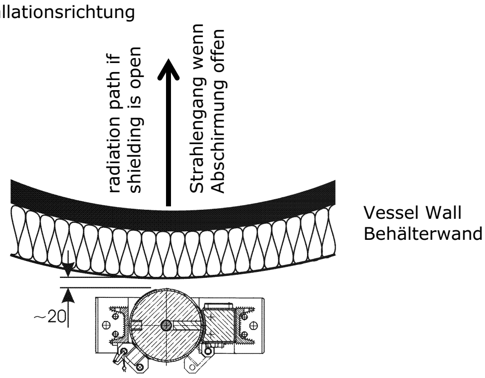


The shielding are marked with BOTTOM to rule out any side-inverted installation.

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

1	point source	Punktstrahler
2	radiation channel	Strahlenaustritt
3	pad lock	Vorhängeschloss
4	position open	Stellung auf
5	position closed	Stellung zu
6	name plate	Typenschild

Direction of Installation
Installationsrichtung

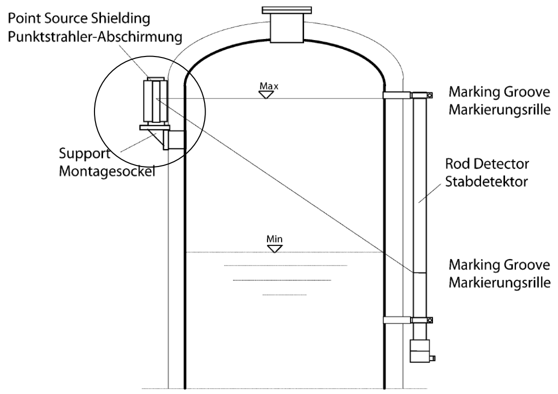


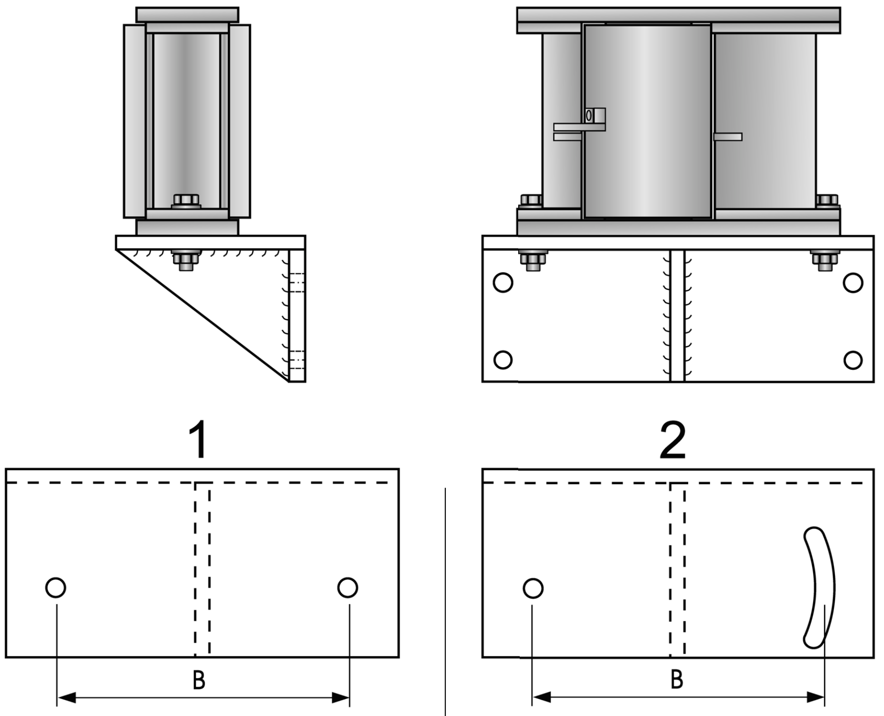
Type Typ	d	A	B	C	D	E	F	G	H	I	J	K	L	M	øO	Weight Gewicht
100	105	240	210	125	11	80	40	15	110	30	25	185	225	25	25	32 kg
150	159	360	320	195	18	100	65	20	150	29	29	302	265	25	35	70 kg
200	203	410	360	220	23	120	75	25	185	22	22	366	340	30	40	150 kg
270	267	580	510	315	26	300	101	35	280	45	55	436	480	45	50	370 kg

BERTHOLD

LB 480

5.1 Proposal for Support
Vorschlag für Montagesockel





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

Der Montagesockel 1 ist leichter herzustellen.

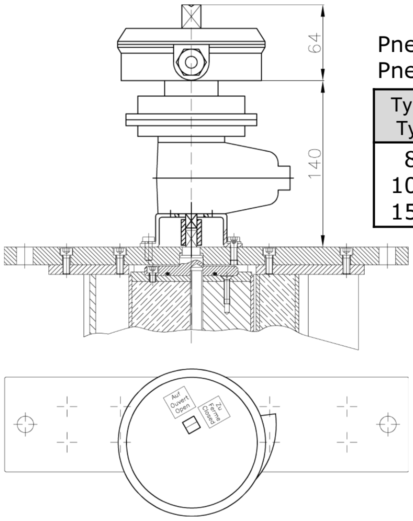
The design 2 of the support plate with the oblong slot, allows an adjustment of the radiation beam to the detector.

Die Ausführung 2 des Montagesockels mit dem Langloch, ermöglicht die Ausrichtung des Strahlers auf den Detektor.

BERTHOLD

LB 480

6. Pneumatic Actuator for Rod and Point Source Shielding (Type 80 … 270)
Pneumatik für Stab- und Punktstrahler-Abschirmungen (Typ 80 … 270)



Pneumatic actuator for **rod source** shielding
Pneumatischer Antrieb für **Stabstrahler**-Abschirmung

Type Typ	without Limit-Switch ohne Endschalter	with Limit-Switch mit Endschalter	with Limit-Switch Exe mit Endschalter Exe
80	49943	49942	50013
100	38169	38171	51444
150	51446	51445	51316

Pneumatic actuator for **point source** shielding
Pneumatischer Antrieb für **Punktstrahler**-Abschirmung

Type Typ	without Limit-Switch ohne Endschalter	with Limit-Switch Exe mit Endschalter Exe
100	40085	40084
150	41689	41690
200	41681	41691
270	-	50531

Other shieldings with pneumatic on request.
Andere Abschirmungen mit Pneumatik auf Anfrage.

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

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

Sofern Sie den Verschlussmechanismus fernsteuern wollen ist eine pneumatische Verschlusseinrichtung optional erhältlich. Die Pneumatik ist zusätzlich mit Endschalter für die Positionsrückmeldung erhältlich.

Achtung: mehrteilige Stabstrahler-Abschirmungen mit Pneumatik können nicht direkt aufeinander montiert werden, sondern müssen seitlich zueinander versetzt angeordnet werden. Für jede Abschirmung wird eine kpl. Pneumatik benötigt. Die Pneumatik darf nur auf Abschirmungen vom Typ I montiert werden.

Data for Pneumatic Actuator

Compressed Air: min. 4 x 10^5 Pa (4 bar) max. 7 x 10^5 Pa (7 bar) connection: G 1/8
Air Quality: clean as usual for compressed air tools, oil free
Temperature Range: -20°C … + 80°C

Daten für pneumatischen Verschlussantrieb

Druckluft: min. 4 x 10^5 Pa (4 bar) max. 7 x 10^5 Pa (7 bar) Anschluss: G 1/8
Luftqualität: Sauber wie bei Druckluft-Werkzeugen üblich, ölfrei
Temperaturbereich: -20°C … + 80°C

Indication Open/Closed via Limit Switch

Option I: IP65, 2 contacts (Open/Closed) 48 VDC, 1 A
Option II: 2 contacts (Open/Closed) max. 250V AC, 1 A Ex-Protection of the limit switches: EEx d IIC T6 Ex-Protection of the limit switch housing: EEx e IIC T6

Signalisierung AUF/ZU durch Endschalter

Option I: IP65, 2 Kontakte (AUF/ZU) 48 VDC, 1 A
Option II: 2 Kontakte (AUF/ZU) max. 250V AC, 1 A Schutzart der Microeinbautaster: EEx d IIC T6 Gehäuseschutzart: EEx e IIC T6

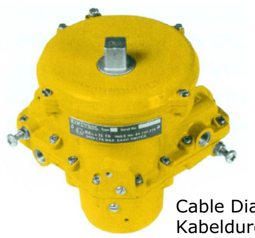
BERTHOLD

LB 480

Dimensions in mm
Abmessungen in mm

6.1 Components for Pneumatic on Rod and Point Source Shielding
Einzelteile für Pneumatik an Stabstrahler- und Punktstrahlerabschirmung

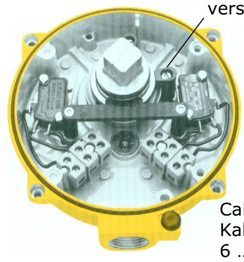
Limit Switch
Endschaltereinheit
Ex de Zone 1



Cable Diameter
Kabeldurchmesser
6 ... 12 mm

Limit Switch
Endschaltereinheit
IP 65 (SPDT)

adjustable cams
verstellbare Nocken



Cable Diameter
Kabeldurchmesser
6 ... 12 mm

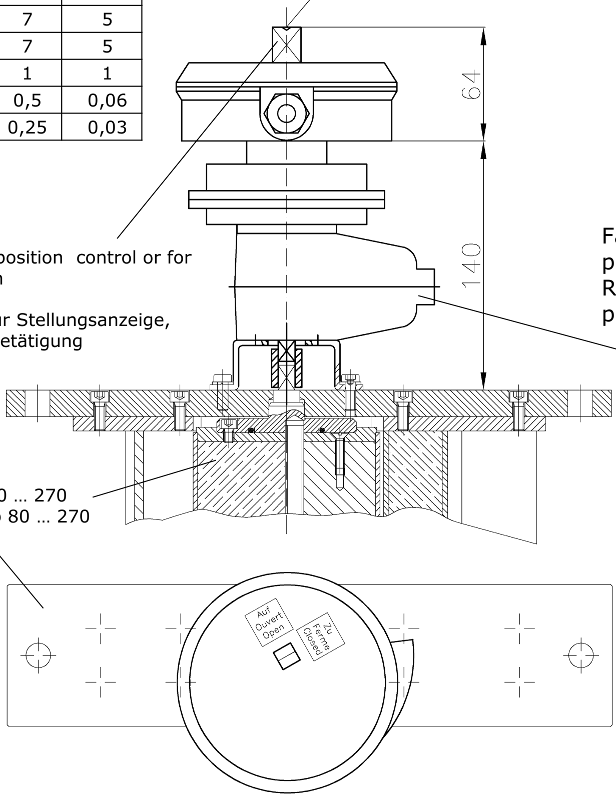
Contact Rating
Kontaktbelastbarkeit

Volt		Load / Last (A)	
AC	DC	R	L
250		7	5
125		7	5
	12	7	5
	24	1	1
	48	0,5	0,06
	250	0,25	0,03

Contact Rating
Kontaktbelastbarkeit

Volt		Load / Last (A)		
AC	DC	R	L	Lamp
250		15	3	1,5
125		15	3	1,5
	12	15	3	1,5
	24	10	2	1
	48	3	0,6	0,3
	250	0,25	0,05	0,025

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

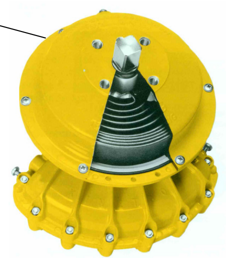


Square neck for position control or for manual operation

Außenvierkant zur Stellungsanzeige, oder manueller Betätigung

Shielding Type 80 ... 270
Abschirmung Typ 80 ... 270

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

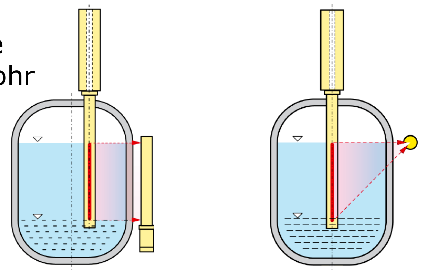


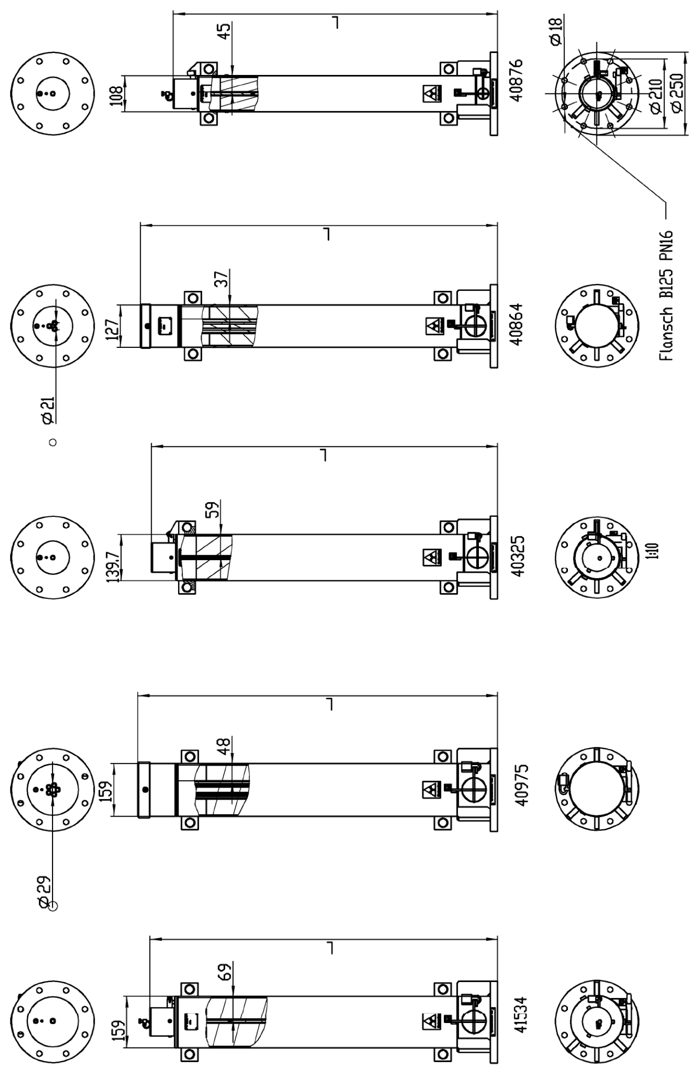
BERTHOLD

LB 480

Dimensions in mm
Abmessungen in mm

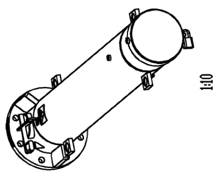
7. Flange Shielding for Rod Source on Dip Pipe
Abschirmungen für Stabstrahler am Tauchrohr





CAUTION
Do not close the shutter, if the source is in measuring position.
Do not remove the steel cord until the source is in home position and the shutter is closed.

ACHTUNG
Bei Strahler in Messpositon, den Verschluss nicht betätigen!
Vor dem Entfernen des Seiles die Strahler sichern und Verschluss schließen.



part no. / Id. Nr.	41534	40975	40325	40864	40876
effective lead thickness / wirksame Bleidicke	69	47.5	58.85	36.5	45
max. Anzahl der Strahler / max. number of sources	1	5	1	3	1
Source length [mm] / Strahlerlänge [mm]	**total length L [mm] / Gesamtlänge L [mm]**				
640	1046	1085	1042	1075	976
840	1246	1285	1242	1275	1176
1040	1446	1485	1442	1475	1376
1240	1646	1685	1642	1675	1576
1440	1846	1885	1842	1875	1776
1640	2046	2085	2042	2075	1976
1840	2246	2285	2242	2275	2176

BERTHOLD

54733-10BA2L
09.2023

2

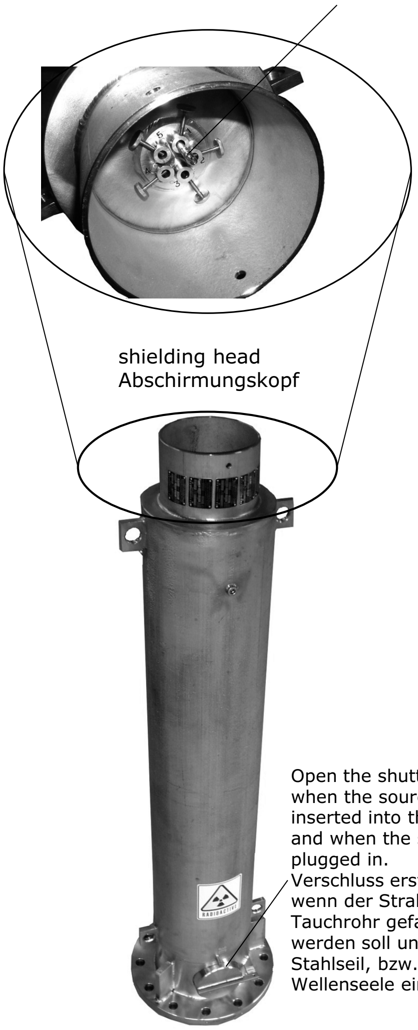
LB 480

7.1 Operation of Flange Shielding
Bedienung der Flanschabschirmung

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

Steel cord for source positioning
Stahlseil zur Strahlerpositionierung

source tail end (inactive)
Strahlerendstück (inaktiv)



shielding head
Abschirmungskopf

Open the shutter only when the source shall be inserted into the dip pipe and when the steel cord is plugged in.
Verschluss erst öffnen wenn der Strahler in das Tauchrohr gefahren werden soll und das Stahlseil, bzw. die Wellenseele eingeklinkt ist.

Operation of the coupling device
Bedienung der Kupplung

A)

source tail end with catch bolt
Strahlerendstück mit Kupplung

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

B)

plug the latch into the catch bolt
Klinke in Kupplung einklinken

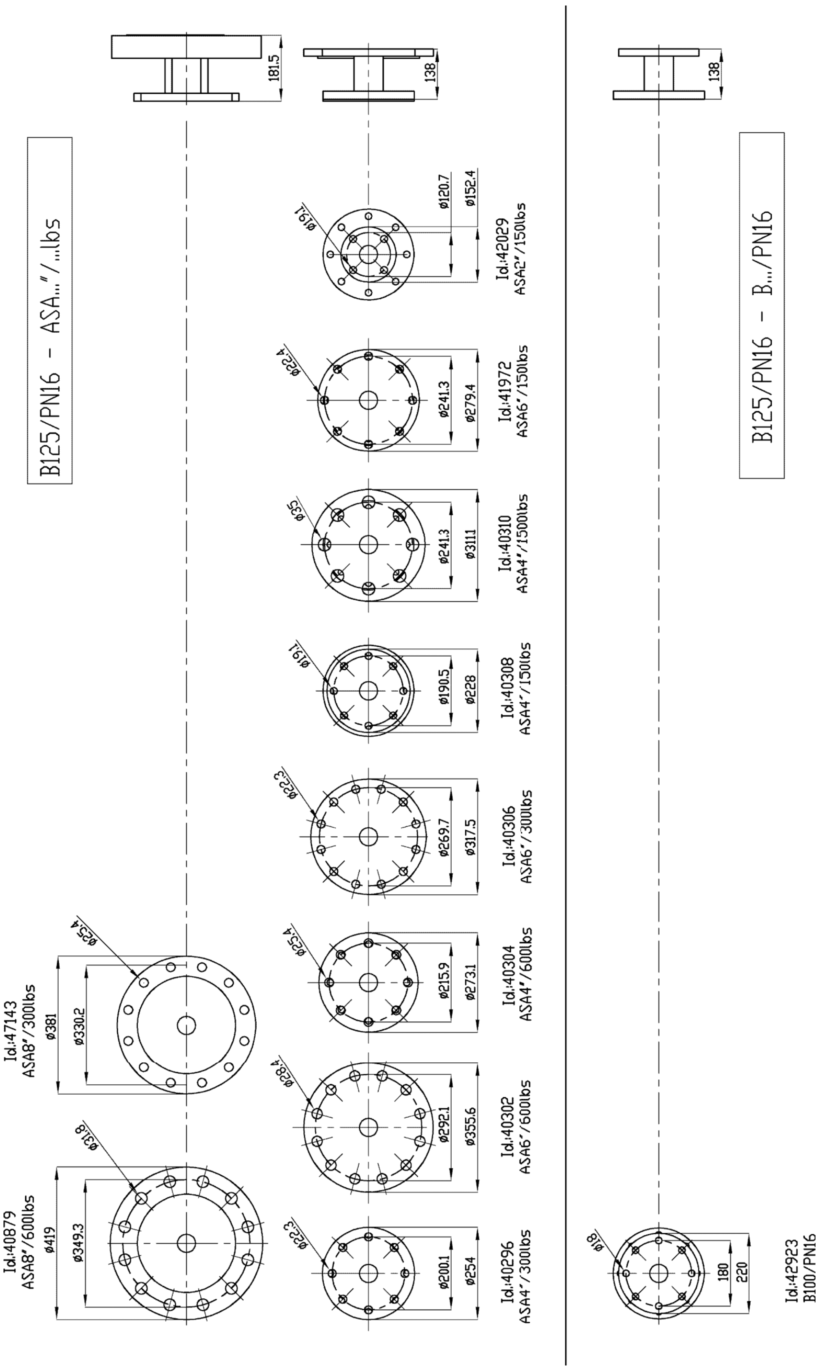
C)

latch plugged into the catch bolt
Klinke in Kupplung eingeklinkt

BERTHOLD

LB 480

7.2 Flange Adaptors for Rod Source Shieldings
Flanschadapter für Stabstrahler-Abschirmungen



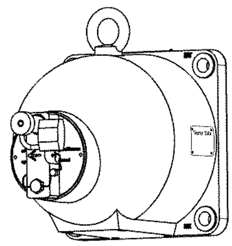
BERTHOLD

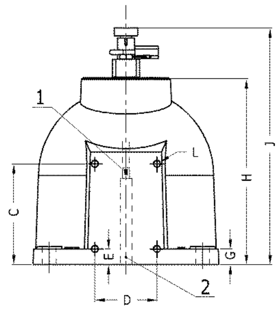
LB 480

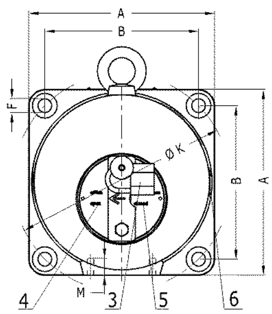
Dimensions in mm
Abmessungen in mm

8. Point Source Shielding LB 744x
Punktstrahler-Abschirmbehälter LB 744x

LB 7440 / 7442 / 7445 / 7446		LB 7444

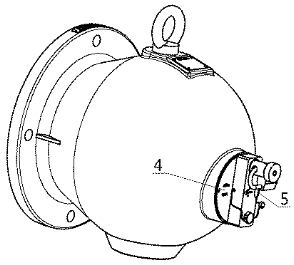


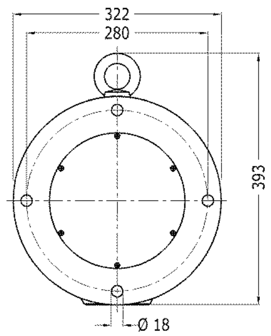


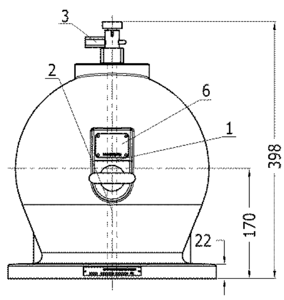


1 Point Source
2 Radiation Exit
3 Lock
4 Position **Open**
5 Position **Closed**
6 Type Label

1 Strahler
2 Strahlenausgang
3 Schloss
4 Position **Offen**
5 Position **Geschlossen**
6 Typenschild







<table>
<tr><th>Housing
Gehäuse</th><th>Type
Typ</th><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th><th>FØ</th><th>G</th><th>H</th><th>J</th><th>KØ</th><th>L</th><th>M</th><th></th><th>kg</th></tr>
<tr><td>Carbon Steel
St 37</td><td>LB 7440-F-CR
LB 7445-F-CR</td><td rowspan="2">180</td><td rowspan="2">142</td><td rowspan="2">75</td><td rowspan="2">60</td><td rowspan="2">15</td><td rowspan="2">18</td><td rowspan="2">20</td><td rowspan="2">173</td><td rowspan="2">238</td><td rowspan="2">200</td><td rowspan="2">M8</td><td rowspan="2">12</td><td rowspan="2">16°</td><td rowspan="2">31</td></tr>
<tr><td rowspan="2">Super Duplex
UNS 32750
SAF 2507
1.4410</td><td>LB 7440-FE-CR
LB 7445-FE-CR</td></tr>
<tr><td>LB 7442-FE-CR</td><td rowspan="2">240</td><td rowspan="2">198</td><td rowspan="2">130</td><td rowspan="2">80</td><td rowspan="2">20</td><td rowspan="2">18</td><td rowspan="2">20</td><td rowspan="2">242</td><td rowspan="2">306</td><td rowspan="2">280</td><td rowspan="2">M10</td><td rowspan="2">14</td><td rowspan="2">9°</td><td rowspan="2">81</td></tr>
<tr><td rowspan="2">Carbon Steel
St 37</td><td>LB 7442-F-CR
LB 7446-F-CR</td></tr>
<tr><td>LB 7444-CR</td><td colspan="12">Dimensions in drawing / Abmessungen in Zeichnung</td><td>6°</td><td>170</td></tr>
</table>

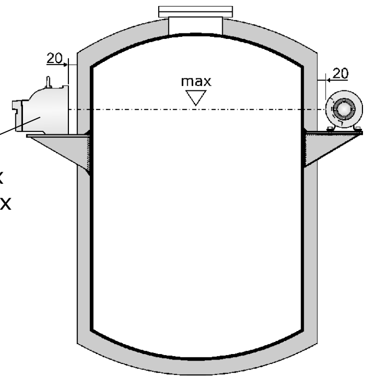
Radiation Angle of the Shielding / Abstrahlwinkel der Abschirmung

BERTHOLD

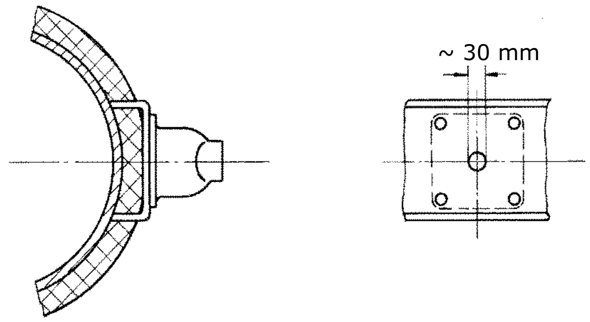
LB 480

Dimensions in mm
Abmessungen in mm

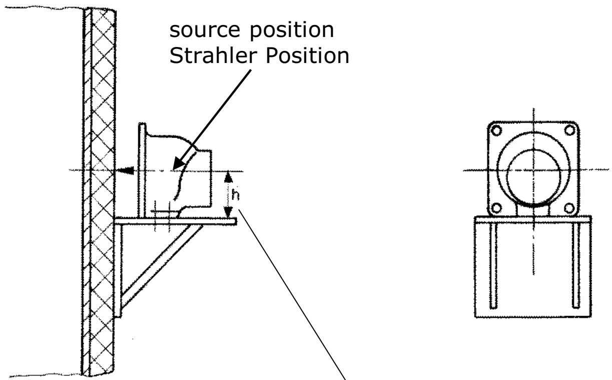
8.1 Mounting Proposal for Source Shielding LB 744x
Montagevorschlag für Abschirmbehälter LB 744x



Source Shielding LB 744x
Abschirmbehälter LB 744x



Flange Installation
Flanschinstallation



Pedestal Installation
Sockelinstallation

	LB 7440 LB 7445	LB 7442 LB 7446	LB 7444
h	90	120	161

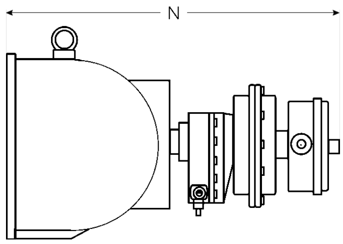
BERTHOLD

2

LB 480

Dimensions in mm
Abmessungen in mm

8.2 Pneumatic Actuator for Source Shielding LB 744x
Pneumatischer Verschlussantrieb für Abschirmbehälter LB 744x



N approx / ca.	Type / Typ
390	LB 7440-F-CR LB 7440-D-CR LB 7440-FE-CR LB 7440-DE-CR
460	LB 7442-F-CR LB 7442-D-CR LB 7442-FE-CR LB 7442-DE-CR
570	LB 7444-CR

Protection Schutz	Part No. Ident.	Description Beschreibung
IP 65	36119	Pneumatic Actuator with Limit Switch Option I Pneumatischer Verschlussantrieb mit Endschalter Option 1
Ex de IIC T6	80919	Pneumatic Actuator with Limit Switch Option II Pneumatischer Verschlussantrieb mit Endschalter Option II
Ex ia IIC T6	43698	Pneumatic Actuator with Limit Switch Option III Pneumatischer Verschlussantrieb mit Endschalter Option III

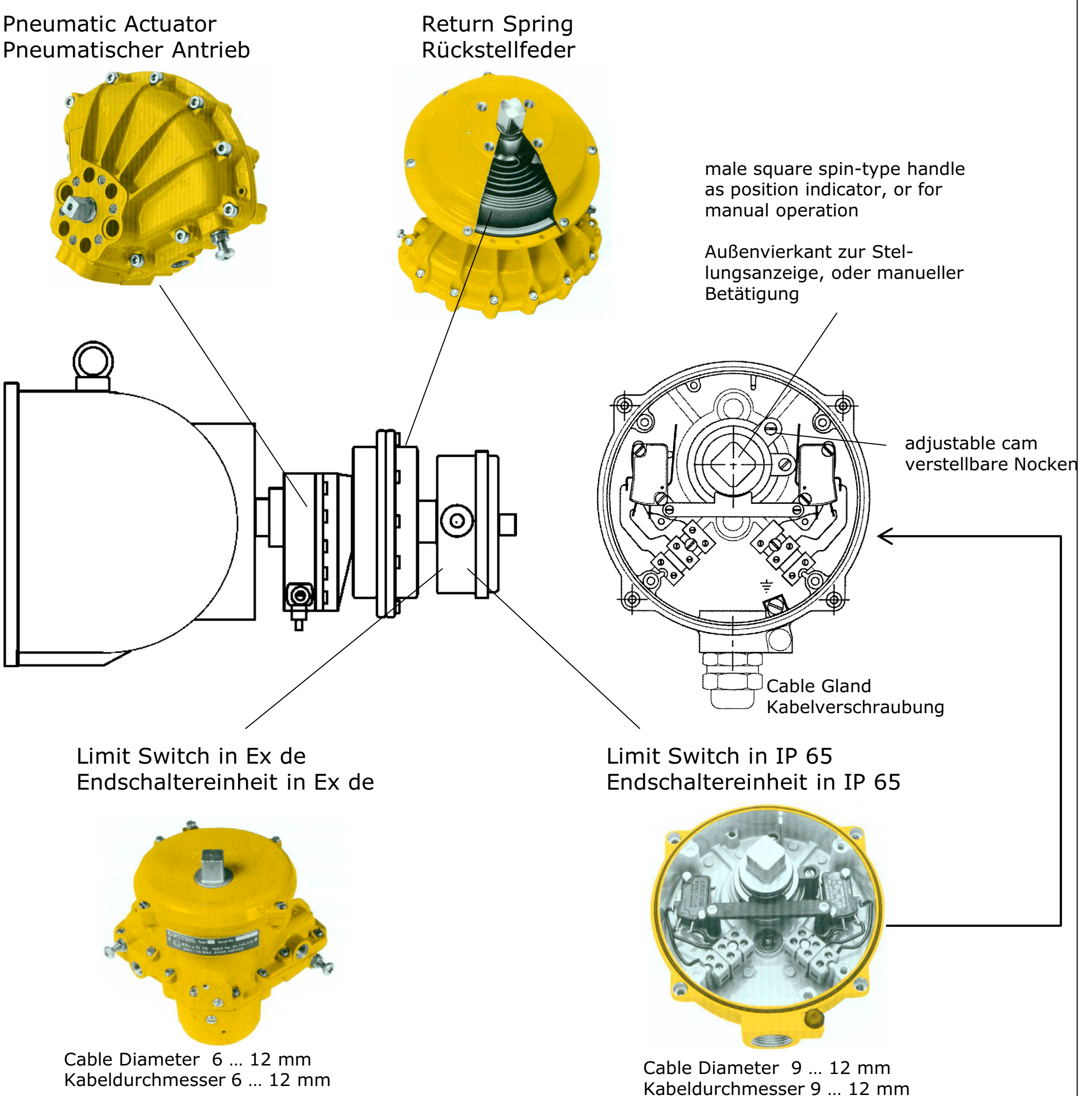
Technical Data for Pneumatic Actuator Technische Daten für pneumatischen Verschlussantrieb	
Compressed Air Druckluft	min. 4 x 10^5 Pa (4 bar) max. 7 x 10^5 Pa (7 bar) Connection / Anschluss: G 1/8
Air Quality Luftqualität:	clean as usual for air compressed tools, oil free Sauber wie für Druckluft-Werkzeuge üblich, ölfrei
Temperature Range Temperaturbereich:	-20°C … +80°C

Limit Switch, Option for Signaling OFF / CLOSED Endschaltereinheit, Optionen für Signalisierung AUF / ZU	
Option I:	IP 65, 2 contacts (OFF/CLOSED) IP 65, 2 Kontakte (AUF/ZU)
Option II:	2 contacts (OFF/CLOSED) Protection for internal micro switches: EEx d IIC T6 Housing protection: EEx e II T6 2 Kontakte (AUF/ZU) Schutzart der Microeinbautaster: EEx d IIC T6 Gehäuseschutzart: EEx e II T6
Option III:	2 Proximity switches EEx ia IIC T6, for intrinsically safe power supply 2 Näherungsinitiatoren EEx ia IIC T6, für eigensichere Speisung

LB 480

Dimensions in mm
Abmessungen in mm

8.3 Components for Pneumatic Actuator
Einzelteile für Pneumatischen Verschlussantrieb



Contact Rating
Kontaktbelastbarkeit

Volt		Load / Last (A)	
AC	DC	R	L
250		7	5
125		7	5
	12	7	5
	24	1	1
	48	0,5	0,06
	250	0,25	0,03

Contact Rating
Kontaktbelastbarkeit

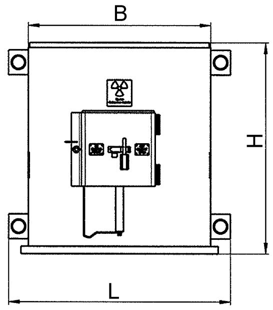
Volt		Load / Last (A)		
AC	DC	R	L	Lamp / Lampe
250		15	3	1,5
125		15	3	1,5
	12	15	3	1,5
	24	10	2	1
	48	3	0,6	0,3
	250	0,25	0,05	0,025

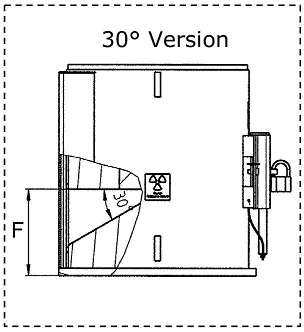
BERTHOLD

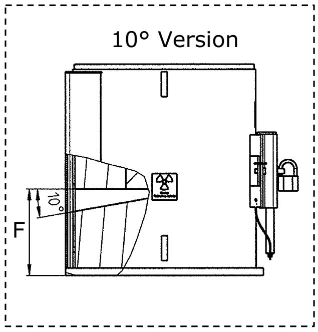
LB 480

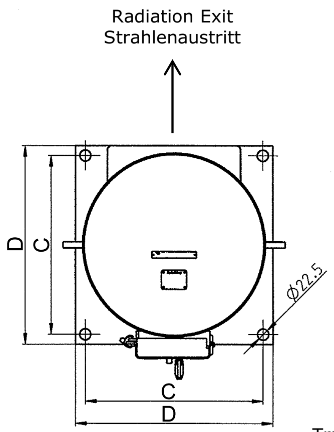
Dimensions in mm
Abmessungen in mm

9. Point Source Shielding LB 8030/8040
Punktstrahler-Abschirmbehälter LB 8030/8040

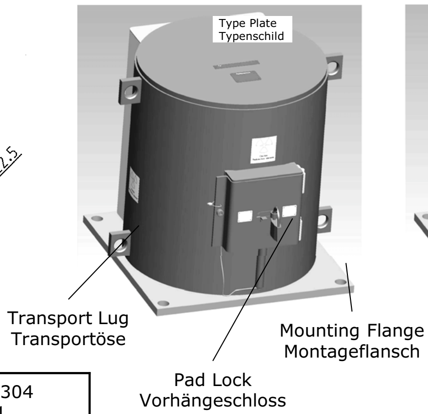




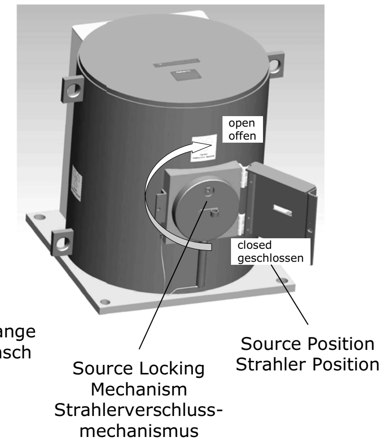




Shutter mechanism locked
Strahlermechanismus abgesperrt



Shutter mechanism accessible
Strahlermechanismus zugänglich



Material	Stainless Steel 304 Edelstahl 1.4301
Painting Lackierung	Polyurethane, yellow Polyurethan, gelb

Type Typ	B	C	D	F	H	L	∡	kg
LB 8030-01	370	360	400	174	425	450	30°	516
LB 8030-02							10°	
LB 8040-01	456	460	500	305	567	536	30°	1014
LB 8040-02							10°	

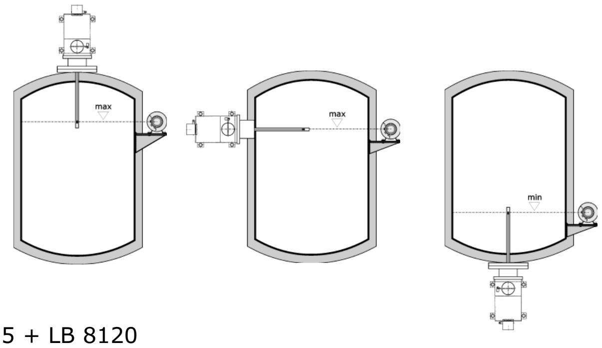
∡ Radiation Angle of the Shielding / Abstrahlwinkel der Abschirmung

BERTHOLD

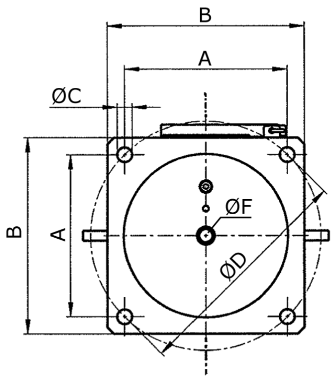
LB 480

Dimensions in mm
Abmessungen in mm

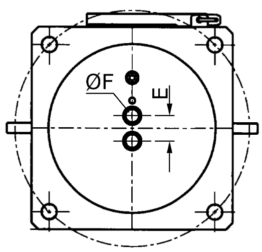
10. Point Source Flange Shielding LB 81xx for Dip Pipe Installations
Punktstrahler-Flansch-Abschirmbehälter LB 81xx für Tauchrohr-Applikationen

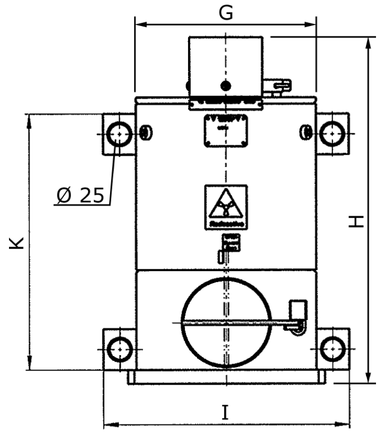


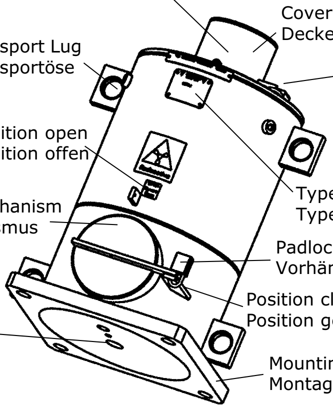
Type/Typ LB 8115 + LB 8120



Version for 2 Sources LB 81xx-20
Version für 2 Strahler LB 81xx-20





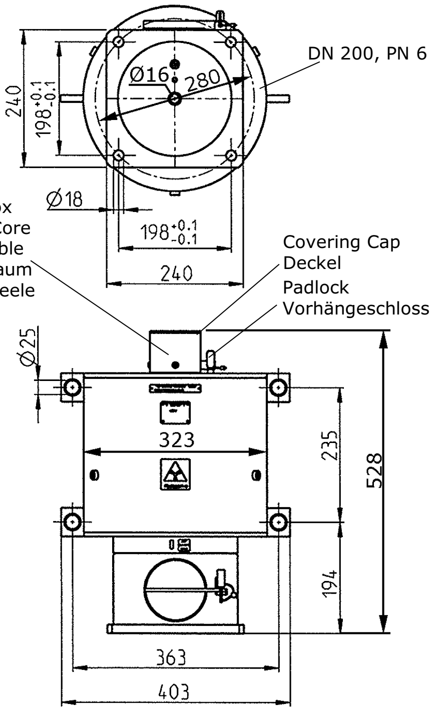


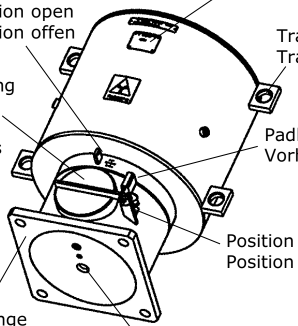
Type Typ	A	B	ØC	ØD	E	ØF	G	H	I	K	kg
LB 8115-01 LB 8115-20	141,5	180	18	200	- 30	16	159	350	239	237	60 kg
LB 8120-01 LB 8120-20	198	240	18	280	- 30	16	219	425 429	300	313	137 kg

LB 480

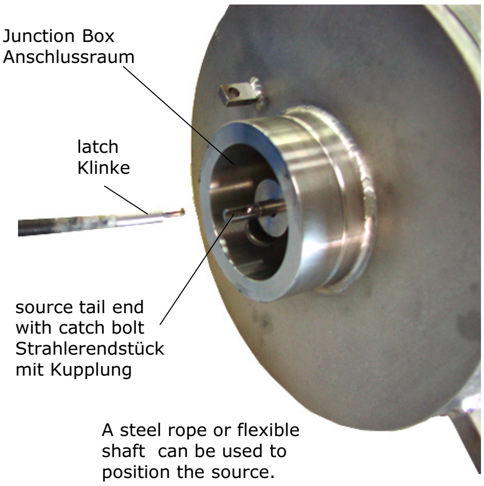
Dimensions in mm
Abmessungen in mm

Type/Typ LB 8125-01





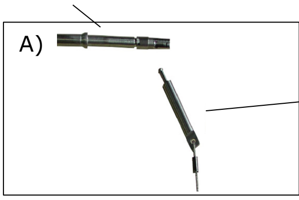
Operation of Flange Shielding
Bedienung der Flanschabschirmung



A steel rope or flexible shaft can be used to position the source.

Zur Positionierung kann ein Stahlseil oder eine Wellenseele genutzt werden.

source tail end with catch bolt
Strahlerendstück mit Kupplung



latch for catch bolt
Klinke für Kupplung

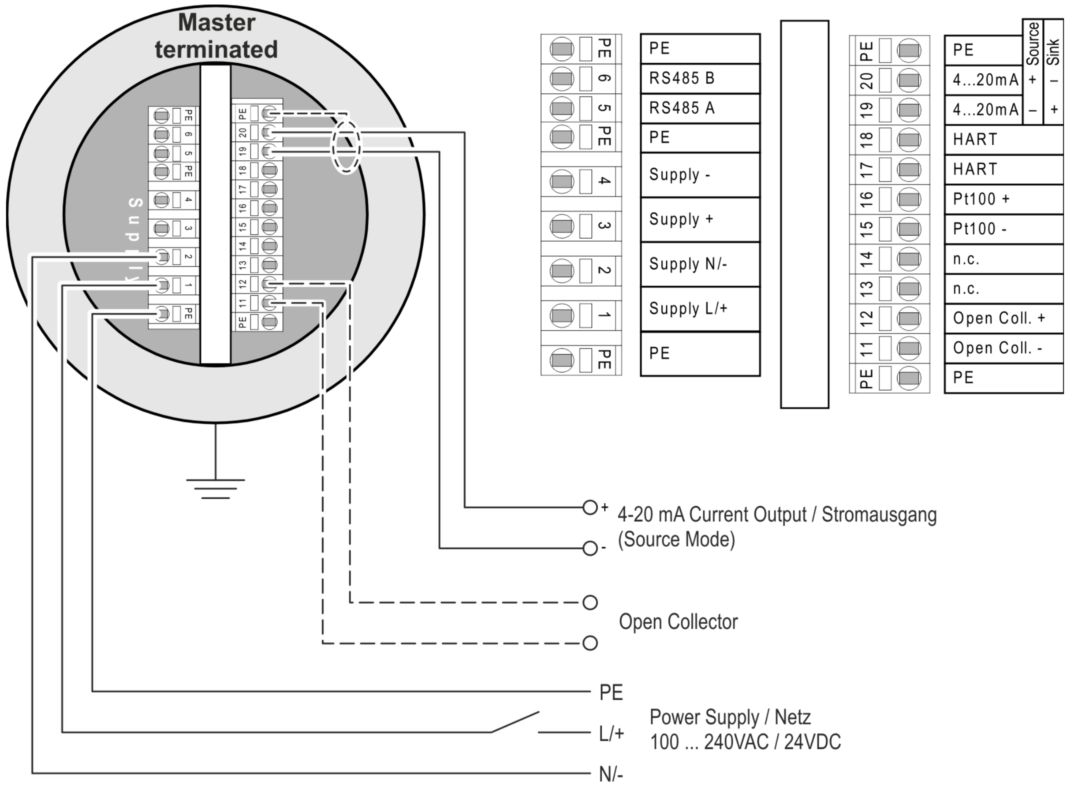
plug the latch into the catch bolt
Klinke in Kupplung einklinken

latch plugged into the catch bolt
Klinke in Kupplung einklinken

LB 480

11. Terminal Connections
Elektrische Anschlusspläne

11.1 Terminal Connections for Single Detector (terminated)
Elektrische Anschlussplan für Einzeldetektor (terminiert)

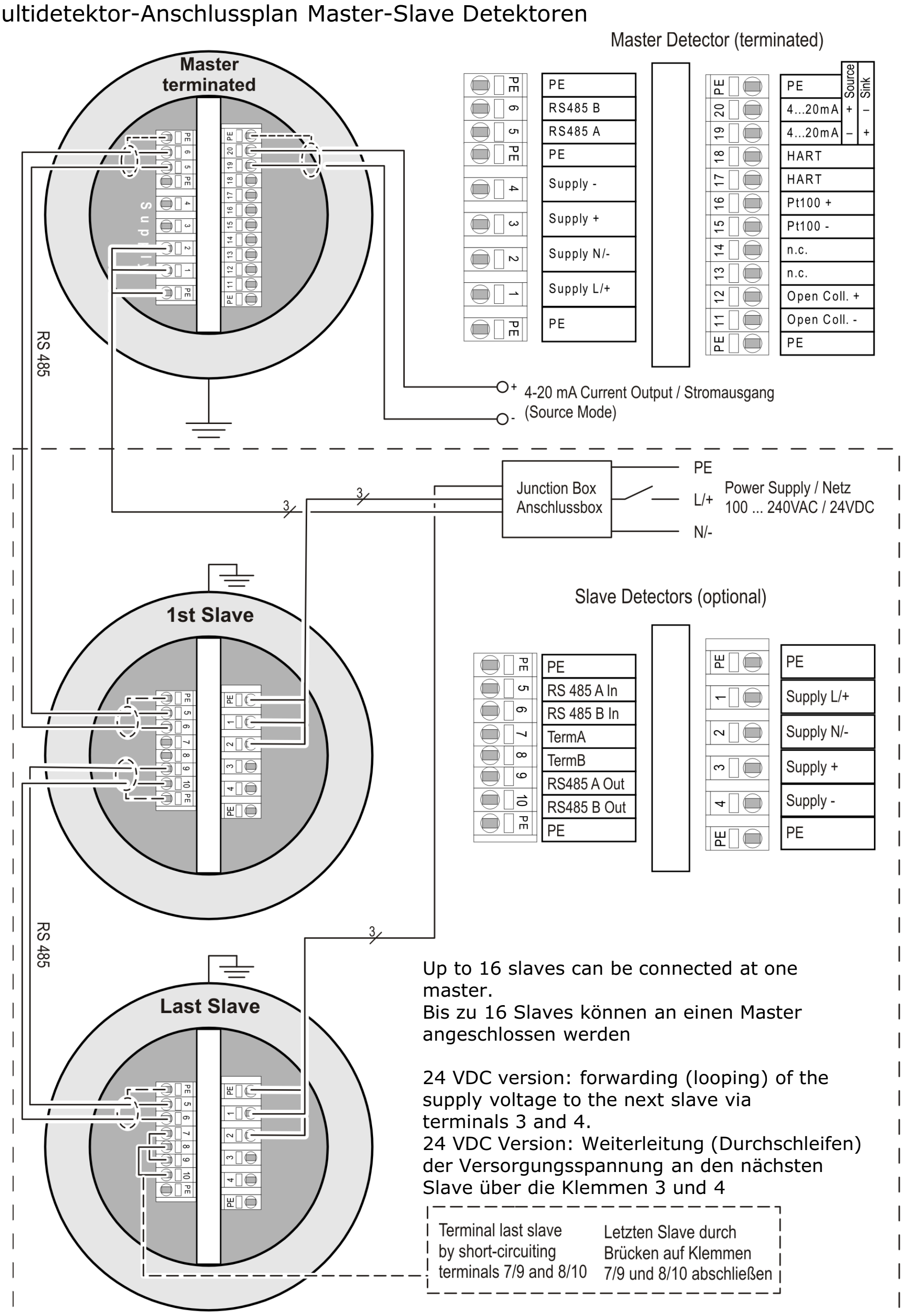


BERTHOLD

2

LB 480

11.2 Multi Detector Connection Diagram Master-Slave Detectors
Multidetektor-Anschlussplan Master-Slave Detektoren



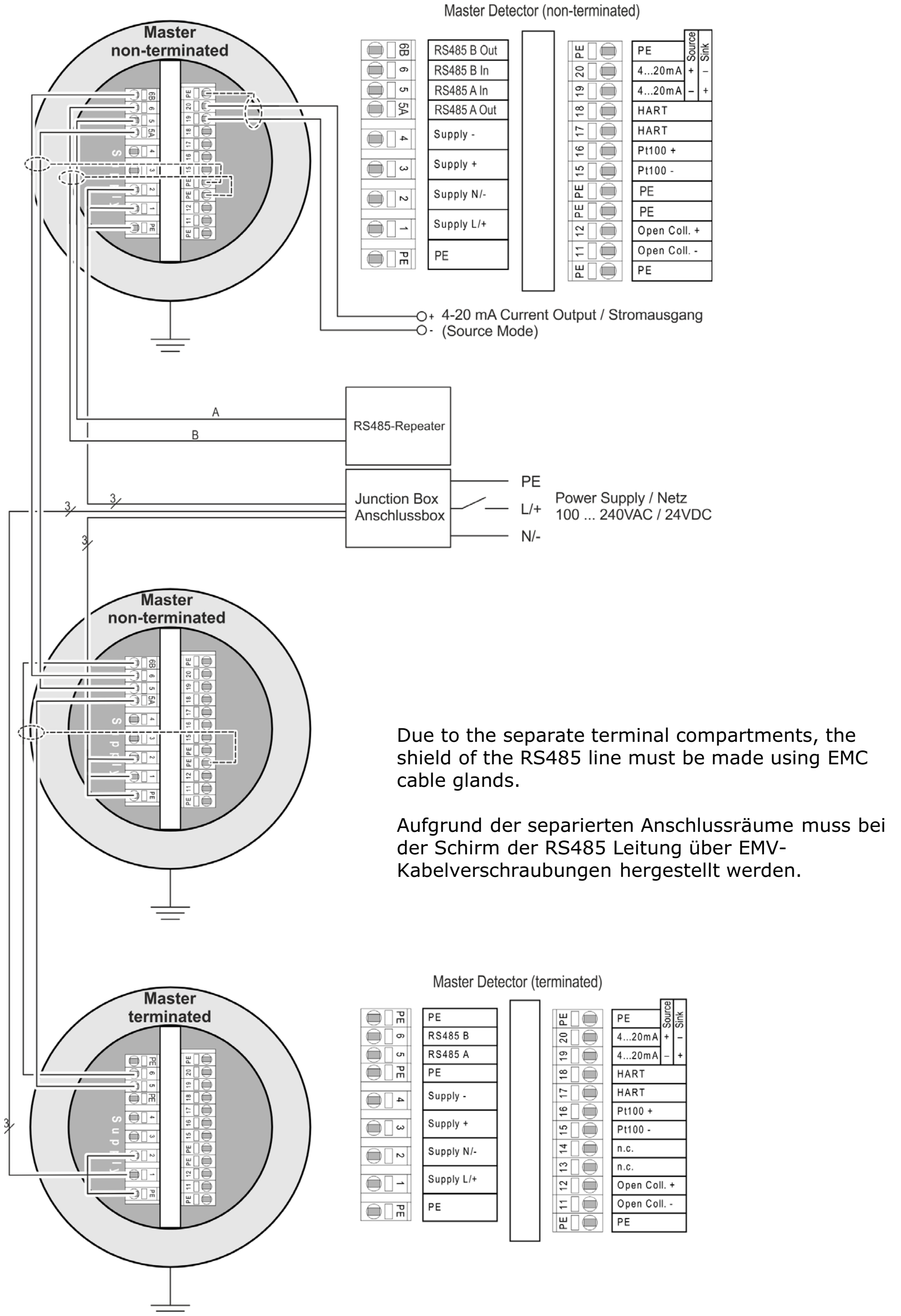
Up to 16 slaves can be connected at one master.
Bis zu 16 Slaves können an einen Master angeschlossen werden

24 VDC version: forwarding (looping) of the supply voltage to the next slave via terminals 3 and 4.
24 VDC Version: Weiterleitung (Durchschleifen) der Versorgungsspannung an den nächsten Slave über die Klemmen 3 und 4

BERTHOLD

LB 480

11.3 Multi Detector Connection Diagram Master-Master Detectors at Repeater Module
Multidetektor-Anschlussplan Master-Master Detektoren an Repeater Modul



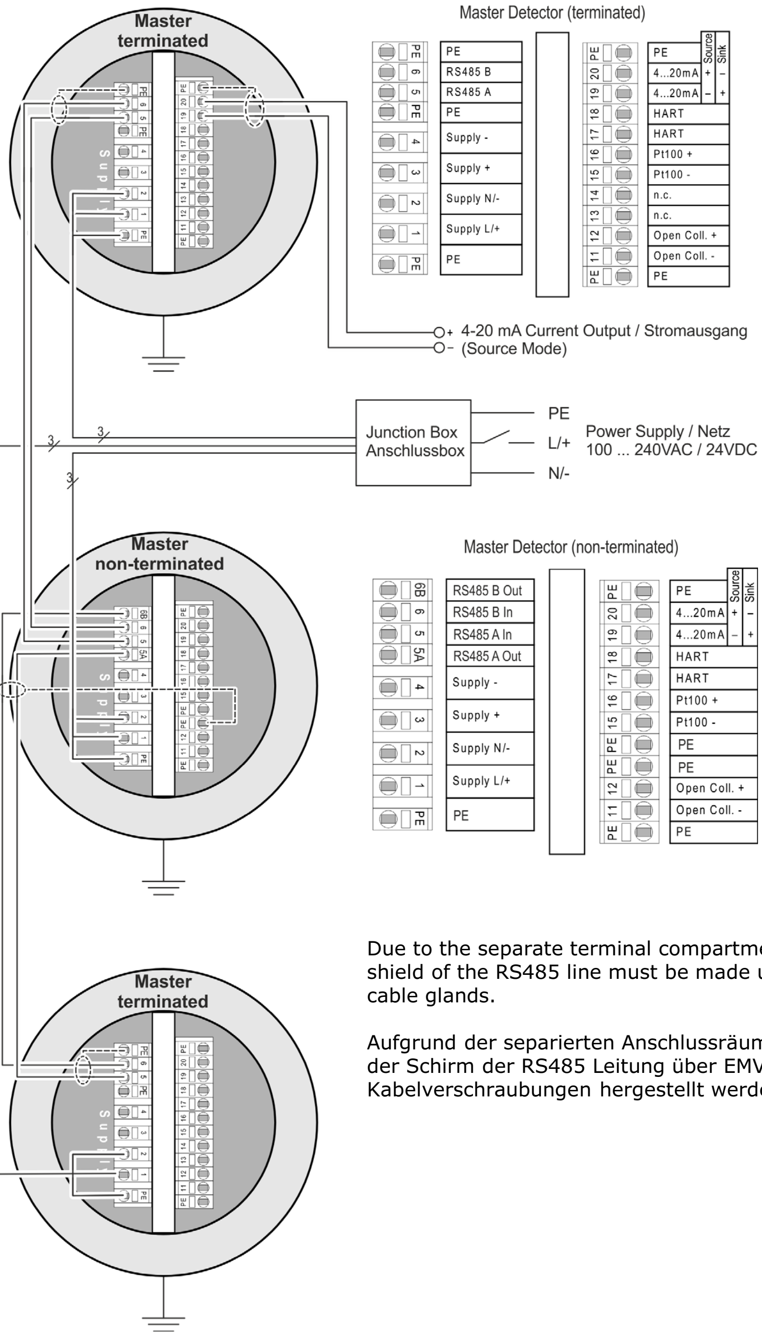
Due to the separate terminal compartments, the shield of the RS485 line must be made using EMC cable glands.

Aufgrund der separierten Anschlussräume muss bei der Schirm der RS485 Leitung über EMV-Kabelverschraubungen hergestellt werden.

BERTHOLD

LB 480

11.4 Multi Detector Connection Diagram Master-Master Detectors at cascaded Arrangement
Multidetektor-Anschlussplan Master-Master Detektoren bei kaskadierter Anordnung



Due to the separate terminal compartments, the shield of the RS485 line must be made using EMC cable glands.

Aufgrund der separierten Anschlussräume muss bei der Schirm der RS485 Leitung über EMV-Kabelverschraubungen hergestellt werden.

BERTHOLD

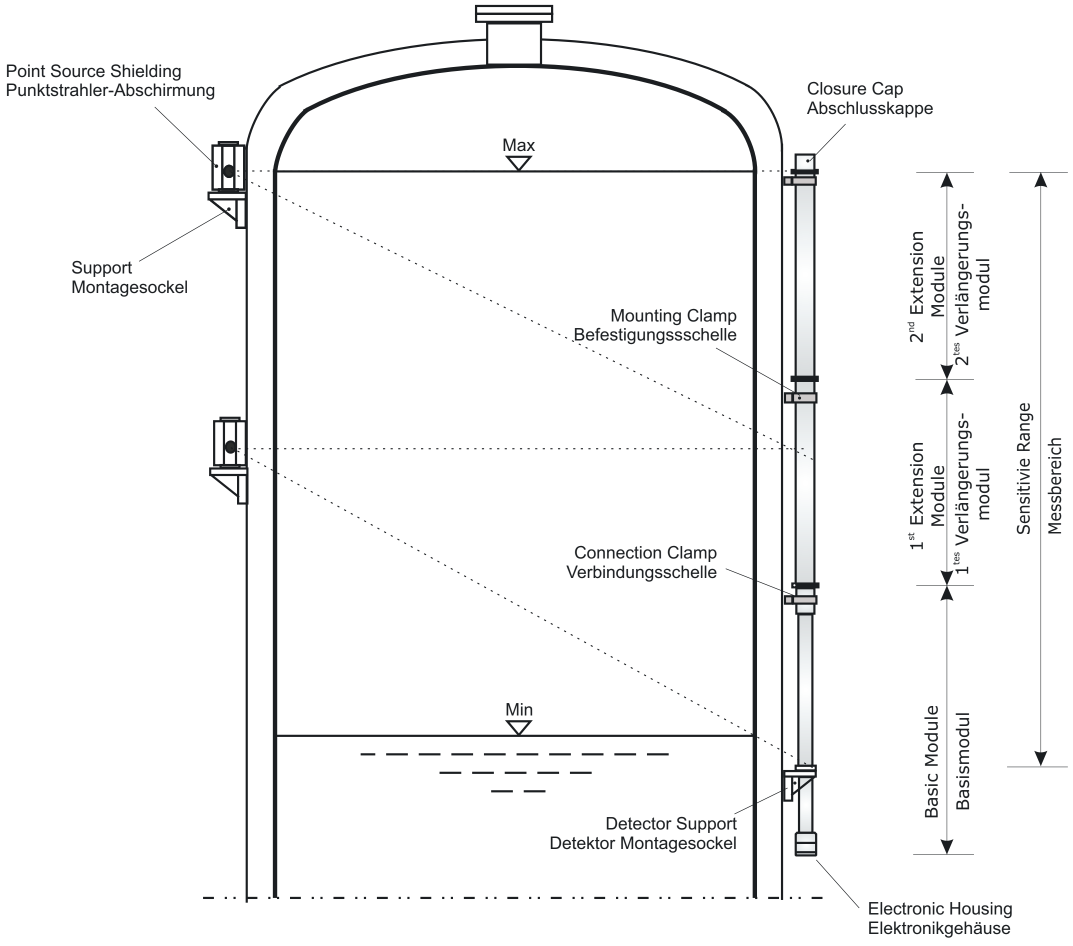
5.2 TI LB 480 TowerSENS

Technical Information
Tower-Sens LB 480

Level Gauge
Füllstandmessung

Field mounted components
Messstellen-Komponenten

Arrangement with Tower-Sens
Anordnung mit Tower-Sens

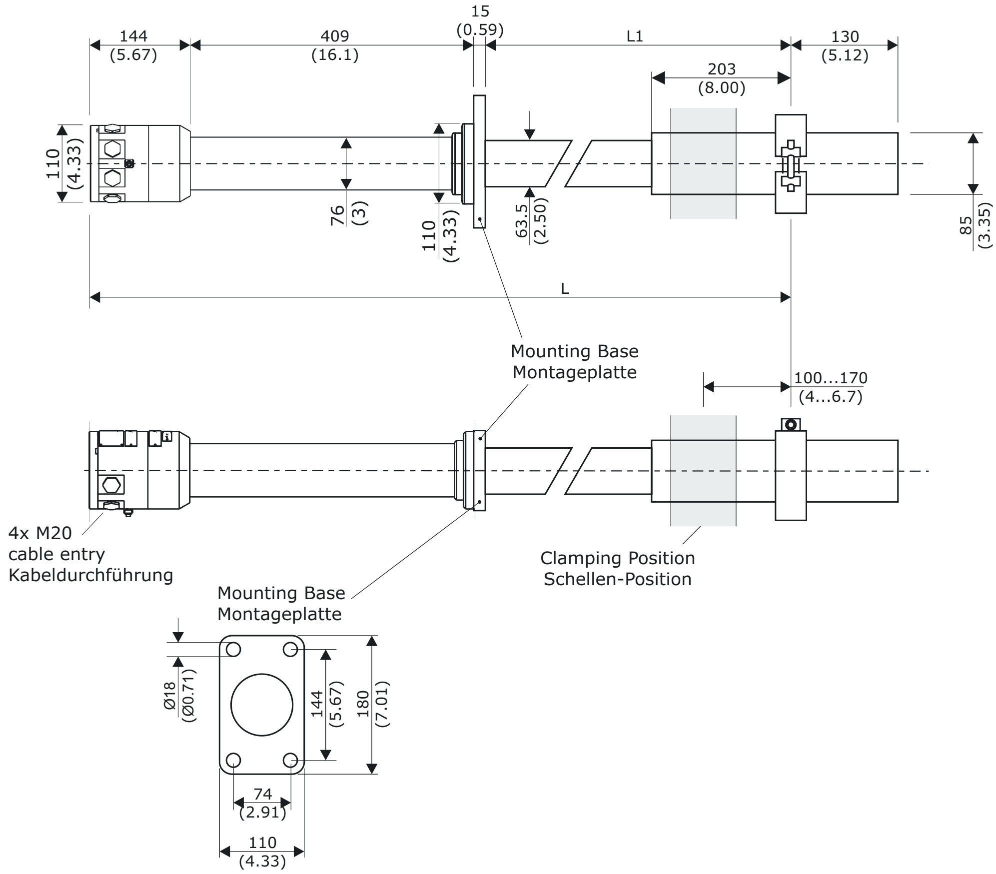


Important!/Wichtig!
The Electronic Housing has to be at the bottom end of the detector!
Das Elektronikgehäuse muss sich am unteren Detektorende befinden!

Tower-Sens LB 480

Dimensions in mm
Abmessungen in mm

1.1 Basic Module without Water Cooling
Basismodul ohne Wasserkühlung



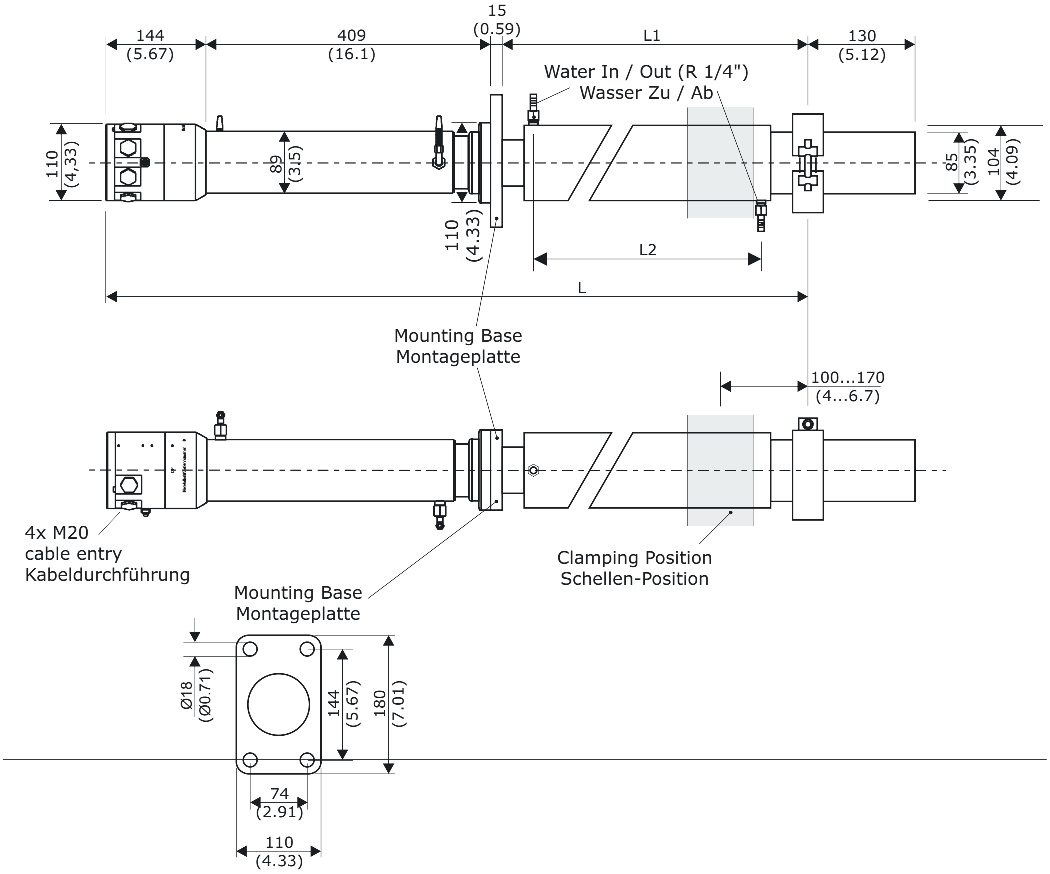
Dimensions in mm / (Inches)
Housing made of stainless steel AISI 304
Abmessungen in mm / (Zoll)
Gehäuse-Material: Edelstahl 1.4301

Type Typ	Sensitive Length L1 Empfindliche Länge L1 mm / (inch)	Length L Länge L mm / (inch)	Weight Gewicht (kg)
Basic Module 2m Basis Modul 2m	1990 (78.3)	2685 (105.7)	26

Tower-Sens LB 480

Dimensions in mm
Abmessungen in mm

1.2 Basic Module with Water Cooling
Basismodul mit Wasserkühlung



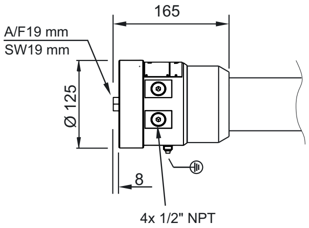
Dimensions in mm / (Inches)
Housing made of stainless steel AISI 304
Abmessungen in mm / (Zoll)
Gehäuse-Material: Edelstahl 1.4301

Type Typ	Sensitive Length L1 Empfindliche Länge L1 mm / (inch)	Length L Länge L mm / (inch)	Length L2 Länge L2 mm / (inch)	Weight Gewicht (kg)
Basic Module 2m Basis Modul 2m	1990 (78.3)	2685 (105.7)	1833 (72.2)	27

Tower-Sens LB 480

Dimensions in mm
Abmessungen in mm

1.3 Basic Module (Version f. Divisions 1/2)
Basismodul (Version f. Divisions 1/2)



sealed with screw plugs
mit Verschlussschrauben geschlossen

Weight = Detector Weight +1.5kg
Gewicht = Detektorgewicht +1.5kg

The detector version for divisions (NEC/CEC) differs only in the terminal housing, compared to the standard version illustrated before. The dimensions of this terminal housing are illustrated in this drawing.

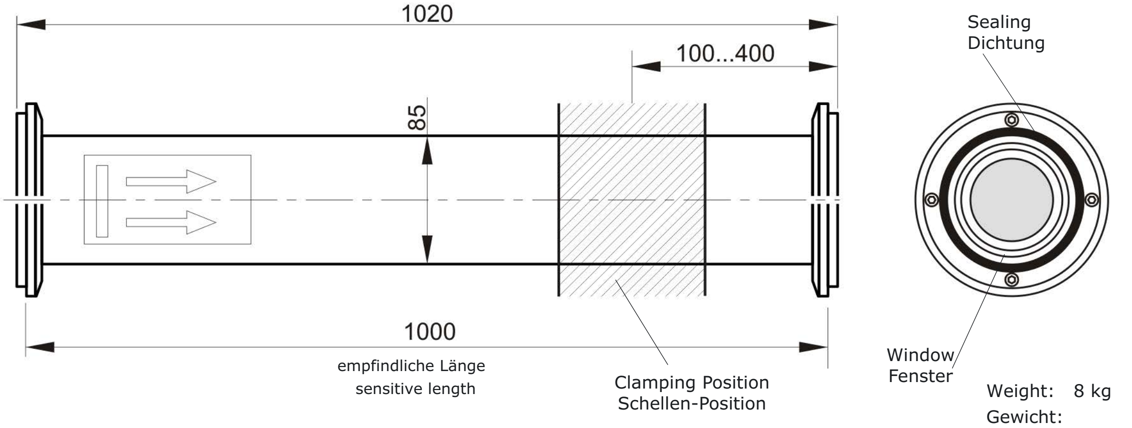
Die Detektor-Version mit Ex-Zulassung für Divisions (NEC/CEC) unterscheidet sich ausschließlich im Anschlusskopf, verglichen mit den zuvor aufgeführten Standardvariante. Die Abmessungen für den Anschlusskopf sind aus dieser Zeichnung zu entnehmen.

Tower-Sens LB 480

Dimensions in mm
Abmessungen in mm

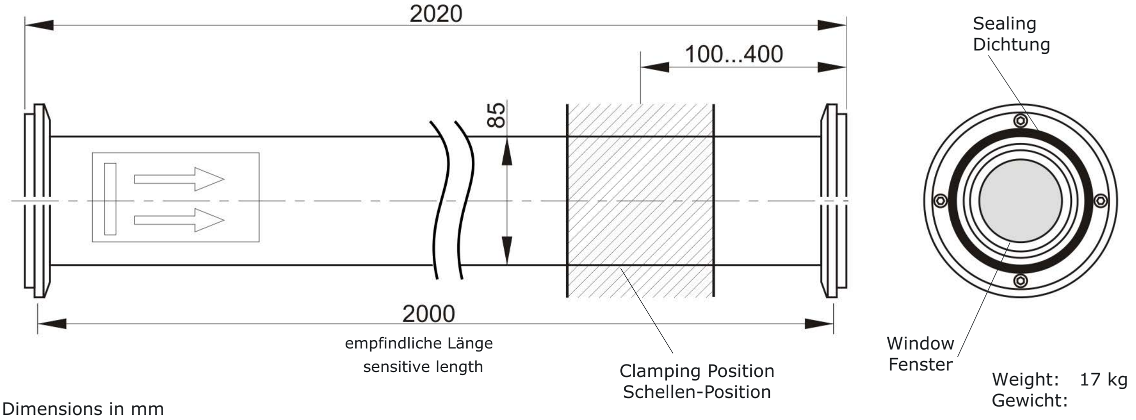
1.4 Extension Modules without Water Cooling
Verlängerungsmodule ohne Wasserkühlung

1.4.1 1 m Module
1 m Modul



Weight: 8 kg
Gewicht:

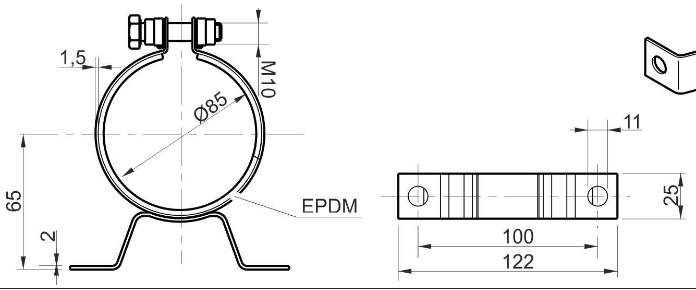
1.4.2 2 m Module
2 m Modul

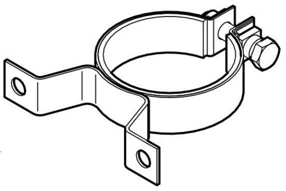


Weight: 17 kg
Gewicht:

Dimensions in mm
Housing made of stainless steel AISI 304
Abmessungen in mm
Gehäuse-Material: Edelstahl 1.4301

1.5 Mounting Clamps for Tower-Sens without Water Cooling
Befestigungsschellen für Tower-Sens ohne Wasserkühlung





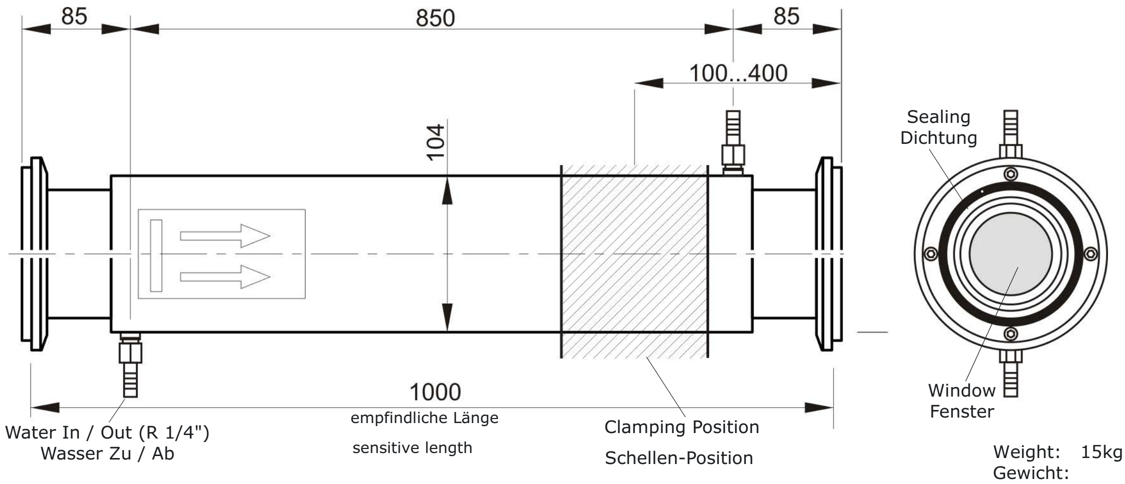
Part No.: 43765
ID-Nr.:

Tower-Sens LB 480

Dimensions in mm
Abmessungen in mm

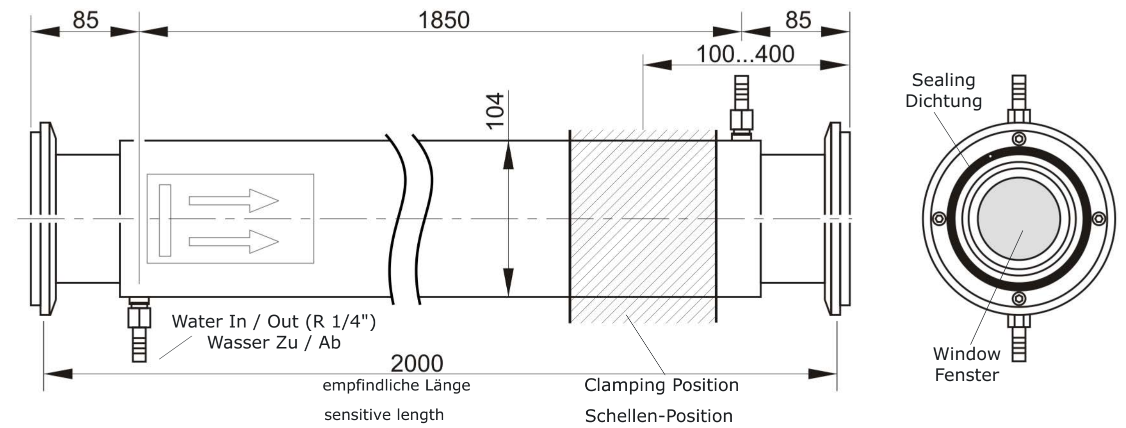
1.6 Extension Module with Water Cooling
Verlängerungsmodul mit Wasserkühlung

1.6.1 1 m Module
1 m Modul



Weight: 15kg
Gewicht:

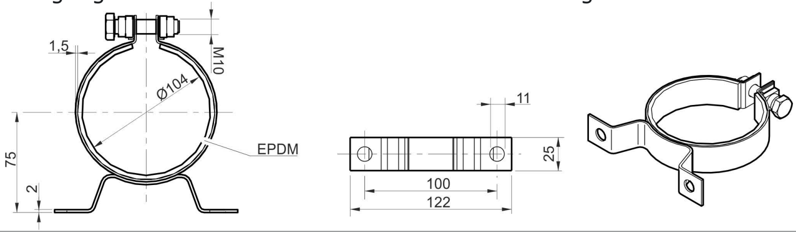
1.6.2 2 m Module
2 m Modul



Dimensions in mm / (Inches) Housing made of stainless steel AISI 304
Abmessungen in mm / (Zoll) Gehäuse-Material: Edelstahl 1.4301

Weight: 32kg
Gewicht:

1.7 Mounting Clamps for Tower-Sens with Water Cooling
Befestigungsschellen für Tower-Sens mit Wasserkühlung

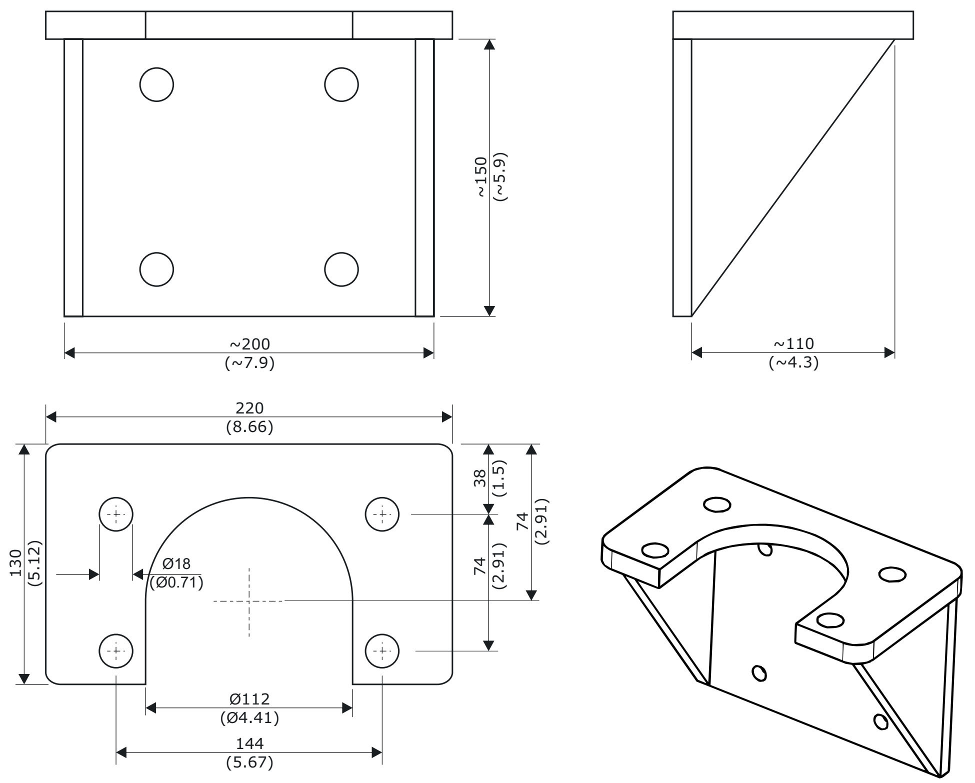


Part No.: 52688
ID-Nr.:

Tower-Sens LB 480

Dimensions in mm
Abmessungen in mm

1.8 Detector Support (by customer)
Detektor Montagesockel (vom Kunden)



1.8 Detector Codes
Detektor Codes

Length	Detector Code
1000 mm	31
3000 mm	33
5000 mm	35
7000 mm	37

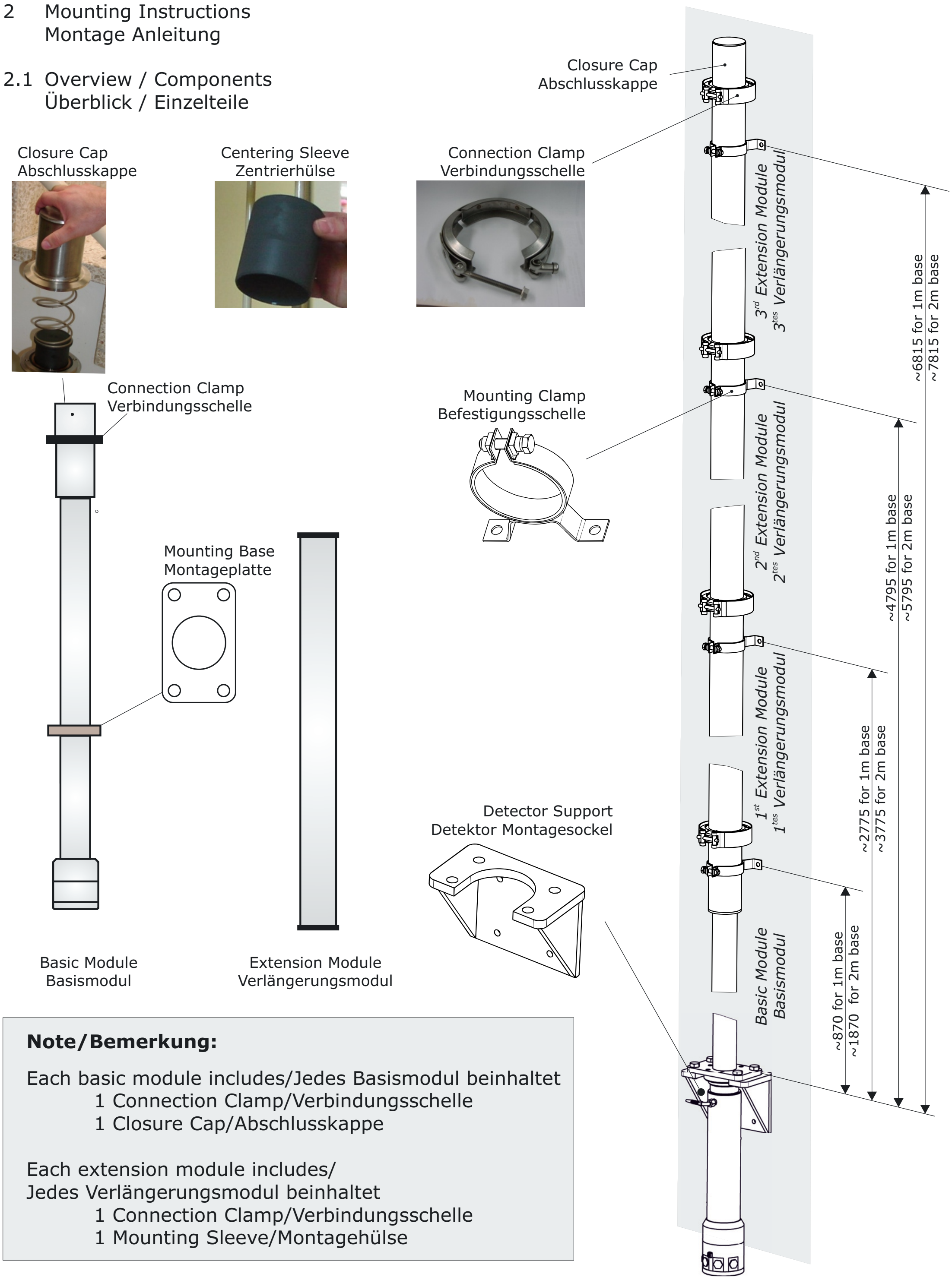
Length	Detector Code
2000 mm	32
4000 mm	34
6000 mm	36
8000 mm	38

Tower-Sens LB 480

Dimensions in mm
Abmessungen in mm

2 Mounting Instructions
Montage Anleitung

2.1 Overview / Components
Überblick / Einzelteile



Note/Bemerkung:

Each basic module includes/Jedes Basismodul beinhaltet
1 Connection Clamp/Verbindungsschelle
1 Closure Cap/Abschlusskappe

Each extension module includes/
Jedes Verlängerungsmodul beinhaltet
1 Connection Clamp/Verbindungsschelle
1 Mounting Sleeve/Montagehülse

Tower-Sens LB 480

Dimensions in mm
Abmessungen in mm

2.2 Step-by-Step Mounting Instructions
Detailierte Montage-Anleitung

Important notes!

- ➢ Protect module end faces from moisture and dirt!
- ➢ Conect detector to power only after mounting is finished!
- ➢ Wait at least 3 hours after installation before comencing calibration or measurements!

Wichtige Hinweise!

- ➢ Modulenden vor Nässe und Verschmutzung schützen!
- ➢ Detektor erst nach Abschluss der Montage ans Netz schließen!
- ➢ Erste Messungen oder Kalibration frühestens 3 Stunden nach Abschluss der Montage durchführen!

Example with 5m Tower-Sens

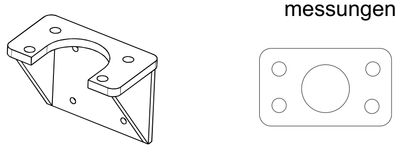
Beispiel für 5m Tower-Sens

Manufacture and Mount Detector Support

- Manufacture a detector support matching the mounting base according to specified dimensions.

Detektor Montagesockel herstellen und montieren

- Detektor Montagesockel passend zur Montageplatte des Tower Sens und den angegebenen Abmessungen herstellen.



Detector Support and Mounting Base
Detektor Montagesockel und Montageplatte

- Mount detector support on the vessel (bottom part).

- Montagesockel am Behälter (unten) anbringen.

Attach Mounting Clamps

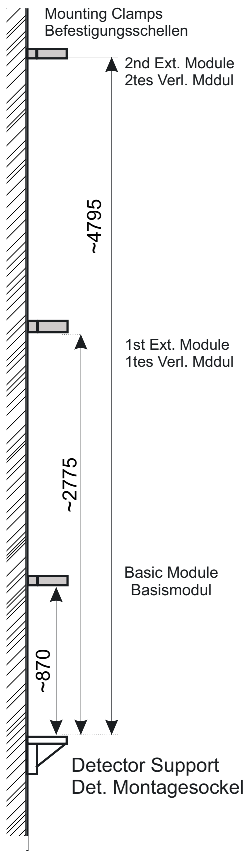
- Attach the mounting clamps for the Tower-Sens on the vessel in the specified distances.

Befestigungsschellen montieren

- Befestigungsschellen für den Tower Sens in den angegebenen Abständen montieren.

Mounting clamps and detector support must be properly alligned with respect to each other!

Schellen und Montagesockel müssen sich im Lot befinden!



Mount Detector Support and Mounting Clamps

Montagesockel und Befestigungsschellen anbringen

2

Tower-Sens LB 480

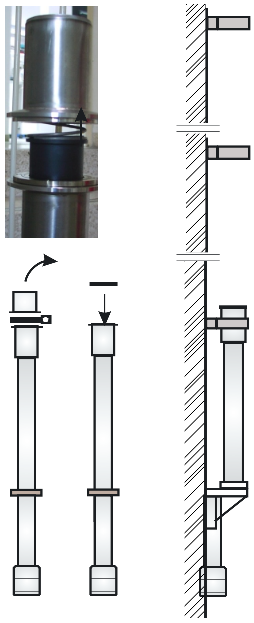
Dimensions in mm
Abmessungen in mm

Install Basic Module

- Remove closure cap from basic module: Press slightly from top against the cap while opening the connection clamp **(a)**.
  Attention: In some cases the protection foil (mirror foil) keeps sticking at the plastic cylinder of the closure cap. In such cases remove it and apply it on the silicon pad from the basic module, in order to protect the surface of the silicon pad.
- Place yellow plastic cover on the top basic module face to protect the window from dirt **(b)**.
- Position the basic module with its mounting base on the detector support and fasten them tightly together with 4 screws **(c)**.
- Secure the basic module by fastening it with the mounting clamps to the vessel **(c)**.

Basismodul montieren

- Bei liegendem Basismodul die Abschlusskappe abnehmen: Dabei gegen die Kappe drücken und die Verbindungsschelle aufschrauben **(a)**.
  Vorsicht: In manchen Fällen bleibt die Schutzfolie (Spiegelfolie) im Plastikzylinder der Abschlusskappe haften. In solchen Fällen die Schutzfolie abnehmen und wieder auf das Silikonkissen des Basismoduls auflegen, damit die Oberfläche der Silikonunterlage geschützt ist.
- Gelbe Plastik-Schutzkappe auf den Detektorstab des Basismoduls aufsetzen **(b)**.
- Basismodul mit der Basisplatte auf den Detektor Montagesockel setzen und mit 4 Schrauben fest verschrauben **(c)**.
- Das obere Ende des Basis-moduls mit der vormontierten Befestigungsschelle sichern **(c)**.



Install Basic Module
Basismodul montieren

Important Note!
- ➢ Do not remove any of the silicon pads from any of the modules!
- ➢ After the entire TowerSENS is installed, no protection foils (mirror foil) may remain between the extension modules and between extension module and the basic module!

Wichtiger Hinweis!
- ➢ Keine der Silikonunterlagen darf von den Modulen abgenommen werden!
- ➢ Wenn der TowerSENS komplett aufgebaut ist, dann dürfen sowohl zwischen den Verlängerungsmodulen, als auch zwischen Verlängerung- und Basismodul keine Schutzfolien (Spiegelfolien) verbleiben!

Install 1st Extension Module
(2 people recommended)

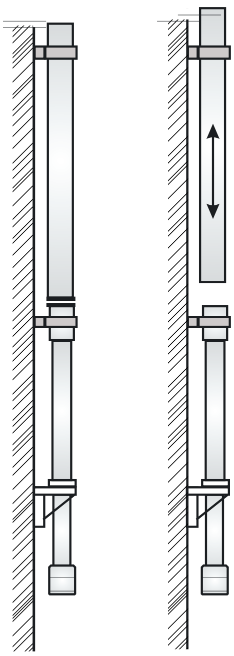
- Position the first extension module on the basic module and secure it with its respective mounting clamp on the top end of the module.
- Slightly open the mounting clamp, move the extension module up by approximately 20 cm and secure it in this position by fastening the mounting clamp again.
- Remove the protectiv plastic cover from the basic module and the bottom extension module.

Protect the module end faces from dirt and moisture!

Erstes Verlängerungsmodul montieren (mit 2 Personen)

- Das erste Verlängerungs-modul auf das Basismodul setzen und oben mit der vor-montierten Befestigungsschelle sichern.
- Befestigungsschelle leicht lösen und Verlängerungs-modul etwa um 20 cm anheben und Schelle wieder festschrauben.
- Plastikschutzkappe am Basismodul und an der Unterseite des Verlängerungsmoduls abnehmen.

Modulenden gegen Schmutz und Nässe schützen!



Install Extension Module
Verlängerungsmodul montieren

Tower-Sens LB 480

Dimensions in mm
Abmessungen in mm

Recommended Intermediate Step

Check of fit with protection foil

- Do **not remove** protection foil yet !
- Place centering sleeve in basic module **(a)**.
- Slightly open the Mounting Clamp of the extension module and lower it carefully into the centering sleeve of the basic module **(b)** and **(c)**.
- If this procedure is possible without difficulties, one can continue the assembly with step "Connecting Modules".
- Move up the extension module and secure it by closing its Mounting Clamp **(d)**.
- Remove centering sleeve again. **(e)**.

Empfohlener Zwischenschritt

Passgenauigkeit überprüfen mit Schutzfolie

- Schutzfolien **nicht** abnehmen!
- Zentrierhülse in das Basismodul einsetzen **(a)**.
- Befestigungsschelle des Verlängerungsmoduls leicht öffnen und Verlängerungsmodul vorsichtig in die Zentrierhülse absetzen **(b)** und **(c)**.
- Wenn dieser Vorgang ohne Widerstand möglich ist, kann der Schritt “Module verbinden” erfolgen.
- Verlängerungsmodul hochziehen und Befestigungsschelle festschrauben **(d)**.
- Zentrierhülse aus dem Basismodul nehmen **(e)**.

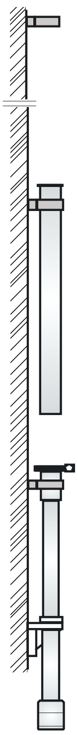
(a) (b) (c) (d) (e)

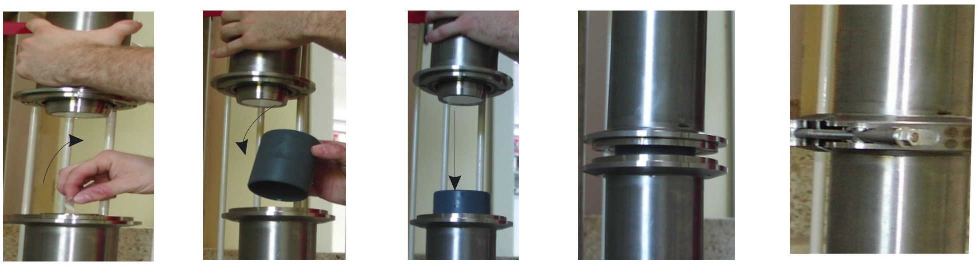
Connecting Modules

- Remove protection foil from basic module and Extension bottom side **(a)**. **Attention:** Don‘t remove the silicon pad from the basic module.
- Insert centering sleeve in basic module **(b)**.
- Slightly open the mounting vlamp of the Extension module and lower it carefully into the centering sleeve of the basic module **(c)** and **(d)**.
- Securly join both modules by closing the connection clamp with a wrench 13: When no gap is visible between the two modules, fastening the clamp by another 2-3 turns is sufficient **(e)**. **Don't close the connection clamp too tightly!**
- Close the Mounting Clamp again.

Module verbinden

- Schutzfolie am Basismodul und an der Unterseite des Verlängerungsmoduls abnehmen **(a)**. **Achtung:** Die Silikonunterlage darf dabei nicht vom Basismodul entfernt werden.
- Zentrierhülse in Basismodul einsetzen **(b)**.
- Befestigungsschelle des Verlängerungsmoduls leicht öffnen und Verlängerungsmodul vorsichtig in die Zentrierhülse absetzen **(c)** und **(d)**.
- Beide Module mit Verbindungsschelle verbinden und mit 13er Schlüssel festschrauben: Wenn kein Spalt zwischen beiden Modulen ist, noch 2 - 3 Umdrehungen weiterschrauben **(e)**. **Nicht zu fest zudrehen!**
- Befestigungsschelle wieder schließen.





(a) (b) (c) (d) (e)

6

Accessories

6.1 Cable glands

The sealing of the screwed fittings on the cable can be made of several sealing rings, depending on the screwed fitting, which have to be adapted to the diameter of the cable. The sealing rings inserted into the screwed fittings allow a relatively large cable clamping area. Remove the sealing rings from the screwed fitting to adapt them to the cable diameter used. A list of screwed fittings available from BERTHOLD TECHNOLOGIES can be found in the manual for explosion protection on *page 1-49*.

The following is an example for a M20 cable gland with additional sealing ring for small cable diameters, that must be removed for cables with larger diameter.

Assembly instructions for ID No. 55412 and 56086

*blue***globe® – Montage**
*blue*globe® – *Installation*

Abb. 1
Fig. 1

blueglobe® mit kleinem Kabeldurchmesser
Bei IP 68 Installationen globemarker® außenliegend

blueglobe® with small cable diameter
With IP 68 installations globemarker® on the outside

Abb. 2
Fig. 2

blueglobe® mit kleinem Kabeldurchmesser
oder globemarker® entfernen

blueglobe® with small cable diameter
or removing globemarker®

Abb. 3
Fig. 3

blueglobe® mit großem Kabeldurchmesser
Bei großem Kabeldurchmesser Inlet entfernen: Schraubendreher senkrecht in Trennnaht einstechen

blueglobe® with large cable diameter
With a large cable diameter – remove inlet. Insert screwdriver vertically into separating seam

Abb. 4
Fig. 4

blueglobe® mit großem Kabeldurchmesser
Inlet aushebeln

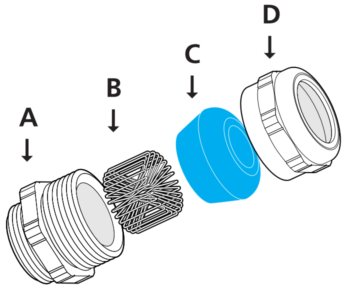
blueglobe® with large cable diameter
Lift out the inlet

Assembly instructions for ID No. 56091

blueglobe TRI® – Montageanleitung
blueglobe TRI® – Assembly Instruction

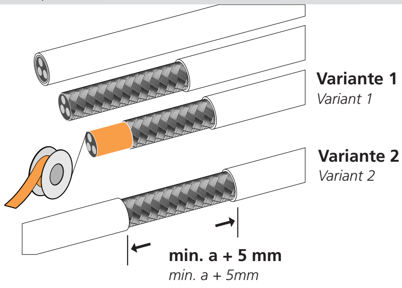
Übersicht Bestandteile
Overview components

Doppelnippel (A), Feder (B), Globe-Dichteinsatz (C), Druckschraube (D)
Double nipple (A), spring (B), globe-sealing insert (C), pressure screw (D)



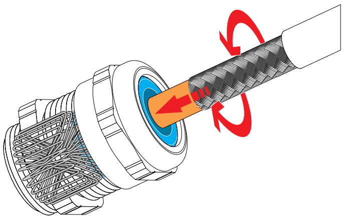
Schritt 1 – Vorbereitung der Montage
Step 1 – Prepare installation

Leitung abmanteln, Geflecht mit Isolierband schützen
Dismantle wire, protect braid



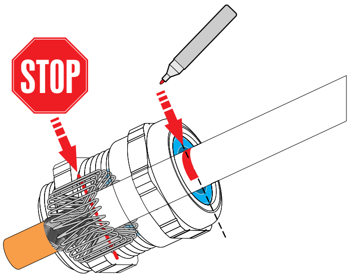
Schritt 2 – Montage
Step 2 – Installation

Kabel mit leichter Drehung einführen
Install cable with slight turn



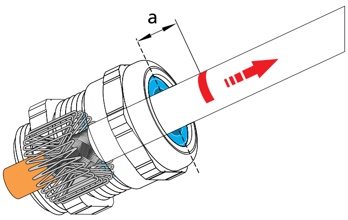
Schritt 3 – Montage
Step 3 – Installation

Markieren, wenn der Kabelmantel die Feder berührt
Mark when cable sheath touches spring



Schritt 4 – Montage
Step 4 – Installation

Kabel gemäß Maß a zurückziehen (siehe Tabelle unten)
Withdraw cable acc. size a (see table)



Schritt 5 – Montage
Step 5 – Installation

Druckschraube mit Drehmoment festziehen (siehe Tabelle unten)
Fix pressure screw with nominal torque (see table)

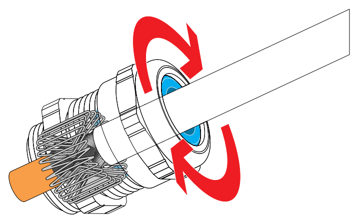


Tabelle
Table

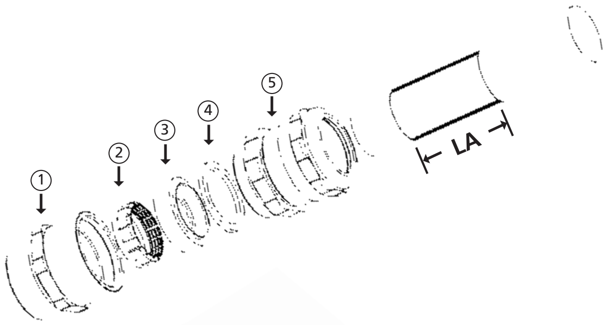
Artikel *Article*	**a/mm** *a/mm*	**Nenndrehmoment/Nm** *Nominal torque/Nm*
bg 212mstri	7	5
bg 216mstri	8	8
bg 220mstri	9	10
bg 225mstri	10	15
bg 232mstri	11	15
bg 240mstri	13	20
bg 250mstri	15	30
bg 263mstri	15	35
bg 275mstri	15	80
bg 285mstri	15	100

Assembly instructions for ID No. 56088 and 56103

blueglobe® AC – Montageanleitung
blueglobe® AC – Assembly Instruction

Übersicht Bestandteile
Overview components

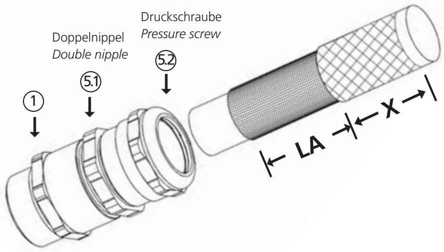
Adapter mit O-Ring ①, Klemmring ②, Druckring ③, Dichtung ④ und Standard - blueglobe® ⑤
Adapter with O-Ring ①, Clamping ring ②, Pressure ring ③, scaling ④, and Standard - blueglobe® ⑤



Schritt 1 – Vorbereitung der Montage
Step 1 – Prepare installation

1. Leitung abmanteln, Armierung kürzen gemäß Tabelle (siehe unten)
1. Dismantle wire, cut armour according table 1 (see below)

2. Adapter ① mit Nenndrehmoment 1 gemäß Tabelle (siehe unten) einschrauben (Komplettverschraubung AC nicht öffnen)
2. Fix adapter ① with torque 1 according table (see below) (do not open complete AC gland)



Schritt 2 – Montage
Step 2 – Installation

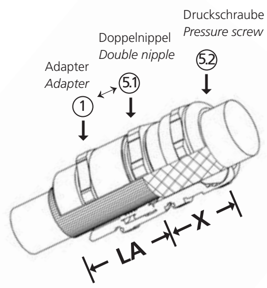
1. Kabel mit Länge X einführen, gemäß Tabelle (siehe unten)
1. Install cable with length X according table (see below)

2. Doppelnippel ⑤.1 mit Nenndrehmoment 1 gemäß Tabelle (siehe unten) anziehen zum Kontaktieren
2. Fix double nipple ⑤.1 with torque according table (see below) for contact

3. Druckschraube ⑤.2 mit Nenndrehmoment 2 gemäß Tabelle (siehe unten) anziehen zur Abdichtung
3. Fix pressure screw ⑤.2 with torque 2 according table (see below) for tightness

Tabelle
Table

Artikel *Article*	**LA/mm** *LA/mm* [min]	**X/mm** *X/mm*	**Drehmoment 1/Nm** *Torque 1/Nm* für/for ① + ⑤.1	**Drehmoment 2/Nm** *Torque 2/Nm* für/for ⑤.2
220bg220msAC13	20	35	15	10
220bg225msAC15	22	37	15	15
225bg225msAC17	22	37	15	15
232bg232msAC23	26	40	25	15
232bg240msAC27	28	43	40	15
240bg240msAC31	28	43	20	20
250bg250msAC36	32	49	50	30
250bg250msAC40	32	49	50	30
263bg263msAC46	32	50	50	35
263bg263msAC51	32	50	50	35
275bg275msAC61	36	62	80	80
285bg285msAC70	38	64	100	100
285bg285msAC78	38	64	100	100

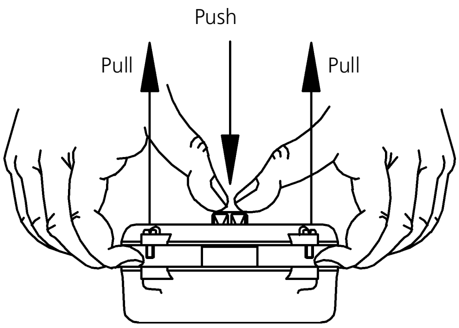


6.2 Limit Switches for Pneumatics

Installation and setup instructions for limit-switch box by KINETROL … -003U Ex ed IIC T6 and … -004U

IMPORTANT
If the limit-switch box … -003U is delivered separately, it has to be stored in a plastic bag until it will be installed.
The certification will keep its validity only if the limit-switch box has been installed correctly on the swivel drive.

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



Direct installation

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

Adjusting the trip cams

- Set revolving wings of the swivel drive to the initial position. Caution: The mechanical end stops of the swivel drive should have been set already to make subsequent correction of the trip cams superfluous.
- Move the respective trip cams on the guide ring until a soft click indicates that the contact of the micro push-button (… -3U) or micro push-button (… -4U) has switched. To be on the safe side, move the trip cams by about 2-3 degrees further and tighten the clamping screw.
- Move revolving wings to the opposite stop position. Compressed air is needed for single-acting swivel drives with spring lock unit.
- Proceed accordingly with the second trip cam.

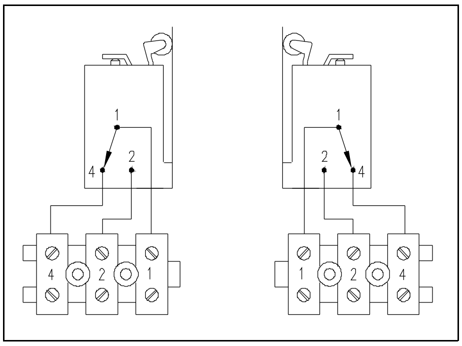
Technical Specification / Electrical Wiring

… **-3U**

2 micro push-buttons

BARTEC 07-1501-6120-63 (closer) for drive size 02/03

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

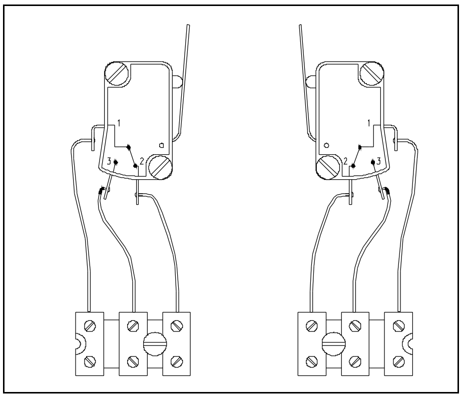


Volt		Load (A)	
AC	DC	Resistor	inductive (max.)
250		7	5
125		7	5
	up to 12	7	5
	up to 24	1	1
	up to 48	0.5	0.06
	up to 250	0.3	0.03

… **-4U**

2 micro push-buttons

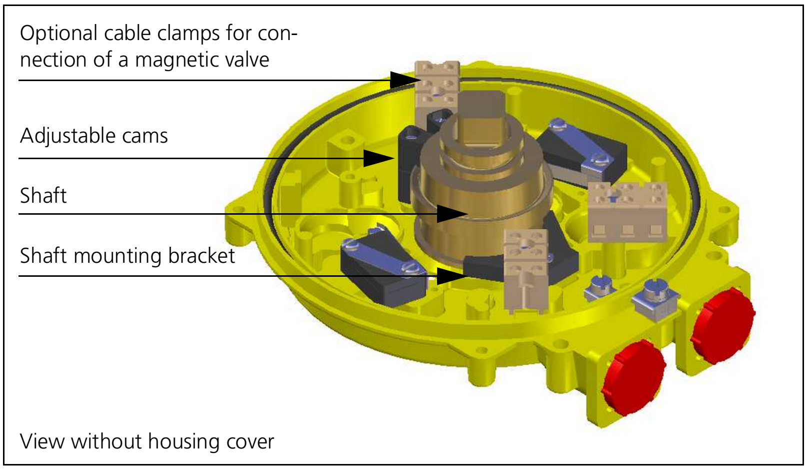
Standard dimensions according to DIN41635



Volt		Load (A)		
AC	DC	Resistor	inductive (max.)	Lamps
250		15	5	1.5
125		15	5	1.5
	up to 12	15	5	1.5
	up to 24	10	1	1
	up to 48	3	0.06	0.3
	up to 250	0.25	0.03	0.025

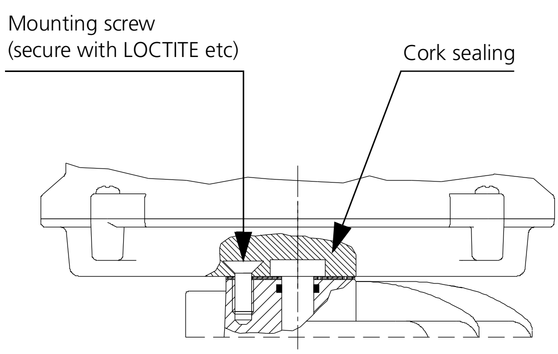
Material: … **-3U and** … **-4U**

	KINETROL …-3U	KINETROL …-4U
Housing	Zinc die casting	
Coating	Epoxy resin, burned in	
Sealing	O-rings (Nitril)	
Temperature range	-25° C to +60° C	-20° C to +80° C
Weight	1,4 kg	
Cable inputs	M20x1.5	M20x1,5; PG13,5; ½" NPT; 4-pole connector (DIN 43650A)
Cable clamp	Terminal cross-section 2.5 mm², grounded conductor terminal 2.5 mm², earthed conductor clamp 4.0 mm²	
Protection type	IP54–65	

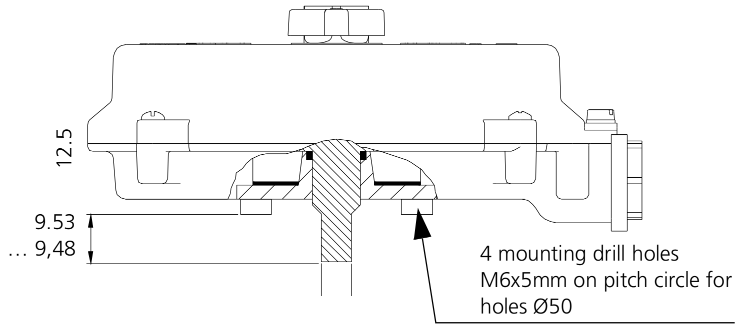


View without housing cover

Technical Specification / Electrical Wiring



Direct installation



Installation according to factory norm

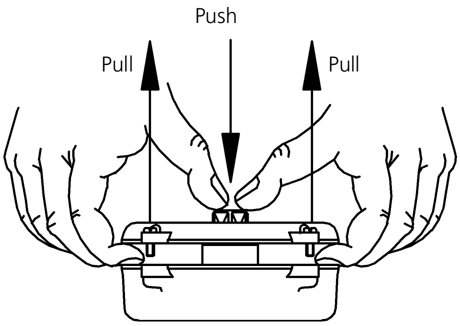
After connecting, tighten the stuffing box fitting.

IMPORTANT

Make sure that the cover sealing is inserted in its groove!

Slightly grease the housing cover in the shaft duct with MoS_2 grease, attach it and tighten cover screws.

Correction of the switching points for drive with pre-assembled limit-switch box



Direct installation

- Unscrew the cover of the supplied limit-switch box and pull it off, as shown in the illustration, while pushing down the limit-switch shaft. Caution: Do not lose the cover sealing!
- Remove shaft mounting bracket by opening the screws and take off the limit-switch shaft.
- Apply LOCTITE (or a similar adhesive) on mounting thread, put on the supplied cork sealing and attach the bottom part of the limit-switch box. Fix it using the screws supplied.
- The two trip cams on the limit-switch shaft are fixed by one screw each. Untighten these screws.

Further steps see *"Adjusting the trip cams"* on *page 2-298* and *"Technical Specification / Electrical Wiring"* on *page 2-299.*

Notes:

Subject to change in the course of further technical development.

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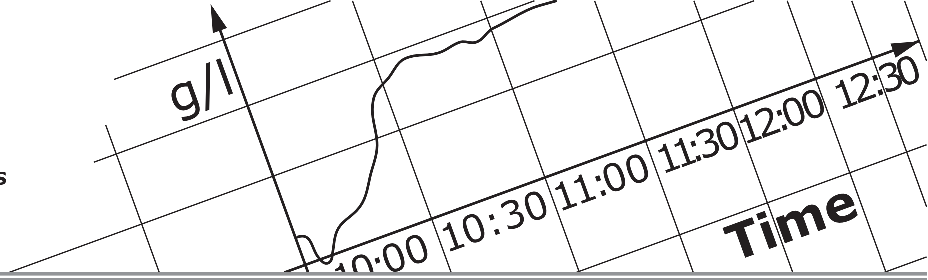


Volume 3 Operation with HART® Communicator

1 HART® Communication

HART® REGISTERED

Certificate of Registration
FieldComm Group Verified

Berthold Technologies GmbH & Co. KG	LB480 Level
Manufacturer	Product Name
00A1	A17A
Manufacturer ID (Hex)	Expanded Device Type (Hex)
7	01
HART Protocol Revision	Device Revision (Hex)
01	05
Hardware Revision (Hex)	Software Revision (Hex)
8/20/2014	FieldComm Group
Test Date	Verification Method

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

“HART REGISTERED” products conform to GB/T 29910.1-6-2013 and IEC 61158 standards.

Registration Number: L2-06-1000-383 Registration Issue Date: 4/16/2015 Approval: T. F. Masters

FieldComm Group™
Connecting the World of Process Automation

HART® is a registered trademark of FieldComm Group

The LB 480 can be operated with the following hosts:

- HART® Communicator (375/475) by Emerson Process
- Siemens Simatic PDM
- AMS DeltaV by Emerson Process

1.1 HART® Protocol

The measured values are transmitted via the following HART® variables:

- PV - Process value (for level %, for density the selected unit)

From software version 01.01.00 on additional variables available:

- SV - CPS live
- TV - CPS average (depending on the time constant)
- QV - Detector temperature

The SensSeries LB 480 is HART®-7 compatible, see certificate.

Download the Device Descriptions (DD) from the homepage of HCF:

https://fieldcommgroup.org/registered-products/

1.2 General Information on the HART® Communicator

IMPORTANT

Changes in the parameters affect the behavior of any connected controller and can lead to undesirable operating conditions. Never change the parameter settings without a full knowledge of this User's Manual as well as a full knowledge of the behavior of the connected controller and the possible influence on the operating process to be controlled.

The measuring system SENSseries LB 480 is compatible with the HART® Communicator Model 375 with firmware 3.0 and the Model 475 (HART® Communicator, HART = Highway Addressable Remote Transducer) by Emerson Process Management GmbH & Co. OHG. Other HART® compatible communicators may also be used, provided they support Enhancements. The HART® Communicator uses the Bell 202 Frequency Shift Keying technique to superimpose high-frequency digital communication signals on the standard 420mA current loop. The minimum load resistance on the 420 mA loop has to be 250 ohms.

Refer to the instruction manual for the HART® Communicator for information on key usage, data entry and equipment interface.

1.3 Connection, Power On and Power Off of the HART® Communicator

WARNING

Risk of explosion!

In hazardous areas, a HART® Communicator may be connected only under the following conditions:

– the current output of the measuring system SENSseries LB 480 is intrinsically safe

– the HART® Communicator is intrinsically safe

– the HART® Communicator has previously never be connected to non-intrinsically safe live electric cables.

The communicator may be switched on only after it has been connected to the HART® current output. Otherwise, communication with the detector is not established.

For safe HART® communication you need an impedance of at least 250 to maximum 500 ohms at the current output.

The Start menu appears as soon as the detector and the Communicator have been connected and commissioned properly (see page *page 3-321*).

From this menu you may directly select the item **Live Display** for online display of the measured values. The measured data are only valid when the probe was calibrated and configured.

The Communicator may be turned off or disconnected only after completion of a possible parameter change of the detector.

1.4 Working with the HART® Communicator

The Communicator is easy to use:

- Use the arrow keys to select a menu item and then press the button with the right arrow key or the ***ENTER*** key. Alternatively, you can press the number listed in front of most menu items on the numeric keypad; then the menu item is called immediately.
- To change information or data, use the softkeys on which the valid function is depicted, e.g. ***SAVE, ABORT, OK, ENTER*** or ***SEND***. Push ***HOME*** to return to the Start menu (see *chapter 2.3*, *"Start Menu", page 3-321*).
- Use the numeric keypad to enter numbers. With these keys you can also enter text for some menu items by pressing the appropriate number key repeatedly.

1.5 Archiving Parameter Sets

Parameter sets can be archived from the LB 480 to a PC via these hosts:

- HART® Communicator Model 375/475
- Siemens Simatic PDM
- AMS DeltaV, Emerson Process
- LB 480-PC (BERTHOLD TECHNOLOGIES specific program for the RS485 interface)

IMPORTANT

Depending on the HOST system, it may happen that certain parameters are not stored correctly.
Therefore, verify the data stored after each archiving step.
Even if you restore the saved data to the LB 480, you have to check the calibration setting afterwards.

1.5.1 HART® Communicator

The HART® Communicator Model 375/475 allows you to archive parameters sets. For this purpose, the parameter set first has to be saved using the software button **SAVE** from the detector to the SD card of the HART® Communicator. The stored data can then be archived to a PC via SD card or via infrared interface. First, preparatory actions have to be performed in the Online menu. The following sequence shows how the parameter set can be transferred from the detector to a PC via SD card.

1. Enter the file name of the parameter set for archiving in the Tag parameter.

   Command: **Tag**

   Execution:
   Online via the HART® Communicator in the **Identification** menu, select the **Tag** parameter and enter a name. Up to 8 characters.

2. Load current measurement parameters to the calibration parameters.

   Command: **Recall**

   Execution:
   Online via the HART® Communicator in the **Cal Parameter** menu, select the command **Recall**.

3. Save parameter set to the HART® Communicator.

   Command: **SAVE**

   Execution:
   Online via the HART® Communicator, push the software button **SAVE** on the display.

   Info:
   The parameter set is now also available offline on the HART® Communicator.

4. Transfer parameter set to PC.

   You need the program "Easy Upgrade Utility" for this step. This program must be installed earlier on the PC.

   Execution:

   - Remove SD card from 475 and insert it into the SD card reader of your PC.
   - Start Easy Upgrade Utility.

   The following steps describe the sequence in "Easy Upgrade Utility":

   - ("Update PC" recommended)
   - Connection type: Card Reader
   - "Connect"
   - Select "More options ...".
   - Select "HART configuration" tab.
   - Select a file in the right box and upload it to the PC database in the left box.

   The parameter set can now be displayed, or printed, by double-clicking.

   For more information about "Easy Upgrade Utility" please refer to the Online help.

To transfer already archived files to the detector:

1. Transfer the file from PC to SD card using "Easy Upgrade Utility".
2. Insert SD card again in the HART® Communicator.
3. Select the parameter set in the offline mode of the HART® Communicator and transfer it to the detector with the **Send** command.

   The detector is now ready for measurement.

To update the data, you have to restart the HART® Communicator.

For archiving with other hosts please see the following chapter.

1.5.2 PDM (Siemens Simatic PDM)

The PDM can also store data in the offline menu. Again, you have to select **Recall** on the **Cal Parameter** menu.

When restoring the data to the detector, it is necessary to transfer the data twice to the detector. This ensures that the data will be properly enabled in the detector.

1.5.3 AMS (DeltaV Emerson Process)

The AMS can save data in the offline menu only from version 10 and above. Again, you have to select **Recall** on the **Cal Parameter** menu.

However, safe transfer of data from the offline menu to the detector can only be guaranteed by transmitting each parameter individually. You have to check whether the corresponding value has actually been transmitted properly. Then in addition you have to select **Restore** in the **Cal Parameter** menu to transfer the calibration values into the measurement parameters.

2 Menu Structure

2.1 Information on the Menu Structure

The menu structure on the following pages provides an overview over all functions of the SENSseries detectors. Using the page numbers indicated you can look up explanations on the function of each menu item.

First *ENTER* then *SEND*

To rule out incorrect entries, you always have to push the ***SEND*** softkey immediately after you have entered a value via the ***ENTER*** button. The ***SEND*** softkey is only visible after values have been changed.

- Push ***ENTER*** to save edited values and parameters in the Communicator.
- Push ***SEND*** to transfer all modified values from the Communicator to the detector.

The following sections assume that you:

- know how to work with the Communicator
- *Volume 2* have read and understood (*"Installing SENSseries"*) of this User’s Manual.

2.1 Menu Overview

Start Menu
- Live Display
- Device Config
- Diagnostic

page 3-321

Live Display
- Operating Mode
- Level
- Current Out
- Cps Average Op
- Cps Average
- Cps Live
- Cps Average Comp
- GPC Comp Factor
- HV Live
- Device Temp.
- Trend

page 3-322

Device Config
- Setup
- Meas Parameter
- Access
- Identification

page 3-324

Diagnostic
- Operating Status
- Log
- Safety
- Slave Status
- Error Status 100…907

page 3-389

continued on *page 3-319*

Setup
- Quick Start
- Sensor Configuration
- Signal Condition
- Cal Parameter
- I/O Setup
- Service

page 3-324

continued on *page 3-317*

continued on *page 3-318*

Meas Parameter, *page 3-381*

Meas Data
- Background
- Meas Table
- Measurement Curve

page 3-381

Meas Settings
- Time Const
- Nuclide
- Cal Method
- Cal Curve Type
- Threshold
- Hysteresis
- Compensation Mode

page 3-382

Meas Readings
- Level
- Cps Average
- Cps Live
- Cps Average Op
- Cps Average Comp
- Cps Sensor Comp
- Active Detector No.
- Cps Single Detector

page 3-383

Access
- Password
- Write Protect
- Safety Mode
- Safety ON
- Safety OFF
- Lock Device Status
- Lock/Unlock Device

page 3-384

Identification, *page 3-386*

Location
- Tag
- Long tag
- Descriptor
- Message

page 3-386

Device Information
- Device Type
- Device Id
- Manufacturer
- Final Assembly Num

page 3-387

Device Revision
- Universal Rev
- Field Dev Rev
- Software Rev
- SW Revision
- SW Revision Date
- Hardware Rev

page 3-388

The parameters shown in gray type appear only in certain settings.
Please refer to the respective parameter description.

The parameters shown in gray type appear only in certain settings.
Please refer to the respective parameter description.

Setup

- Quick Start
- Sensor Configuration
- Signal Condition
- ...
- ...
- ...

page 3-324

Quick Start, *page 3-325*

Step 1

- Date
- Time

page 3-325

Step 2

- Time Constant
- Nuclide
- ReadIn Time

page 3-326

Step 3

- Read In
- Background
- Cal Point 0%
- Cal Point 100%
- Calibrate + Preset

page 3-327

Sensor Configuration, *page 3-330*

Date & Time

- Date
- Time
- Active Detector No.

page 3-331

Sensor Settings

- Active Detector No.
- Error Code
- Detector Device Id
- Detector Code
- HV Mode
- HV Live
- HV Average
- HV Manual
- HV Default
- Cps Single Detector

page 3-332

Config Slave Detectors

- Nbr of Slaves
- Add Slave
- Remove Slave
- Refresh Slave Table
- Detector Table

page 3-335

Signal Condition, *page 3-336*

Signal Parameter

- Time Const
- Error Handling
- Set Error Handling
- Signal Unlocked
- PRC Comp Factor
- GPC Comp Factor Limit

page 3-337

Reading Range

- Lower Range Value
- Upper Range Value
- % Meas Range

page 3-338

Signal Dependency

- Response Mode
- Io Factor
- Waiting Time
- RI Sigma
- Meas Delay Time
- RS Sigma

page 3-339

Source Exchange

- Selection
- Warning Date
- Max Reading Fluctuation

page 3-341

Setup

- ...
- ...
- ...
- Cal Parameter
- I/O Setup
- Service

page 3-324

Cal Parameter, *page 3-343*

Cal Points
- ReadIn
- Background
- Background Comp
- Cal Point No.
- Cal Level
- Cal Rate
- Cal Rate Comp
- Cal Rate at Op
- Sort
- Calibration Chart

page 3-345

Cal Settings
- Nuclide
- Calibration Method
- Cal Curve Type
- ReadIn Time

page 3-349

Product Conditions
- Measuring Path
- Product Density
- Compensation Mode
- Gas measuring path
- Setup Gas Density
- Gas Density at Op

page 3-351

Calc Comp Factor
- ReadIn
- Comp Table Index
- Cps Level
- Cps Density
- Calculate Factor
- Comp Factor
- Cal Rate Comp Table

page 3-357

Adapt Calibration
- Adjust Lower Point (*page 3-359*)
- Adjust Upper Point (*page 3-361*)
- Restore Upload
- Restore Date

page 3-358

Calibrate
page 3-344

Recall
page 3-345

I/O Setup, *page 3-362*

Current Output
- Current Loop Monitoring
- Loop Alarm Type
- Error Current Value
- Current Lower Limit
- Current Upper Limit
- D/A trim

page 3-363

Digital Output, *page 3-365*

Digital Out Function
page 3-365

Digital Out State
page 3-366

Level Threshold Settings
- Switch Function
- Threshold
- Hysteresis

page 3-367

Temp. Threshold Settings
- Temp. Upper Limit
- Temp. Lower Limit
- Temp. Hysteresis
- Temp. Unit
- Device Temp.

page 3-368

Digital Input
- Digital In Function
- Digital In State

page 3-369

HART Interface
- Poll Addr
- Set Poll Addr
- Num Req Preams
- Num Resp Preams

page 3-370

Service
- PMT
- Sensor Temperature
- Test
- Plateau
- License Key
- Reset Device

page 3-371

continued on *page 3-320*

The parameters shown in gray type appear only in certain settings.
Please refer to the respective parameter description.

Diagnostic
- Operating Status
- Log
- Safety
- Slave Status
- Error Status 100…907

page 3-389

Operating Status
- Device Status
- Ext dev status
- Device Variables Status
- Config Change Status
- Lock Dev Status
- Error Status

page 3-390

Device Status

page 3-390

Ext dev status

page 3-390

Device Variables Status
- Level Data Quality
- Level Limit Status

page 3-391

Config Change Status
- Modification Counter
- Reset Modification Flag

page 3-391

Lock Dev Status

page 3-391

Error Status
- Meas Setup Status
- Operating Mode
- Error Code
- Acknowledge Error

page 3-392

Log
- Error Log
- Modification Log

page 3-395

Error Log
- Active Detector No.
- Refresh Error Log
- Error Log Table
- Reset Error Log
- Error Code
- Acknowledge Error

page 3-395

Modification Log
- Refresh Modification Log
- Modification Log Table
- Reset Modification Log

page 3-396

■ The parameters shown in gray type appear only in certain settings.
Please refer to the respective parameter description.

Service
- PMT
- Sensor Temperature
- Test
- Plateau
- License Key
- Reset Device

page 3-371

PMT
- Active Detector No.
- HV Live
- HV Feedback
- Meas CH CPS
- Control CH CPS
- Auxiliary CH CPS
- PMT Current
- PMT Current Max
- Reset Current Extrema

page 3-372

Sensor Temperature
- Device Temp.
- Device Temp. Min
- Device Temp. Max
- Reset Temp Extrema

page 3-373

Test, *page 3-374*

Test Settings
- Level Mode
- Level
- Cps Average Mode
- Cps Average Test
- Cps Comp Average Mode
- Cps Comp Average Test
- Device Temp. Mode
- Device Temp. Test

page 3-374

I/O Test Settings
- Digital Out Mode
- Digital Out Test State
- Digital In Mode
- Digital In Test State
- Loop Current Mode
- Loop test

page 3-377

Plateau, *page 3-378*

Plateau Measurement
- Active Detector No.
- HV Start
- HV Stop
- HV Step
- Meas. Time
- HV Mode
- HV Live
- Cps Single Detector
- Cps Live

page 3-379

Plateau View
- Active Detector No.
- Refresh Plateau
- Plateau Table
- Plateau Curve

page 3-380

Plateau Information
- Active Detector No.
- Plateau Date
- PlateauTab Entries

page 3-380

License Key
- Application Level
- License Key Part 1
- License Key Part 2
- License Key Part 3
- License Key Part 4
- License Key Part 5
- Set License Key

page 3-371

Reset Device

page 3-371

The parameters shown in gray type appear only in certain settings.
Please refer to the respective parameter description.

2.1 Start Menu

The Start menu is the first and highest level for communication with the SENSseries. From the Start menu you have access to all other menu items.

The Start menu appears if you...

- switch on the connected HART® Communicator or
- push the ***HOME*** softkey anywhere in the menu.

1 Live Display

Shows the menu with the currently measured values (*page 3-322*).

2 Device Config

Leads to the menu for setting the detector parameters (*page 3-324*).

3 Diagnostic

Opens the menu displaying status and error information and the protocols for errors and parameter changes (*page 3-389*).

2.2 Live Display

1 Operating Mode

Shows the current operating status.

The following states may occur:

- ***RUN***

  The measurement is in the normal measurement mode.

- ***WARNING***

  A warning message is displayed.

  If the error is no longer displayed in **Active Error**, you can check the error log (**Device Config ▶ Diagnostic ▶ Log**, *page 3-395*). In *chapter 8* on *page 3-437* you find a list of possible causes and troubleshooting procedures.

- ***ERROR***

  An error is indicated.

  If the error is no longer displayed in **Active Error**, you can check the error log (**Device Config ▶ Diagnostic ▶ Log**, *page 3-395*). In *chapter 8* on *page 3-437* you find a list of possible causes and troubleshooting procedures.

- ***SHUTDOWN***

  A serious error is indicated.

  If the error is no longer displayed in **Active Error**, you can check the error log (**Device Config ▶ Diagnostic ▶ Log**, *page 3-395*).

  In *chapter 8* on *page 3-437* you find a list of possible causes and troubleshooting procedures. If the error does not disappear after restart (power off and then on, or software reset, *page 3-371*), then the detector must be replaced.

- ***HOLD***

  The measurement is in the hold state, which means that the measured value and the current output signal is frozen. This status can occur under the following conditions:

  - the plateau recording is running
  - interference radiation was detected
  - the digital input is on Hold

- ***TEST***

  A test value is enabled, see *chapter 2.39*, *page 3-374*.

2 Level

Indication of the current level in percent (primary variable).

The measured value shows you if

- calibration utilizes or exceeds the measuring range
- the calibration is correct
- a possible gas density was sufficiently taken into account when calibrating

3 Current Out

Displays the actual output current at the analog output in mA.

4 Cps Average Op

⇒ Visible only if **Compensation Mode** = ***AUTO GPC***.

Displays the compensated count rate from which the measured value is calculated (level in %) when ***AUTO GPC*** is enabled.

5 Cps Average

Shows the current count rate averaged over the time constant.

6 Cps Live

Shows the current non-averaged count rate.

7 Cps Average Comp

⇒ Visible only if **Compensation Mode** = ***AUTO GPC***

Displays the averaged count rate of the compensation detector.

8 GPC Comp Factor

⇒ Visible only if **Compensation Mode** = ***AUTO GPC***

Displays the compensation factor for the gas density compensation.

9 HV Live

Displays the current HV (high voltage) at the photomultiplier. If **HV Mode** is set to ***AUTO*** (normal operation), the values in **HV Live** must change, viewed over several seconds.

10 Device Temp.

Displays the temperature inside the detector.

11 Trend

Displays the trend of important measured values such as level, count rate and temperature.

2.3 Device Config

1 Setup

Opens the Setup menu. If ***Setup !locked!*** appears here, then the access has to be enabled via **Access** (*page 3-324*).

2 Meas Parameter

Leads to the menu displaying the currently valid measurement parameters that are used to determine the measured value (*page 3-381*).

Each calibration with **Calibrate** overwrites these values again. These readings help the user to check his calibration.

3 Access

Opens the menu for entering the password, the options to prevent configuration changes and to activate the safety mode (*page 3-384*).

4 Identification

Opens the menu displaying various detector parameters, such as model, device ID, software and hardware revision (*page 3-386*).

2.4 Setup

Menu path: **Device Config ▶ Setup**.

These menus allow you to make changes to the settings and the calibration of the detector. Upon delivery of the instrument, access to all menu items is possible without password. If a password has been entered and activated, you must enter it again to allow access (see *chapter 2.49*, *page 3-384*).

Use **Recall** (**Device Config ▶ Setup ▶ Cal Parameter ▶ Recall**, *page 3-343*), if you only want to change a few settings. This will copy the current settings in the menus for the setup and you can make changes to individual settings.

Enable the changes with **Calibrate** (**Device Config ▶ Setup ▶ Cal Parameter ▶ Calibrate**), see *chapter 2.20*, *page 3-343*.

1 Quick Start

Opens a menu that enables fast user-guided, initial configuration of the detector (*page 3-325*).

2 Sensor Configuration

Opens the menu for the sensor settings (*page 3-330*).

3 Signal Condition

Opens the menu for the signal processing settings (*page 3-336*).

4 Cal Parameter

Opens the menu for the calibration (*page 3-343*).

5 I/O Setup

Opens the menu for the I/O functions (*page 3-362*).

6 Service

Opens the menu for testing and service functions as well as for the plateau measurement and display of the plateau values (*page 3-371*).

2.5 Quick Start

Menu path: **Device Config ▶ Setup ▶ Quick Start**.

QuickStart allows you to quickly take the detector in operation, without having to deal with the complete menu. If you also need a special feature from the main menu, you can activate it there any time.

If several detectors are connected in a cascade, then you have to enable the multi-detector operation first (see *chapter 6.1*).

IMPORTANT
*Changes in the **Quick Start** menu must finally be activated with **Calibrate + Preset** (in Step 3).*

2.6 Quick Start, Step 1

Enter the current date and time.

The correct date is important for the automatic decay compensation of the isotope. Since the activity of the source diminishes with time, the calibration count rates will be compensated automatically through the date. The decay compensation takes place daily at 09:01 h

1 Date

Current date. The date is specified in the following format:

MM/DD/YYYY.

If the detector detects that the date deviates, a date error is indicated. If **Error Handling** is set to ***NORMAL***, then the detector continues to work with the stored date. Otherwise (setting ***SENSITIVE***) the current output also goes to fault current.

2 Time

Current time. The time is specified in the following format:

hh:mm:ss

Differences in time have virtually no effect on the correction of the decrease in activity. However, the correct time is helpful to check the detector function: If an error occurs, you can see in the error log (**Device Config ▶ Diagnostic ▶ Log**, *page 3-395*) when exactly the error occurred.

2.7 Quick Start, Step 2

1 Time Constant

The time constant smoothes the output signal. Statistical fluctuations, as well as level fluctuations due to the process, e.g. by agitators, are smoothed. A time constant of 20 s is usually reasonable.

2 Nuclide

▶ Enter here the isotope (nuclide) that is used in your source:

- ***Co-60***
- ***Cs-137***
- ***USER DEFINED***

This entry controls the automatic decay compensation. The correct entry is also important in a single-point calibration and for gas density compensation. The isotope used is listed on the type plate of the shielding and on your delivery documents. The item ***USER DEFINED*** allows you to use any isotope you want. In this case, additional parameters are requested: Specify the half-life under **Half Life Time** and the absorption coefficient at **Absorption**.

What happens when you have selected the wrong isotope?

As a result of the wrong decay compensation, you will get a deviating display only after several weeks or months, with the deviation increasing over time. If you perform a calibration with the gas density compensation GDA, or a 1-point calibration, the wrong isotope will also calculate wrong calibration data.

3 ReadIn Time

▶ Here you can define the period of time over which the count rate is to be read-in for each calibration point.

The statistical variation of the count rate is averaged over this time period. The longer it is, the better the mean value. A time period of 30 s (default setting) is usually reasonable.

2.8 Quick Start, Step 3

This menu allows you to determine the calibration date and then calibrate the instrument. If you calibrate, these data are transferred to the "Measurement Data" menu and thus activated for the measurement.

1 Read In

Start reading-in the count rates. While the count rate is read in, the average is calculated and displayed continuously. You define the reading-in period under **ReadIn Time** (*"Quick Start, Step 2"*).

▶ First choose which calibration point you want to read in:

- ***BACKGROUND***

  First you have to measure the background, so that the detector can correctly compensate for the decay of the radiation source. Before taking measurements, make sure you do not measure any radiation from the radiation source

  The easiest way to ensure this is if the source is not yet mounted. Otherwise, close the beam path and fill the container in addition.

- ***Cal Point 0%***

  For this measurement, the level in the tank must be below the measuring range or the tank must be completely empty. While you read-in, the level must not rise above 0% and the conditions within the tank must match the conditions during operation as far as possible.

  If appropriate for your application and if it affects the beam path, this applies, for example, to:

  – Gas density
  – Agitator
  – Cooling/Heating jacket

- ***Cal Point 100%***

  For the measurement, the level in the tank must be above the monitoring level or the tank must be completely filled. While you read-in, the level must not drop below 100% and the conditions within the tank must as far as possible match the conditions during operation. If appropriate for your application and if it affects the beam path, this applies, for example, to:

  – Gas density
  – Agitator
  – Cooling/Heating jacket

When reading-in the count rates, the time remaining up to the end of the operation is displayed. Finally, you are prompted to confirm the detected count rate with ***OK***. To shorten the read-in process, you can stop any time by pressing ***OK***.

2 Background

The term background refers to the background radiation which is present in the environment. The background radiation has to be measured so that the detector can correctly compensate for the decay of the radiation source.

▶ Select **ReadIn** to read in the count rate for the background radiation.

If you already know the value, you can enter it here.

3 Cal Point 0%

Count rate with empty container or at a level below the measuring range.

▶ Select **ReadIn** to read in the count rate.

If you already know the value, you can enter it here.

4 Cal Point 100%

Count rate with full container or at a level above the measuring range.

▶ Select **ReadIn** to read in the count rate.

If you already know the value, you can enter it here.

5 Calibrate + Preset

With this menu item you enable the calibration data determined during the measurements. The calibration data are transferred to the parameter set **Meas Parameter**. Thus, the detector will get a new calibration which in the future will be used to determine the measured values.

After the calibration, a status message is displayed, indicating if the activation of the calibration data has been carried out successfully. If not, the measurement parameters are unchanged. Possible status messages are:

- ***0-OK***

  The calibration carried out is OK.

- ***1-ERROR BACKGROUND***

  The count rate of the background radiation is higher than that for the calibration points for empty or full (**Cal Point 0%** or **Cal Point 100%**).

- ***2-ERROR NOT SORTED***

  The calibration points are not entered in sequence and need to be sorted.

- ***3-ERROR CURVE NOT MONOTONOUS***

  Not all count rates are decreasing with increasing level.

- ***4-ERROR MISSING CALIBRATION POINT***

  There is a calibration point with indication of the value in % but without count rate.

- ***5-COMPENSATION ERROR***

  A gas density compensation at exponential characteristic curve is not possible.

- ***6-DATE ERROR***

  A date is still set to the default value of 1.1.2000. At **Calibrate**, check the **Date** parameter. At **Restore**, check the date in **Restore Date**.

- **7-CHECK ERROR**

  The status of the calibration parameters could not be fully verified. In this case, repeat the calibration. If the error occurs again, replace the detector, at least the detector electronics.

NOTICE

The above described plausibility check cannot prevent that the user may read-in incorrect data. If in doubt, please consult a BERTHOLD TECHNOLOGIES service technician.

The following settings are made automatically at **Calibrate + Preset**:

- **Compensation Mode** = ***OFF***
- **Calibration Method** = ***Multipoint***
- Lower calibration point set to 0%
- Upper calibration point set to 100%
- **Cal Curve Type** = ***Normal***

2.9 Sensor Configuration

Menu path: **Device Config ▶ Setup ▶ Sensor Configuration**.

The sensor settings are preset at the factory.

1 Date & Time

Opens the menu for the date and time (*page 3-331*).

2 Sensor Settings

Opens the menu for the detector code and HV settings (*page 3-332*).

3 Config Slave Detectors

Opens the menu for the configuration of the Slave detectors (*page 3-335*).

2.10 Date & Time

Menu path: **Device Config ▶ Setup ▶ Sensor Configuration ▶ Date & Time**.

The correct date is important for the automatic decay compensation of the isotope. Since the activity of the source diminishes with time, the calibration count rates will be compensated automatically in the **Meas Data** menu through the date. The decay compensation takes place daily at 09:01 h. A capacitor ensures that the date and time continue to run for about a month even when the detector is turned off and even if the power supply is switched off. If the detector has not been supplied with power for a longer period of time (several weeks), then the capacitor may be empty. If the power supply is switched on again, then the clock starts with the last saved date and an error message "Real time clock not valid" indicates that the date must be updated.

1 Date

Current date. The date is specified in the following format:

MM/DD/YYYY.

If the detector detects that the date deviates, a date error is indicated. The response of the signal output is dependent on the setting for **Error Handling** (**Signal Parameter**, *page 3-337*):

- ***NORMAL***

  The measurement continues with the last saved date.

- ***SENSITIVE***

  The measurement goes to the safe condition and the current output goes to fault current.

2 Time

Current time. The time is specified in the following format:

hh:mm:ss

Differences in time have virtually no effect on the correction of the decrease in activity. However, the correct time is helpful to check the detector function: If an error occurs, you can see in the error log (**Device Config ▶ Diagnostic ▶ Log**, *page 3-395*) when exactly the error occurred.

3 Active Detector No.

▶ Choose the detector for which you want to display the current values in this window.

- **Detector No.** = ***0*** shows the date and time of the master detector.
- **Detector No.** = ***1*** shows the date and time of slave 1.
- **Detector No.** = ***2*** shows the date and time of slave 2.
- etc.

2.11 Sensor Settings

Menu path: **Device Config ▶ Setup ▶ Sensor Configuration ▶ Sensor Settings**.

1 Active Detector No.

▶ Choose the detector for which you want to display the current values in this window.

- **Detector No.** = ***0*** shows the date and time of the master detector.
- **Detector No.** = ***1*** shows the date and time of slave 1.
- **Detector No.** = ***2*** shows the date and time of slave 2.

etc.

2 Error Code

Indicates if an error is present in the active detector.

If no error is present, then ***0*** is displayed here.

An error message is displayed with a three digit number. The cause of the error and suggestions for correcting the error are described in *"Error Handling"* in *chapter 8*.

3 Detector Device Id

Shows the specific HART® device number of the active detector.

This information is set by BERTHOLD TECHNOLOGIES and can't be changed by the user.

4 Detector Code

The currently selected detector code is displayed.

The detector code is crucial for the proper function of the automatic HV control (high voltage control).

The detector code has already been set by BERTHOLD TECHNOLOGIES. It is dependent on the scintillator size and the detector type, see *Volume 2*, *chapter 1.6*, *"Detector Codes"*, on *page 2-174*.

5 HV Mode

The HV-mode (high-voltage control) provides the following options:

- ***AUTO***

  Automatic HV control Select this mode in normal measurement mode. It enables a temperature-stable operation of the detector.

- ***MANUAL***

  Manual HV control This setting is used for testing purposes; you can also provisionally set the operating point of the detector. The specified voltage must, however, lie in the plateau.

  If you select ***Manual***, the automatic HV control is switched off. The HV is then set to the value that was set in the menu item **HV Manual** (8).

- ***PLATEAU***

  Starts the plateau measurement. If you select ***PLATEAU***, the measurement mode is exited and the plateau of the multiplier measured, which is used in the detector. The plateau is measured using the settings in the menu **Device Config ▶ Setup ▶ Service ▶ Plateau**.

  At the end of the plateau measurement the detector automatically switches back to **HV Mode**: ***AUTO*** or ***MANUAL***, depending on which mode was last set.

6 HV Live

Displays the current HV (high voltage) at the photomultiplier. If **HV Mode** is set to ***AUTO*** (normal operation), the values in **HV Live** must change, viewed over several seconds.

7 HV Average

Shows the average HV (high voltage) of the last 10 days.

Significant deviations from **HV Live** to **HV Average** are considered and reported as errors.

If you change **HV Default**, **HV Average** automatically takes the value from **HV Default**.

8 HV Manual

You can enter a fixed HV value. The value becomes active when you select ***MANUAL*** at **HV-Mode**.

9 HV Default

HV Default causes:

– A quick operation point control after power failure

  After a power failure, the HV starts at the last HV Average value which results from the HV Default. This will significantly reduce the start-up phase after power failure.

– Error detection in case of HV-drift

  If the HV deviates too far (+40%, -20%) from the HV Default or if the HV reaches the limits of the range of 300 V or 1300 V, this is reported as an error.

– Special feature: 0V

  For maintenance purposes, the HV Default can also be set to 0V. In this case, the mechanisms described above are suspended; after a power failure, the measurement begins to get adjusted at 800 V.

HV Default has already been determined and set by BERTHOLD TECHNOLOGIES. If this value deviates during the *first commissioning* by more than 5% from **HV Live**, then you have to adjust **HV Default** new.

▶ Set **HV Default** to 0.

▶ Read off the value in **HV Live** 30 minutes later.

▶ Enter the value read in **HV-Default**.

With the CrystalSENS, please note that the count rate during this process is above 300 cps to allow the HV to adjust itself.

Tip
The operating point in new detectors is usually between 400 to 900 V. If you get a different value, please contact BERTHOLD TECHNOLOGIES or your local representative.

10 Cps Single Detector

Shows the count rate of the active detector normalized to one second.

2.12 Config Slave Detectors

Menu path: **Device Config ▶ Setup ▶ Sensor Configuration ▶ Config Slave Detectors**.

IMPORTANT
Date and time have to be checked before all other parameters and updated, if necessary. If the device is more than a month out of service, then an error message indicates that the date must be updated.

1 Nbr of Slaves

Number of slaves that are connected to and have communication with the master.

2 Add Slave

For multi-detector arrangements (cascading several detectors).

▶ To add a slave detector, assign it a detector number between 1 to 16 and enter its device ID number.

3 Remove Slave

▶ Interrupt the communication to a slave by entering its detector number.

4 Refresh Slave Table

Updates the **Detector Table**.

5 Detector Table

Shows all slaves in a clearly laid out table that are connected to the master and communicate with the master. The table also shows the function of the connected detector.

- ***MEAS***

  The detector is used for multi-detector operation (cascading).

- ***COMP***

  The detector is operated as compensation detector. For example, for automatic gas density compensation.

The table also indicates whether an error message in a detector is present.

If no error is present, then ***0*** is displayed in the relevant column.

An error message is displayed with a three digit number. The cause of the error and suggestions for correcting the error are described in *"Error Handling"* in *chapter 8*.

2.13 Signal Condition

Menu path: **Device Config ▶ Setup ▶ Signal Condition**.

This menu contains some special features which have a direct impact on the signals of the measurement:

- the way of signaling
- general warning and error messages
- special warning signs for early detection of functional limitations

An important issue are the settings in the menu item **Error Handling** in the **Signal Parameter** menu.

1 Signal Parameter

Opens the menu for error handling and settings for the signal output (*page 3-337*).

2 Reading Range

The measuring range can be specified in this menu.

3 Signal Dependency

Opens the menu in which the interference radiation detection or the rapid switchover can be enabled.

4 Source Exchange

Opens the menu in which the early warning for the source replacement can be set.

2.14 Signal Parameter

Menu path: **Device Config ▶ Setup ▶ Signal Condition ▶ Signal Parameter**.

1 Time Constant

The time constant smoothes the output signal. Statistical fluctuations, as well as level fluctuations due to the process, e.g. by agitators, are smoothed. A time constant of 20 s is usually reasonable.

2 Error Handling

Displays the current state ***NORMAL***, or ***SENSITIVE*** set under **Set Error Handling**.

3 Set Error Handling

Here you can set a different weighting of errors and error handling:

- ***SENSITIVE***

  All error messages result in an error current (e.g. 22 mA) at the current output. Warnings are no error messages, they have a lower priority and they are not signalized by the current output by an error current. However warnings are signalized by the HART protocol, or can be signalized by the digital output (open collector). In order to observe warnings you need to monitor your HART® protocol, or to activate and monitor the digital output of the LB 480.

  The setting ***SENSITIVE*** is automatically enabled when the Safety Mode is selected.

- ***NORMAL***

  Only fatal errors are signalized at the current output. Fatal errors are errors that tells the user, this system is definitely faulty. The error current (e.g. 22 mA) will be signalized only at fatal errors. Minor errors and warnings are information that tells the user the reading is uncertain, or it tells the reading will be uncertain if no measures or no precautions will be taken. Minor errors and warnings are not signalized with an error current. They are signalized by the HART® protocol or with the digital output (open collector) of the LB 480.

  To also get minor error and warning messages, you must also evaluate the messages via the HART® signal or the digital output.

IMPORTANT
*You may select the **NORMAL** setting only if hazards to persons or the environment or damage to property as a result of a faulty measured value can be ruled out.*

To use the digital output for the above mentioned messages, you need to use the setting ***WARNING + ERROR*** in the menu **Digital Out Function** (**Device Config ▶ Setup ▶ I/O Setup ▶ Digital Output ▶ Digital Out Function**, *page 3-365*).

Tip
Error handling is described in detail in *chapter 8* starting on *page 3-437*.

4 Signal Unlocked

You will get alerted when the device is unlocked with a password. The warning message 901 is output. Choose ***WARNING*** only if the control system is to be alerted when the device was unlocked with the password.

- ***OFF***

  The function is switched off.

- ***WARNING***

  Once the detector is unlocked with a password, a warning is issued. If **Error Handling** is set to ***SENSITIVE***, then a fault current is output in addition to the alarm.

The reaction can be identified based on the list in *chapter 8.2* on *page 3-438*.

5 PRC Comp Factor

Required only in special cases where a compensation for low radioactive radiant products is necessary.

This feature can be used to compensate for a possible difference in sensitivity between compensation detector and level detector in order to optimize the PRC measurement.

6 GPC Comp Factor Limit

Required only if **Compensation Mode** is set to ***AUTO GPC***, i.e. only for automatic gas density compensation.

When this limit is exceeded, a warning is issued, indicating that the compensation of the gas density must be questioned. In this case, both the calibration and the compensation measurement have to be checked.

2.15 Reading Range

Menu path: **Device Config ▶ Setup ▶ Signal Condition ▶ Reading Range**.

1 Lower Range Value

▶ Enter the lower limit of the measuring range where 4 mA is to be output.

2 Upper Range Value

▶ Enter the upper limit of the measuring range where 20mA is to be output.

3 % Meas Range

Displays the current percentage value within the measuring range. It depends on the current level value and the measuring range. At a measuring range of 0 to 100% this corresponds to the level reading.

2.16 Signal Dependency

Menu path: **Device Config ▶ Setup ▶ Signal Condition ▶ Signal Dependency**.

Use this menu, for example, to detect external radiation from weld inspections, or short-term use of other sources in the vicinity of the detector.

If the current count rate exceeds the threshold set in **Io Factor** or in **RI Sigma**, the interference radiation warning will be issued. In this case:

– the measured value is frozen and

– the current output holds the last measured value

The measurement remains frozen as long as the external radiation is present, plus the waiting time that has been set in Waiting Time.

To get the warning messages, you have to evaluate the messages via the HART® signal or the digital output.

3

IMPORTANT

If interference radiation detection is enabled, the measured values are output with a delay. The delay is adjustable from 0 to 5 seconds.
The delay is required so that at the moment of detection the measured value remains unaffected, even though in this case, increased count rates are already present. For this reason, while interference radiation detection is active, no applications can be run where the reaction time must be below the set delay.

For detailed information please refer to the section Interference Radiation Detection (*chapter 7.5, page 3-428*).

1 Response Mode

Additional parameters are displayed, depending on which function you select.

▶ Select the detection mode:

- ***DISABLED***

  Interference radiation detection and Rapid switchover are disabled.

- ***RAD. INTERFERENCE***

  Interference radiation detection is enabled.

  For detailed information please refer to the section Interference Radiation Detection (*chapter 7.5, page 3-428*).

- ***RAPID SWITCH***

  Rapid switchover is enabled.

  The use of the function ***RAPID SWITCH*** is recommended only for special applications where the output signal has to adapt rapidly to the new value, e.g. for measurements on small containers and if sudden level changes occur.

IMPORTANT
*The function **RAPID SWITCH** should not be enabled when the measurement is installed into a control loop, since this function works with two different time constants.*

2 Io Factor

Defines the threshold where the interference radiation detection responds. With the default value of 1.5, the threshold is 1.5 times the active empty count rate and is suitable for most applications.

You can adjust the factor for the threshold yourself. Note that a value below 1.5 may trigger faulty switching caused by fluctuations in the measured values. Increasing the factor decreases the sensitivity. Increase the factor if false alarms are triggered by significant fluctuations in the measured values, for example, by agitator blades.

3 Waiting Time

If interference radiation is detected, the measurement is "frozen" and will be released at the earliest after the waiting period is over. You have to enter the value for the waiting time in seconds.

4 RI Sigma

RI Sigma must be set correctly to detect changes caused by interference radiation within the measuring range. This value is the threshold where the interference radiation detection responds if a sudden increase in radiation occurs. The higher the value, the higher the threshold and the less likely the response to interference radiation.

The default value of 10 is suitable for most applications.

With irregular levels, e.g. due to agitators, the interference radiation detection would be triggered constantly due to strong level fluctuations. In these cases it may be necessary to define a higher Sigma value. To turn the Sigma function off, you can enter the number ***0***.

Choose a low value if you need a fast response time of a few seconds (3 to 10 seconds). Choose a high value if the filling is slow, and therefore there are no great demands on the response time.

5 Meas Delay Time

If interference radiation detection is enabled, the measured values are output with a delay. The delay is adjustable from 0 to 5 seconds.

The delay is required so that at the moment of detection the measured value remains unaffected, because in this case, increased count rates are already present which may distort the measured value.

6 RS Sigma

⇒ Displayed only when **Response Mode** is set to ***Rapid Switch***.

This value is the threshold where the rapid switchover responds. The higher the value, the higher the threshold and the less likely the response to interference radiation.

The default value of 10 is suitable for most applications.

With irregular levels, e.g. due to agitators, the interference radiation detection would be triggered constantly due to strong level fluctuations. In these cases, you must set Sigma to a higher value.

2.17 Source Exchange

Menu path: **Device Config** ▶ **Setup** ▶ **Signal Condition** ▶ **Source Exchange**.

Often, it is not apparent to the user when a source must be replaced. Activate the message "Source Exchange" if you want to be warned in time that the source has to be replaced. Reasons for a source replacement may be to ensure the measurement function, or, for radiation protection reasons, a maximum service life of the source.

To get the warning messages, you have to evaluate the messages via the HART® signal or the digital output.

IMPORTANT

Usually, the manufacturer recommends a service life of the source of about 10 years. A longer service life of the source has to be clarified with the Radiation Safety Officer in charge who is familiar with the local radiation protection requirements.
*The service life approved by the Radiation Safety Officer limits the maximum period of use, even if a longer technical service life is displayed under **Warning Date**. In this case, select **DATE** at **Selection** and enter the source exchange date specified by the Radiation Safety Officer.*

1 Selection

- ***OFF***

  No message is output.

- ***DATE***

  The message Source Exchange is output on a specific date. Enter the date in **Warning Date**.

- ***Reading Fluctuation***

  In **Max Reading Fluctuation**, enter a maximum fluctuation of the level reading, which should not be exceeded. After entering the maximum fluctuation width, the detector automatically calculates the date of the source exchange. The date is displayed under ***Date***.

2 Warning Date

If you have selected ***DATE*** at **Selection**, you have to enter the date when you want to get the Source Exchange warning (format: MM/DD/YYYY.

3 Max Reading Fluctuation

If you have selected ***Reading Fluctuation*** at **Selection**, you have to enter here the maximum fluctuation width of the level reading. The value entered refers to a plus/minus fluctuation around the mean value with a probability of occurrence of two Sigma.

After entry of a value, the date on which the warning will be expected is displayed in **Warning Date**.

Tip

The fluctuation of the level reading can be reduced by increasing the time constant. Accordingly, the Source Exchange warning will be issued later.

2.18 Cal Parameter

Menu path: **Device Config ▶ Setup ▶ Cal Parameter**.

In this menu you can calibrate and adjust the measuring system and set the parameters needed to perform the measurement.

Readjustment of an already calibrated measurement:

The count rates in this menu and the submenus are not decay compensated[1]. For this reason, after several weeks the calibration characteristic curve cannot be changed using data from **Cal Parameter**; rather, it must be changed using the values from **Meas Parameter**. These values correspond to the data the LB 480 is currently using to run measurements. The data in **Meas Parameter** also include the decay compensated count rates of the calibration points which were used last to calibrate the LB 480. Select **Recall** to obtain the decay compensated values. The current values from **Meas Parameter** (**Device Config ▶ Meas Parameter**) are copied back here.

3

IMPORTANT

*Changes in these parameters have an influence on the measurement only when you select the **Calibrate** command.*

1 Cal Points

Opens the menu for the calibration (*page 3-345*).

2 Cal Settings

Opens the menu for entering the basic detector-specific settings that needs to be performed before calibration (*page 3-349*).

3 Product Conditions

Opens the menu for entering the basic product-specific settings that needs to be performed before calibration (*page 3-351*).

4 Cal Comp Factor

⇒ Visible only if **Compensation Mode** is set to ***AUTO GPC***.

You need this menu if you want to find the Comp Factor, because the standard **Comp Factor** = 1 is only valid when the measuring system utilizes the beam path to 45 degrees. The more you deviate from it, the more important it is to determine the Comp Factor yourself. This requires that you pressure up the container and read in the count rates at different pressures. The larger the pressure range in which measuring points are recorded and the more points you record, the more accurate will be the **Comp Factor** later.

5 Adapt Calibration

The menu contains functions to adjust the characteristic curve and to take over older calibration data.

1. Each source will lose activity over time and become weaker; this is called source decay. For this reason, the count rate measured at the detector decreases in the course of time. The process can be calculated using a mathematical function and is automatically compensated for by the SENSseries detectors.

6 Calibrate

With this menu item you enable the calibration data determined during the measurements. In this case, the calibration data are transferred from **Cal Parameter** to **Meas Parameter**. Thus, the detector will get a new calibration which in the future will be used to determine the measured values.

After the calibration, a status message is displayed, indicating if the activation of the calibration data has been carried out successfully. If not, the measurement parameters are unchanged. Possible status messages are:

– ***0-OK***

  The calibration carried out is OK.

– ***1-ERROR BACKGROUND***

  The count rate of the background radiation is higher than that for the calibration points for empty or full (**Cal Point 0%** or **Cal Point 100%**).

– ***2-ERROR NOT SORTED***

  The calibration points are not entered in sequence and need to be sorted.

– ***3-ERROR CURVE NOT MONOTONOUS***

  Not all count rates are decreasing with increasing level.

– ***4-ERROR MISSING CALIBRATION POINT***

  There is a calibration point with indication of the value in % but without count rate.

– ***5-COMPENSATION ERROR***

  A gas density compensation at exponential characteristic curve is not possible.

– ***6-DATE ERROR***

  A date is still set to the default value of 1.1.2000. At **Calibrate**, check the **Date** parameter. At **Restore**, check the date in **Restore Date**.

– ***7-CHECK ERROR***

  The status of the calibration parameters could not be fully verified. In this case, repeat the calibration. If the error occurs again, replace the detector, at least the detector electronics.

NOTICE

The above described plausibility check cannot prevent that the user may read-in incorrect data. If in doubt, please consult a BERTHOLD TECHNOLOGIES service technician.

7 Recall

Allows you to copy the current data set from **Meas Parameter** to **Cal Parameter**. This allows you to revise the valid parameters, without this having an influence on the measurement at first. After you have finished editing, you can activate the changed settings with **Calibrate**.

Recall is also necessary because the count rates in the calibration parameters (**Cal Parameter**) in contrast to the count rates of the measuring parameters (**Meas Parameter**) are not decay compensated.

IMPORTANT
***Recall** overwrites all settings of the **Cal Parameter** menu.*

2.19 Cal Points

Menu path: **Device Config ▶ Setup ▶ Cal Parameter ▶ Cal Points**.

IMPORTANT
*Changes in this parameter group have an effect only when you call **Calibrate** (**Device Config ▶ Setup ▶ Cal Parameter ▶ Calibrate**, page 3-343).*

This menu allows you to adjust the measuring system.

1 ReadIn

Start reading-in the count rates. While the count rate is read in, the average is calculated and displayed continuously. You define the reading-in period under **ReadIn Time** (**Device Config▶ Setup ▶ Cal Parameter ▶ Cal Setting**).

First choose which calibration point you want to read in:

- ***BACKGROUND***

  The background radiation has to be measured so that the detector can correctly compensate for the decay of the radiation source. Before taking measurements, make sure you do not measure any radiation from the radiation source

  The easiest way to ensure this is if the source is not yet mounted. Otherwise, close the beam path and in addition fill the container.

- ***ACTIVE POINT***

  The count rate for the calibration point displayed under **Point No. Cal.** is read in. For all calibration points, the conditions in the container must match the conditions during operation as closely as possible. If appropriate for your application and if it affects the beam path, this applies, for example, to:

  - Gas density
  - Agitator
  - Cooling/Heating jacket

  Note that for a 1-point calibration, the second calibration point is displayed only, but cannot be read-in.

  When reading-in the count rates, the time remaining up to the end of the operation is displayed. Finally, you are prompted to confirm the measured count rate with ***OK***. To shorten the read-in process, you can stop any time by pressing ***OK***.

2 Background

The term background refers to the background radiation which is present in the environment. The background radiation has to be measured so that the detector can correctly compensate for the decay of the radiation source.

▶ Select ***ReadIn*** to read in the count rate for the background radiation. If you already know the value, you can enter it here.

3 Background Comp

⇒ Visible only if **Compensation Mode** is set to ***AUTO GPC***.

The **Background Comp** is the background radiation which is present in the environment and is measured by the compensation detector.

With **ReadIn *BACKGROUND*** the count rate for background comp is automatically read in.

If you already know the value, you can enter it here.

4 Cal Point No.

Indicates to which calibration point the parameters below refer, such as **Cal Level** and **Cal Rate**. The selected calibration point corresponds to the ***ACTIVE POINT*** in **ReadIn**.

5 Cal Level

Enter here the percentage for the calibration point that appears in **Cal Point No.**.

6 Cal Rate

Count rate for the calibration point that appears in **Cal Point No.**. To delete a calibration point, you have to set both the value in **Cal Level** and the associated count rate to 0.

▶ Select ReadIn to read in the count rate. If you already know the value, you can enter it here.

7 Cal Rate Comp

⇒ Visible only if **Compensation Mode *AUTO PRC*** or ***AUTO GPC*** is selected.

Count rate of the compensation measurement for the calibration point that appears in **Cal Point No.**.

With **ReadIn** the compensation count rate is read in at the same time as the count rate for the level measurement.

8 Cal Rate at Op

⇒ Visible only if **Compensation Mode** is not set to ***OFF***.

Shows the count rate calculated under operating conditions, depending on the respective compensation mode.

9 Sort

If the individual calibration points are not entered in the order low level to high level, then the calibration points can be sorted using this menu item.

The calibration points must be sorted before enabling **Calibrate**!

10 Calibration Chart

Allows a clear presentation of the calibration points.

- **Max Nbr Cal Points**

  Displays the maximum possible number of calibration points.

- **Refresh Cal Table**

  Updates the calibration points contained in **Cal Table**.

- **Cal Table**

  Shows all calibration points in a table. You can edit the calibration points in this table.

- **Clear Table**

  Clears all values from the calibration table.

- **Calibration Curve**

  Shows all calibration points in a calibration curve.

2.20 Cal Settings

Menu path: **Device Config ▶ Setup ▶ Cal Parameter ▶ Cal Settings**.

The basic settings for the calibration are defined in this menu.

IMPORTANT

Changes in this parameter group have an effect only when you call ***Calibrate*** *(****Device Config ▶ Setup ▶ Cal Parameter****,* *page 3-344**).*

1 Nuclide

▶ Enter here the isotope (nuclide) that is used in your source:

- ***Co-60***
- ***Cs-137***
- ***USER DEFINED***

This entry controls the automatic decay compensation. The correct entry is also important in a single-point calibration and for gas density compensation. The isotope used is listed on the type plate of the shielding and on your delivery documents. The item ***USER DEFINED*** allows you to use any isotope you want. In this case, additional parameters are requested: Specify the half-life under **Half Life Time** and the absorption coefficient at **Absorption**.

What happens when you have selected the wrong isotope?

As a result of the wrong decay compensation, you will get a deviating display only after several weeks or months, with the deviation increasing over time. If you perform a calibration with the gas density compensation GDA, or a 1-point calibration, the wrong isotope will also calculate wrong calibration data.

2 Calibration Method

Different calibration methods are used depending on the application and the local conditions. If you need help, please refer to *chapter 7.3* and *chapter 7.4*.

You can choose from the following calibration methods:

- **1-POINT LIN**

  Use the 1-point calibration only if full calibration is not possible.

  This method requires an empty calibration (level below measuring range). Using additional inputs such as product density and measurement path (**Device Config ▶ Setup ▶ Cal Parameter ▶ Product Conditions**), the count rate for the upper calibration point is then determined automatically.

- **MULTIPOINT**

  Level measurements are mostly calibrated using this method. In addition to the empty calibration, you can also carry out a full calibration and, if necessary, calibrate additional calibration points between 0 and 100%.

  Up to 10 calibration points can be entered. In most cases, however, 2 calibration points suffice: empty and full.

- **1-POINT EXP**

  Rarely used.

  Use the exponential 1-point calibration if you expect an exponential characteristic curve and full calibration is not possible. This method requires an empty calibration (level below measuring range). Using additional inputs such as product density and measurement path (**Device Config ▶ Setup ▶ Cal Parameter ▶ Product Conditions**), the count rate for the upper calibration point is then determined automatically.

- **2-POINT EXP**

  Rarely used.

  Use the exponential 2-point calibration if you expect an exponential characteristic curve and wish to perform a full calibration as well.

3 Cal Curve Type

- **NORMAL**

  Is used in almost all cases.

  With rising level, a falling count rate is expected.

- **REVERSED**

  Is rarely used, for example with so-called backscatter measurements.

  With rising level, a falling count rate is expected.

4 ReadIn Time

▶ Define here the period of time over which the count rate is to be read-in with **ReadIn** for each calibration point.

The statistical variation of the count rate is averaged over this time period. The longer it is, the better the mean value. A time period of 30 s (default setting) is usually reasonable.

2.21 Product Conditions

Menu path: **Device Config** ▶ **Setup** ▶ **Cal Parameter** ▶ **Product Conditions**.

On this menu you enter the basic product-specific settings that need to be performed before calibration.

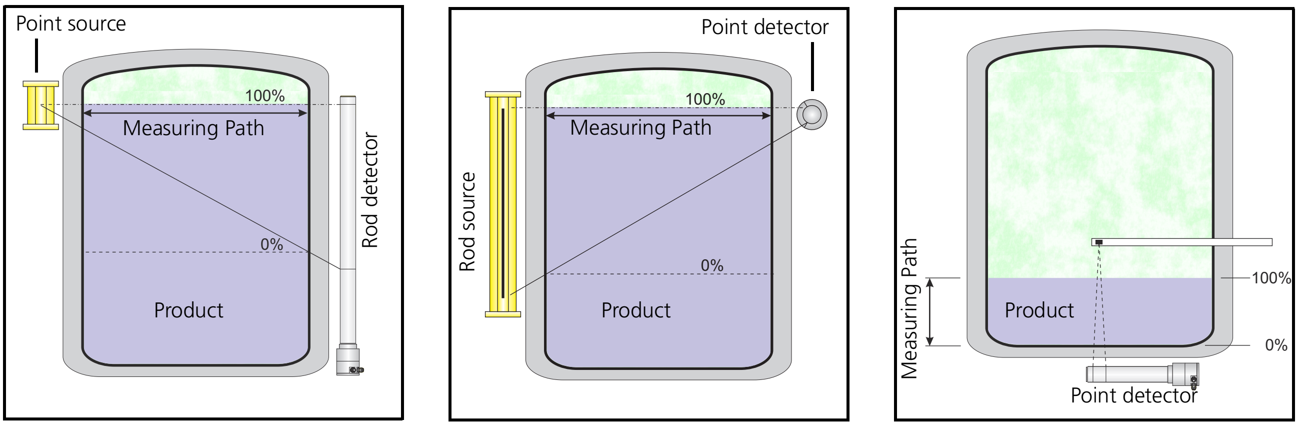
Entries for these parameters are required only in the following cases:

- For a 1-point calibration if full calibration is not possible.
- For containers with a gas pressure as long as the calibration cannot be performed at the same gas pressure as in operation.
- For containers with varying gas pressure, if the gas pressure is to be compensated for automatically.
- For products containing natural radioactivity which is to be compensated for automatically.

1 Measuring Path

This menu item is required for **Calibration Method *1-POINT*** to determine the full count rate automatically.

The value to be entered is the length of the beam path through the measured product.



3

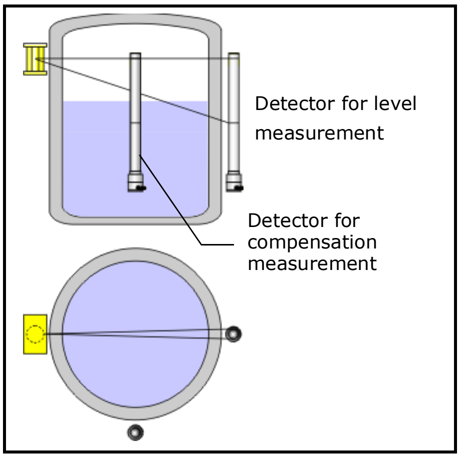
2 Product Density

This parameter is required for **Calibration Method *1-POINT*** to determine the full count rate automatically.

For liquids you have to enter the fluid density in kg/m^3, for solids, the bulk density.

If you known the fluid density and the bulk density only approximately, then you have to enter the lowest expected value.

3 Compensation Mode



The following settings are possible:

- ***OFF***

  The compensation is switched off.

- ***AUTO PRC*** (Product Radiation Compensation)

  Only required for level measurements on products containing natural radioactivity. This requires a compensation measurement which consists of the same detectors and is mounted at the same height on the container as the level measurement. The compensation measurement should not receive any radiation from the radiation source for the level measurement. Therefore it is mounted on the container offset by 90 degrees.

  For calibration, the compensation measurement must be mounted and connected, and level measurement must be logged in at the master. Additional parameters required for this calibration appear on the Calibration menu.

  The following requirements are necessary for a PRC-measurement:

  – the detector for the compensation measurement must be the same as for the level measurement
  – the distance to the vessel wall must be equal for both detectors
  – the vertical mounting position of the two detectors must be equal
  – the vessel wall thickness of the two detectors must be equal
  – the radioactivity present in the product must be evenly distributed
  – the 0% and the 100% point must be calibrated. The background of both detectors must be less than the respective 100% value.

The PRC measurement cannot be used if the radiation source is mounted in a dip tube in the container, because the radiation from this source would also be measured by the PRC-detector.

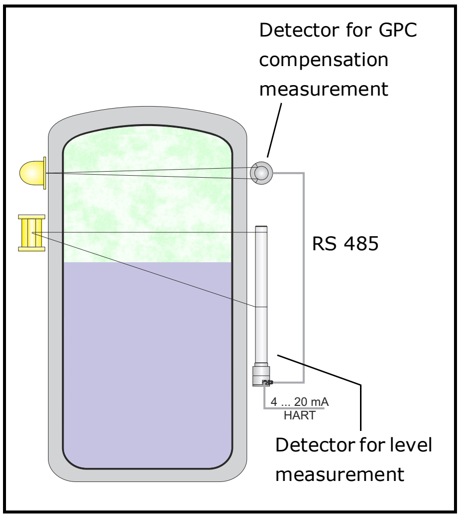
Please note that complete data archiving is not possible with the PRC function enabled.

- ***MANUAL GDA*** (Gas Density Adjustment)

  If the container in operation is under gas pressure (> about 2 bar) and the calibration cannot be carried out under operating pressure, then it is possible to calculate in advance the count rates that should be obtained under operating pressure. Additional parameters are displayed which are required for the compensation.

  - Gas measuring path
  - Setup Gas Density
  - Gas Density at Op

  Please note that with a multi-point calibration the GDA can only be used when the same gas density is available at all calibration points during calibration. Only the calibration point at 100% is excluded, provided that the measurement path in the container is completely filled with product.



- ***AUTO GPC*** (Gas Property Compensation)

3

IMPORTANT

This function requires special knowledge and should be enabled only by a Berthold service engineer, or by a specially trained person.

If the vessel is in operation under gas pressure (> about 2 bar) and the gas pressure is not constant, then a continuous gas density compensation is advisable. An additional measurement is required which is arranged above the liquid level measurement and constantly measures the gas density in the container. Additional parameters required for this calibration appear on the Calibration menu.

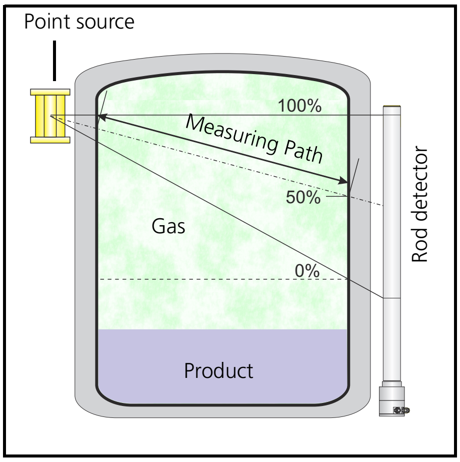
A further prerequisite for GPC is that the source used for level measurement as well as for compensation measurement contain the same isotope. This means, if a level measurement is carried out using Cs-137, then the compensation measurement must also be carried out with Cs-137.

GPC cannot be used for a level measurement with point source and point detector.

4 Gas Measuring Path

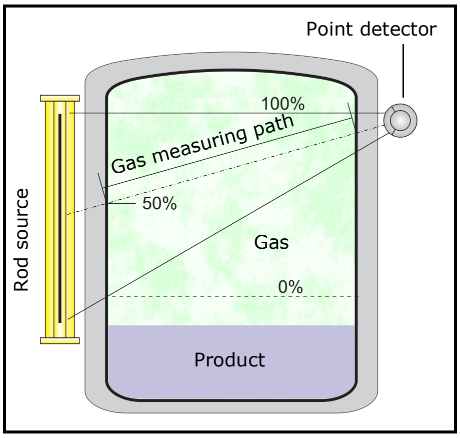
⇒ Visible only if **Compensation Mode** is set to ***MANUAL GDA***.

▶ Enter the average measurement path through the gas-filled room.



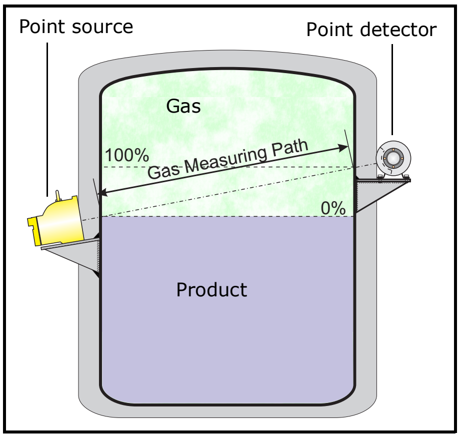
With point sources and rod detectors:

The path from the point source to the center of the measuring range. However, only the path through the container, i.e. in the gas-filled room.



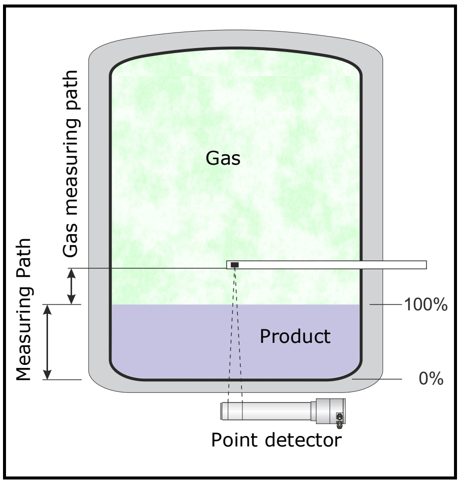
With point detectors and rod sources:

The path from the point source to the center of the measuring range. However, only the path through the container, i.e. in the gas-filled room.



In oblique irradiations with point source and point detector:

The path from the source to the detector. However, only the path inside the gas-filled room.



In absorption measurements with point source and point detector:

The path between the maximum level (100%) and the dip tube in which the source is installed.

However, only the section in the room filled with gas.

5 Setup Gas Density

⇒ Visible only if **Compensation Mode** is set to ***MANUAL GDA***.

▶ Enter the gas pressure in kg/m^3 which is present during calibration.

Use this parameter only if the gas density during calibration is different from the gas density under operating conditions.

Using the gas density, a compensated count rate is then calculated from the count rate in **Lower Cal Pt-Empty** (**Device Config ▶ Setup ▶ Cal Parameter ▶ Cal Points ▶ Cal Rate at OP**), which you can read off under **Op Lower Point**.

Prerequisite for the proper correction are correct entries in the following menu items:

- **Setup Gas Density**
- **Op Gas Density**
- **Measuring Path**
- **Nuclide**

3

Gas pressure < 1 bar

Gas densities with a pressure below 1 bar are generally negligible. Therefore, you can enter 0 kg/m^3.

Gas pressure > 1 bar

Determine the gas density under operating conditions very carefully in order to keep the error of the automatic compensation as small as possible. Better and more accurate would be the measurement of the empty count rate with gas and a gas density that is likely to be below operating conditions.

Gases with hydrogen

If hydrogen is present in the gas, then the absorption of the Gamma radiation is greater than would be expected by the actual gas density. This effect can be compensated by a increasing the gas density to be entered. If you cannot determine the increased absorption, please contact BERTHOLD TECHNOLOGIES.

6 Gas Density at Op

⇒ Visible only if **Compensation Mode** is set to ***MANUAL GDA***.

▶ Enter the gas pressure in kg/m^3 you expect under operating conditions.

Use this parameter only if the gas density during calibration is different from the gas density under operating conditions.

Using the gas density, a compensated count rate is then calculated from the count rate in **Lower Cal Pt-Empty** (**Device Config ▶ Setup ▶ Cal Parameter ▶ Cal Points ▶ Cal Rate at OP**), which you can read off under **Op Lower Point**.

Prerequisite for the proper correction are correct entries in the following menu items:

- Setup Gas Density
- Op Gas Density
- Measuring Path
- Nuclide

Gas pressure < 1 bar

Gas densities with a pressure below 1 bar are generally negligible. You may therefore enter 0 kg/m^3.

Gas pressure > 1 bar

Determine the gas density under operating conditions very carefully in order to keep the error of the automatic compensation as small as possible. Better and more accurate would be the measurement of the empty count rate with gas and a gas density that is likely to be below operating conditions.

Gases with hydrogen

If hydrogen is present in the gas, then the absorption of the Gamma radiation is greater than would be expected by the actual gas density. This effect can be compensated by a increasing the gas density to be entered.

If you cannot determine the increased absorption, please contact BERTHOLD TECHNOLOGIES.

2.22 Calc Comp Factor

Menu path: **Device Config ▶ Setup ▶ Cal Parameter ▶ Cal Comp Factor**.

⇒ Visible only if **Compensation Mode** is set to ***AUTO GPC***.

You need this menu if you want to determine the **Comp Factor**, because the standard **Comp Factor** = 1 is only valid when the measuring system utilizes the beam path to 45 degrees. The more you deviate from it, the more important it is to determine the **Comp Factor** yourself. This requires that you pressure up the container and read in the count rates at different pressures. The larger the pressure range in which measuring points are recorded and the more points you record, the more accurate will be the **Comp Factor** later.

1 ReadIn

Start reading-in the count rates. The count rates of the compensation detector and those of the level measurement are read in at the same time. While the count rate is read in, the average is calculated and displayed continuously.

Under **ReadIn Time** you define the read-in period.

▶ First choose under **Comp Table Index**, which calibration point you want to read in. You can select the data points 0...9.

When reading-in the count rates, the time remaining up to the end of the operation is displayed. Finally, you are prompted to confirm the detected count rate with **OK**. To shorten the read-in process, you can stop any time by pressing **OK**.

2 Comp Table Index

Displays the number of the measuring point whose values are displayed in **Cps Level** and **Cps Density**.

3 Cps Level

Count rate of the level measurement for the measuring point that is displayed in **Comp Table Index**.

▶ Select **ReadIn** to read in the count rate. If you already know the value, you can enter it here.

4 Cps Density

Count rate of the gas density measurement for the measuring point that is displayed in **Comp Table Index**.

▶ Select **ReadIn** to read in the count rate. If you already know the value, you can enter it here.

5 Calculate Factor

Calculates the compensation factor resulting from the measuring points in this menu.

This factor corresponds to the slope of the characteristic curve. The calculated value is displayed in parameter **Comp Factor**.

6 Comp Factor

Includes the compensation factor determined using this menu. It compensates for differences in measurement sensitivity between the level measurement and the gas density measurement.

7 Cal Rate Comp Table

Shows the read-in measuring points in a table (**Comp Table**) or a characteristic curve (**Comp Curve**).

2.23 Adapt Calibration

Menu path: **Device Config ▶ Setup ▶ Cal Parameter ▶ Adapt Calibration**.

The menu contains functions to adjust the characteristic curve and to take over older calibration data.

1 Adjust Lower Point

Use this feature only if you:

- replace the source, and a characteristic curve with several calibration points has been entered.
- wish to calibrate the measurement with one calculated characteristic curve and only one empty calibration, if necessary, with a full calibration.

Changes in this menu affect the entire calibration curve and then require enabling of **Adjust Curve LP** and then **Calibrate** for the changes to take effect.

2 Adjust Upper Point

Use this feature only if you want to adjust the entire calibration curve with one calibration of the upper calibration point.

Changes in this menu affect the entire calibration curve and then require enabling of **Adjust Curve LP** and then **Calibrate** for the changes to take effect.

If you want to specifically calibrate the upper calibration point, without this affecting the other calibration points, you must calibrate this measuring point in the **Cal Points** menu.

3 Restore Upload

Restore upload has a similar function as **Calibrate**, but considers a validity date, for example, of older calibration data and automatically performs a decay compensation.

First, you have to save the original set of parameters in the HOST or the HART® Communicator as off-line parameters. The off-line parameters can then be restored to the detector. Then enable this parameter set with **Restore Upload**. The validity date (**Restore Date**) of the calibration, which is contained in the off-line parameters, will automatically be compared with the current date in the detector and the calibration count rate is adjusted accordingly.

4 Restore Date

Restore Date contains the validity date that is used for the function **Restore Upload**. It can be loaded with the calibration data set or entered by hand.

2.24 Adjust Lower Point

Menu path: **Device Config ▶ Setup ▶ Cal Parameter ▶ Adapt Calibration ▶ Adjust Lower Point**.

Use this function:

- after a source replacement to re-calibrate an existing multi-point calibration (> 2 calibration points). All you need is one calibration point at empty, or at least at a low level.
- if the characteristic curve has been entered in the detector based on calculation records as a multi-point calibration. All you need for calibration is one calibration point at empty, or at least at a low level. If no full absorption is to be expected at 100% level, we also recommend a calibration at 100% level, with **Adjust Upper Point**.

The calibration has the effect that all other calibration points are adjusted accordingly in percent.

1 ReadIn

Start reading-in the count rates. While the count rate is read in, the average is calculated and displayed continuously. The reading-in period is defined under **ReadIn Time**, which is located in the **Cal Settings** menu.

2 Lower Level

Level in % at which the lower calibration point is to be read in. With empty container or at a level below the measuring range it would be 0%. If 0% is not possible, the lower calibration point can also be read in at a low level, for example, 20%.

3 Lower Rate

Count rate with empty container or 0% level. If 0% is not possible, the lower calibration point can also be read in at a low level, for example, 20%.

▶ Select **ReadIn** to read in the count rate.
If you already know the value, you can enter it here.

Tip
Preferably, the lower calibration point should be recorded at 0% level or with an empty container. Other levels for calibration are possible, but can then calculate the 0% value only, which may lead to deviations in the display with an actually empty container.

4 Lower Comp Rate

⇒ Available only if **Compensation Mode** = ***AUTO PRC*** or ***AUTO GPC*** is selected.

Contains the count rate of the compensation measurement for the lower calibration point. With **ReadIn** the compensation count rate is read in at the same time as the count rate for the level measurement.

5 Lower Rate at Op

⇒ Available only if **Compensation Mode** is **not** set to ***OFF***.

Shows the count rate calculated under operating conditions, depending on the respective compensation mode.

6 Adjust Curve LP

Calculates a new calibration curve based on the value pair (**Lower Level** + **Lower Rate**) and the calibration curve which is stored under **Cal Points**. The new curve is also stored under **Cal Points**.

2.25 Adjust Upper Point

Menu path: **Device Config ▶ Setup ▶ Cal Parameter ▶ Adapt Calibration ▶ Adjust Upper Point**.

Use this function if no full absorption is expected at 100% level and the curve has already been entered in the detector based on calculation records as multi-point calibration.

In this case, you can carry out, after a previously done empty adjustment with **Adjust Lower Point**, an additional calibration with full container, with **Adjust Upper Point**.

The calibration has the effect that all other calibration points are adjusted accordingly in percent.

1 ReadIn

Start reading-in the count rates. While the count rate is read in, the average is calculated and displayed continuously. The reading-in period is defined under **ReadIn Time**, which is located in the **Cal Settings** menu.

2 Upper Level

Level in % at which the upper calibration point is to be read in. With full container or at a level above the measuring range it would be 100%. If 100% is not possible, the lower calibration point can also be read in at a lower level, for example, 80%.

3 Upper Rate

Level in % at which the upper calibration point is to be read in. With full container or at a level above the measuring range it would be 100%. If 100% is not possible, the lower calibration point can also be read in at a lower level, for example, 80%.

▶ Select **ReadIn** to read in the count rate.
If you already know the value, you can enter it here.

Tip

Preferably, the upper calibration point should be recorded at 100% level or with a full container. Other levels for calibration are possible, but can then calculate the 100% value only, which may lead to deviations in the display with an actually full container.

4 Upper Comp Rate

⇒ Available only if **Compensation Mode** = ***AUTO PRC*** or ***AUTO GPC*** is selected.

Contains the count rate of the compensation measurement for the upper calibration point. With **ReadIn** the compensation count rate is read in at the same time as the count rate for the level measurement.

5 Upper Rate at Op

⇒ Available only if **Compensation Mode** is **<u>not</u>** set to ***OFF***.

Shows the count rate calculated under operating conditions, depending on the respective compensation mode.

6 Adjust Curve UP

Calculates a new calibration curve based on the value pair (**Upper Level** + **Upper Rate**) and the calibration curve which is stored under **Cal Points**. The new curve is also stored under **Cal Points**.

2.26 I/O Setup

Menu path: **Device Config ▶ Setup ▶ I/O Setup**.

This menu allows you to set the analog and digital inputs and outputs and the interfaces.

1 Current Output

Opens the menu with the settings for the current output (*page 3-363*).

2 Digital Output

Opens the menu with the settings for the digital output (*page 3-365*).

3 Digital Input

Opens the menu with the settings for the digital input (*page 3-369*).

4 HART Interface

Opens the menu with the settings for the HART® interface (*page 3-370*).

2.27 Current Output

Menu path: **Device Config ▶ Setup ▶ I/O Setup ▶ Current Output**.

1 Current Loop Monitoring

▶ Enable or disable the monitoring of the 4-20 mA current signal. Monitoring checks whether the set current is actually flowing in the current loop, and signals an error if any deviation is detected.

You have the following setting options:

- ***ENABLED***

  Monitoring is enabled (default setting).

  Unless there are compelling reasons, you should keep this setting. The setting is automatically enabled when the Safety Mode is selected.

- ***DISABLED***

  Monitoring is disabled. The HART Communicator outputs a corresponding message.

Tip

In case of a gross deviation or loose contact, monitoring may have the effect that the fault condition can only be reset by a software reset. The software reset menu can be done in the menu **Service** (**Device Config ▶ Setup ▶ Service ▶ Reset Device**, *page 3-371*) or by turning the power supply off and then on again.

2 Loop Alarm Type

▶ Here you specify the fault current, i.e. the current that is to be output in case of error.

IMPORTANT

*In Safety Mode, only the values **High** and **Low** are possible.*

You have the following setting options:

- ***High***

  In case of error the current output is set to >21mA.

- ***Low***

  In case of error the current output is set to <3.6mA.

- ***Hold Last Value***

  In case of error the current output holds the last measured value.

- ***Value***

  In case of error, the current output is set to the current value, which is set in **Error Current Value**.

3 Error Current Value

▶ Here you can define the fault current in mA, if you have chosen ***Value*** at **Loop Alarm Type**. With the settings ***High*** and ***Low***, the corresponding current values are displayed (>21mA/ <3.6mA).

4 Current Lower Limit

Lower limit of the current range for the 4-20 mA current output.

For adjustment purposes or to safely identify an under measuring range condition, the current range available for the measurement signal is extended beyond the standard range of 4-20 mA. According to Namur specifications (NE 43), the lower current value must, however, not be less than 3.8 mA. However, you can define the minimum value in the range from 3.8 to 4 mA.

5 Current Upper Limit

Upper limit of the current range for the 4-20 mA current output.

For adjustment purposes or to safely identify an over measuring range condition, the current range available for the measurement signal is extended beyond the standard range of 4-20 mA. According to Namur specifications (NE 43), the upper current value must, however, not be higher than 20.5mA. However, you can define the maximum value in the range from 20 to 20.5mA.

6 D/A trim

This menu item allows you to adjust the current output. You will need a power meter which is looped into the current loop. In a menu-guided process, 4mA and 20mA are defaulted one after the other. You are prompted to enter the actual value displayed on your current meter.

IMPORTANT

The impedance on the current output must always be lower than 500ohms, but at least 250ohms.

2.28 Digital Output

Menu path: **Device Config ▶ Setup ▶ I/O Setup ▶ Digital Output**.

The digital output provides a wiring for different signals. Without additional I/O cards the digital output is an open collector which is switched fail safe. This means that the transistor is conductive, as long as no alarm is reported and is blocked if an alarm is signaled. For more information on the digital output, see *Volume 2* in *chapter 3, "Electrical Installation", page 2-225*.

IMPORTANT

*If you use the setting **NORMAL** in the menu **Error Handling** (⇆⇨◁↓⇨⇨ ⇆⇕⇔←↓→ **▶ Setup ▶ Signal Condition ▶ Signal Parameter ▶ Error Handling**), only errors are reported via the current output. Alerts can then be received only through one of the following signal outputs:*

– *via the digital output as a binary signal*
– *via the HART® signal as a text message*

1 Digital Out Function

▶ Here you can define the switching function of the digital output. You have the following setting options:

- ***ALARM***

  The alarm is triggered when the threshold (alarm threshold for the level) is exceeded or fallen short of, i.e. it reacts in parallel with the current output signal. The switching behavior is dependent on the switching function selected at **Switch Function** (**Device Config ▶ Setup ▶ Cal Parameter ▶ Cal Settings ▶ Switch Function**, *page 3-367*).
  If an error occurs, the digital output goes to alarm.

- ***DET. TEMP***

  The alarm is triggered when the detector temperature is below or above the permissible temperature range. The temperature range is specified in **Sensor Temperature** (**Device Config ▶ Setup ▶ I/O Setup ▶ Digital Output ▶ Temp. Threshold Settings**, *page 3-368*).

- ***HOLD***

  The alarm is triggered when the measurement is on hold, i.e. the measured value is frozen. This can be caused, for example, by the digital input or by RID.

- ***WARNING + ERROR***

  The alarm is triggered when the detector signals an error or reports a warning. In *chapter 8* on *page 3-437* you find a list of possible causes and troubleshooting procedures.

- ***RAD. INTERFERENCE***

The alarm is triggered when interference radiation is detected. The function can be selected only if you have selected ***RAD. INTERFERENCE*** at **Response Mode** (**Device Config ▶ Setup ▶ Signal Condition ▶ Radiation Interference ▶ Response Mode**, *page 3-339*).

Tip
The alarm for ***RAD. INTERFERENCE*** is output even when you select ***WARNING + ERROR***.

2 Digital Out State

Displays the current value of the digital output. If the test mode is active, then the test value is displayed. The following functions can be displayed:

- ***Normal***
- ***Alarm***

3 Level Threshold Settings

Opens the menu in which the limit value for the alarm output can be set (*page 3-367*).

4 Temp. Threshold Settings

Opens the menu for the temperature-related settings (*page 3-368*).

2.29 Level Threshold Settings

Menu path: **Device Config ▶ Setup ▶ I/O Setup ▶ Digital Output ▶ Level Threshold Settings**.

1 Switch Function

▶ Here you define whether the switching function for the digital output (open collector) is used as a High Alarm or Low Alarm. The switching direction ensures the fail-safe function of the digital output (open collector).

You have the following setting options:

- ***MAX***

  Alarm is triggered if the limit value is exceeded (high alarm).

- ***MIN***

  Alarm is triggered if the limit value is not reached (low alarm).

2 Threshold

▶ Enter the level limit value in % where the alarm is to be output.

3 Hysteresis

The hysteresis prevents switching back and forth caused by statistical fluctuations of the measured values. The default value is 5%.

2.30 Temp. Threshold Settings

Menu path: **Device Config ▶ Setup ▶ I/O Setup ▶ Digital Output ▶ Temp. Threshold Settings**.

1 Temp. Upper Limit

Upper limit value for the detector temperature.

An alarm may be signaled via the digital output if this temperature is exceeded. To do this, set the digital output to the function ***DET. TEMP***. The alarm is also signaled when the minimum detector temperature (**Temp. Lower Limit**) is not reached.

Tip
You can use this feature, for example, as a pre-alarm, for the detection of an over-temperature, or control the cooling water cycle of the detector so that the cooling water flow is started at elevated temperature.

2 Temp. Lower Limit

Lower limit value for the detector temperature.

An alarm may be signaled via the digital output if this temperature is not reached. To do this, set the digital output to the function ***DET. TEMP***. The alarm is also signaled when the maximum detector temperature (**Temp. Lower Limit**) is exceeded.

Tip
You can use this function as a pre-alarm for under-temperature, so that a possibly connected cooling water system does not freeze, or a heater is turned on.

3 Temp. Hysteresis

Hysteresis for the temperature limit values.

4 Temp. Unit

Unit for the detector temperature. The temperature can be indicated in Fahrenheit or in Celsius.

5 Device Temp.

Displays the temperature inside the detector.

2.31 Digital Input

Menu path: **Device Config ▶ Setup ▶ I/O Setup ▶ Digital Input**.

The digital input can be controlled by the process control system. The reaction occurs when a short circuit of the input takes place; the signal must be bounce-free.

IMPORTANT

*If **Safety Mode** is enabled, the digital input is disabled automatically.*

The digital input is only available as an option. It is available for versions with HART signal, but not for detectors with fail-safe signal output.

1 Digital In Function

▶ Here you can define the switching function of the digital input. You have the following setting options:

- ***OFF***

  The digital input is disabled.

- ***HOLD***

  The measurement is frozen (hold mode) as long as the contact is closed.

- ***EMPTY***

  Runs an empty calibration. The input must be closed only briefly in order to start the process.

- ***FULL***

  Runs a full calibration. The input must be closed only briefly in order to start the process.

2 Digital In State

Indicates whether the input is open or closed.

2.32 HART Interface

Menu path: **Device Config ▶ Setup ▶ I/O Setup ▶ HART Interface**.

1 Poll Addr

Shows the current polling address. The address can be set with **Set Poll Address**.

2 Set Poll Address

Allows you to set the polling address for multidrop operation.

Enter only a polling address > 0 if the multidrop mode is used to operate several HART® devices at one current loop. Otherwise, leave the value at 0, since with a polling address > 0 the current output has no function anymore.

To use the multi-drop mode the current output must be passive (sink mode).

Multidrop mode

The host terminal uses the multidrop mode to identify the field device if more than one HART® device is connected to the same HART® loop. From HART® 6, up to 63 HART® devices can be inter-connected in one HART® loop. Each device must have a different polling address between 1 and 63.

If an address is set which is higher than 0, the Multidrop Mode is selected automatically and the current output is switched to a fixed current value of 4 mA. Then only the digital HART® communication will be available.

IMPORTANT

For safe HART® communication, the current output must have a minimum impedance of 250ohms and a maximum impedance of 500ohms.

3 Num Req Preams

Display of the requested preambles during communication between detector and communicator to initiate the start of communication.

The value is set to 3 and cannot be changed.

4 Num Resp Preams

Number of returned preambles during communication between detector and communicator to initiate the start of communication.

The default value is 5. At a higher number, the communication is slowed down slightly. The setting range is 5 to 20.

2.33 Service

Menu path: **Device Config ▶ Setup ▶ Service**.

This menu allows you to access various test functions, enter the license key and perform a detector reset.

1 PMT

Opens the menu showing the anode current of the photomultiplier (PMT) (*page 3-372*).

2 Sensor Temperature

Opens the menu showing the various detector temperatures (*page 3-373*).

3 Test

Opens the menu with the various test functions (*page 3-374*).

4 Plateau

Opens the menu for the plateau measurement and display of the plateau values (*page 3-379*).

5 License Key

The license key allows you to enable the detector for other applications (level, density). You can get a license key through your sales partner or directly from BERTHOLD TECHNOLOGIES GmbH & Co. KG.

Write down your license key in your operating manual. Each detector has its own license key.

6 Reset Device

The menu offers you several ways to reset the detector or certain functions:

- ***Active Detector No.***

  Choose the detector you want to reset.
  - **Detector No. =** ***0*** selects the master detector.
  - **Detector No. =** ***1*** selects slave 1.
  - etc.
- ***SW RESET*** (Software Reset)

  Starts the detector new. The function corresponds to the switching off and on of the supply voltage.
- ***FACTORY RESET***

  Resets most settings to factory default. Some settings, such as the adjustment of current output and the license key will be preserved.

2.34 PMT

Menu path: **Device Config ▶ Setup ▶ Service ▶ PMT**.

This menu allows the qualification of the photomultiplier (PMT) after consultation with BERTHOLD TECHNOLOGIES. Increased current values at the multiplier indicate a strong radiation levels (caused, for example, by weld testing), or a defect at the PMT, or the HV control.

1 Active Detector No.

Choose the detector for which you want to display the PMT values.

- **Detector No. = *0*** shows the PMT values of the master detector.
- **Detector No. = *1*** shows the PMT values of slave 1.
- etc.

2 HV Live

Displays the current HV (high voltage) at the photomultiplier. If **HV Mode** is set to ***AUTO*** (normal operation), the values in **HV Live** must change, viewed over several seconds.

3 HV Feedback

Display of the read back HV value which is actually present at the multiplier. The display is used to control the HV.

4 Meas CH CPS

Count rate in the measuring channel.

5 Control CH CPS

Count rate in the control channel.

6 Auxiliary CH CPS

Count rate in the auxiliary channel.

7 PMT Current

Displays the current anode current.

8 PMT Current Max

Display of the stored maximum value for the multiplier tube current (**PMT Current**).

9 Reset Current Extrema

Clears the maximum value of the multiplier tube current (**PMT Current Max**).

2.35 Sensor Temperature

Menu path: **Device Config ▶ Setup ▶ Service ▶ Sensor Temperature**.

On this menu you can view the various detector temperatures.

1 Device Temp.

Displays the current detector temperature. The temperature is measured in the electronics of the detector.

2 Device Temp. Min

Display of the lowest temperature measured.

3 Device Temp. Max

Display of the highest temperature measured.

4 Reset Temp Extrema

Clears the stored values in **Device Temp. Min** and **Device Temp. Max**.

2.36 Test

Menu path: **Device Config ▶ Setup ▶ Service ▶ Test**.

These menus allow you to perform various tests on the detector. All tests have a direct influence and are not delayed by the time constant.

If you lock the device with the password or if the Safety Mode is enabled, all test settings will be disabled automatically.

1 Test Settings

Opens the menu offering various test options for the detector (*page 3-374*).

2 I/O Test Settings

Opens to the menu offering various test options for the digital inputs and outputs (*page 3-377*).

2.37 Test Settings

Menu path: **Device Config ▶ Setup ▶ Service ▶ Test ▶ Test Settings**.

This menu allows you to check your calibration setting by simulating the measurement signal.

1 Level Mode

Here you can check if the process value is correctly transmitted from the field device to the process control system.

To simulate a level reading, you have to:

1. Enter a level value at **Level**.
2. Select ***FIXED VALUE*** at **Level Mode**.

IMPORTANT

*After the test, do not forget to switch from **FIXED VALUE** back to **NORMAL**; otherwise your measurement signal will remain frozen at this value.*

2 Level

▶ Enter the value to be simulated.

To enable the simulation, you must set ***FIXED VALUE*** at **Level Mode**.

3 Cps Average Mode

This item allows you to check whether your calibration is correct. Enter a count rate and then check the simulated level reading.

To simulate a level reading via a count rate, you have to:

1. Enter a count rate at **Cps Average Mode**.
2. Select ***FIXED VALUE*** at **Cps Average Test**.

IMPORTANT
*After the test, do not forget to switch from **FIXED VALUE** back to **NORMAL**; otherwise your measurement signal will remain frozen at this value.*

4 Cps Average Test

▶ Enter the value to be simulated.

To enable the simulation, you must set ***FIXED VALUE*** at **Cps Average Mode**.

5 Cps Comp Average Mode

⇒ Only visible when the compensation measurement ***AUTO GPC*** or ***AUTO PRC*** is enabled.

Allows you to simulate a count rate for the connected compensation detector.

To simulate a count rate, you have to:

1. Select ***FIXED VALUE*** at **Cps Comp Average Test**.
2. Enter a count rate at **Cps Comp Average Mode**.

IMPORTANT
*After the test, do not forget to switch from **FIXED VALUE** back to **NORMAL**; otherwise your value for the compensation measurement will remain frozen.*

6 Cps Comp Average Test

⇒ Only visible when the compensation measurement ***AUTO GPC*** or ***AUTO PRC*** is enabled.

Enter the value to be simulated.

To enable the simulation, you must set ***FIXED VALUE*** at **Cps Average Mode**.

7 Device Temp. Mode

Allows you to verify if over- or under-temperature is signaled via the digital output. Enter a test temperature and then check the signal at the digital output.

To check the digital output with a test temperature, you have to:

1. Set the digital output via **Digital Out Function** to ***DET. TEMP*** (**Device Config ▶ Setup ▶ I/O Setup ▶ Digital Output ▶ Digital Out Function**, *page 3-365*).
2. Enter a temperature value in **Device Temp. Test**.
3. Select ***FIXED VALUE*** at **Device Temp. Mode**.

IMPORTANT

*After the test, do not forget to switch from **FIXED VALUE** back to **NORMAL**; otherwise the temperature signaling will remain frozen.*

8 Device Temp. Test

▶ Enter a temperature value in order to test the digital output as a signal output for over- or under-temperature.

To enable the simulation, you must set ***FIXED VALUE*** at **Device Temp. Mode**.

2.38 I/O Test Settings

Menu path: **Device Config ▶ Setup ▶ Service ▶ Test ▶ I/O Test Settings**.

This menu allows you to perform various tests on the analog and the digital inputs and outputs.

1 Digital Out Mode

To enable the test, you have to:

1. Select ***FIXED VALUE*** at **Digital Out Mode**.
2. Enter ***CLOSED*** or ***OPEN*** at **Digital Out Test State**.

IMPORTANT
*After the test, do not forget to switch from **FIXED VALUE** back to **NORMAL**; otherwise the signaling will be kept.*

2 Digital Out Test State

▶ Choose ***OPEN*** or ***CLOSED*** to check the appropriate reaction at the digital output.

To enable the simulation, you must set ***FIXED VALUE*** at **Digital Out Mode**.

3 Digital In Mode

Allows you to simulate a signal at the digital input and examine its impact on the detector.

To enable the test, you have to:

1. Set a function for the digital input via **Digital In Function** (**Device Config ▶ Setup ▶ I/O Setup ▶ Digital Input ▶ Digital In Function**, *page 3-369*).
2. Select ***FIXED VALUE*** at **Digital In Mode**.
3. Enter ***CLOSED*** or ***OPEN*** at **Digital In Test State**.

IMPORTANT
*After the test, do not forget to switch from **FIXED VALUE** back to **NORMAL**; otherwise the signaling will be kept.*

4 Digital In Test State

▶ Choose ***OPEN*** or ***CLOSED*** to check the appropriate reaction of the detector.

▶ To enable the simulation, you must set ***FIXED VALUE*** at **Digital In Mode**.

5 Loop Current Mode

Indicates whether the current output is active or frozen. The following displays are possible:

- ***ENABLED***

  The current output is active.
- ***DISABLED***

  The current output is frozen.

The current output is frozen in the following cases:

– if it is set to fault current

– in multi-drop mode (**Set Poll Address**, see *page 3-370*)

– in test mode

6 Loop test

Allows you to selectively output current values at the current output. Thus you can check the correct function of the current output and the display value in the process control system. Enter the desired value in mA.

2.39 Plateau

Menu path: **Device Config ▶ Setup ▶ Service ▶ Plateau**.

This menu leads to the plateau measurement and to the display of the plateau values.

1 Plateau Measurement

Leads to the plateau measurement (*page 3-379*).

2 Plateau View

Enables the display of the plateau data in a table or as a plateau curve.

3 Plateau Information

General information on the plateau measurement.

2.40 Plateau Measurement

Menu path: **Device Config ▶ Setup ▶ Service ▶ Plateau ▶ Plateau Measurement**.

For information on how to perform a plateau measurement please refer to *chapter 6.2*, *page 3-414*.

1 Active Detector No.

▶ Choose the detector for which you want to record a plateau.

- **Detector No.** = ***0*** selects the master detector.
- **Detector No.** = ***1*** selects slave 1.
- etc.

2 HV Start

▶ Enter the HV start value in volts.

3 HV Stop

▶ Enter the HV stop value (end value of the measurement) in volts.

4 HV Step

▶ Enter the step size in volts, which should lie between the measuring points.

5 Meas. Time

▶ Enter the length of time over which each measuring point should be averaged, for example 20 s.

6 HV Mode

The menu item offers the following options:

- ***AUTO***

  Enables the automatic HV control. Set this operating mode for the normal measurement mode. This enables a temperature-stable operation of the detector.

- ***MANUAL***

  This setting is typically used for testing purposes only. You can specify, for example, the provisional operating point of the detector. The specified voltage must, however, lie in the plateau.

  As soon as you enable ***Manual***, the automatic HV control is switched off. The HV is then set to the value that was specified at HV Manual.

- ***PLATEAU***

  Starts the plateau measurement. The measurement mode is exited and the plateau of the multiplier which is used in the detector is measured. The measurement is done with the settings defined in the menu items **HV Start**, **HV Stop**, **HV Step** and **Meas. Time**.

  At the end of the plateau measurement the detector automatically switches back to **HV Mode**: ***AUTO*** or ***MANUAL***, depending on which mode was last set.

7 HV Live

Displays the current HV (high voltage) at the photomultiplier. If **HV Mode** is set to ***AUTO*** (normal operation), the values in **HV Live** must change, viewed over several seconds.

8 Cps Single Detector

Display of the count rate of each master or slave detector.

9 Cps Live

Displays the current total count rate of all detectors.

2.41 Plateau View

Menu path: **Device Config** ▶ **Setup** ▶ **Service** ▶ **Plateau** ▶ **Plateau View**.

This menu allows you to display the plateau data in a table or as a plateau curve.

1 Active Detector No.

Choose the detector for which you want to display the plateau values.

- **Detector No.** = ***0*** shows the plateau values of the master detector.
- **Detector No.** = ***1*** shows the plateau values of slave 1.
- etc.

2 Refresh Plateau

Updates the plateau table by loading the data from the detector.

3 Plateau Table

Shows the plateau data points in a table.

4 Plateau Curve

Shows the plateau data points in a curve.

2.42 Plateau Information

Menu path: **Device Config** ▶ **Setup** ▶ **Service** ▶ **Plateau** ▶ **Plateau Information**.

General information on the plateau measurement.

1 Active Detector No.

▶ Choose the detector for which you want to display the plateau values.

- **Detector No.** = ***0*** shows the plateau values of the master detector.
- **Detector No.** = ***1*** shows the plateau values of slave 1.
- etc.

2 Plateau Date

Shows the date of the last plateau recording.

No plateau recording exists, if the date 01/01/2000 is displayed.

3 Plateau Tab Entries

Displays the number of data points for the plateau measurement.

2.43 Meas Parameter

Menu path: **Device Config ▶ Meas Parameter**.

These menus show the currently valid measurement parameters.

1 Meas Data

Shows the menu with the currently measured values (*page 3-381*).

2 Meas Settings

Opens the menu showing the most important detector settings (*page 3-382*).

3 Meas Readings

Opens the menu presenting an overview of all raw count rates that are specifically needed for a compensation measurement *(page 3-383)*.

2.44 Meas Data

Menu path: **Device Config ▶ Meas Parameter ▶ Meas Data**.

The menu shows the measured and automatically calculated measurement settings (parameters). The count rates are corrected daily at 09:01 h through the automatic decay compensation; the values, therefore, become smaller in the course of a few weeks.

1 Background

Displays the count rate for the background radiation (background) which is present in the environment.

2 Meas Table

After calibration, the calibration points are displayed here in a table. Using this table, the measurement shows the current level.

3 Measurement Curve

After calibration, the calibration points are displayed here in a calibration curve.

2.45 Meas Settings

Menu path: **Device Config ▶ Meas Parameter ▶ Meas Settings**.

1 Time Const

Shows the time constant used to average the measured value.

2 Nuclide

Display of the isotope (nuclide) selected for the calibration. It must be the same as the source which is used at the measuring site.

- ***Co-60***
- ***Cs-137***
- ***USER DEFINED***

This information controls the automatic decay compensation and must match the information on the type plate of the shielding.

3 Cal Method

Indicates which type of calibration was last performed:

- ***1-POINT LIN*** (1-point linear)
- ***MULTIPOINT*** (multi-point calibration with 2 ... 11 points)
- ***1-POINT EXP*** (1-point exponential)
- ***2-POINT EXP*** (2-point exponential)

4 Cal Curve Type

Indicates whether the curve was calibrated rising or falling.

- ***STANDARD***

  With rising level, the count rates of the calibration points are falling.
- ***REVERSED***

  With rising level, the count rates of the calibration points are rising. Only needed in special cases, such as backscatter measurements.

5 Threshold

Shows the switching threshold where the measurement sets the digital output on alarm. To use this signal, you have to set the parameter **Digital Out Function** to ***ALARM*** under **I/O Setup**.

6 Hysteresis

The hysteresis prevents that the signal bounces during switching. A value of 5% is common.

7 Compensation Mode

Indicates with which additional compensation calibration was performed.

- ***OFF***

  Any compensation is disabled (default).
- ***AUTO PRC***

  Compensation is enabled so that radiation from the product does not distort the measured value.
- ***MANUAL GDA***

  The calibration has taken into consideration that the container is under gas pressure during operation.
- ***AUTO GPC***

  Compensation is enabled so that fluctuations in the gas pressure do not distort the measured value.

2.46 Meas Readings

Menu path: **Device Config ▶ Meas Parameter ▶ Meas Readings.**

1 Level

Shows the current level in %.

2 Cps Average

Shows the current count rate averaged over the time constant.

3 Cps Live

Displays the current count rate.

4 Cps Average Op

⇒ Visible only if **Compensation Mode** = ***AUTO GPC*** or ***AUTO PRC*** is selected.

Shows the compensated count rate which was used to calculate the current measured value.

5 Cps Average Comp

⇒ Visible only if **Compensation Mode** = ***AUTO GPC*** or ***AUTO PRC*** is selected.

Displays the averaged count rate of the compensation detector.

6 Cps Sensor Comp

⇒ Visible only if **Compensation Mode** = ***AUTO GPC*** or ***AUTO PRC*** is selected.

Displays the non-averaged count rate of the compensation detector.

7 Active Detector No.

▶ Select the detector for which you want to display the non-averaged count rate (**Cps Single Detector**).

- **Detector No.** = ***0*** shows the count rate of the master detector.
- **Detector No**. = ***1*** shows the count rate of slave 1.
- etc.

8 Cps Single Detector

Shows the count rate of the detector, which you had selected with **Active Detector No.**.

2.47 Access

Menu path: **Device Config ▶ Access**.

On this menu you can enter the password, enable write protection to prevent configuration changes and activate the safety mode.

1 Password

Enter a password to protect the detector against unauthorized access. Then access to editable parameters is disabled. To undo the protection again, you must enter the password again.

You can choose any password you want; it may comprise a maximum of 8 characters or digits.

Possibly activated test settings are reset when enabling password protection.

Tip
Write down your password to be able to unlock the detector later. Please contact BERTHOLD TECHNOLOGIES if you lose your password.

2 Write Protect

Indicates whether the detector is protected against changes in the settings (parameters).

- ***NO***

  The detector is not write protected, so that the settings can be edited.
- ***YES***

  The detector is write protected; settings cannot be edited, but they can still be displayed.

3 Safety Mode

Indicates whether the safety mode is enabled:

- ***ON***

  Safety mode is enabled.
- ***OFF***

  Safety mode is disabled.

4 Safety ON

The safety mode has to be enabled for safety-relevant applications.

IMPORTANT
*Activation of the Safety Mode does not automatically turn a detector into a device that can be used in a SIL safety circuit. Only a system marked SIL on the type plate can be used with the SIL data in the safety manual in a safety circuit. SIL-certified detectors are marked with an "S" in the LB number key LB 480-xx-xx-xx-xx-x**S**x-x.*

In safety mode, safety-limiting values are set to a safety-compatible setting. In addition, you will be prompted to protect the detector with a password.

The following settings must be set to enable the **Safety Modus**:

- Current Loop Monitoring = ***ENABLED***
- HV Mode = ***AUTO***
- Test Settings = ***NORMAL***
- Digital In Function = ***OFF***
- Multidrop: Poll Addr = ***0***

When enabling the **Safety Modus**, the parameter **Error Handling** is automatically set to ***SENSITIVE***.

During multi-detector operation, all connected slave detectors are also set to **Safety Mode** as soon as the Master is set to **Safety *ON***.

IMPORTANT
***HV default** must have the correct value (operating point).*

If you have changed the factory-set HV value, you have to determine it again. Determine the operating point and enter this value in **HV Default** (**Device Config ▶ Setup ▶ Sensor Configuration ▶ Sensor Settings ▶ HV Default**, *page 3-334*). See also *chapter 6.2*, *page 3-414*.

Tip
The operating point in new detectors is usually between 400 to 900 V. If you get a different value, please contact BERTHOLD TECHNOLOGIES or your local representative.

3

5 Safety OFF

Disables the safety mode. You need the password to disable the safety mode.

If you disable the safety mode, the following settings are made automatically:

– **Write Protect** is set to ***OFF***
– **Error Handling** is set to ***NORMAL*** *(see page 3-337).*

6 Lock Device Status

Indicates whether the detector is enabled or disabled for access to the HART® interface by other users.

7 Lock/Unlock Device

Locks or unlocks the detector to prevent access by other users to the HART® interface.

2.48 Identification

Menu path: **Device Config ▶ Identification**.

This menu shows various detector parameters, such as model, device ID, software and hardware revision.

1 Location

Opens the menu showing information about the tag (*page 3-386*).

2 Device Information

Opens the menu showing information about the detector (*page 3-387*).

3 Device Revision

Opens the menu showing the hardware and software revisions (*page 3-388*).

2.49 Location

Menu path: **Device Config ▶ Identification ▶ Location**.

This menu shows information about the tag.

1 Tag

Shows the tag number. You can edit information, any text is possible. Up to 8 characters.

2 Long tag

Shows the tag number. You can edit information, any text is possible. Up to 32 characters.

3 Descriptor

Shows a tag description. You can edit information, any text is possible.

4 Message

Shows a message. You can edit information, any text is possible.

2.50 Device Information

Menu path: **Device Config ▶ Identification ▶ Device Information**.

This menu shows information about the detectors.

1 Device Type

Shows the model name of the SENSseries. This information cannot be edited by the user.

2 Device Id

Identification number of the detector. It shows the specific HART® device number. This information is set up by BERTHOLD TECHNOLOGIES and edited be changed by the user.

3 Manufacturer

Shows the manufacturer's name. This information cannot be edited by the user.

4 Final Assembly Num

Number for identification of the detector.

2.51 Device Revision

Menu path: **Device Config ▶ Identification ▶ Device Revision**.

This menu shows the hardware and software revisions.

1 Universal Rev

Shows the revision of the specific universal HART® command set.

For the SENSseries you need the Universal Commands for HART® 6 or higher. This requires that the 375 Field Communicator of the Emerson Process Management GmbH & Co. OHG or a compatible model is used which supports enhancements.

If the Communicator has a lower version than HART® 6, then the so-called *Generic DD* will be started. The Generic DD does have a HART®-specific command set, but this does not sufficient for the SENSseries.

2 Field Dev Rev

Shows the compatibility of the detector with DD on the Communicator. This number, e.g. 2, indicates that DD Revision 2 is necessary which supports the full functional range of the detector. See also *chapter 7.7*, *page 3-432*.

3 Software Rev

Displays the software revision (embedded software). This information depends on the currently installed firmware and cannot be changed.

4 SW Revision

Software revision with presentation according to NAMUR.

5 SW Revision Date

Date of the software revision.

4 Hardware Rev

Shows the hardware revision. This information is set up by BERTHOLD TECHNOLOGIES and edited be changed by the user.

2.52 Diagnostic

This menu provides status and error information and allows you to view the error logs and setting changes logs (parameter changes).

Tip
In *chapter 8* on *page 3-437* you find a list of possible causes and troubleshooting procedures.

1 Operating Status

Opens the menu showing the operating status (*page 3-390*).

2 Log

Opens the menu showing the logs for error and setting changes (*page 3-395*).

3 Safety

The status of all settings listed here must be ***OFF*** when you have enabled **Safety ON** (**Device Config ▶ Access**, *page 3-384*).

4 Slave Status

Shows on which slave there is currently an error.
A list of 16 slave detectors with error status is displayed.

- ***OFF* =** error free
- ***ON* =** an error is indicated

Tip
If an error is present, you can select the respective slave under **Diagnostic ▶ Error Log** and you can read out the error status of the respective detector.

5 Error Status 100 … 907

Here you can check the status of all error messages that are possible in the detector.

- ***OFF*** = error free
- ***ON*** = an error is indicated

2.53 Operating Status

Menu path: **Diagnostic ▶ Operating Status**.

1 Device Status
Displays the current device status (standard HART® command).

2 Ext dev status
Shows the extended device status (standard HART® command, *page 3-390).*

3 Device Variables Status
Opens the menu showing the status of the detector variable (standard HART® command, *page 3-391).*

4 Config Change Status
Opens the menu showing the number of changes *(see page 3-392)*.

5 Lock Dev Status
Indicates to what extent the device is locked against access to the HART® interface by other devices.

- ***Device is Locked***
- ***Lock is Permanent***
- ***Locked by Primary Master***

6 Error Status
Opens the menu providing an overview of the operating status of the measurement *(see page 3-391).*

2.54 Ext dev status

Menu path: **Diagnostic ▶ Operating Status ▶ Ext dev status**.

Displays the current extended device status (standard HART® command).

- ***Maintenance required***

  The extended device status "Maintenance Required" is not used.
- ***Device variable alert***

  This status is signaled if any of the following conditions exist:
  - Primary Variable Out Of Limits
  - Non-Primary Variable Out Of Limits
  - Process Data Status[1] of a device variable is not in the status GOOD
  - Limit Status[1] of a device variable is not in the status NOT_LIMITED
- ***Critical Power Failure***

  Not used
  (Only applicable to rechargeable battery or battery-operated devices.)

1. Process Data Status and Limit Status are included in the Device Variable Status.

2.55 Device Variables Status

Menu path: **Diagnostic ▶ Operating Status ▶ Device Variables Status**.

1 Level Data Quality

Indicates the quality of the main variables (standard HART® command).

2 Level Limit Status

Indicates whether the limits of the main variables were reached (standard HART® command).

2.56 Config Change Status

Menu path: **Diagnostic ▶ Operating Status ▶ Config Change Status**.

1 Modification Counter

Shows the number of parameter changes that were made since the last **Factory Reset**.

2 Reset Modification Flag

Resets the modification flag under **Device Status**.

2.57 Lock Device Status

Menu path: **Diagnostic ▶ Operating Status ▶ Lock Device Status**.

Indicates to what extent the device is locked against access to the HART® interface by other devices.

- Device is Locked
- Lock is Permanent
- Locked by Primary Master

2.58 Error Status

Menu path: **Diagnostic ▶ Operating Status ▶ Error Status**.

1 Meas Setup Status

Displays the status of the calibration parameters. The status is updated after each decay compensation (at 09:01 h) and after each date change. It informs you that the measurement is still working safely. One of the following status messages is displayed:

– ***0-OK***

  The calibration carried out is OK.

– ***1-ERROR BACKGROUND***

  The count rate of the background radiation is higher than that for the calibration points for empty or full (**Cal Point 0%** or **Cal Point 100%**).

– ***2-ERROR NOT SORTED***

  The calibration points are not entered in sequence and need to be sorted.

– ***3-ERROR CURVE NOT MONOTONOUS***

  Not all count rates are decreasing with increasing level.

– ***4-ERROR MISSING CALIBRATION POINT***

  There is a calibration point with indication of the value in % but without count rate.

– ***5-COMPENSATION ERROR***

  A gas density compensation at exponential characteristic curve is not possible.

– ***6-DATE ERROR***

  A date is still set to the default value of 1.1.2000. At **Calibrate**, check the **Date** parameter. At **Restore**, check the date in **Restore Date**.

– ***7-CHECK ERROR***

  The status of the calibration parameters could not be fully verified. In this case, repeat the calibration. If the error occurs again, replace the detector, at least the detector electronics.

2 Operating Mode

Displays the operating status of the measurement. One of the following status messages is displayed:

- ***RUN***

  The measurement is in the normal measurement mode.

- ***WARNING***

  A warning is displayed and the following steps are carried out:

  - entry in the error log (the error is stored in the error memory)
  - the error will be reported digitally via HART®
  - the error is reported binary via the digital output (Digital Out) if this output has been set to ***WARNING + ERROR*** (see *chapter 2.30*, *page 3-365*)

  If the error is no longer displayed in **Active Error**, you can check the error log (**Device Config ▶ Diagnostic ▶ Log**, *page 3-395*). In *chapter 8* on *page 3-437* you find a list of possible causes and troubleshooting procedures.

- ***ERROR***

  An error is displayed and the following steps are carried out:

  - entry in the error log (the error is stored in the error memory)
  - the error will be reported digitally via HART®
  - the error is reported binary via the digital output (Digital Out) if this output has been set to ***WARNING + ERROR*** (see *chapter 2.30*, *page 3-365*)
  - the fault current goes to >21mA

  If the error is no longer displayed in **Active Error**, you can check the error log (**Device Config ▶ Diagnostic ▶ Log**, *page 3-395*). In *chapter 8* on *page 3-437* you find a list of possible causes and troubleshooting procedures.

– ***SHUTDOWN***

An serious error is displayed and the following steps are carried out:

- entry in the error log (the error is stored in the error memory)
- the error will be reported digitally via HART®
- the error is reported binary via the digital output (Digital Out) if this output has been set to ***WARNING + ERROR*** (see *chapter 2.30*, *page 3-365*)
- the fault current goes to >21mA
- the measurement is stopped.

The error remains active until it is eliminated and a reboot or software reset has been carried out. If the error does not disappear after restart (power off and then on, or software reset, *page 3-371*), then the detector must be replaced.

– ***HOLD***

The measurement is in the hold state, which means that the measured value and the current output signal are frozen. This status can occur under the following conditions:

- the plateau recording is running
- interference radiation is detected
- the digital input (option) is shorted

– ***TEST***

A test value has been enabled in the menu **Service ▶ Test** (*page 3-374*).

3 Error Code

Indicates if an error message is present.
If no error is present, then ***0*** is displayed here.

An error message is displayed with a three digit number. The cause of the error and suggestions for correcting the error are described in *chapter 8*, *Error Handling*.

5 Acknowledge Error

Acknowledges the currently pending error.

2.59 Log

This menu provides information about the history of the error messages and parameter changes. Up to 25 events can be entered.

1 Error Log

Opens the menu displaying the errors that have occurred.

2 Modification Log

Opens the menu showing the history of the settings made.

2.60 Error Log

Menu path: **Diagnostic** ▶ **Log** ▶ **Error Log**.

Update the error log by selecting **Refresh Error Log** before you select one of the following menu items. Otherwise, no or only old entries may be displayed.

Tip

In *chapter 8* on *page 3-437* you find a list of possible causes and troubleshooting procedures.

1 Active Detector No.

▶ Choose the detector for which you want to show the current entries or for which you want to display the pending error under "Error Code".

- **Detector No.** = ***0*** shows the error entries in the master detector.
- **Detector No.** = ***1*** shows the error entries in slave 1.
- etc.

2 Refresh Error Log

Updates entries in the error log table.

3 Error Log Table

The last 25 errors are displayed in a table. The table contains the error code and the time the error occurred. The prerequisite is that the date and time were set correctly.

4 Reset Error Log

Deletes all entries in the error log.

5 Error Code

Indicates if an error message is present.

If no error is present, then "0" is displayed here.

An error message is displayed with a three digit number. The cause of the error and suggestions for correcting the error are described in *chapter 8*, *"Error Handling"*.

5 Acknowledge Error

Acknowledges the currently pending error.

3

2.61 Modification Log

Menu path: **Diagnostic ▶ Log ▶ Modification Log**.

Update the modification log by selecting **Refresh Modification Log** before you select one of the following menu items. Otherwise, no or only old entries may be displayed.

1 Refresh Modification Log

Updates the modification log.

2 Modification Log Table

The last 25 modifications are displayed in a table. The table includes the old and the new parameter value and the time the change was made. The prerequisite is that the date and time were set correctly.

3 Reset Modification Log

Deletes all entries in the modification log.

3

Getting Started via the HART® Communicator

The measuring system SENSseries LB 480 is compatible with the 375 Field Communicator (HART® Communicator,
HART = Highway Addressable Remote Transducer) by Emerson Process Management GmbH & Co. OHG. Other HART® compatible communicators may also be used, provided they support Enhancements. The HART® Communicator Model 275 by Emerson Process Management GmbH & Co. OHG *cannot* be used.

⚠ WARNING

Make sure before commissioning that

- the detector is not damaged,
- the detector is properly installed,
- the connections have been carried out properly,
- the cables are properly inserted,
- unused cable entries are sealed with plugs certified according to Directive 2014/34/EU,
- the cover is tight,
- the dummy plugs and cable glands or conduits are tight.

The measuring system can be taken into operation either via the *HART® Communicator* or via a *PC and the SIMATIC PDM* software.

Basically, the procedure for getting started is nearly identical for both versions. The difference is only the interface through which the measuring system communicates.

This chapter describes how to take the measuring system into operation via the *HART® Communicator*. Previous knowledge of the functionality of the *HART®* Communicator used is assumed.

3.1 Steps for Getting Started

Step	Activity	Page
1	Check if the Device Description is installed on the HART® Communicator (see HART® Communicator User's Manual); if necessary, have it installed by the manufacturer.	–
2	Connect HART® Communicator.	*3–309*
3	Turn HART® Communicator on (see HART® Communicator User's Manual).	–
4	Calibrate measuring system.	*3–401*
5	Create setup protocol.	*3–449*

4

Quick Guide to Calibration

Prerequisites

- The detector is installed and is supplied from the mains.
- The factory setting of parameters have not been changed yet. Otherwise, perform a factory reset (see *chapter 5.1.1*).
- The user is familiar with the basic calibration of a radiometric measurement.
- The user is aware of the risks of incorrect calibration.
- Communication with the HART® Communicator is established.

The following calibration is based on a two-point calibration, which requires an empty and a full calibration.

Tip
Set the date and time when the error message 105 appears.

▶ Select the menu item **Quick Start**: **Device Config ▶ Setup ▶ QuickStart**.

QuickStart Menu

Step 1, Date	Step 2, Setup	Step 3, Calibration Points
Date Time	Time Constant Nuclide ReadIn Time	Read In Background Cal Point 0% Cal Point 100% Calibrate + Preset
page 3-325	*page 3-326*	*page 3-327*

Step 1 - Date/Time

▶ Check and update the date.

▶ Check and update the time.

Step 2 - Setup

▶ Select **Nuclide**: ***Cs-137*** or ***Co-60*** (see type plate of the source shielding).

Step 3 - Calibration Points

At the CrystalSENS you can skip the following item *Background,* unless the measurement is safety-relevant.

Background

The source shielding is not mounted at the measuring point, but at least it is adequately shielded (see *chapter 7.1*, *page 3-419*).

▶ Select **ReadIn *BACKGROUND*** and wait until the measurement time is over.

Empty calibration

Source is mounted and beam path open (see *chapter 7.2*, *page 3-421*). The tank is empty or the level below the limit value.

▶ Select **ReadIn Cal Point 0%** and wait until the measurement time is over.

Full Calibration

The beam path of the shielding is closed, or better, the tank is full.

▶ Select **ReadIn Cal Point 100%** and wait until the measurement time is over.

Calibration

▶ Select **Calibrate + Preset**.

The message ***0-OK*** must be displayed, otherwise correct the calibration error as per the error message and reselect **Calibrate + Preset**.

On the following pages you can find detailed calibration instructions.

Tip

Always carry out a test calculation after every calibration. This will ensure that your calibration data are plausible and the detector is set correctly (see *chapter 2.39*, *page 3-374*, **Cps Average Mode** and **Cps Average Test**).

5 Calibration

NOTICE

Errors in the calibration or in the parameter setting can lead to false results. This may possibly lead to loss of production, or to damage in the system.

For testing, we recommend using the test settings in the Service menu to simulate the calibration points.

A test run, ideally under operating conditions, will give you a high level of safety that your calibration is accurate. The entire measuring range has to be covered in this test run.

Basically we recommend to have commissioning carried out by the BERTHOLD TECHNOLOGIES service.

Prerequisites for calibration with the HART® Communicator

- The detector is installed correctly and is powered from the mains (see *Volume 2*, *chapter 2* and *chapter 3*).
- The HART® Communicator is connected to the current loop.

5.1 Preparing Calibration

For correct calibration of the measuring system, you have to ensure that the detector and basic settings are correct.

- Turn the HART® Communicator on.

  After power on, the Start menu appears.

Tip
Push ***HOME*** to return from any level back to the Start menu.

If the detector has been in stock for a long time, it may happen that the internal clock no longer displays the current date. In this case, the error message *105 Real time clock not valid* is displayed. Update the date and time to reset the error message (see *chapter 2.12*, *page 3-331*).

If you are sure that the detector and basic configuration are correct, you can start with the calibration of the measuring system immediately as described in *chapter 5.2*.

Otherwise proceed as follows:

- If the device is still locked with a password, undo the password protection (see *page 3-384*).
- Reset the detector to factory defaults (see *chapter 5.1.2*)
- Adjust the value for HV default (see *page 3-403*). This is usually not necessary, since the detector is factory-calibrated.

5.1.1 Reset SENSseries to Factory Settings

If the Start menu is not already displayed, push ***HOME*** to go to the Start menu.

- Select **Device Config ▶ Setup ▶ Service ▶ Reset Device**.
- Select ***FACTORY RESET*** and confirm the security prompt.

  After successful reset, the message *Device is reset!* appears.
- Now turn the HART HART® Communicator OFF and ON again.

The parameters in the detector are now again identical with the factory setting (delivery state).

5.1.2 Adjusting the HV Default

HV Default has already been determined and set by BERTHOLD TECHNOLOGIES. If this value deviates during the *first commissioning* by more than 5% from **HV Live**, then you have to adjust **HV Default** new.

The adjustment of **HV Default** is only successful if the current count rate in the
CrystalSENS is at least at 300 cps. With SuperSENS, UniSENS and TowerSENS the count rate is irrelevant.

If the Start menu is not already displayed, push ***HOME*** to go to the Start menu.

- Select **Device Config ▶ Setup ▶ Sensor Configuration ▶ Plateau ▶ Sensor Settings** .
- Select **HV Mode *AUTO***, if this is not already set.
- Save the changes with ***SEND***.
- Wait until the HV value (**HV Live**) has been adjusted.

  This takes about 2 minutes in the CrystalSENS and 30 minutes in the SuperSENS, UniSENS and TowerSENS.
- Read off the value **HV Live**.
- Enter the value read-off at **HV Default**.
- Save the changes with ***SEND***.

This completes the adjustment of the HV Default value.

5.1.3 Detector Code

Set the detector code according to the table in *Volume 2, chapter 1.6, "Detector Codes"*.

5.2 Calibration with Quick Start

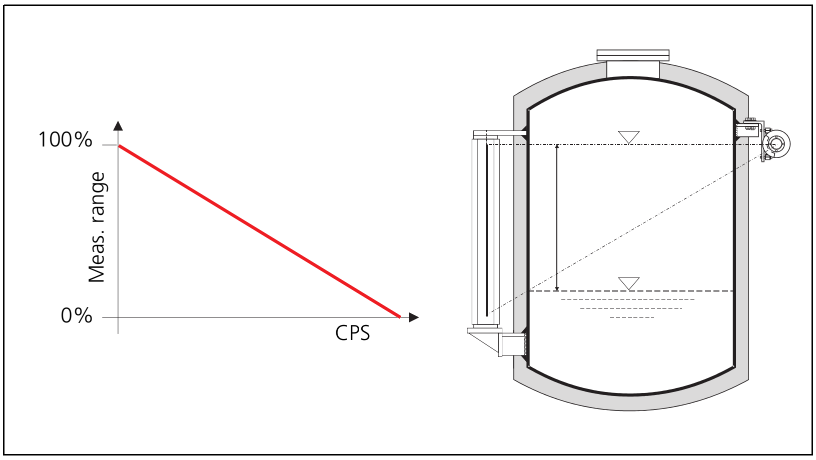


Fig. 5-1 Two-point calibration

This chapter describes the calibration in the **Quick Start** menu in detail. A quick reference guide can be found in *chapter 4*.

The **Quick Start** menu allows a two-point calibration with empty and full calibration. The two-point calibration is the most frequently used calibration method.

The following reasons could make it necessary that you carry out the calibration, on the main menu under **Cal Parameters** rather than in **Quick Start**, e.g.:

- because during operation the container is under high gas pressure, this gas pressure, however, is not available for the calibration
- because a multi-point calibration is required to linearize the calibration curve
- because no linear but an exponential characteristic curve is required
- because an automatic compensation measurement is required
- because the container cannot be fully filled and the closing of the source shielding is not applicable for the full adjustment.

We will advise you if you have any doubts as to the correct procedure.

If the Start menu is not already displayed, push ***HOME*** to go to the Start menu.

▶ Select **Device Config** ▶ **Setup** ▶ **Quick Start**.

QuickStart Menu

Step 1, Date	Step 2, Setup	Step 3, Calibration Points
Date Time	Time Constant Nuclide ReadIn Time	Read In Background Cal Point 0% Cal Point 100% Calibrate + Preset
page 3-325	*page 3-326*	*page 3-327*

This menu contains three steps (**Step 1** to **Step 3**) with the corresponding submenus. Go through the individual steps menu item for menu item.

5.2.1 Step 1

▶ Enter the current date (**Date**) and time (**Time**). The Date is specified in the format MM/DD/YYYY, the Time in the format hh:mm:ss.

The correct date is important for the automatic decay compensation of the isotope. Since the activity of the source diminishes with time, the calibration count rates will be compensated automatically through the date. The decay compensation takes place daily at 09:01 h. Time differences have no impact on the correction of the decline in activity. However, the correct time is helpful to check the detector function: In case of error, you can see in the error log when the error occurred.

5.2.2 Step 2

Time Constant

▶ Enter the desired time constant.

The time constant smoothes the output signal. Statistical fluctuations and level fluctuations due to the process, e.g. by agitators, are smoothed. A time constant of 20 s is usually reasonable.

Nuclide

▶ Enter here the isotope (nuclide) that is used in your source:

- ***Co-60***
- ***Cs-137***
- ***USER DEFINED***

This entry controls the automatic decay compensation. The correct entry is also important in a single-point calibration and for gas density compensation. The isotope used is listed on the type plate of the shielding and on your delivery documents. The item ***USER DEFINED*** allows you to use any isotope you want. In this case, additional parameters are requested: Specify the half-life under **Half Life Time** and the absorption coefficient at **Absorption**.

What happens when you have selected the wrong isotope?
As a result of the wrong decay compensation, you will get a deviating display only after several weeks or months, with the deviation increasing over time. If you perform a calibration with the gas density compensation GDA, or a 1-point calibration, the wrong isotope will also calculate wrong calibration data.

ReadIn Time

▶ Define here the period of time over which the count rate is to be read-in for each calibration point.

The statistical variation of the count rate is averaged over this time period. The longer it is, the better the mean value. A time period of 30 s (default setting) is usually reasonable.

5.2.3 Step 3

ReadIn

Start reading-in the count rates with **ReadIn**. While the count rate is read in, the average is calculated and displayed continuously. Under **ReadIn Time** (*"Quick Start, Step 2"*) you define the read-in period.

When reading-in the count rates, the time remaining (Remaining Time) up to the end of the operation is displayed. Finally, you are prompted to confirm the detected count rate with ***OK***. To shorten the read-in process, you can stop any time by pressing ***OK***.

Under **ReadIn** you can read-in the following calibration points:

- BACKGROUND
- Cal Point 0%
- Cal Point 100%

Read-in Background

First you have to measure the background, so that the detector can compensate for the decay of the radiation source correctly. Before taking measurements, make sure you do not measure any radiation from the radiation source

The easiest way to ensure this is if the source is not yet mounted. Otherwise, close the beam path and fill the container in addition.

For detailed information about the background, see *chapter 7.1* and *chapter 7.2*.

▶ Under **ReadIn**, select ***BACKGROUND***.

▶ Confirm with ***OK*** as soon as **Remaining Time** = 0s.

Read in Cal Point 0%

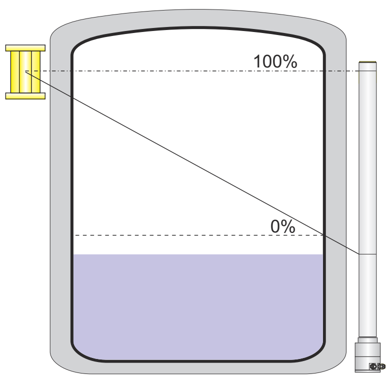
For the next measurement, the level in the tank must be below the measuring range or the tank must be completely empty. While you read-in, the level must not rise above 0% and the conditions within the tank must match the conditions during operation as far as possible.

If appropriate for your application and if it affects the beam path, this applies, for example, to:

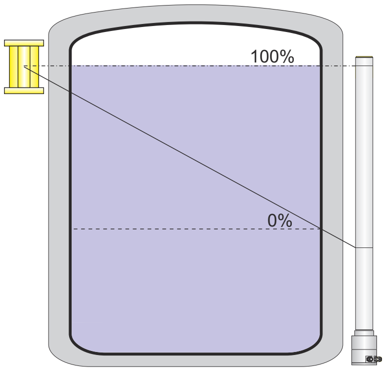
– Gas density
– Agitator
– Cooling/Heating jacket

▶ Under **ReadIn** select ***Cal Point 0%***.

▶ Confirm with ***OK*** as soon as **Remaining Time** = 0s.



Level below the monitoring limit



Full container

Read in Cal Point 100%

For the measurement, the level in the tank must be filled to at least 100% or the tank must be completely filled. While you read-in, the conditions within the tank must as far as possible match the conditions during operation. If appropriate for your application and if it affects the beam path, this applies, for example, to:

- Gas density
- Agitator
- Cooling/Heating jacket

▶ Select **ReadIn Cal Point 100%**.

▶ Confirm with ***OK*** as soon as **Remaining Time** = 0s.

Calibrate + Preset

With this menu item you enable the calibration data determined during the measurements. The calibration data are transferred to the parameter set **Meas Parameter**. Thus, the detector will get a new calibration which in the future will be used to determine the measured values.

After the calibration, a status message is displayed, indicating if the activation of the calibration data has been carried out successfully. If not, the measurement parameters are unchanged. Possible status messages are:

- ***0-OK***

  The calibration carried out is OK.

- ***1-ERROR BACKGROUND***

  The count rate of the background radiation is higher than that for the calibration points for empty or full (**Cal Point 0%** or **Cal Point 100%**).

- ***2-ERROR NOT SORTED***

  The calibration points are not entered in sequence and need to be sorted.

- ***3-ERROR CURVE NOT MONOTONOUS***

  Not all count rates are decreasing with increasing level.

- ***4-ERROR MISSING CALIBRATION POINT***

  There is a calibration point with indication of the value in % but without count rate.

- ***5-COMPENSATION ERROR***

  A gas density compensation at exponential characteristic curve is not possible.

- ***6-DATE ERROR***

  A date is still set to the default value of 1.1.2000. At **Calibrate**, check the **Date** parameter. At **Restore**, check the date in **Restore Date**.

- **7-CHECK ERROR**

  The status of the calibration parameters could not be fully verified. In this case, repeat the calibration. If the error occurs again, replace the detector, at least the detector electronics.

The following additional settings are made at **Calibrate + Preset**:

- **Compensation Mode** = ***OFF***
- **Calibration Method** = ***Multipoint***
- Lower calibration point set to 0%
- Upper calibration point set to 100%
- **Cal Curve Type** = ***Normal***

▶ At the end, fill out the commissioning log, see *chapter 9*, *page 3-449*.

Tip

Always carry out a test calculation after every calibration. This will ensure that your calibration data are plausible and the detector is set correctly (see *chapter 2.39*, *page 3-374*, **Cps Average Mode** and **Cps Average Test**).

This completes the calibration.

Advanced functions

In addition to calibration with **Quick Start**, you can also calibrate using the **Cal Parameter** menu. Further options are offer there, such as:

- Single-point or multi-point calibration
- Empty, full adjustment with a known characteristic curve
- Upload, download of calibration parameters
- Calibration of products with natural radioactivity
- Calibration with gas density compensation

You can enable additional signals and messages in the menu **Signal Condition**.

Via **I/O Setup** you can use existing or optional I/Os to output or process signals.

In order to avoid the risk that the device supplies faulty signals, it is imperative that you familiarize yourself with these additional features before you use them.

5.3 Ensuring the Function of the Measurement

Please proceed as follows to ensure that the measurement is working correctly after calibration or parameter change:

- Check the live display
- Compare the measured values with the control system
- Simulate measured values with test generator
- Perform test run with product
- Archive the calibration data

5.3.1 Simulating Measured Values with a Test Generator

The measuring system has an internal test generator to generate counts that can be used to check the calibration and thus the measured value display accurately.

For this purpose the counting rates of the calibration values may be used.

▶ Select **Device Config** ▶ **Setup** ▶ **Service** ▶ **Test** ▶ **Test Settings**.

▶ Set **Cps Average Mode** to ***FIXED VALUE***.

▶ Enter the calibration count rate for **Cps Average Test**.

▶ Read off the expected measured value at**Level** or **Density**.

In addition to the calibration count rates, you may also enter intermediate values, if necessary, to check the measured value display.

At the same time, you can also compare the measured value display in the control system for every single count rate with the measured value displayed in the LB 480 to ensure the correct transfer of the measurement signal.

After this simulation has been completed, you have to switch the parameter **Cps Average Mode** back to ***NORMAL***. If you forget this, the measurement remains frozen. As a reminder, the Communicator cyclically outputs error message 106 and the **Operating Status** of the measurement shows ***TEST*** (instead of RUN).

5.3.2 Checking the Live Display

Check the live display to make sure no error is displayed and the measurement is in the normal measurement mode. You can also see whether the measured values are plausible and are output correctly.

- Select **Live Display**.
  - The **Operating Mode** must show ***RUN***.
  - At **Level** or **Density**, the current target value must be displayed and must be alive *
  - At **Current OUT**, the current target value must be displayed and must be alive *

*) Alive = the display must fluctuate around a mean

5.3.3 Test Run with Product

This test will give you the highest level of security, as it is performed under real conditions. The test should be performed under operating conditions, if possible; i.e. any existing stirrer should run and a gas pressure existing during operation should also be present during the test. However, often this involves a lot of effort, so that the options on site and the need have to be clarified first. In many cases, water rather than product may be used for a test run and a possible gas pressure can often be simulated with nitrogen. The differing density between the product and the substitute product used for the test has to be taken into account.

Level

- Fill the container. Move the container under operating conditions from empty to full.
- Record the measurement signal and verify this.

Substitute procedures such as closing the source when the container is empty can be used only to a limited extent as a functional test.

If substitute procedures are chosen, the restrictive conditions must be carefully evaluated.

Limit switch

- Control the limit level under operating conditions.
- Record the response of the measurement and verify it.

Substitute procedures such as closing the source when the container is empty can be used only to a limited extent as a functional test.

If substitute procedures are chosen, the restrictive conditions must be carefully evaluated.

Density measurement

A density measurement is best tested using sample values. To this end, samples distributed over the measuring range should be taken and these should be compared with the display value.

If the measuring area also covers the density of 1g/cm^3, then water may also be used for the test. If it is not possible to control different densities within the measuring range, a one-point calibration can alternatively be performed. Since only one point within the measuring range is tested, it must be clarified whether this test is sufficient for the application.

If in doubt, please ask the BERTHOLD TECHNOLOGIES Service for support.

5.3.4 Archiving Calibration Data

We generally recommend to archive both the calibration and all other settings. This greatly simplifies and accelerates any necessary exchange of the measuring system. Also, incorrect operation may cause data loss and in this case archived data may be very helpful.

There are several ways to archive data.

- Fill out the parameter protocol in the Appendix to the operating instructions
- Digital storage of data

Several options are available for digital storage, depending on the communication interface and host used:

- LB 480-PC (Berthold specific program for the RS485 interface)
- HART® Communicator
- Siemens Simatic PDM
- AMS Emerson Process

See also *Volume 3, chapter 1.5*.

6

Functional Processes

The following chapter describes the major functional processes that occur when working with the SENSseries.

6.1 Multidetector Operation

Prerequisite:

- Master is wired to the slave(s) as shown in the Technical Data.
- Master and slave(s) are supplied with mains voltage.
- HART® Communication with master is established.

The commissioning of the complete master-slave arrangement (cascade) can now be performed on the master.

The slave detectors must be logged in at the master as follows.

▶ Select **Device Config** ▶ **Setup** ▶ **Sensor Configuration** ▶ **Config Slave Detectors** ▶ **Add Slave**.

▶ Enter the address for the first detector (1-16). For the first detector this is usually the "1".

▶ Select the slave function ***MULTI DETECTOR***.

▶ Enter the device ID for each detector. The device ID can be found on the type plate of each detector (3 to 5-digit number).

▶ If other slave detectors are connected, you have to repeat the process with the other slave detectors.

▶ If an error message occurs during log-in, check whether the connected detector is wired correctly and is powered by the mains.

▶ At last, check your entries for the multi-detector operation using the table, which you can access under **Slave Table**.

6.2 Plateau Measurement

These parameters determine how the plateau measurement is to be performed.

Below we will describe how to perform a plateau measurement. The plateau measurement checks the function of the detector.

IMPORTANT
The radiation conditions must be constant while recording the plateau!

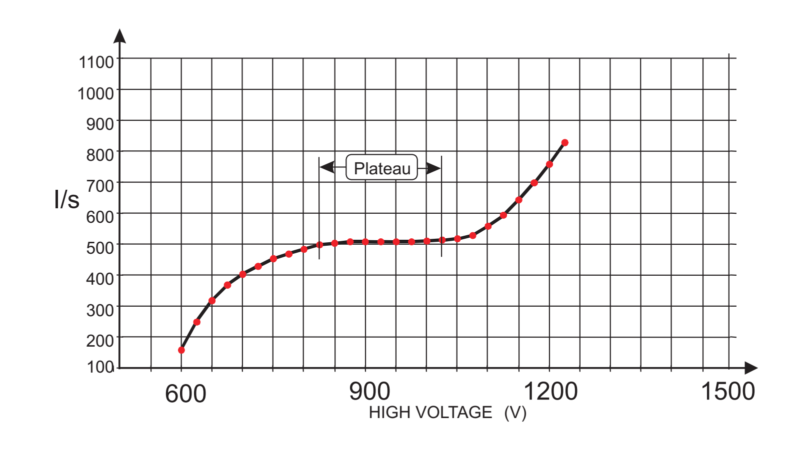


Bild 6-1 Result of a plateau measurement

The plateau is the flat section of the curve and it is typically approx. 200V long (see also Volume 2, *chapter 4.5*). Please note that the above characteristic curve and the following information is only valid for a NaI detector. With a polymer scintillator the plateau is steeper and may have to be qualified by a BERTHOLD service technician.

The crystal-multiplier assembly or the complete detector has to be replaced if:

- the plateau is shorter than 50V
- the count rate changes by more than 5% per 100 Volt high voltage

IMPORTANT
During the plateau measurement the level measurement is held at the last measured value.

If the Start menu is not already displayed, push ***HOME*** to go to the Start menu.

- Select **Device Config ▶ Setup ▶ Service ▶ Plateau ▶ Plateau Measurement**.
- At **Active Detector No.** enter the detector for which you want to record the plateau.
  - **Detector No.** = ***0*** selects the master detector.
  - **Detector No.** = ***1*** selects slave 1.
  - etc.
- At **HV Start** enter the high voltage (e.g. 500V, minimal 300V), where the plateau measurement should start and confirm the input with ***ENTER***.
- At **HV Stop** enter the high voltage (e.g. 1000V, maximum 1300V), where the plateau measurement should stop and confirm the input with ***ENTER***.
- At **HV Step** enter the step size between the measurement points (e.g. 50V) and confirm by pressing ***ENTER***.

  The step width determines the number of value pairs. The larger the step width, the lower the number of the value pairs!
- At **Meas. Time** enter the time how long a measurement point should be recorded or the count rate is to be averaged (e.g. 20 s) and confirm the entry with ***ENTER***.
- Transfer the entries with ***SEND***.
- Select ***PLATEAU*** at **HV Mode** to start the plateau measurement.

  The plateau measurement is started. For this purpose, the measuring mode is exited and the plateau of the multiplier which is used in the detector is measured.

During the plateau measurement the values of the following parameters are updated continuously:

- **HV Live**: HV value of the voltage at which the count rate is being measured.
- **Cps Single Detector:** Count rate of the selected detector.
- **Cps Live**: Total count rate of all detectors.

At the end of the plateau measurement the detector automatically switches back to **HV Mode**: ***AUTO*** or ***MANUAL***, depending on which mode was last set.

The plateau measurement is now complete and can be viewed and reviewed under **Plateau View** as a table or plateau curve.

3

6.3 Master Reset

Besides the options described in **Device Config ▶ Setup ▶ Service ▶ Reset Device** on *page 3-371* to reset the detector or certain functions, there is the *Master Reset*, which deletes *all* parameters. You have to open the housing to perform the Master Reset.

IMPORTANT

Perform a Master Reset only if a previous
SW Reset *or even a* ***Factory Reset*** *was not successful.*

Please keep in mind that after a ***Master Reset****:*
– the previously set parameters will be lost
– the license key must be entered again
– current output and HV default have to be adjusted
– the measurement needs to be calibrated

If in doubt, have this work carried out by the BERTHOLD TECHNOLOGIES service.

WARNING

Risk of explosion!

For detectors that are used in hazardous areas, the housing must only be replaced by the BERTHOLD TECHNOLOGIES service or by persons authorized by BERTHOLD TECHNOLOGIES. If this is not possible, you must replace the entire detector or return it to the manufacturer for repair.

For non-Ex devices, you can proceed as described below.

Preparing for Master Reset

You will need:

- M5 and M8 Allen wrenches to open the housing.
- Jumpers to bridge two pins.
- Your original license key from your code listing or from the Service menu.
- Multimeter to adjust the current output.
- Detector code for HV adjustment
- The current value for **HV Default** (*chapter 2.13*, *page 3-332*).
- Clean working environment, so that no debris or dirt can get into the electronics.

⚠ WARNING

Risk of fatal injury due to electric shock!

If the housing is open you may come into contact with live parts if the power supply is connected.

The Master Reset has to be carried out with open housing cover and the power supply turned on. Power supply is applied to the terminals 1 to 4.

Furthermore, high voltage is present in the area of the base of the board for the photomultiplier.

Perform Master Reset

1. Disconnect detector from mains.
2. Open housing.
3. Plug bridge on connector "F" (the connector is located on the CPU board next to the large capacitor).
4. Turn detector on and wait 10 seconds.
5. Turn detector off again.
6. Pull bridge off connector "F".
7. Turn detector on and wait 10 seconds.
8. Turn detector off again.
9. Connect HART® Communicator to the current output in the terminal compartment.
10. Turn detector on again and wait 10 seconds.
11. Acknowledge error message on HART® Communicator.
12. Enter License Key new, menu **Device Config ▶ Setup ▶ Service ▶ License Key**, see *chapter 2.35*, *page 3-371*.
13. Adjust current output with multimeter, menu **Device Config ▶ Setup ▶ I/O Setup ▶ Current Out ▶ D/A trim**, see *chapter 2.29*, *page 3-363*.

IMPORTANT

The adjustment is absolutely essential, even if the current output appears to be OK.

14. Enable monitoring of the 4-20 mA current signal (set to ***ENABLED***), menu **Device Config ▶ Setup ▶ I/O Setup ▶ Current Out ▶ Current Loop Monitoring**.
15. Set **Detector Code**, menu **Device Config ▶ Setup ▶ Sensor Configuration ▶ Sensor Settings ▶ Detector Code**, see *page 2-174*.
16. Set **HV Default**, see *chapter 5.1.2*.

This completes the reset, the detector is now ready for calibration.

7 Explanations

7.1 Background

The term "background" refers to the count rate resulting from the natural environmental radiation. The background level is largely dependent on the scintillator volume. The background is not accounted for by the decay compensation as it is regarded as a constant.

An error when recording the background may later lead to drift effects in the measurement. Influences from neighboring radiation sources must be avoided.

The background has to be recorded only for SuperSENS, UniSENS and TowerSENS. The background need not be recorded for the CrystalSENS.

Below we will present three options for measuring the background. The best approach for your background measurement is dependent on the situation on site and on the type of radiation source.

Best solution

With empty (*Fig. 7-1* left) or full (*Fig. 7-1* right) tank and mounted detector, but without the shielding or without the source installed in the shielding.

IMPORTANT
The detector must not receive any radiation from the radiation shielding which has been put on the side and is closed. To this end, the shielding with the source has to be put in an adequate distance (approx. 15 m), or behind a thick concrete wall.

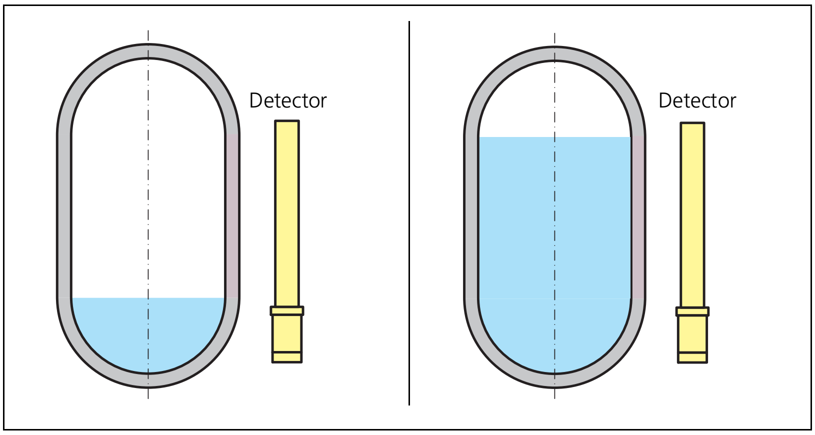


Fig. 7-1 Best solution

Second best solution

With a *full* container, mounted detector and attached shielding and with the radiation sources installed and *closed* source exit channel.

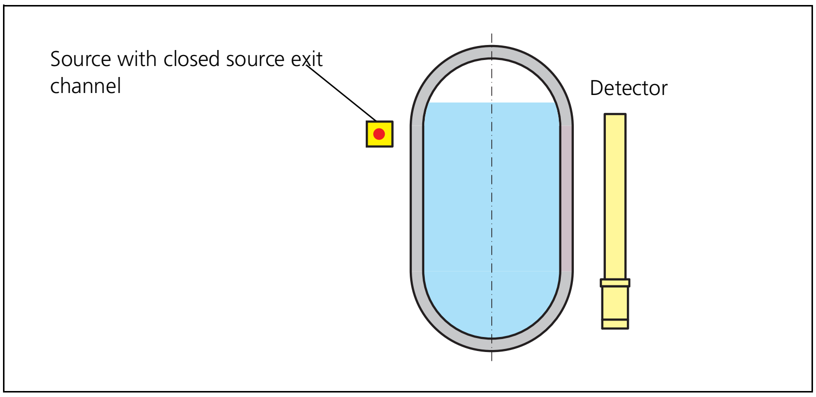


Fig. 7-2 Second best solution

Third best solution

This procedure is recommended only for Cs-137 sources.

With an *empty* tank, mounted detector and attached shielding and built-in radiation sources and *closed* source exit channel. In this way, the detector usually receives a small amount of residual radiation from the source

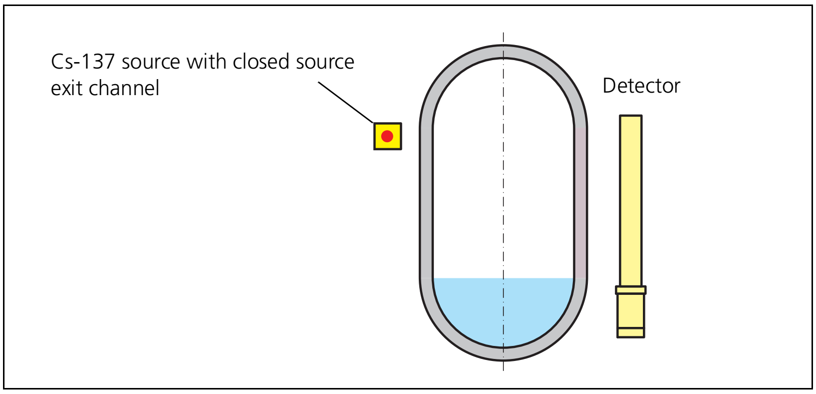


Fig. 7-3 Third best solution

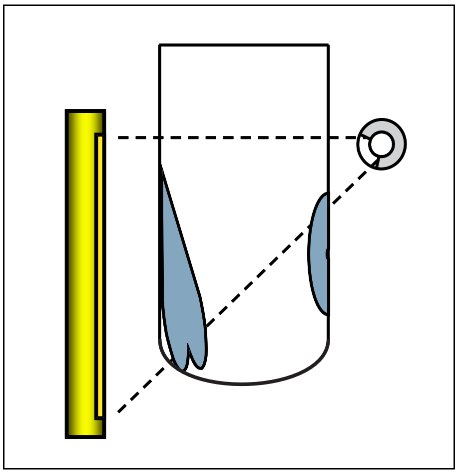
7.2 Conditions for Empty Calibration

IMPORTANT
Empty calibration, particularly for high-pressure containers, must be conducted under the same conditions as operation (pressure, temperature). If certain operating conditions cannot be achieved during the calibration, the calibration must be calculated, or corrected using the appropriate functions (e.g. GDA) in this software.

- For empty calibration, all shielded containers of the measuring system must be mounted.
- The source shutter must be open.
- The tank should be empty or be filled below 0% of the measuring range.
- If the container is partially filled, e.g. 20%, the lower calibration point can be adjusted provisionally.

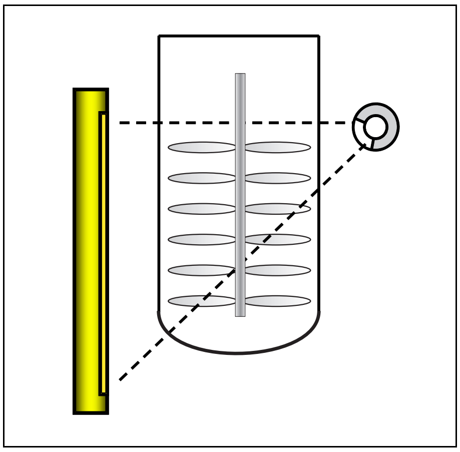
  Prerequisite is that you know the exact actual level. In this case, the value corresponding to this calibration point is to be entered as the level reading. With this method, however, non-linearities may cause an error at 0%. Proper empty adjustment should be conducted as soon as possible.

Wall deposits



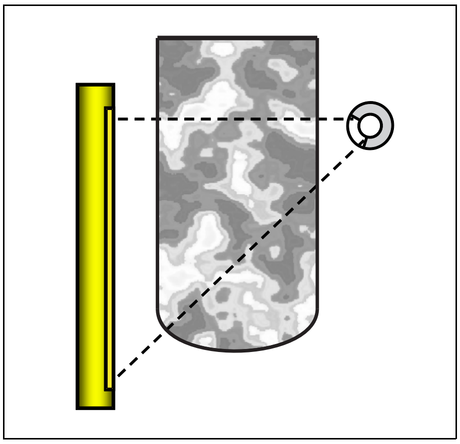
The container must be empty and clean without any residues. If deposits gather along the walls during operation, empty calibration should be conducted periodically.

IMPORTANT
For wall deposits a measurement system with a Co-60 source is less sensitive than one with a Cs-137 source.



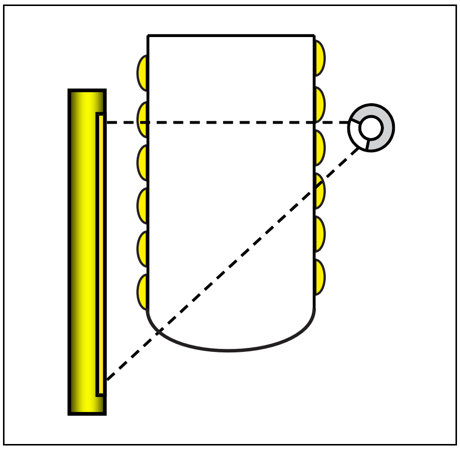
Agitator

- The agitator must be in operation if it has any impact on the measurement.



High gas pressure

- If the container is under high gas pressure during operation, the empty calibration also has to be carried out under this gas pressure. If this is not possible, then the empty calibration can be done without gas pressure and the count rate can be compensated using the **GDA** function and the corresponding entries for gas density and measuring path.



Cooling and heating jackets

- Cooling and heating jackets must be filled for calibration. In order to get the density of the cooling/heating fluid, it should be at the same temperature as during operation.

7.3 Linear and Exponential

This function is used only for 1-2 point calibrations.

Linear

The relation between level and count rate is linear.

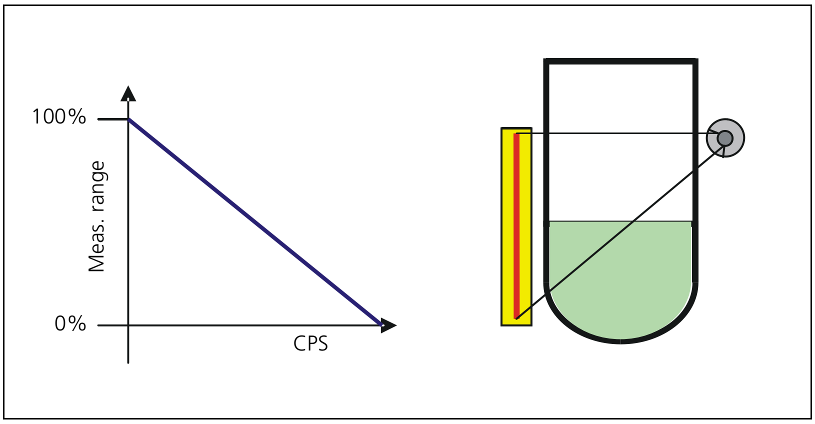


Fig. 7-4 Linear relation

Linear calibration is used in applications involving rod sources and point detectors

Exponential

The relation between level and count rate is an exponential function.

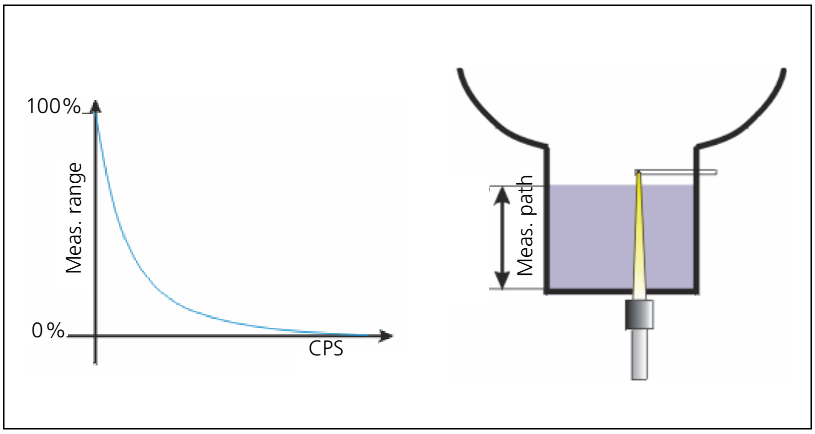


Fig. 7-5 Exponential

This calibration is used in applications involving point sources and point detectors

7.3.1 Exponential one-point calibration

If the container cannot be completely filled after operation has started, then a one-point calibration can be performed. To this end, enter a measuring path and product density. Then an empty adjustment is performed; to this end, enter the original level value as a percentage, and the corresponding count rate. For full calibration, only the final level value is to be entered. The count rate has already been calculated automatically from the absorption coefficient.

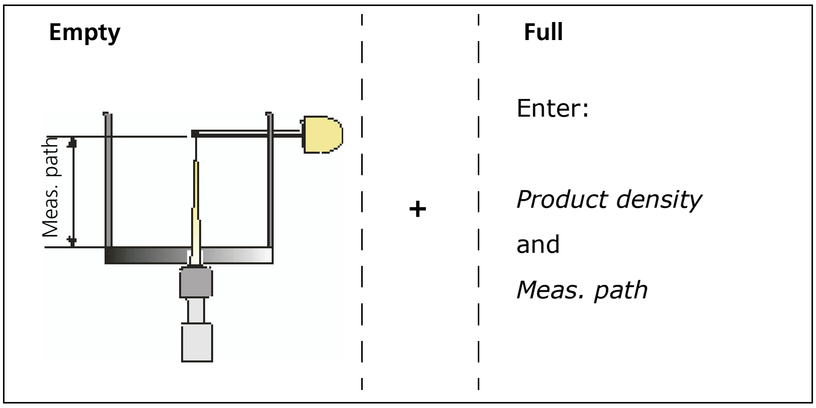


Fig. 7-6 One-point calibration

7.3.2 Exponential two-point calibration

In value pair 1, the empty container is calibrated while in value pair 2, the full container is calibrated.

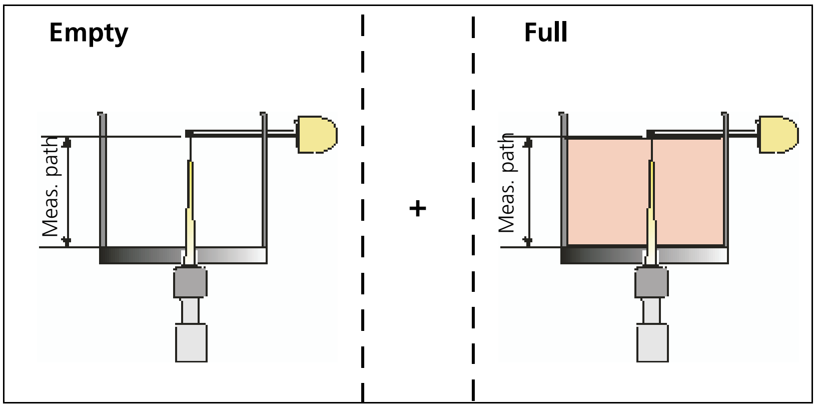


Fig. 7-7 Two-point calibration

7.4 Multi-point calibration

Polygon line

When should a polygon calibration be conducted?

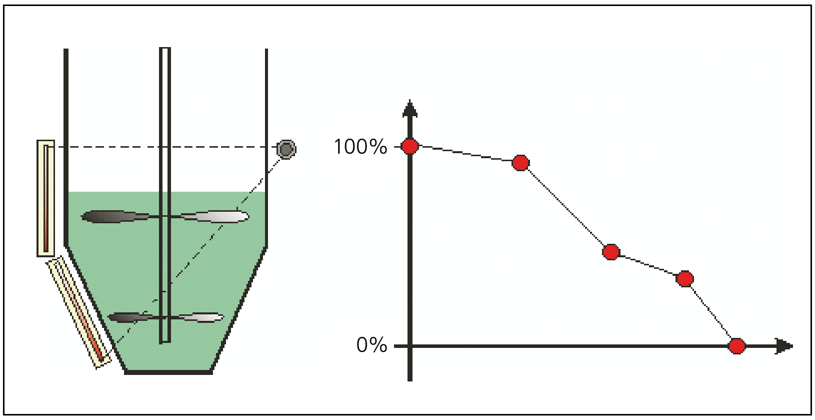


Fig. 7-8 Multi-point calibration

A polygon calibration makes sense:

- if high precision is called for
- on irregular container shapes such as conical or lying cylindrical vessel
- if accessories such, e.g. an agitator, are in the radiation path.

As a rule, the container is filled in steps of 5 to 10 different levels. With the values measured in this way, the SENSseries can be adjusted.

If it is not possible to fill the different levels with the product, you may also use one product which is equal in density. Often water is used as replacement for the product. Please contact our field service staff, or BERTHOLD TECHNOLOGIES directly to get more information on optimum calibration.

Tip

Try to record as many value pairs as possible, but use as few value pairs as possible for calibration. A few calibration points can be handled and controlled more easily than a lot of calibration points. This also reduces the risk of input errors.

If you have measured several calibration points it is quite helpful to draw the calibration curve. Using the curve it is easy to tell which calibration points are not necessary, i.e. those that fall between calibration points already in a flat line.

3

7.4.1 Explanation on the Calibration of Lower Calibration Point

This empty calibration will have influence on the whole curve. Due to this, all count rates will be adjusted. That will keep the shape of the curve, because all calibration points are extrapolated as percentage of the difference between the old- and the new "lower calibration point".

Adjustment can be conducted for two reasons:

- In the past you have done a multi-point calibration.
  Now you will update the calibration by adjusting the lower calibration point only, e.g. if the source has been replaced.
- A theoretical curve with several points is calculated. It is possible to enter these calibration points.
  Then update the calibration curve by adjusting the lower calibration point only.

The adjustment will be done as follows:

1. Table with value pairs before adjustment.

Level in %	Count rate in cps
0	7000
40	5000
70	3000
100	200

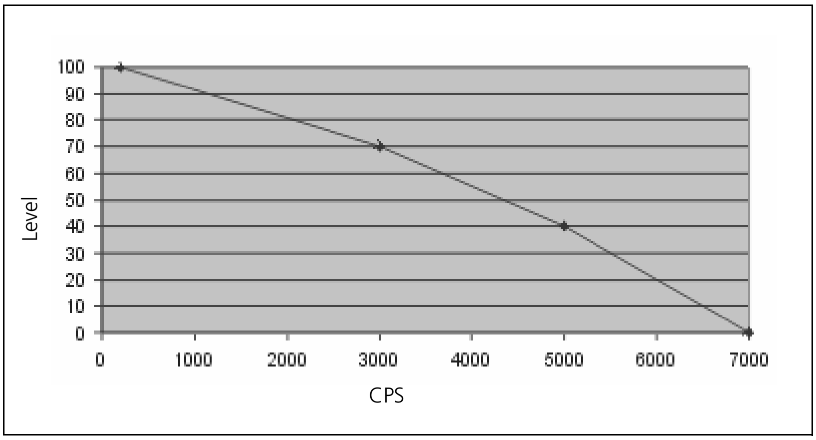


Fig. 7-9 Calibration curve

2. Adjust lower calibration point (0%) by 5000 cps.
   (background e.g. = 100 cps)

3. Table with value pairs after adjustment.

Level in %	Count rate in cps
0	5000
40	3580
70	2159
100	171

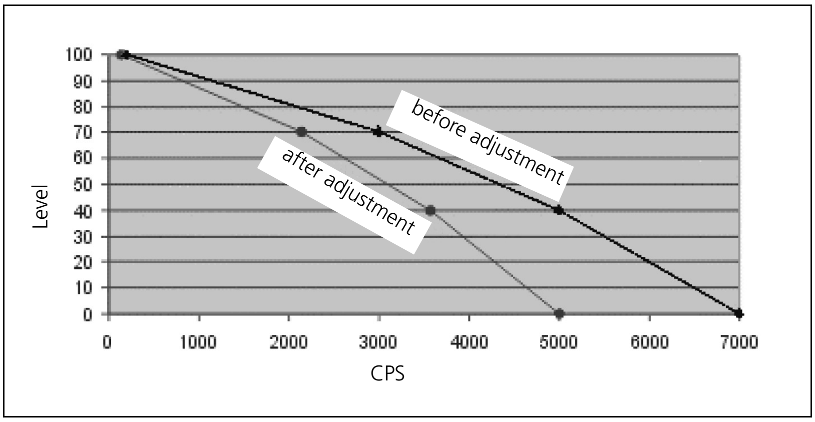


Fig. 7-10 Calibration curve

All count rates for each calibration point are adjusted automatically using the following formula.

cps$_{new}$ =
(**cps**$_{old}$ - **Bq**) * (**cps** 0%$_{new}$ - **Bg**) / (**cps** 0%$_{old}$ - **Bg**) + **Bg**

cps$_{new}$: new calculated count rate

cps 0%$_{new}$: new count rate at 0%

cps 0%$_{old}$: old count rate at 0%

cps$_{old}$: old count rate

Bg: Background

Example from the table at 70%

cps 0%$_{new}$: 5000cps
cps 0%$_{old}$: 7000cps
cps$_{old}$ (70%): 3000cps
Bg: 100cps

cps$_{new}$ = (3000-100) * (5000-100)/(7000-100) + 100 = 2159cps

7.5 Radiation Interference Detection

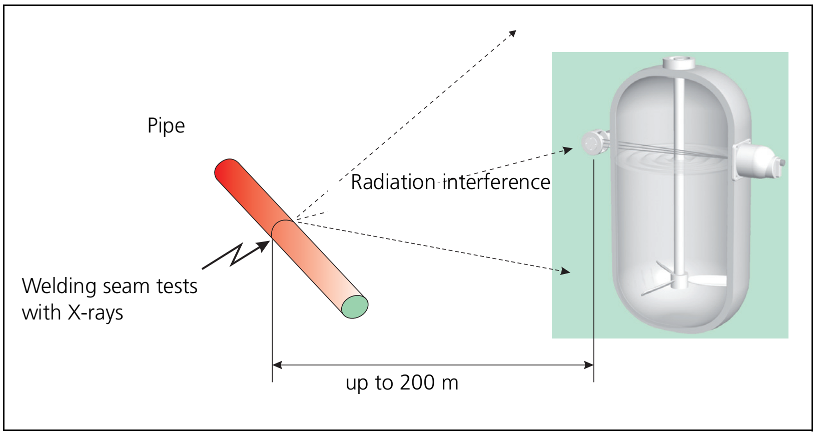


Fig. 7-11 Radiation interference

7.5.1 Detecting Interference Radiation

The high Gamma sensitivity of scintillation detectors may cause a false reading. To detect interfering radiation, a double plausibility check can be enabled.

The alarm is triggered by:

Scenario A:

Maximum possible count rate (empty calibration)

Is > Io * 1.5

Is = current count rate in cps integrated over one second
Io = maximum count rate at empty calibration

Scenario B:

Mean value of current count rate monitored.

The system sensitivity, i.e. the distance of the alarm thresholds is defined as the multiple of the mean statistical variations and can be entered as Sigma value as needed. The time constant is one second.

When reaching the alarm threshold, a message is signalized via HART®. This signal can also be output via the digital output and as a failure current.

Is > Im + n * Sigma

Im = current count rate integrated over one second

n = multiple value of Sigma

Further information on scenario A:

A relative limit value is monitored, i.e. the alarm threshold is reached when exceeding a maximum dose rate (calibration value at empty vessel) at the detector.

False alarms due to operative factors are not possible. However, only stronger interfering radiation is detected.

Further information on scenario B:

A differential limit value is monitored, i.e. each fast rise of the dose rate triggers an alarm.

Even minor outside radiation is detected, when it occurs erratically. Operative factors such as fast emptying of the vessel or opening the shielding container may trigger false alarms.

To rule out false alarms with sufficient statistical safety, you should enter n > 5. The mathematical correlation shows that the distance of the alarm threshold is dependent upon the respective mean count rate In.

For calculation it holds:

$$\text{Sigma} = \sqrt{\text{cps}}$$

Example

Count rate Im = 300 cps, n = 6

$$\text{Is} = \text{Im} + n \times \sqrt{\text{In}}$$

$$\text{Is} = 300 + 6 \times \sqrt{300} = 404 \text{ cps}$$

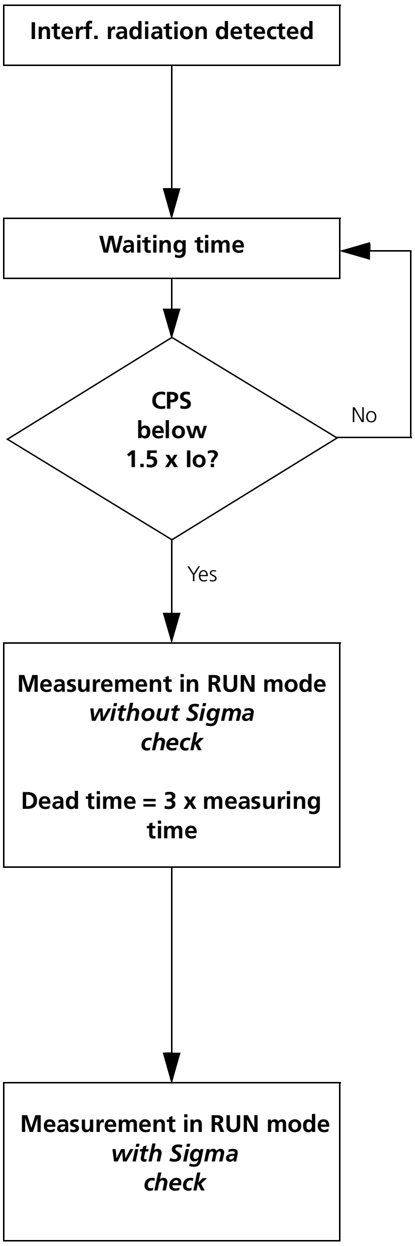
Thus, an alarm is signaled as soon as IS exceeds 404 cps.

IMPORTANT

Due to the dynamic behavior of the interfering radiation detection, a quick increase of the pulse rate due to operational factors (e.g. very fast emptying of the vessel or large short-term level changes caused by agitators) can be interpreted as interfering radiation. Due to a high Sigma value, false triggering by these operating conditions can be suppressed. However, the radiation interference detection also becomes less sensitive.

For example, opening the useful beam channel on the shielding can also cause a quick increase of the count rate. You have to reset the alarm that is then triggered, or better, do not enable the interfering radiation detection at first. However, it would be better not to enable the interfering radiation detection at first. Enable the interfering radiation detection only after calibration.

7.5.2 Interference Radiation Detection Flow Chart



If radiation interference is detected, following will happen:

If interference radiation is detected, the measurement switches to the HALT mode.

- Measured value and current output are "held".

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

At the end of the waiting time the system checks if the arriving count rate is smaller than 1.5-times the calibrated empty count rate (Io) (see scenario A). If not, the waiting time starts again.

If the count rate is below 1.5-times the empty count rate, the measurement automatically switches to the RUN mode. Sigma detection (see scenario B) is disabled for 3 x measuring time (= dead time).

Example:

If the measurement time is 20s, the dead time is 60s. This time is needed for the measurement to adjust to a possibly changed level, without triggering interference radiation detection. During this time, interference radiation is detected only when the count rate has increased to 1.5-times the empty count rate.

At the end of the waiting time the system checks if the arriving count rate is smaller than 1.5-times the calibrated empty count rate (Io).

7.6 Time Constant

The time constant smoothes the output signal. Statistical fluctuations, as well as level fluctuations due to the process, e.g. by agitators, are smoothed.

The measured data supplied by the detector is averaged with the time constant.

A so-called RC-averaging is carried out:

nM = aM + ((AZR - aM) * (1 - e(-t/τ)

nM = new mean value

aM = old mean value

AZR = current, non-averaged count rate (current display count rate)

t = time interval between the measurements in seconds

τ = time constant in seconds

Fig. 7-12 shows the reaction of the output signal in case of erratic filling of the container (input change) from 0 to 100%.

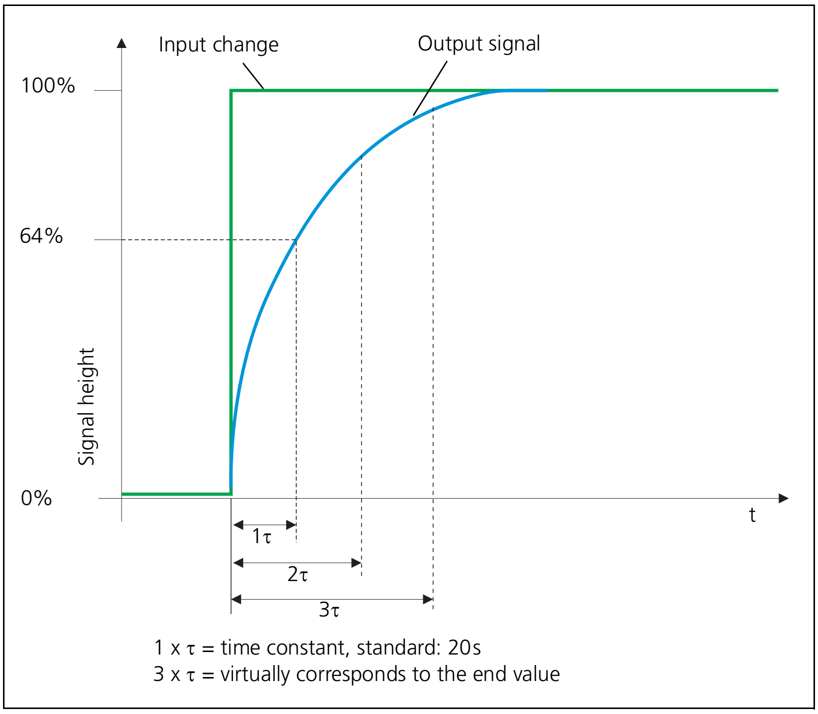


Fig. 7-12 Time constant

7.7 Software Versions

Two programs are needed to operate the SENSseries:

- *Embedded Software:* It is stored in the SENSseries (hardware).
- *Device Description (DD):* It is stored on the HART® Communicator.

To ensure that operation works smoothly, the DD version has to correspond to the embedded software on the SENSseries.

Proceed as follows to find the revision of the Device Description (DD) LB 480. The Device Description is the user interface the HART® Communicator requires to operate the respective device, e.g. the SENSseries LB 480. Each device requires its own DD.

7.7.1 Software Management

Show software versions

If the Start menu is not displayed, push ***HOME*** to go to the Start menu.

- ▶ Exit the Start menu by selecting the button "to the left".
- ▶ Select **UTILITY.**
- ▶ Select **SIMULATION.**
- ▶ Select **BERTHOLD TECHNOLOGIES.**
- ▶ Select LB 480.

Here you can read the revision of the Device Revision (Dev vX) and the Device Description (DD vX).

Type of modifications

HART® distinguishes two different types of software modifications:

- Modifications affecting functions and thus the DD and the embedded software.

  This type of modification will affect the compatibility to previous software versions.
- Modifications which only affect the DD or only the embedded software.

  These modifications do not affect the compatibility to the previous software version.

Example:

If a new function is added which allows you to enable or disable the digital input of the SENSseries then the embedded software has to be changed.

Likewise, a selection option has to be provided in the DD. Since this function was not yet implemented in previous versions, this will lead to incompatibilities with older software versions.

Two version numbers each

HART® has therefore introduced a system for identification which, at the same time, also describes the compatibility of the DD with the embedded software. Therefore, there are two HART®-specific version numbers for each software modification.

- A number that is incremented for *each* modification:
  - Software rev for the embedded software
  - DD v for the Device Description
- A number that is incremented only *if compatibility with the previous software is no longer given:*
  - Fld dev rev for the embedded software
  - Dev v for the Device Description

The table below shows the software versions of the SENSseries LB 480 for the version with HART® Communicator:

Embedded software version in the SENSseries			Device Description	
	Software versions (indicated on the HART® Communicator			
	under ... ▸ **review**		under ... ▸ **simulation**	
Software version	Software rev	Fld dev rev	Dev v	DDv
1.00.00	1	1	1	1
1.00.01	2	1	1	1
1.00.02	3	1	1	1
1.00.03	4	1	1	1
1.00.04	5	1	1	1

Explanations

Software release in the SENSseries (embedded software)

The software release of the embedded software in the SENSseries is described by the following three identifications:

- *Software version:* Berthold internal version number, e.g. 1.02.01
  - It is needed when the embedded software of the SENS-series is to be updated.
- *Software rev:* ongoing revision number, e.g. 12
  - It is incremented with each embedded software modification.
  - Display of the *Software rev* see *page 3-432*.
- *Fld dev rev:* Field Device Revision, e.g. 3
  - This number will be incremented only when new commands have been implemented which create an incompatibility to previous DD versions.
  - It is stored in the embedded software of the SENSseries.
  - It shows which DD is required to utilize the full range of functions.
  - It is checked for compatibility by the DD (Dev v).
  - Display of the *Fld dev rev*, see *page 3-432*.

Software release of the DD (Device Description)

The software release of the DD on the HART® Communicator is identified by two version numbers:

- *Dev v:* Device Version, e.g. 3

  Revision number of the DD on the Communicator.
  - It is incremented only for modifications where new commands have been implemented that create an incompatibility with previous versions.
  - It is checked for compatibility with the *Field Device Revision* (see above).
  - Display of the *Dev v* see *page 3-432*.
- *DD v:* DD Version, e.g. 3

  Consecutive number of the DD on the Communicator.
  - It is incremented for any DD modification.
  - If may be higher than the *Dev v*.
  - Display of the *DD v*, see *page 3-432*.

Compatibility

You can load several different revisions onto the HART® Communicator. The Communicator compares the *Field Device Revision* of the SENSseries with the *Device Version* of the DD. The compatible DD version is started automatically.

What to do if ...

If no suitable DD is available on the HART® Communicator, then one of the following two things may happen:

Scenario 1:

The DD on the Communicator is older than the version of the embedded software in the SENSseries.

Example:
DD on the Communicator: **Dev v1**
Field Device Revision: **Fld dev rev: 2**

The following warning is displayed on the Communicator:

This means the DD has to be updated to utilize the full functionality of the detector.

Then follows the question: ***Continue with old description? Yes/No***

▶ Select ***Yes***.

You can continue working normally with the detectors. Only new functions that do not yet support the DD are not available.

Scenario 2:

The DD on the HART® Communicator is more up-to-date than the version of the embedded software in the SENSseries:

Example:
DD on the Communicator: **Dev v2**
Field Device Revision: **Fld dev rev: 1**

Then the *Generic DD* starts. HART® does not allow that in this case an existing DD by the manufacturer will be loaded, as otherwise the program on the Communicator may crash. In the Generic DD you cannot calibrate and many parameters for the SENSseries are missing.

Universal Revision

All Berthold-DD's require the Universal Commands for HART® 6 or higher.

This requires that the HART® Communicator by Emerson Process, Model 375/475 is used.

Other HART® compatible communicators with HART® 6 may also be used, provided they support Enhancements.

If the Communicator has a lower version than HART® 6, then the *Generic DD* will be started.

To determine the version of the Universal Commands, call on the HART® Communicator the menu **Device Config ▸ Setup ▸ Identifications ▸ Device Revision ▸ Universal Rev.**.

3

8 Error Handling

Errors are indicated by the digital output and/or via fault current. Error messages are displayed on the HART® Communicator. All error messages are stored in the error log together with date and time. To view the error log, select **Device Config ▶ Diagnostic ▶ Log ▶ Error Log**.

8.1 Error Handling Modes

The behavior in case of errors is dependent on the weighting set in Error Handling (**Device Config ▶ Setup ▶ Signal Condition ▶ Signal Parameter**, *chapter 2.16*, *page 3-337*): ***NORMAL*** or ***SENSITIVE***.

Both operation modes behave as follows:

- ***SENSITIVE***

  All faults cause the current output to report a *Fault current*. To also get warning messages, you must also evaluate the messages via the HART® signal or the digital output.

  The setting ***SENSITIVE*** is automatically enabled when the Safety Mode is selected.

- ***NORMAL***

  Only fatal errors are reported as a fault current. Thus, the measured value via the current signal will fail only if the measurement can no longer be used.

  To also get minor error and warning messages, you must also evaluate the messages via the HART® signal or the digital output.

IMPORTANT
*You may select the **NORMAL** setting only if hazards to persons or damage to property a as a result of a faulty measured value can be ruled out.*

Select ***SENSITIVE*** if system safety is an important issue. Use ***NORMAL*** if a failure of the measurement is non-critical for human health and the environment and production safety is an important issue.

To use the digital output for the above mentioned messages, you need to use the setting ***WARNING + ERROR*** on the menu **Digital Out Function** (**Device Config ▶ Setup ▶ I/O Setup ▶ Digital Output ▶ Digital Out Function**, see *chapter 2.30*, *page 3-365*).

8.2 Device Response to Errors

The following tables provide a description of the error codes, error and warning messages, information about the reason for the error and how to remedy the error. To keep the list clearer, we have created two separate lists for ***SENSITIVE*** and ***NORMAL***.

The list is so detailed as to cover and diagnose all possible error sources in such a radiometric measuring system. Thus, it is possible to offer the user a high level of safety and diagnostic options.

Meaning of the individual columns:

Identification	Meaning
x	An error message is issued.
–	*No* error message is output.
Error Log	The error that occurred is written to the error log.
HART®	An error telegram is digitally output via the HART® to the process control system. The control system must evaluate the HART® signal.
Digital Out	The digital output of the detector is actuated. In the standard version, this is an open collector.
Fault current	The current output switches to fault current. The 4-20 mA measurement signal is no longer available. The measurement signal is then available only via the digital HART® protocol.
SHUTDOWN	The current output switches to fault current, the HV (high voltage on the photomultiplier) goes to 0V. The measurement stops and can only be restarted by a restart of the detector or a software reset after the problem is solved.
Self-repairing	If the error disappears, then the fault condition is removed automatically. If the error is not self-repairing, then you need to reset the error state by rebooting or software reset.
Quality of measurement value for Master and Slave (only HART®)[1]	
g	Measured value is good
u	Measured value is doubtful
f	Measured value is frozen
b	Measured value is bad

1. The digital HART® protocol conveys the measured value as well as its quality.

8.2.1 Error Signaling

Code	Error message	Error Handling N=Normal S=Sensitive	Error Log	HART®	Digital Out	Fault current	SHUTDOWN	Slave Status	Master Status	Self-repairing
101	HW module missing or not tested	N	x	x	x	x	x	b	b	–
		S	x	x	x	x	b	b	–	x
102	Device data-set error	N	x	x	x	x	x	b	b	–
		S	x	x	x	x	x	b	b	–
103	RAM Error	N	x	x	x	x	x	b	b	–
		S	x	x	x	x	x	b	b	–
104	Device Error	N	x	x	x	x	x	b	b	–
		S	x	x	x	x	x	b	b	–
105	Real time clock not valid	N	x	x	x			u	u	–
		S	x	x	x	x		b	b	–
106	Test mode active	N						g	u	–
		S						g	u	–
107	Watchdog reset	N	x					g	g	x
		S	x	x	x	x	x	b	b	–
108	Safety parameter invalid	N						g	g	–
		S	x	x	x	x		b	b	x
200	Data flow	N	x	x	x	x	x	b	b	–
		S	x	x	x	x	x	b	b	–
201	Error by analog input calibration	N	x	x	x			u	u	–
		S	x	x	x	x		u	u	x
202	Clock signal deviation	N	x	x	x	x	x	b	b	–
		S	x	x	x	x	x	b	b	–
300	Data flow	N	x	x	x	x	x	b	b	–
		S	x	x	x	x	x	b	b	–
301	Error by ADC calibration	N	x	x	x			u	u	–
		S	x	x	x	x		u	u	–
302	Error by DAC calibration	N	x	x	x			u	u	–
		S	x	x	x	x		u	u	–
303	Supply 5.0V	N	x	x	x	x		b	b	x
		S	x	x	x	x		b	b	x
304	Reference 2.0V	N	x	x	x	x		b	b	x
		S	x	x	x	x		b	b	x
305	Reference 2.5V	N	x	x	x	x		b	b	x
		S	x	x	x	x		b	b	x
306	ERROR GND CPU ST9	N	x	x	x	x		b	b	x
		S	x	x	x	x		b	b	x
307	No impulses in measuring channel	N	x	x	x	x		b	b	x
		S	x	x	x	x		b	b	x
308	No impulses in control channel	N	x	x	x			u	u	x
		S	x	x	x	x		b	b	x
309	No impulses in auxiliary channel	N	x	x	x			u	u	x
		S	x	x	x	x		b	b	x

Code	Error message	Error Handling N=Normal S=Sensitive	Error Log	HART®	Digital Out	Fault current	SHUTDOWN	Slave Status	Master Status	Self-repairing
310	Impulse difference measuring channel	N	x	x	x	x		b	b	x
		S	x	x	x	x		b	b	x
311	Impulse difference control channel	N	x	x	x	x		b	b	x
		S	x	x	x	x		b	b	x
312	Impulse difference auxiliary channel	N	x	x	x	x		b	b	x
		S	x	x	x	x		b	b	x
313	Instable pulse rate	N						g	g	x
		S						g	g	x
314	Threshold of measurement channel 1	N	x	x	x			u	u	x
		S	x	x	x	x		b	b	x
315	Threshold of measurement channel 2	N	x	x	x			u	u	x
		S	x	x	x	x		b	b	x
316	Threshold of control channel 1	N	x	x	x			u	u	x
		S	x	x	x	x		b	b	x
317	Threshold of control channel 2	N	x	x	x			u	u	x
		S	x	x	x	x		b	b	x
318	Threshold of auxiliary channel 1	N	x	x	x			u	u	x
		S	x	x	x	x		b	b	x
319	Threshold of auxiliary channel 2	N	x	x	x			u	u	x
		S	x	x	x	x		b	b	x
320	HV voltage	N	x	x	x			u	u	x
		S	x	x	x	x	x	b	b	–
321	Generated HV voltage	N	x	x	x	x		b	b	x
		S	x	x	x	x	x	b	b	–
322	HV reached its limit value	N	x	x	x	x		b	b	x
		S	x	x	x	x		b	b	x
323	HV average is 20% lower than default HV	N	x	x	x	x		b	b	x
		S	x	x	x	x		b	b	x
324	HV average is 40% higher than default HV	N	x	x	x			g	g	x
		S	x	x	x	x		u	u	x
325	Lower PMT current limit is exceeded	N	x					u	u	x
		S	x					u	u	x
326	Upper PMT current limit is exceeded	N	x	x	x	x	x	b	b	–
		S	x	x	x	x	x	b	b	–
327	Temperature sensor deviation	N	x	x	x			u	u	x
		S	x	x	x	x		b	b	x

Code	Error message	Error Handling N=Normal S=Sensitive	Error Log	HART®	Digital Out	Fault current	SHUTDOWN	Slave Status	Master Status	Self-repairing
328	Temperature warning	N	x	x	x			g	g	x
		S	x	x	x	x		b	b	x
329	Temperature out of allowed limits	N	x	x	x	x		b	b	x
		S	x	x	x	x	x	b	b	–
330	Detector mal-function	N	x	x	x	x		b	b	x
		S	x	x	x	x		b	b	x
400	Data flow	N	x	x	x	x	x	b	b	–
		S	x	x	x	x	x	b	b	–
401	Supply 11V	N	x	x	x	x		b	b	x
		S	x	x	x	x		b	b	x
402	Supply 5V	N	x	x	x	x		b	b	x
		S	x	x	x	x		b	b	x
403	Supply 5VM	N	x	x	x	x		b	b	x
		S	x	x	x	x		b	b	x
404	Supply 3.3V	N	x	x	x	x	x	b	b	–
		S	x	x	x	x	x	b	b	–
405	RS-485 Commu-nication error	N	x	x	x	x		b	b	x
		S	x	x	x	x		b	b	x
406	Remote device warning	N	x	x	x			u	u	x
		S	x	x	x			u	u	x
407	Remote device error	N	x	x	x	x		b	b	x
		S	x	x	x	x		b	b	x
500	Data flow	N	x	x	x	x	x	b	b	–
		S	x	x	x	x	x	b	b	–
502	Digital input mal-function	N	x	x	x			g	u	x
		S	x	x	x	x		g	b	x
503	Digital output malfunction	N	x	x	x	x		g	g	x
		S	x	x	x	x		g	g	x
504	Inherited Mes-sage	N	x					g	g	x
		S	x					g	g	x
600	Data flow	N	x	x	x	x	x	b	b	–
		S	x	x	x	x	x	b	b	–
601	License Key Error	N	x	x	x	x	x	b	b	–
		S	x	x	x	x	x	b	b	–
603	Measuring Error check <Error Status>	N	x	x	x			g	u	–
		S	x	x	x	x		g	b	–
604	Decay Compen-sation Error	N	x	x	x			g	u	–
		S	x	x	x	x		g	b	–
605	Source Exchange	N	x	x	x			g	g	x
		S	x	x	x			g	u	x
606	Radiation Inter-ference	N	x	x	x			g	f	x
		S	x	x	x	x		g	f	x
607	RID Interference	N	x	x	x			g	g	x
		S	x	x	x			g	g	x
608	Inherited Mes-sage	N	x					g	g	x
		S	x					g	g	x
609	Rate Factor exceeds its limit	N	x	x	x			g	u	x
		S	x	x	x			g	u	x
610	Inherited Mes-sage	N	x					g	g	x
		S	x					g	g	x
611	Inherited Mes-sage	N	x					g	g	x
		S	x					g	g	x
612	Inherited Mes-sage	N	x					g	g	x
		S	x					g	g	x
613	Inherited Mes-sage	N	x					g	g	x
		S	x					g	g	x
700	Data flow	N	x	x	x	x	x	b	b	x
		S	x	x	x	x	x	b	b	–
701	Impulse differ-ence	N	x	x	x	x		g	g	x
		S	x	x	x	x		g	g	x
702	Current loop mal-function	N	x	x	x	x		g	g	–
		S	x	x	x	x		g	g	–
703	CLoop Monitor-ing Disabled	N	x					g	g	x
		S	x					g	g	x
704	ERROR GND CPU ST6	N	x	x	x			g	g	x
		S	x	x	x	x		g	g	x
900	Data Flow	N	x	x	x	x	x	b	b	–
		S	x	x	x	x	x	b	b	–
901	Signal Unlocked	N	x	x	x			g	u	x
		S	x	x	x	x		g	b	x

8.2.2 Error Handling

Code	Error message	Error reason	Error Handling
101	HW module missing or not tested	Hardware error	The error can be eliminated only by replacing the detector or the detector electronics.
103	RAM Error		
104	Device Error		
108	Safety parameter invalid		
200	Data flow		
201	Error by analog input calibration		
202	Clock signal deviation		
300	Data flow		
301	Error by ADC calibration		
302	Error by DAC calibration		
303	Supply 5.0V		
304	Reference 2.0V		
305	Reference 2.5V		
306	ERROR GND CPU ST9		
307	No impulses in measuring channel		
308	No impulses in control channel		
309	No impulses in auxiliary channel		
310	Impulse difference measuring channel		
311	Impulse difference control channel		
312	Impulse difference auxiliary channel		
313	Instable pulse rate		
314	Threshold of measurement channel 1		
315	Threshold of measurement channel 2		
316	Threshold of control channel 1		
317	Threshold of control channel 2		
318	Threshold of auxiliary channel 1		
319	Threshold of auxiliary channel 2		
330	Detector malfunction		
400	Data flow		
401	Supply 11V		
402	Supply 5V		
403	Supply 5VM		
404	Supply 3.3V		
500	Data flow		
502	Digital input malfunction		
503	Digital output malfunction		
600	Data flow		
700	Data flow		
701	Impulse difference		
704	ERROR GND CPU ST6		
900	Data Flow		

3

Code	Error message	Error reason	Error Handling
102	Device data-set error	Parameter set invalid	If the error appears on restart after a new software has been loaded, then you have to do a **Factory Reset**. If the fault is still present then, an additional **Software Reset** is required. If the fault appears during operation, then you can fix the error only by replacing the detector or the detector electronics.
105	Real time clock not valid	Date invalid	If the device was turned off, check or update the date and time. If the unit was in operation when the error occurred, then there is a defect in the hardware. The error can be eliminated only by replacing the detector electronics.
106	Test mode active	A safety parameter could not be set.	Check or reset all test settings in the Service menu.
107	Watchdog reset	A line failure has triggered an error in the program flow and the device has been restarted automatically.	If the error occurs again, the detector electronics has to be replaced. If the exchange is unsuccessful, search for electromagnetic interference.
108	Safety Parameter invalid	Safety parameter invalid	Check in the Diagnostics menu which of the safety parameters could not be set and why.
320	HV voltage	A faulty measurement was detected in the high voltage.	The error can be eliminated only by replacing the detector electronics or the photomultiplier.
321	Generated HV voltage		
322	HV reached its limit value		
323	HV average is 20% lower than default HV		
324	HV average is 40% higher than default HV		
325	Lower PMT current limit is exceeded	The PMT current is >50µA.	Either there is strong radiation interference, or the photomultiplier (PMT) is defective and therefore has to be to exchanged.
326	Upper PMT current limit is exceeded	The PMT current is >100µA.	
327	Temperature sensor deviation	The redundantly measured electronics temperatures differ more than 10° C from each other.	The error can be eliminated only by replacing the detector electronics.
328	Temperature warning	The temperature in the detector has exceeded 75° C, or fell below -35° C.	Assemble water cooling, respectively assemble a trace heating system.
329	Temperature out of allowed limits	The temperature in the detector has exceeded 80° C, or fell below -40° C.	We recommend to return the detector for repair to the manufacturer, even if the detector appears to be functioning still.
405	RS-485 Communication error	Master-slave communication disturbed.	Check the wiring between master and slave, the detector address and the supply voltage.
406	Remote device warning	A slave returns a warning message.	Go to the Diagnostics menu and check in the local slave table which warning message is indicated for which slave.

Code	Error message	Error reason	Error Handling
407	Remote device error	A slave returns an error message.	Go to the Diagnostics menu and check in the local slave table which error message is indicated for which slave.
504	Inherited Message	A new software application has been installed and a previously stored fault is not existent in the new application.	Clear the fault memory with **Reset Error Log**.
601	License Key Error	The license key is invalid or does not match the application.	Check and correct license key. If necessary, consult BERTHOLD TECHNOLOGIES.
603	Measuring Error check <Error Status>	During decay compensation, an error was detected in the measurement parameters.	For more information on the cause of the error please go to the Diagnostics menu under **Error Status**.
604	Decay Compensation Error	The decay compensation could not be performed.	The error can be eliminated only by replacing the detector electronics.
605	Source Exchange	Based on the criteria entered, it was found that the source is too weak.	Replace source at the next opportunity. Please contact the manufacturer.
606	Radiation Interference	Based on the criteria entered radiation interference was detected.	Check whether welding seam tests were performed, or whether the criteria are set incorrectly or not optimally.
607	RID Interference	Message in this software is not active.	
608	Inherited Message	A new software application has been installed and a previously stored fault is not existent in the new application.	Clear the fault memory with **Reset Error Log**.
609	Rate Factor exceeds its limit	The automatic gas density compensation is enabled. During the measurement, the density compensation factor has exceeded the permissible range.	Check the calibration and the settings of the gas density compensation.
610	Inherited Message	A new software application has been installed and a previously stored fault is not existent in the new application.	Clear the fault memory with **Reset Error Log**.
611	Inherited Message	A new software application has been installed and a previously stored fault is not existent in the new application.	Clear the fault memory with **Reset Error Log**.
612	Inherited Message	A new software application has been installed and a previously stored fault is not existent in the new application.	Clear the fault memory with **Reset Error Log**.

3

Code	Error message	Error reason	Error Handling
613	Inherited Message	A new software application has been installed and a previously stored fault is not existent in the new application.	Clear the fault memory with **Reset Error Log**.
702	CLoop Malfunction	– Loose connection in the current loop. – Impedance in the current loop >500Ω – Fault in the power output of the LB 480	If a loose connection or a too high impedance can be ruled out, the probe must be returned to the factory for repair.
703	CLoop Monitoring Disabled	The monitoring of the current output is turned off. Message always appears when restarting.	Enable the monitoring on the I/O Setup menu, unless there are reasons to keep the monitoring switched off.
901	Signal Unlocked	The detector has been unlocked with the password.	The warning message was generated as a result of the setting in **Signal Unlocked**, see *chapter 2.16*, *page 3-337*.

8.3 Trouble Shooting

Problem	Cause	Solution
No signal	System is not working	Check power supply
Count rate too low	Shielding not open or not open correctly.	Check lock and secure it in position OPEN
	Alignment of the effective radiation towards the detector is incorrect	Correct and optimize alignment
	Container installations in the beam path	Offset irradiation plane
	Wall deposits in the container	Remove wall deposits or perform new calibration if wall deposits cannot be removed.
	Source has reached the end of its service life	Replace source
No or incorrect level reading	Entry of final level end values incorrect	Check calibration values and level reading
Level reading fluctuates strongly	Time constant too small	Increase time constant in the Parameter menu (min. 20s)
	Wrong calibration	Check calibration values
	Rapid switchover with too small Sigma value	Increase Sigma value or disable automatic time switch
	Count rate too low (see above)	Check age of source and irradiation level; replace detector
Level reading shows drifts	Detector stabilization faulty	Replace detector
	Multiplier faulty	Exchange multiplier
Current output at 24mA	Current output faulty or defective.	Recalibrate current output. Then restart detector by **Software Reset** or by turning the power supply off/on. If the current output cannot be calibrated, the detector needs to be repaired.

3

8.4 Reset

The SENSseries detectors can be reset in various ways. Use the menu **Device Config ▶ Setup ▶ Service** to perform a software reset or reset all settings to factory default.

1. Software reset: ***SW RESET***

   Starts the new detector, the parameters remain unchanged. The function corresponds to the switching off and on of the supply voltage.

2. Factory reset: ***FACTORY RESET***

   Resets most settings to factory default. Some settings, such as the adjustment of current output and the license key will be preserved. Turn the HART® Communicator off and on again after you have initiated the reset.

Switching the supply voltage off/on also causes a reset similar to the software reset, but in this case possible "hardware blocks" will also be fixed. The parameters remain unchanged.

See also *chapter 6.3*, *"Master Reset", page 3-416*.

8.5 Operation Modes during Measurement

Select **Operating Mode** (menu **Live Display**, *page 3-322*) to view the current operating status.

8.6 Error Reset

If an error or a warning is identified, an error message is displayed. This error message must be reset. If the error still occurs after resetting, it will be indicated again on the display.

If the error is corrected, but the error message is still displayed, the error can be acknowledged as follows:

- with **Acknowledge Error** under **Diagnostic ▶ Operating Status**
- with **Software Reset** under **Device Config ▶ Setup ▶ Service ▶ Reset Device**
- by switching the supply voltage off and on.

8.7 Fault Current

There are four different ways of how the current output should respond to errors:

- *High:* Hold at >21mA.
- *Low:* Hold at <3.6mA.
- *Hold:* Hold last measured value.
- *Value:* Hold at a selected value between 2 and 22mA. The corresponding value must be defined in **Error Current Value** (see *page 3-363*).

Example for *High*

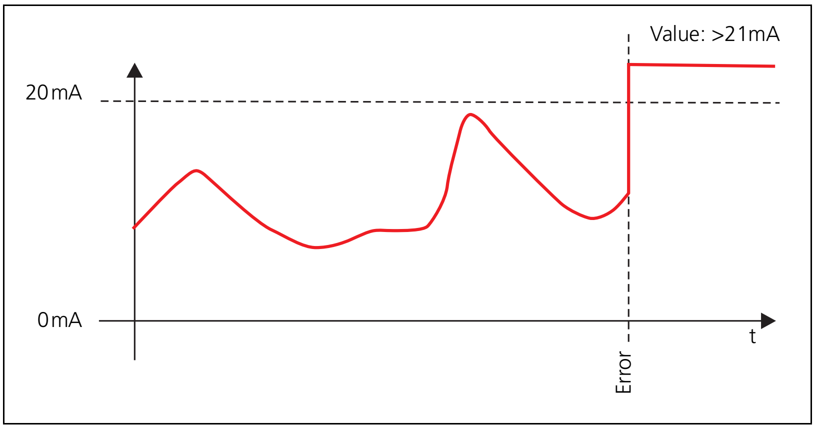


Fig. 8-1 Example for High

Example for *Hold*

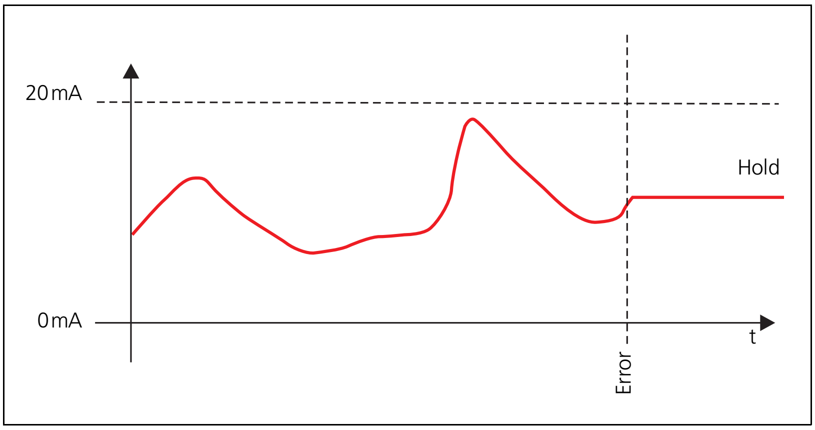


Fig. 8-2 Example for Hold

9 Setup Protocol

For reasons of clarity, only those parameters are listed in the following list which have a decisive influence on the measured signal.

As an alternative to completing the list below, you can also transfer and print the data digitally, via the HART® signal. See also *chapter 1.5, "Archiving Parameter Sets", page 3-310*.

▶ After commissioning, enter the parameters in the following parameter list in order to document the start-up.

TAG No.		**Date**	
Isotope		**Activity**	
Source no.		**Detector**	
Product		**HV**	

Path	Parameters	Unit	Standard	SETUP
Device Config ▶ Meas Parameter ▶ Meas Data				
	Background	cps	50	
Device Config ▶ Meas Parameter ▶ Meas Data ▶ Meas Table				
Point	**Level**	**Rate**	**Rate at Op**	**Comp Rate**
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				

Path	Parameters	Unit	Standard	SETUP
Meas Parameter ▶ Meas Settings				
	Time Const	s	20	
	Nuclide	Cs-137 / Co-60	Cs-137	
	Cal Method	1-POINT LIN MULTIPOINT 1-POINT EXP 2-POINT EXP	MULTIPOINT	
	Cal Curve Type	STANDARD / REVERSED	STANDARD	
	Threshold	%	60%	
	Hysteresis	%	5%	
	Compensation Mode	OFF AUTO PRC MANUAL GDA AUTO GPC	OFF	
Device Config ▶ Setup ▶ Sensor Configuration ▶ Date - Time				
	Date	MM/DD/YYYY		
	Time	hh:mm:ss		
Device Config ▶ Setup ▶ Sensor Configuration ▶ Sensor Settings				
	Detector Code	0 … 50	0	
	HV Mode	AUTO / MANUAL		
	HV Live	V		
	HV Average	V		
	HV Manual	V		
	HV Default	V		
Device Config ▶ Setup ▶ Signal Condition ▶ Signal Parameter				
	Time Const	s	20	
	Error Handling	NORMAL / SENSITIVE	NORMAL	
	Signal Unlocked	OFF / ON	OFF	
Device Config ▶ Setup ▶ Signal Condition ▶ Reading Range				
	Lower Range Value	%	0	
	Upper Range Value	%	100	

Path	Parameters	Unit	Standard	SETUP
Device Config ▶ Setup ▶ Signal Condition ▶ Signal Dependency				
	Response Mode	DISABLED RAPID SWITCH RAD INTERFERENCE	DISABLED	
	Io Factor		1.5	
	Waiting Time	s	60	
	RI Sigma		10	
	Meas Delay Time	s	4	
Device Config ▶ Setup ▶ I/O Setup ▶ Current Output				
	Current Loop Monitoring	DISABLED ENABLED	ENABLED	
	Loop Alarm Type	HIGH LOW HOLD LAST VALUE VALUE	HIGH	
	Error Current Value	mA	22.00	
	Current Lower Limit	mA	3.80	
	Current Upper Limit	mA	20.50	

Path	Parameters	Unit	Standard	SETUP

Notes:

Subject to change in the course of further technical development.

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