Anexa Nr. 1		
Lot 1. Contaminometru pentru laboratorul de medicina nucleara, LB 147, Berthold, Austria		
130320		
Monitor stationar pentru determinarea contaminarii a articolelor de îmbrăcăminte, mâinilor, picioarelor, cu detectoare scintilatoare de suprafața		
Parametru	**Specificaţia solicitata**	**Specificaţia ofertata**
Tipul detectorului	gamma , beta si alfa	gamma , beta si alfa, **DA**
Intervalul de energie măsurabil	alpha > 2 MeV, beta > 100 keV, gamma and x-rays, 5 keV…2.3 MeV	alpha > 2 MeV, beta > 100 keV, gamma and x-rays, 5 keV…2.3 MeV, **DA**
Radionuclizi măsurați:	Tc-99m, I-125, I-123, Ga-67, Re-186, Co-57, Co-60, Cs-137, Cr-51, I-131, Sr-90 si altele	Tc-99m, I-125, I-123, Ga-67, Re-186, Co-57, Co-60, Cs-137, Cr-51, I-131, Sr-90 si altele **DA**
Numarul de canale	2 cite10000 cps	2 cite10000 cps **DA**
Detector maini	Scintilator , cu suprafata minim de 160 cm2 pentru fiecare maina, sensibil	**DA** Scintilator , cu suprafata minim **345** cm2 pentru fiecare maina, sensibil
Detector picioare	Scintilator , cu suprafata minim de 1000 cm2	**DA** Scintilator , cu suprafata 1110 cm2 **DA** **(555 cm2 pentru fiecare picior)**
Detector haine	Detectorul mâini poate fi folosit ca detector haine	Detectorul mâini poate fi folosit ca detector haine **DA**
Interfata utilizator	LCD	LCD **DA** 7" Touch Panel
Siguranta software	Protejat prin parola	Protejat prin parola **DA**
Conexiune retea	Ethernet 1 Gbps	Ethernet 1 Gbps **DA**
Temperatura de functionare	0-40 ˚C	0-40 ˚C **DA**
Umiditatea relativă	Max. 90% fără condens	Max. 90% fără condens **DA**
Alimentarea electrică	220 (–15% / +10%)V, 50±1 Hz	220 (–15% / +10%)V, 50±1 Hz **DA**
Timpul de măsurare	Reglabil de la 1 până la 99 de secunde	Reglabil de la 1 până la 99 de secunde **DA**
Consum de energie	Nu mai mult de 20 VA	**DA 14.5 VA**
Numărări de fond	Media cu timpul măsurarii ajustat (60-600 secunde)	Media cu timpul măsurarii ajustat (60-600 secunde) **DA**
Alarma minimă	Alarma minimă se produce atunci când niciunul dintre detectoare nu primește un impuls într-o perioadă de 10 secunde	Alarma minimă se produce atunci când niciunul dintre detectoare nu primește un impuls într-o perioadă de 10 secunde **DA**
Prag de alarmare	Reglabil pentru fiecare detector între: 1 - 9999 cps, 0,1 - 999 Bq / cm2 (setare implicită 4 Bq / cm2)	Reglabil pentru fiecare detector între: 1 - 9999 cps, 0,1 - 999 Bq / cm2 (setare implicită 4 Bq / cm2) **DA**
Greutate	Nu mai mare de 45 kg	**DA 35 kg**
Material carcasa	efectuat din metal	efectuat din metal **DA**
Tip montare	Pe podea	Pe podea **DA**
Instruire bioingineri	Da	**DA**
Instruire utilizatori	Da	**DA**
Garantie	minim 24 luni	minim 24 luni **DA**
Manual de service	Da, in limba romana/engleza	Da, in limba romana/engleza **DA**
Manual de utilizare	Da, in limba romana/engleza	Da, in limba romana/engleza **DA**
Certificate	CE, ISO	CE, ISO **DA**
Metrologie	Verificare in laborator national acreditat	Verificare in laborator national acreditat **DA**

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EU-Declaration of Conformity (ORIGINAL)

File.No.: CE30100-2

We, hereby declare under our sole responsibility that the design of the following products / systems / units / machines together with the associated detectors 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.

Product name: ***personal contamination monitor***

Type / model: ***LB 147 / LB 148***

	directive	**applied standards**	
RoHS	2011/65/EG		
EMC	2014/30/EU	EN 61326-1	2013
LVD	2014/35/EU	EN 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. Jürgen Briggmann

Head of R&D
Bad Wildbad, 23rd of March, 2017

C E R T I F I C A T E

Management system as per
DIN EN ISO 9001 : 2015

In accordance with TÜV NORD CERT procedures, it is hereby certified that

Berthold Technologies GmbH
Goldschlagstraße 182
1140 Wien
Austria

applies a management system in line with the above standard for the following scope

Sales & Service for Measuring Instrument for Process Control, Bioanalytic and Radiation Protection

Certificate Registration No. 44 100 121573
Audit Report No. ZER1629a

Valid from 2019-06-21
Valid until 2022-06-20

Certification Body
at TÜV NORD CERT GmbH

TÜV Nord Austria GmbH
Diefenbachgasse 35
1150 Vienna, Austria

Vienna, 2019-06-17

This certification was conducted in accordance with the TÜV NORD CERT auditing and certification procedures and is subject to regular surveillance audits.

DAkkS Deutsche Akkreditierungsstelle D-ZM-12007-01-01

THE INTERNATIONAL CERTIFICATION NETWORK

CERTIFICATE

DQS has issued an IQNet recognized certificate that the organization

BERTHOLD TECHNOLOGIES GmbH & Co. KG

Calmbacher Straße 22
75323 Bad Wildbad
Germany

with the organizational units/sites as listed in the annex

has implemented and maintains a **Quality Management System**.

for the following scope:
Development and manufacturing Measuring Instruments for Process Control, Bioanalytic and Radiation Protection

which fulfills the requirements of the following standard:

ISO 9001 : 2015

Issued on:	2020-11-30
Expires on:	2023-11-29

This attestation is directly linked to the IQNet Partner's original certificate and shall not be used as a stand-alone document.

Registration number: DE-000051 QM15

Alex Stoichitoiu
President of IQNet

IQNet Partners*:

AENOR *Spain* AFNOR Certification *France* APCER *Portugal* CCC *Cyprus* CISQ *Italy*
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* The list of IQNet partners is valid at the time of issue of this certificate. Updated information is available under www.iqnet-certification.com

Annex to IQNet Certificate Number: 000051 QM15

BERTHOLD TECHNOLOGIES GmbH & Co. KG

Calmbacher Straße 22
75323 Bad Wildbad
Germany

Location	Scope
544341 **BERTHOLD TECHNOLOGIES GmbH (Schweiz)** **Chollerstrasse 37** **6300 Zug** **Switzerland**	sales and service
533688 **BERTHOLD TECHNOLOGIES (U.K.) Ltd.** **6 Allied Business Centre** **Coldharbour Lane** **Harpenden** **AL5 4UT** **United Kingdom**	sales and service

THE INTERNATIONAL CERTIFICATION NETWORK

CERTIFICATE

DQS has issued an IQNet recognized certificate that the organization

BERTHOLD TECHNOLOGIES GmbH & Co. KG

Calmbacher Straße 22
75323 Bad Wildbad
Germany

has implemented and maintains an **Environmental Management System**.

for the following scope:
Development and manufacturing Measuring Instruments for Process Control, Bioanalytic and Radiation Protection

which fulfills the requirements of the following standard:

ISO 14001 : 2015

Issued on:	2020-11-30
Expires on:	2023-11-29

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Registration number: DE-000051 UM15

Alex Stoichitoiu
President of IQNet

IQNet Partners*:

AENOR *Spain* AFNOR Certification *France* APCER *Portugal* CCC *Cyprus* CISQ *Italy*
CQC *China* CQM *China* CQS *Czech Republic* Cro Cert *Croatia* DQS Holding GmbH *Germany* EAGLE Certification Group *USA*
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* The list of IQNet partners is valid at the time of issue of this certificate. Updated information is available under www.iqnet-certification.com

THE INTERNATIONAL CERTIFICATION NETWORK

CERTIFICATE

DQS has issued an IQNet recognized certificate that the organization

BERTHOLD TECHNOLOGIES GmbH & Co. KG

Calmbacher Straße 22
75323 Bad Wildbad
Germany

has implemented and maintains an
Occupational Health and Safety Management System.

for the following scope:
Development and manufacturing Measuring Instruments for Process Control, Bioanalytic and Radiation Protection

which fulfills the requirements of the following standard:

ISO 45001 : 2018

Issued on:	2020-11-30
Expires on:	2023-11-29

This attestation is directly linked to the IQNet Partner's original certificate and shall not be used as a stand-alone document.

Registration number: DE-000051 OHS18

Alex Stoichitoiu
President of IQNet

IQNet Partners*:

AENOR *Spain* AFNOR Certification *France* APCER *Portugal* CCC *Cyprus* CISQ *Italy*
CQC *China* CQM *China* CQS *Czech Republic* Cro Cert *Croatia* DQS Holding GmbH *Germany* EAGLE Certification Group *USA*
FCAV *Brazil* FONDONORMA *Venezuela* ICONTEC *Colombia* Inspecta Sertifiointi Oy *Finland* INTECO *Costa Rica*
IRAM *Argentina* JQA *Japan* KFQ *Korea* MIRTEC *Greece* MSZT *Hungary* Nemko AS *Norway* NSAI *Ireland*
NYCE-SIGE *México* PCBC *Poland* Quality Austria *Austria* RR *Russia* SII *Israel* SIQ *Slovenia*
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BERTHOLD

LB 147 / LB 148

Personal Contamination Monitors

detect and identify

LB 147 / LB 148

Personal Contamination Monitors

Functions and accessories

Numerous service functions permit easily measurements for necessary periodical tests. This includes automatic calibration routines for all detectors and a fast system test. All in- and outputs can be checked very quickly by means of further service functions.

A personal identification is possible by means of an optional card reader or transponder. Evaluation of personal data and acquisition of measured values in a database are carried out using the optional HFM program.

Display representation of the measuring data

An optional signal tower is connected via USB or via a built-in relay. In addition it is possible to connect a door controller with configuration possibilities in the software, too.

A remote parameter program is available for configuration and documentation of the monitors. Besides the direct communication, the application can also be used offline to create or edit file settings.

Following interfaces are available: 5 USB (Host), 1 USB (Device), 1 Ethernet 10/100/1000 Mb, 1 RS232 und 1 RS485. The signal tower, transponder, magnetic card reader or printer (all optional) are connected to the USB interface.

Up to 10000 measuring data can be stored and transferred via USB or Ethernet to an external computer. As an alternative a serial port can be used. An extensive communication protocol permits the integration into a measurement network.

Reading measured data and performing software updates can be done very quickly via one of five USB (Host) ports.

Back with electrical connections

LB 148 with detectors for backs of hands

Equipment concept

The Personal Contamination Monitors LB 147 and LB 148 are contamination monitors designed for use in the radiation protection field to detect contamination caused by alpha and beta/gamma radiation. Low-maintenance thin-layer ZnS (Ag) scintillators are used as detectors. The operation is via a touch panel on a graphical display.

Four automated guided hand detectors of LB 148 enable a simultanously measurement of both palms and backs of hands. For LB 147 it is possible to activate an automatic request for back of hand measurement. LB 147 is also available as a narrow version (LB 147 Slim) with a changed positioning of the hand detectors. Additionally the LB 147 and LB 148 are also available as a Alpha Sense Version with special protection grid modifications for lower alpha detection limits. All versions have a removable hand probe for frisker measurements.

Each detector has its own calibration factor for each nuclide and its own spillover factor for each alpha nuclide. More than 50 nuclides with their calibration factors according to DIN ISO 7503-1 and A-100 are already deposited in the software.

By means of the scintillation technology it is possible to measure alpha and beta/gamma contaminations simultaneously but the devices can also be used as pure alpha or pure beta/gamma monitor. The results can be represented in the optional units Bq/cm^2 or cps. The detection limits of each measured value are calculated according to DIN ISO 11929 and stored together with the measurement values.

The background radiation is continuously monitored for each detector and used to compensate the measurement with the long-term average background value. Before the start of each measurement the background is checked for fluctuations, too.

A clear menue guidance provides a simple operation. The built-in power supply adjusts automatically to the various alternating voltage supplies.

LB 147 with signal tower

LB 147 Slim

Technical Data

LB 147 / LB 148

Detectors

***A:** LB 147/LB 148 ****B:** Alpha Sense

Radiation detector	ZnS(Ag) Szintllator
Material entrance window	2 x 3 µm metallized plastic (0.4 mg/cm²)

Hand Detectors

Dimensions entrance window	150 mm x 230 mm		
Sensitive area	345 cm²		
Background	α-channel about 0.1cps β-γ-channel about 15cps		
Typ. Efficiencies (according to ISO 7503-1)		**A***	**B****
	^{241}Am	33 %	43 %
	^{14}C	20 %	25 %
	^{36}Cl	49 %	70 %
	^{90}Sr/^{90}Y	52 %	66 %
Typ. MDA (according to ISO 11929) with 10 s measuring time in Bq/cm²	^{241}Am	0.026	0.019
	^{14}C	0.649	0.460
	^{36}Cl	0.135	0.078
	^{90}Sr/^{90}Y	0.126	0.088

Foot Detectors

Dimensions entrance window	150 mm x 370 mm		
Sensitive area	555 cm²		
Background	α-channel about 0.2cps β-γ-channel about 40cps		
Typ. Efficiencies (according to ISO 7503-1)		**A***	**B****
	^{241}Am	19 %	40 %
	^{14}C	21 %	21 %
	^{36}Cl	54 %	71 %
	^{90}Sr/^{90}Y	43 %	64 %
Typ. MDA (according to ISO 11929) with 10 s measuring time in Bq/cm²	^{241}Am	0.055	0.026
	^{14}C	0.954	0.961
	^{36}Cl	0.191	0.137
	^{90}Sr/^{90}Y	0.254	0.153

Ambient Conditions

Temperature range	- 5 °C to + 40 °C
Rel. humidity	0 % to 90 %, no condensation

Electronics

CPU	NXP i.MX 6 ARM Cortex-A9 Windows Embedded Compact 2013
Display	Coloured 7" Touch Panel 800 x 480 Pixel
Ports	5 USB(Host), 1 USB(Device), 1 Ethernet 10/100/1000Mb, 1 RS 232, 1 RS 485
External signal transmitters	3 relays max. 50 V, 5A
Power supply	100 - 240 VAC wide-range input
Power consumption	approx. 14.5 W, Fuse 2A

Mechanical Data

Dimensions in cm	(W x H x D)
LB 147 / Alpha Sense	about 65 x 125 x 80
LB 147 Slim	about 45 x 125 x 90
LB 148	about 85 x 125 x 82
Weight	
LB 147 / Slim / Alpha Sense	approx. 35 kg
LB 148 / Alpha Sense	approx. 45 kg

Accessories (optional)

	Ident. Nr.
LB 147	45356-10
LB 147 Slim	45356-15
LB 147 Alpha Sense	45356-16
LB 148 / Alpha Sense	56542 / 56542-16
Mobile set (only f. LB 147)	52874
Transponder system (RFID)	66164
Chip / Card (RFID)	59495 / 59503
Magnetic card reader	66442
Magnetic card	34481
Signal tower f. LB 147 (red/green)	65252
Signal tower f. LB 148 (red/green)	65252
Calibration source ^{36}Cl / ^{241}Am	29336 / 25509
HFM program	42849-042
Stomach and thyroid probe*	49950
Stomach probe*	53516
Thyroid probe*	53517

* only for LB 147, only for export

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This instrument is not intended to be used for diagnostic and/or therapeutic purpose for human beings and is not a medical device according to the definitions of the European Council Directive 93/42/EEC concerning medical devices.

LB 147 / LB 148 en · Id. No. DC00490PR2 · 02-2019 · Rev.01 · Subject to change without further notice.

Contamination Monitor
LB 147

Operating Manual
45356BA2

Rev. No.: 16, 08/2018

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Table of Contents

1 Important Information

1.1 Some Preliminary Remarks

The product is handed over to you by the manufacturer BERTHOLD TECHNOLOGIES GmbH & Co. KG (hereinafter referred to as Berthold) complete and functionally reliable.

This operating manual describes how to:

- set up the product
- establish electrical connections
- perform measurements
- make software settings
- connect the extension modules (optional)
- service the product
- fix errors.

Be sure to read this manual thoroughly and completely before working with the product. It is our aim to provide you with all the information required for the safe and complete operation.

However, if you have any questions that are not answered in this manual, please feel free to contact Berthold.

1.2 Storage Location

This operating manual and all product-related documentation relevant for the particular application must always be readily available and accessible close to the device.

1.3 Target Group

This operating manual is intended for trained professionals who are familiar with the handling of electrical and electronic modules and with communication and measurement technology.

A trained professional is someone who due to their technical training, know-how, experience and knowledge of relevant regulations is able to assess the tasks assigned to them and who can identify possible dangers.

1.4 Validity of the Operating Manual

The operating manual becomes valid with the handover of the Berthold product to the operator. Revision number and release date of this operating manual are indicated in the footer. A change management is not offered by the manufacturer Berthold.

Modifications in this operating manual are possible at any time without giving reasons.

NOTE

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

1.5 Copyrights

1.6 Convention

Identification	Meaning	Example
Quotation marks	Field in software user interface	“Calibrate”
Vertical line	Path	Settings | Selection
Angle brackets	Keys and buttons	**<Update>**
Parenthesis	Graphic reference	Attach the plug (Fig. 1, item 1)

In the description of the software, the term “click” refers to a procedure that is to be executed. This also includes the tapping of a button or an area on the touch display if no mouse is used to control the software.

1.7 Symbols Used in the Operating Manual

In this manual, warning signs appear whenever there is a risk of personal injury or material damage. The measures described must be observed to prevent hazards.

⚠ DANGER

Indicates an **imminently** hazardous situation which, if not avoided, will certainly result in serious injury or death.

⚠ WARNING

Indicates a **potentially** hazardous situation which, if not avoided, could result in serious injury or death.

⚠ CAUTION

Indicates a **potentially hazardous** situation which, if not avoided, may result in minor or moderate injury and property damage.

NOTE

If this information is not observed, this may lead to disturbances in the sequence of operations and/or property damage.

IMPORTANT

Paragraphs marked with this symbol provide important information about the device and how to handle the device.

Tip

Includes practical tips and other useful information.

1.7.1 Symbols Used on the Device

Caution voltage!

Risk of tipping!

Do not dispose of the product with household waste.

1.8 Conformity

Berthold declares, at its sole responsibility, that the construction of this product, in the form as delivered by Berthold, conforms to the relevant EU directives mentioned in the original declaration of conformity.

This declaration shall lose its validity if the product is modified without prior consultation with Berthold or if the product is used not in compliance with the intended use.

2 Safety

2.1 Hazards and Safety Measures

- Read this manual thoroughly and completely before working with the product.
- Keep this manual in a location that is easily accessible to all users at all times.

2.2 Intended Use

The Contamination Monitor LB 147 is a compact measuring device for laboratory use. It is designed for alpha, beta/gamma contamination measurements and may only be used for this purpose.

If contamination by radioactive material is detected, the operator of the contamination monitor shall determine appropriate measures for decontamination. Radiation Safety Officers have to inform and instruct the users of the contamination monitor about these measures.

You act in compliance with the intended use:

- If you strictly follow the instructions and sequences of tasks and avoid any unauthorized actions endangering your safety and the proper functioning of the system!
- If you follow all safety instructions!
- If you carry out, or have carried out, the required maintenance work!
- If you only use accessories and spare parts supplied by Berthold.

The following is not in compliance with the intended use and must be prevented:

- Non-observance of the safety instructions and the information on operation, maintenance and disposal provided in the operating manual.
- Failure to follow the operating instructions to the delivered products.
- The use under conditions other than the terms and conditions stated by the manufacturer in their technical documentation, data sheets, operating and installation manuals and other specifications.
- The use of the device or parts thereof that are damaged or corroded. This also applies to the seals and cables used.
- Modifications and changes to the system components.
- The device is not suitable for use in hazardous areas and must therefore not be used in such areas. The device is not explosion-proof.
- Operation without observing the manufacturer's recommended safety precautions.
- Manipulating or bypassing existing safety devices.

Berthold is liable and guarantees only that the device complies with the published specifications. If the product is used in a manner that is not described in this manual, the protection of the device is compromised and the warranty will be voided.

2.3 Qualification of Personnel

NOTE

All work on and with the device must be performed by persons having at least a general knowledge under the guidance of a technical expert or an authorized person.

In this operating manual, reference is made at various points to the qualification of persons who may be entrusted with various tasks during installation, operation and maintenance.

There are three groups of persons:

- Competent persons
- Trained persons
- Authorized persons.

Competent persons

NOTE

Persons having general knowledge must always be guided by a trained person. When dealing with radioactive substances, a Radiation Safety Officer must also be consulted in addition.

Competent persons are e.g. technicians or welders who can undertake different tasks during the transportation, assembly and installation of the device under the guidance of an authorized person. This may also include site personnel. Such persons must have experience in dealing with the device.

Trained persons

- Trained persons are persons who have adequate knowledge in the required area as a result of their professional training; they are familiar with the relevant national health and safety regulations, accident prevention regulations, guidelines and good engineering practice.
- Trained personnel must be capable of safely assessing the results of their work and they must be familiar with the content of this operating manual.

Authorized persons

Authorized persons are persons who are either appointed to perform a task as a result of legal regulations, or persons who have been authorized by Berthold to perform specific tasks. When radioactive materials are involved, the Radiation Safety Officer must also be consulted.

NOTE

Risk Prevention Officers may not carry out activities as Radiation Safety Officers!

Radiation Safety Officers must have completed specialized training with certification.

2.4 Operator's Responsibilities

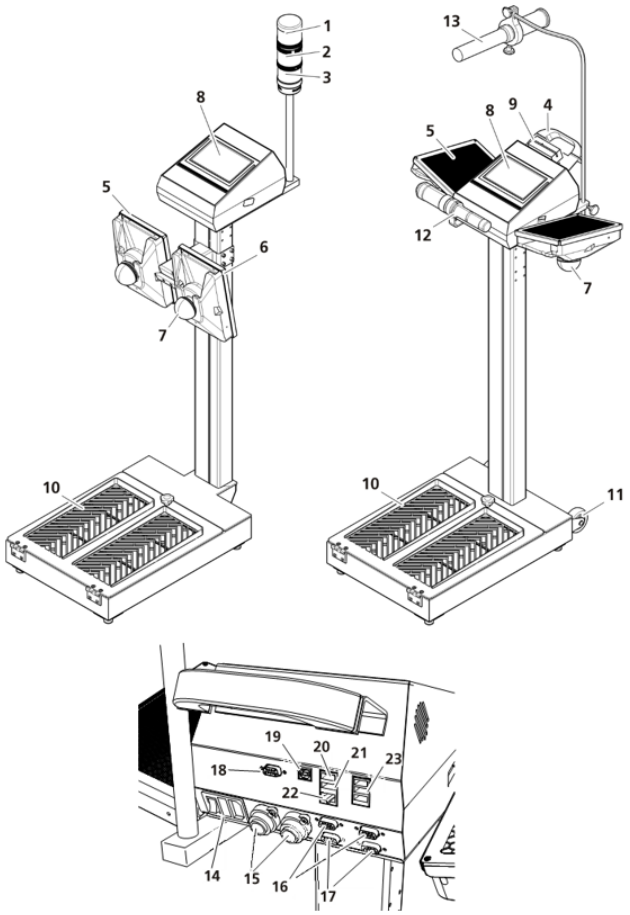
The operator of the device must provide regular training for their personnel on the following topics:

- Observance and use of the operating manual and the statutory provisions.
- Intended use of the product.
- Observance of the instructions of the Radiation Safety Officer.
- Observance of the instructions of Site Security and the operator’s user instructions.
- Regular inspection/maintenance of the device.

3 System Description

The Contamination Monitor LB 147 is a contamination monitor designed for use in the radiation protection field to detect contamination caused by alpha and beta/gamma radiation. Low-maintenance thin-layer ZnS (Ag) scintillators are used as detectors. The LB 147 is operated via a touch panel on a graphical display.

3.1 Overview



1	**Signal horn (optional)**	**12**	**Stomach probe**
2	**Signal light red (optional)**	**13**	**thyroid probe**
3	**Signal light green (optional)**	**14**	**Power supply module**
4	**Handle (optional)**	**15**	**Sockets external signal transmitter**
5	**Hand detector left**	**16**	**Connection sockets hand detectors**
6	**Hand detector right (clothing probe)**	**17**	**Connection sockets for stomach and thyroid probe**
7	**Handle hand detector**	**18**	**RS 232/RS 485 socket**
8	**Display / Touchscreen**	**19**	**USB socket type B**
9	**Magnetic card reader or transponder (optional)**	**20**	**USB socket type A**
		21	**USB socket for signal tower (optional)**
10	**Foot plate**	**22**	**Ethernet**
11	**Wheels (optional)**	**23**	**USB socket type A (3x)**

Fig. 1 LB 147 Overview (left: slim version, right: standard version, below: rear view)

3.2 Principle of Measurement

As soon as you step on the foot plate, the system is enabled and starts with the measurement of feet and hands. The person is identified prior to measurement by means of a magnetic card reader or a transponder (optional).

The contamination of clothes is measured by means of the removable right hand probe.

If no contamination is detected, a gate can be unlocked.

3.3 Hardware

Up to 10,000 measured data can be stored and transferred to external computers via the USB or Ethernet interface. Alternatively, the serial interface can be used. A comprehensive communication protocol allows the integration into a monitoring network.

All instrument parameters are permanently stored in a flash memory. Up to 32 devices can be networked simultaneously to one RS485 data bus with up to 1200 m in length using the integrated RS485 hardware.

The built-in power supply automatically adjusts to the various alternating voltage supplies. All external inputs and outputs are pluggable.

A device software update can be performed via the USB interface.

3.4 Software

The Contamination Monitor is delivered with a pre-installed software. The revision level (version) of the software is displayed in the menu | System (see chapter 7.4).

This manual describes the software version 1.2.0.0.

3.5 Optional Equipment

- Mobile set (for mobile version)
- Transponder system – RFID (for personal identification)
- Transponder chip/card (for transponder)
- Magnetic card reader (for identification of persons)
- Magnetic card (magnetic card reader)
- Signal tower (signalling the device state and contamination)
- Calibration source (^{36}Cl, approx. 1 kBq / ^{241}Am, approx. 1 kBq)
- stomach and thyroid probe
- HFC program for personal data evaluation and acquisition of the measured values in a database.

4 Transport

⚠ CAUTION

Risk of injury from heavy and bulky device

- Use appropriate tools and at least 2 persons to transport the device.
- You must comply with the requirements for the safe handling of heavy weight equipment.
- Ensure good stability and utilize the prepared mounting options.

4.1 Unpacking / Scope of Delivery

The product will be delivered fully configured to order. Check the delivery for completeness and integrity as per the order. Immediately report any missing, defective or incorrect equipment.

The following components must be available to get started:

- Monitor LB 147 including measurement electronics
- 2 hand and 2 foot probes
- 100/240 VAC connection cable
- Operating manual
- Mobile set (optional)
- Magnetic card reader or transponder (optional)
- Signal tower (optional)
- Transponder chip/card (optional)
- Magnetic card (optional)
- Calibration source (optional)
- stomach and thyroid probe (optional)
- CD-ROM HFC program with USB dongle (optional)

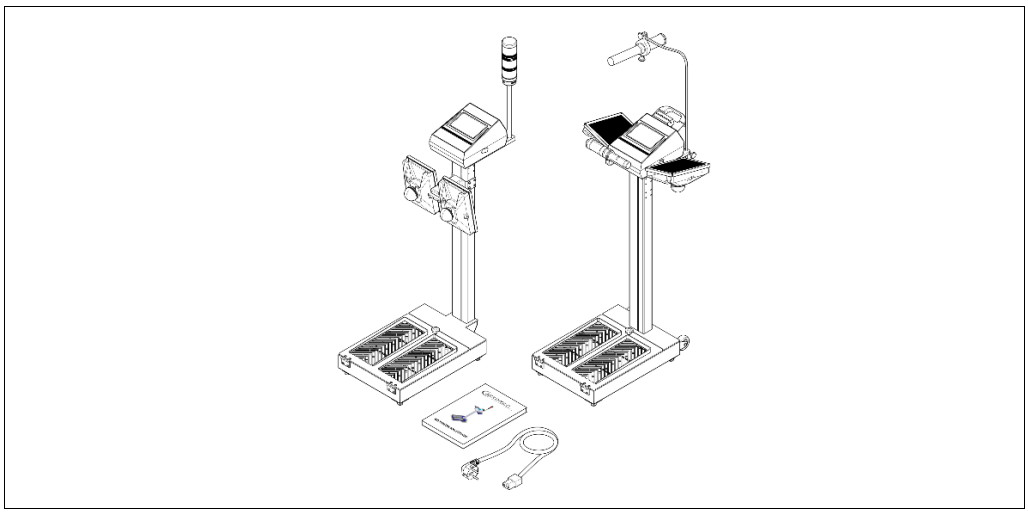


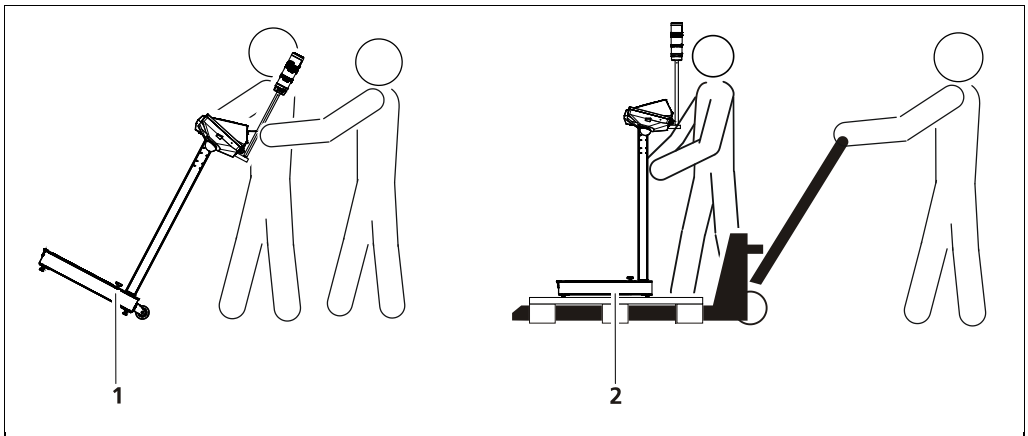
Fig. 2 Scope of delivery (left: slim version, right: standard version)

4.2 Transporting the System

⚠ CAUTION

Risk of injury from heavy and bulky device

- Use appropriate tools and at least 2 persons to transport the device.
- You must comply with the requirements for the safe handling of heavy weight equipment.



1 Device with mobile set
2 Device without mobile set

Fig. 3 Transporting the device

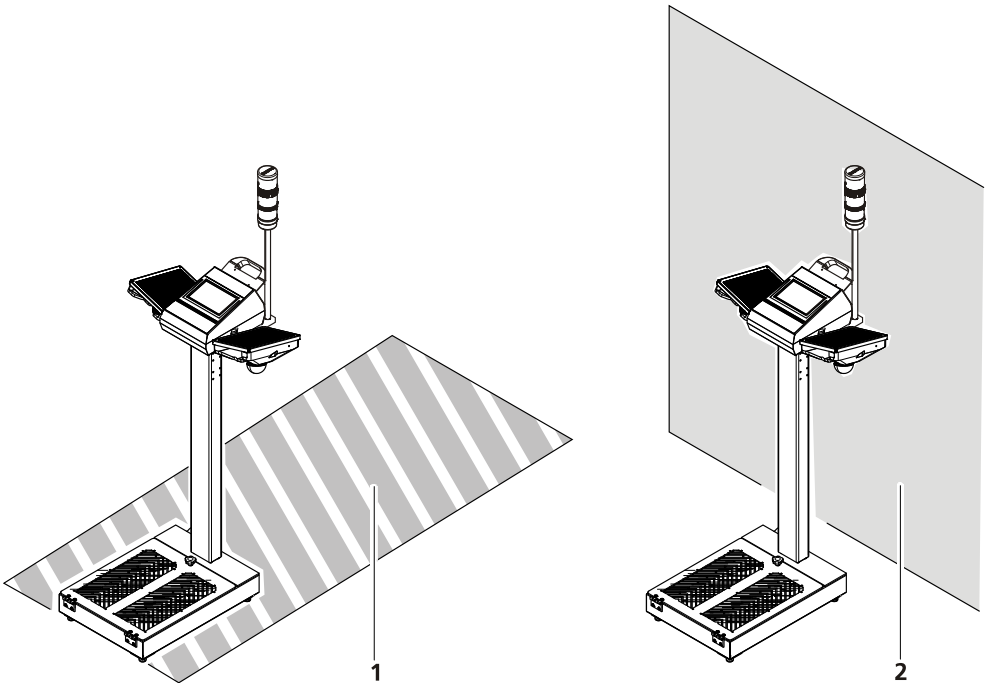
Transporting the device with mobile set (optional)

1. Hold the monitor at the handle.
2. Carefully tilt the monitor until the wheels touch the ground. Pay attention to the signal tower (optional).
3. Move the monitor to the installation site.

Transporting the device without mobile set

- Have two persons lift the monitor onto a suitable transport device and move the monitor to the installation site.

4.3 Setting up the System



1 Restricted area
2 Wall

Fig. 4 Setting up the system

Installation requirements:

- The floor at the installation site must be horizontal and level.
- Secure the area behind the device by setting up the device with its back directly to the wall (Fig. 4, item 2) or by guarding off the rear area (Fig. 4, item 1) or by blocking access to this area.
- See chapter 9 Technical Information for details on the required ambient conditions.

5 Getting Started

5.1 Safety Instructions

⚠ DANGER

Risk of fatal injury due to electric shock!

- Do not touch any live components or areas of the system.
- Installation and maintenance work on the device may be carried out by qualified personnel only (see chapter 1.3 Target Group).
- Always observe the relevant safety regulations.
- The measuring system, the connected relay contacts and all inputs and outputs must be disconnected during installation and servicing work on the hardware and while installing the cables.
- Only connect devices to the product which meet the applicable safety standards.
- In case of an electric shock, carry out the required first aid measures and call the emergency services immediately.

5.2 Ambient Conditions

See chapter 9 Technical Information for details on the required ambient conditions.

NOTE

The Contamination Monitor LB 147 must be installed inside a closed building.

NOTE

No external radiation and interference radiation and no high or fluctuating ambient levels must be present at the installation site of the Contamination Monitor LB 147.

5.3 Electrical Connection

NOTE

Only Berthold approved parts must be used to start up the device.

Mains connection

The device is equipped with a combination element with mains switch and filter and has to be connected to a supply system with 100-240 VAC 50/60 Hz. Use only the original power cable (3-pole, L-N-PE, H05VV-F 3G 0,75mm²) to connect the device to the mains.

RS 232 / RS 485 port

The serial cable (null modem cable) for the RS232 interface must be shielded and should not exceed a length of 20 m. A shielded twisted pair data cable up to a maximum length of 1200 m has to be connected to the RS485 port.

Ethernet port

Transmission mode = 1000BASE-T*5 / 100BASE-TX

Use a CAT5e cable or better. To avoid communication problems, we recommend using an STP cable (shielded twisted pair).

USB port

5 USB ports are located on the rear panel (Fig. 5, item 8, 9 and 11). The signal tower (optional), transponder or magnetic card reader (optional) are connected to these USB interfaces.

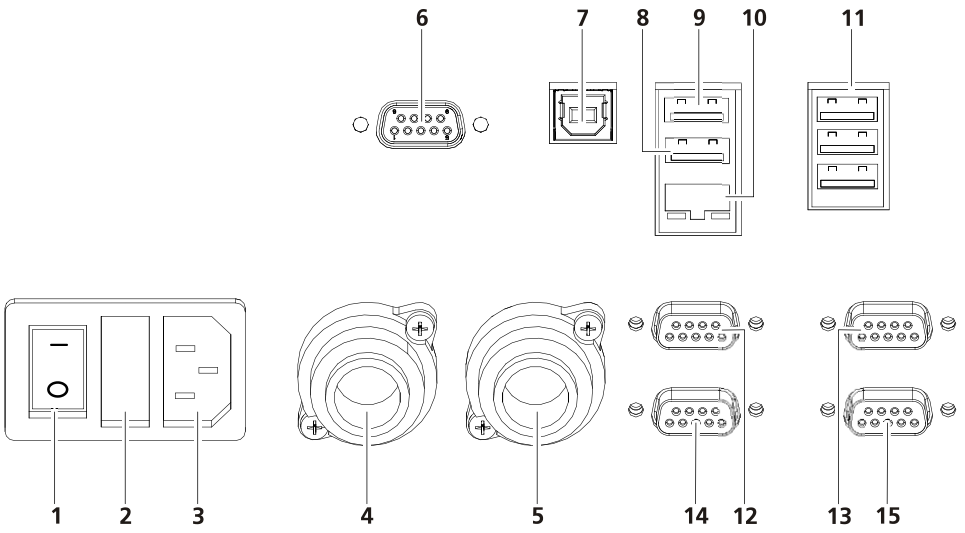
Cables and wires

- Make sure that the electrical data on the rating plate correspond to the data of your power supply.
- Make sure you are using the correct cable for the electric power supply.
- Connect the cable with special care.
- The connection cable and its installation must comply with current regulations.
- When installing the cable, make sure that mechanical damage to cable insulation from sharp edges or moving metal parts are ruled out.

Install the connection cables so that

- the permissible minimum bending radii for the respective conductor cross-section are not undershot;
- the cables are installed strain-relieved and abrasion-free.
- The cables must comply with the technical data specified in the requirements and the wire cross-sections.
- The cables used must be suitable for a temperature that is at least 10° C above the maximum permissible ambient temperature.

5.3.1 Connector Pin Assignment



1	On / Off Switch	8	USB port for signal tower (optional)
2	Fuse (2A, slow)	9	USB port type A
3	Power supply port	10	Ethernet
4	Jack external signal transmitter (Alarm)	11	USB port type A (3x)
5	Jack external signal transmitter (gate)	12	Connection socket left hand detector
6	RS 232/RS 485 port	13	Connection socket right hand detector
7	USB port type B	14	Connection socket for stomach probe (optional)
		15	Connection socket for thyroid probe (optional)

Fig. 5 LB 147 Connector pin assignment (rear panel)

5.3.2 Connecting the Power Supply

The LB 147 can be supplied with various external power supplies.

The combination element covers a range from 100 to 240 VAC and the frequency range is between 50 and 60 Hz. A manual switch is not necessary.

- Connect the 100/240 VAC supply cable (included) to the terminal for the power supply (Fig. 5, item 3).

NOTE

A power failure or a voltage drop may result in loss of data. Therefore, we recommend to operate the system only with an uninterruptible power supply.

5.3.3 Connecting the Probes (Detectors)

In addition to the fixed foot detectors, two hand detectors can be connected to the device (Fig. 5, item 12, item 13).

The power supply for the probes is +5 VDC, the control voltage for controlling the high voltages of the probes is in the range from 0 to 4,095 VDC, with a resolution of 12 bits. The set control voltage can be adjusted in the menu | System (see chapter 7.4). The current consumption of the probes is about 40 or 80 mA.

The probes provide a standard pulse as counting signal (width: >0.8 µs, amplitude: 4 to 6 V).

Stomach and thyroid probe

Optionally, a stomach and thyroid probe can be connected (Fig. 5, item 14 and 15). The power supply for these probes is +5 VDC.

The probes provide a standard pulse as counting signal (width: >0.8 µs, amplitude: 4 to 6 V).

An appropriate holder (included in delivery) is provided for positioning the stomach/thyroid probe (Fig. 18).

NOTE

The probes may only be connected when the device is switched off.

- Connect the probe cable shielding to the cable connector housing.
- Connect the cable with special care.
- The connection cable and its installation must comply with current regulations.
- When installing the cable, make sure that mechanical damage to cable insulation from sharp edges or moving metal parts are ruled out.

5.3.4 Connecting the Signal Transmitter

The optional signal tower is connected via USB (Fig. 5, item 8).

External signal transmitter

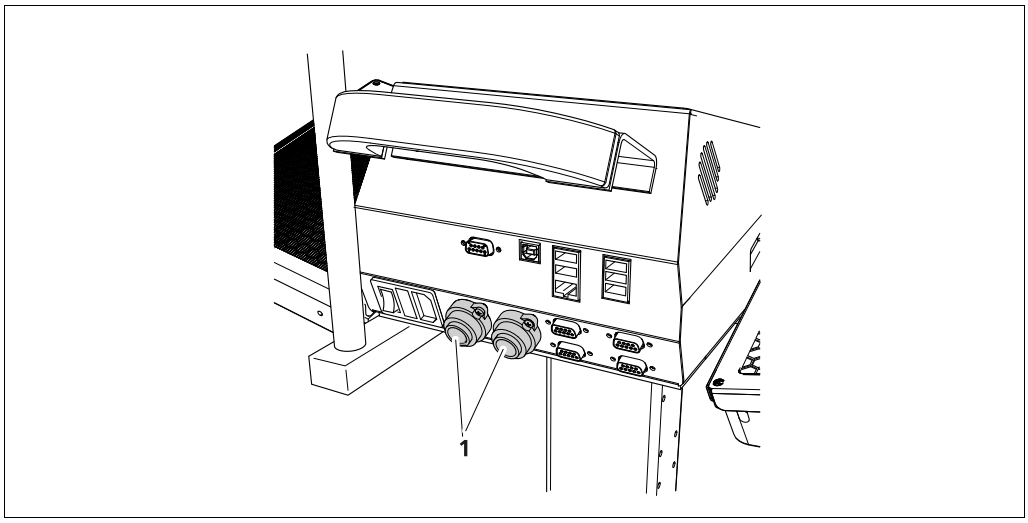


Fig. 6 Connecting external signal transmitter

The unit has 3 built-in potential-free relays, each with a changeover contact for DC or AC voltage up to 50 V, 5 A (Fig. 6). A further signal transmitter (Fig. 7 and Fig. 8) can be connected via a 7-pin socket and a barrier via a 4-pin socket (see chapter 5.3.5 Connecting the door controller).

NOTE

The signal transmitter may only be connected with the unit switched off.

Pin	Description	Relay
1	Contact open when turned off	Relay 1: Ready (light green)
2	Changeover relay 1	
3	Contact closed when turned off	
4	Contact open when turned off	Relay 2: Contaminated (light red or red + horn)
5	Changeover relay 2	
6	Contact closed when turned off	

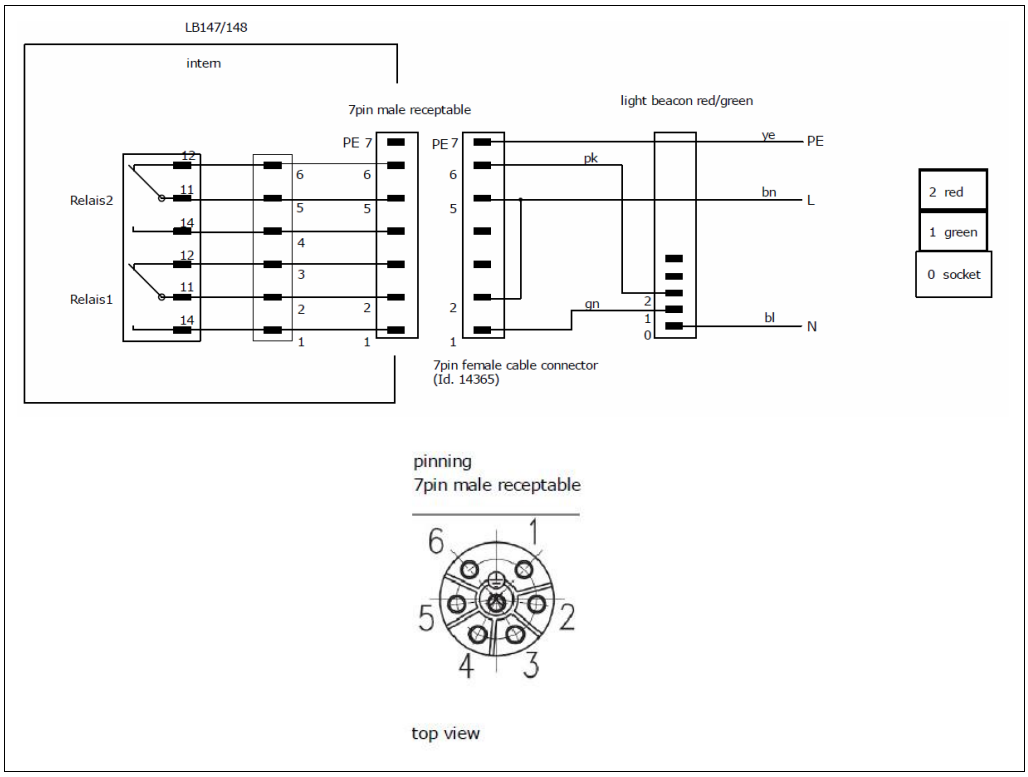


Fig. 7 Connecting external signal transmitters (green/red)

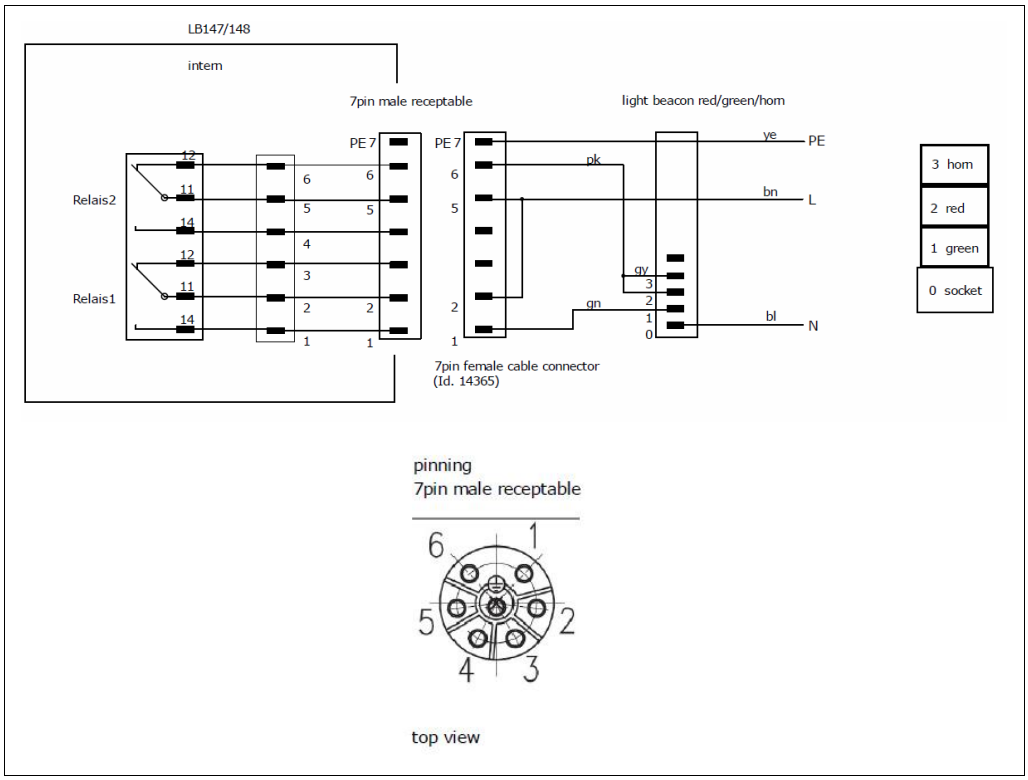


Fig. 8 Connecting external signal transmitters (green/red/horn)

5.3.5 Connecting the door controller

When using a door controller (Fig. 9), the function <Gate> must be enabled in the menu | System (see chapter 7.4). In addition, you have to set a time for how long the gate is to be opened.

During operation, all relays are in the normal state, i.e. energised, if no errors or alarms are present

NOTE

Only non-inductive consumers may be connected to the relay changer (e.g. no motors) to ensure interference immunity.

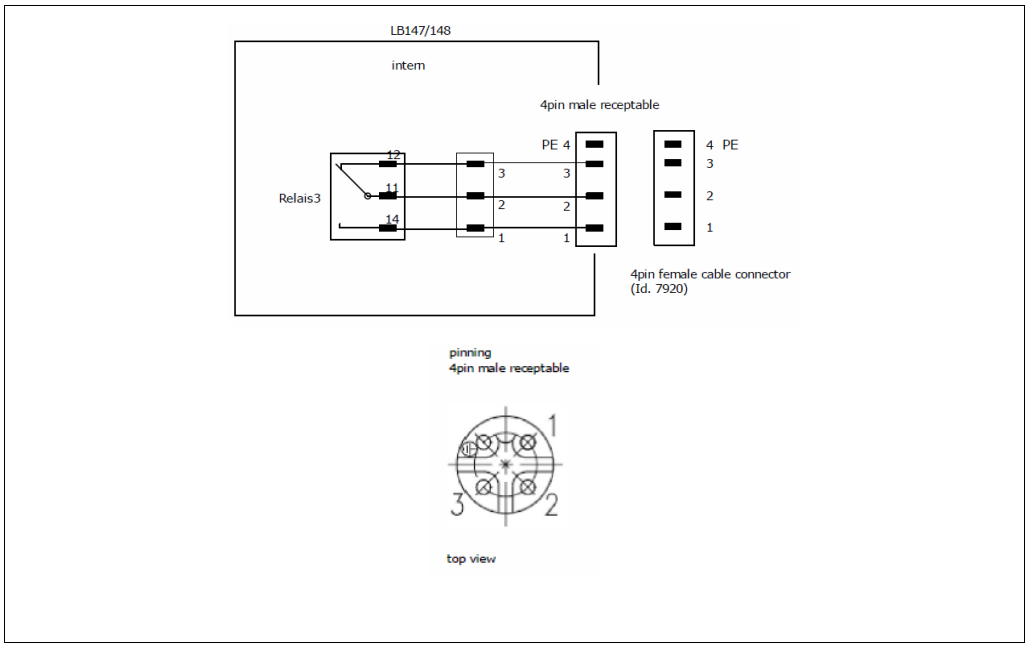


Fig. 9 Connecting external signal transmitters (GATE)

Pin	Description		Relay
1	Contact open	If door is controlled or unit is switched off	Relay 3: Gate
1	Contact closed	If door is not controlled or unit is switched on	
2	Changeover relay 3		
3	Contact open	If door is not controlled or unit is switched on	
3	Contact closed	If door is controlled or unit is switched off	

5.3.6 RS232/RS485 Interface

The device includes a configurable serial interface (RS232 or RS485) (Fig. 1, item 18 and Fig. 5, item. 6).

The serial interface is used for connecting an external computer, the RS485 interface is used in particular for application in measuring networks (alternatively, the measuring network can be set up via the Ethernet or USB interface). The baud rate (2400 – 38400 baud) can be set by software (see chapter 7.17 Connect).

All other parameters are not configurable: 8 data bits, 1 start bit, 1 stop bit, no parity, hardware handshaking (with RS485 no handshaking).

RS232 cable lengths should not exceed 20 - 30 m. As to the RS485, up to 32 devices can be connected to a twisted pair cable with a cable length of up to 1200 m. The highest transfer rate also depends on the length of the cable and may have to be adjusted. The cable shield should be connected to electrically isolated ground.

	RS232	RS484
Voltage level	negative: -6V to –12V positive: +6V to +12V	difference signal in accord-ance with standard
Cable lengths	< 30m	< 1200m, max. 32 devices per bus cable
Cable type	shielded 5-core cable	shielded twisted-pair cable (data cable), impedance: 120 Ohm

5.3.7 USB Interfaces

There are 5 master interfaces and 1 slave interface (Fig. 5, items 8, 9, 11). One master interface is provided for connecting the optional signal tower (Fig. 5, item 8).

5.3.8 Transponder (optional)

The transponder is connected via one of the five USB interfaces.

5.3.9 Ethernet Interface

The device includes one Ethernet interface (Fig. 5, item 10). The Ethernet interface is used as a transmission medium for communication between the PC and the LB 147. Upon activation (see chapter 7.16 Hardware Test) of the CE Rem. display (remote con-trol), the unit can be operated via the network connection (see chapter 7.17 Connect).

5.4 Disconnecting the Device from Mains

⚠ DANGER

Risk of fatal injury due to electric shock!

- Do not touch any live components or areas of the system.
- Pull the plug, not the cord, to disconnect a cable from the device.

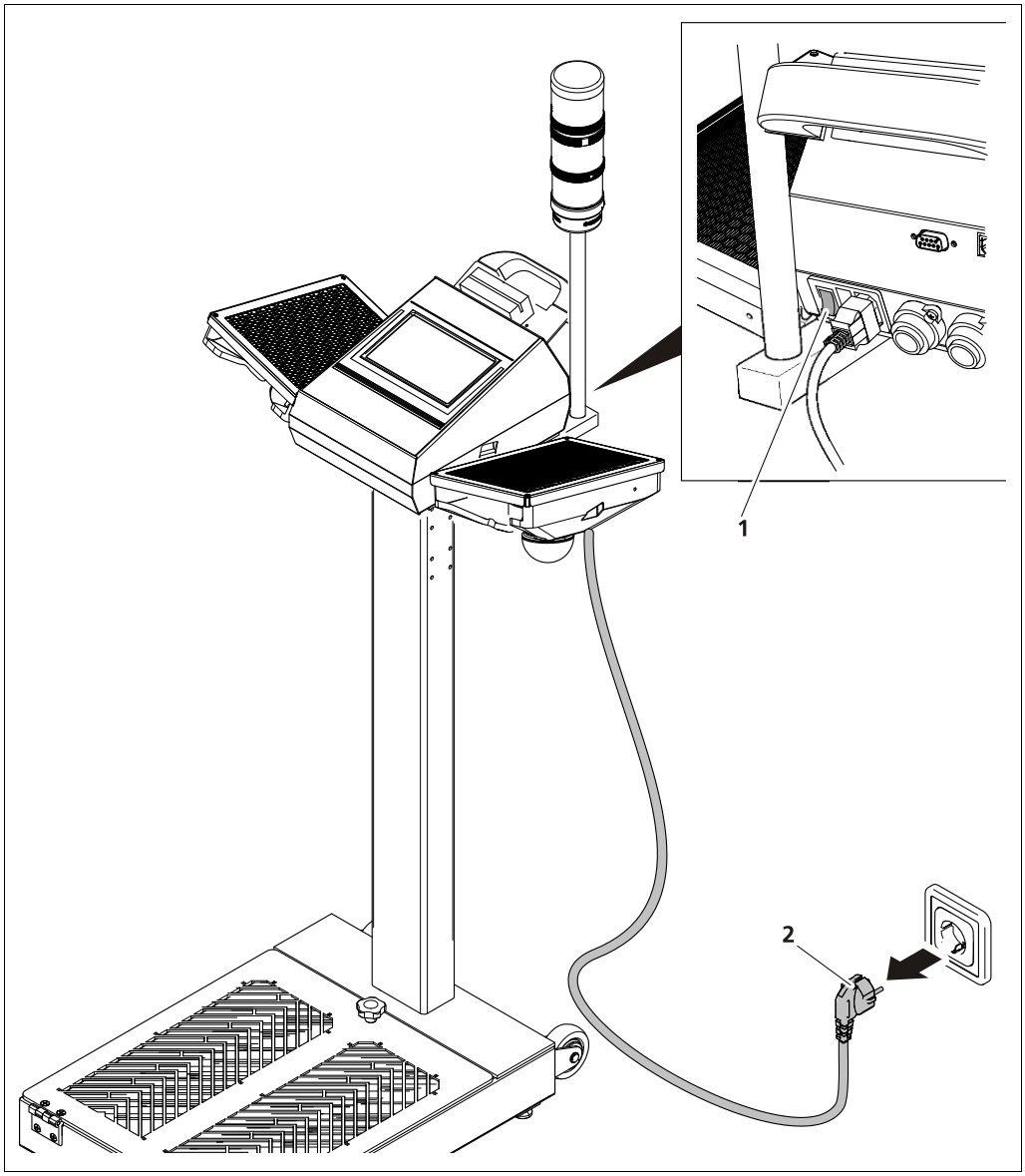


Fig. 10 Disconnecting the device from mains

1. Switch off device at the rear panel (Fig. 10, item 2).
2. Pull the plug (Fig. 10, item 2).

6 Operation

6.1 Power On / Off

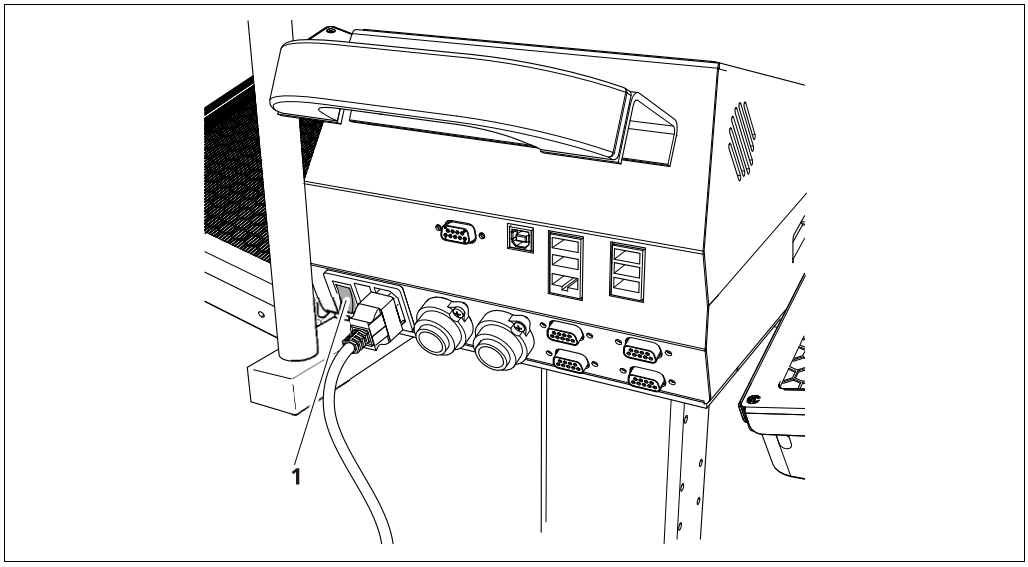


Fig. 11 On / Off switch

Power on

To start up the system properly, all probes and additional peripherals must be connected to the LB 147 and configured.

Switch on the Contamination Monitor LB 147 at the switch (Fig. 11, item 1) on the rear of the device.

- The system boots and checks all components / connections and starts the LB 147 software.

NOTE

If the device does not start properly, switch it off and pull the mains plug. Contact the Berthold customer service.

⚠ CAUTION

Eye damage

The strong light from infrared sensors can cause eye damage.

- Do not look into the infrared sensors.

Power off

The Contamination Monitor LB 147 cannot be shut down. Switch off the Contamination Monitor LB 147 at the switch (Fig. 11, item 1) on the rear of the device.

- All measured values and settings that have not been saved will be deleted.

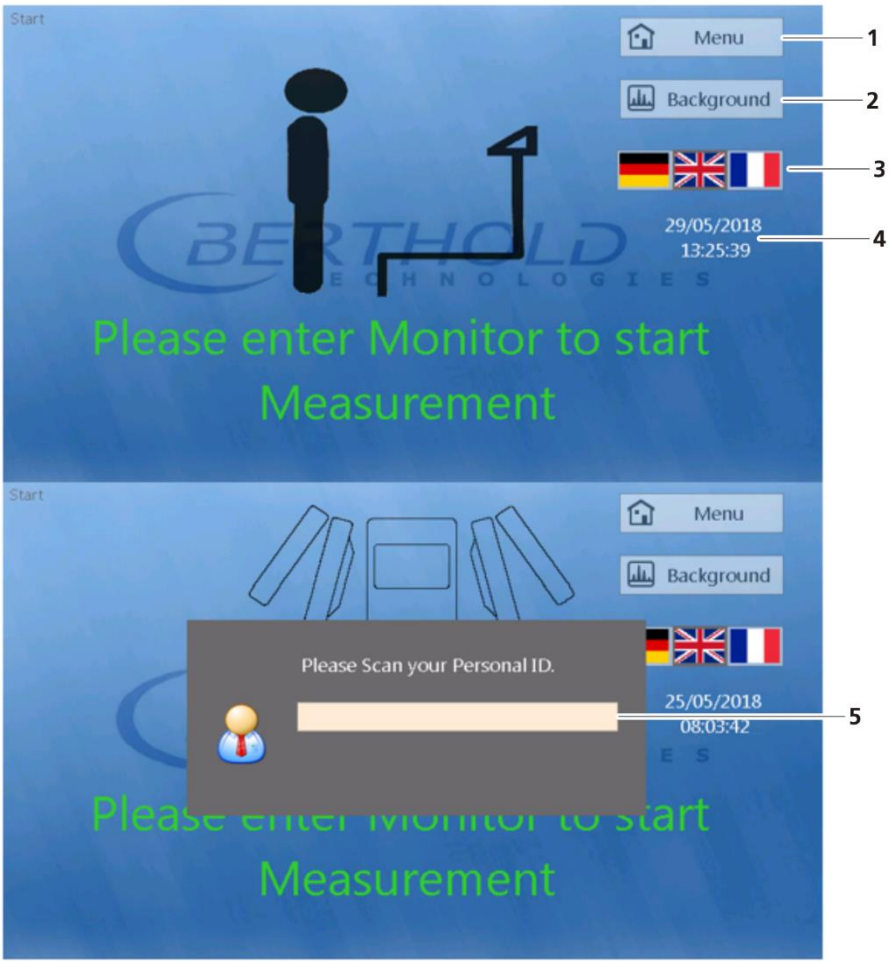
6.2 Daily Operation

⚠ CAUTION

Health hazards due to radioactive contamination

The dispersion of contamination must be prevented.

- If you detect any contamination, please follow the procedures.
- Please consult with the Radiation Safety Officer in charge of the operation.
- Initiate measures for decontamination.



1 "Menu" button
2 "Background" button (view current background)
3 "Language" button
4 Date and time
5 Prompt (optional)

Fig. 12 Starting the system

The <Menu> button takes you to the overview of the individual submenus (see chapter 7 Software). The background can be displayed via <Background>.

Performing a Contamination Measurement

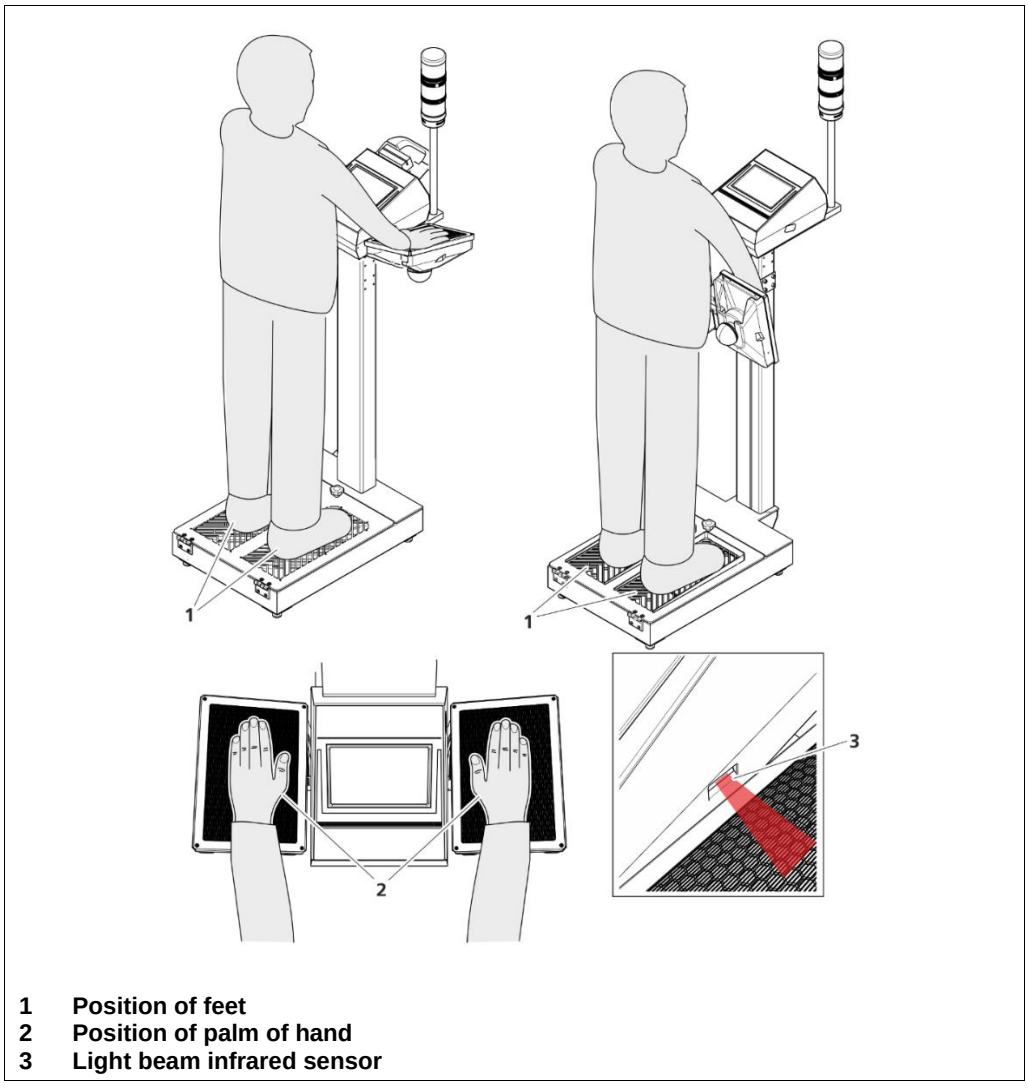
1. Step onto the foot plate with both feet (Fig. 13, item 1). Make sure your feet are completely on the foot grates.

▶ The system starts.

2. Scan your magnetic card / chip. This prompt (see Fig. 12, item 5) Fig. 12 Starting the systemis displayed only when the presence control is enabled (see chapter 7.4 System).

NOTE

If no error or warning messages are displayed, the LB 147 is in the measurement ready state: Signal = green (optional signal tower). If errors are detected, a warning message is displayed and a measurement is not possible.



1 Position of feet
2 Position of palm of hand
3 Light beam infrared sensor

Fig. 13 Positioning feet and hands

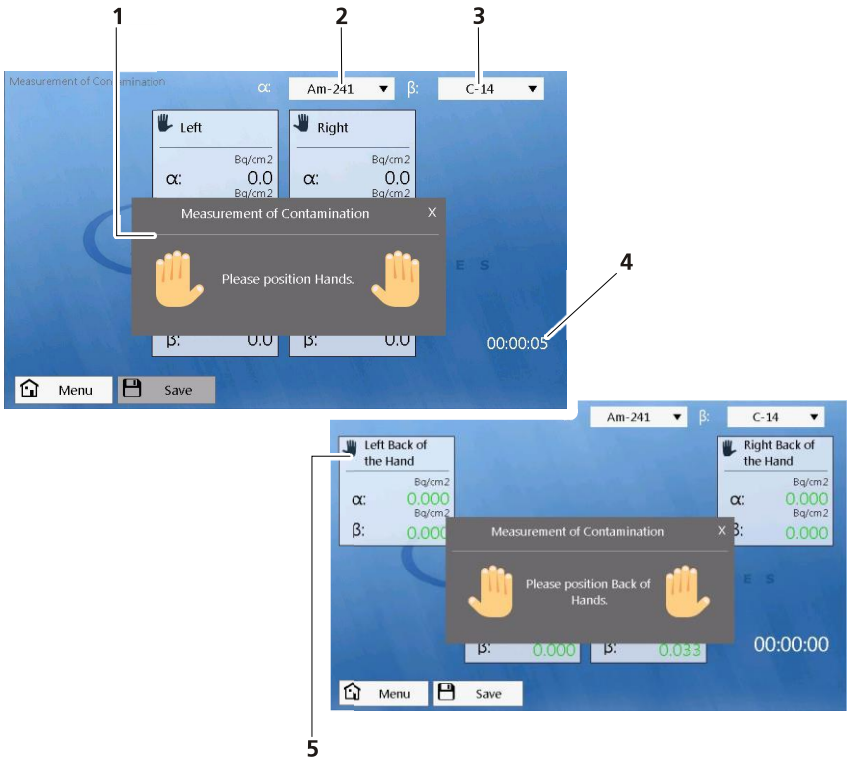
3. Place your hands on the hand detectors to start the contamination measurement (Fig. 13, item. 2).

▶ If the voice output is enabled (see chapter 7.4 System) you hear the message “Put your palms of hand on the detectors”.

- The system performs the measurement of the activated nuclides on feet and hands at the same time.
- If the voice output is enabled (see chapter 7.4 System), the remaining measuring time of 10 seconds set by default is reached and counted downwards. The total measuring time can be set individually in the menu | Parameters (see chapter 7.6).

4. Keep your hands on the detectors and do not step off the foot plate while the measurement is running. The remaining measurement time (Fig. 14, item 4) is displayed at the bottom right.

- If you leave the foot plate or the hand detectors too soon, the measurement is interrupted and must be restarted.



1 **Hand and foot measurement**
2 **Current alpha nuclide being measured**
3 **Current beta nuclide being measured**
4 **Time remaining**
5 **Measurement of the back of hand (optional)**

Fig. 14 Performing a contamination measurement

- If the back of hand measurement is enabled (see chapter 7.6, Parameters)), you will be prompted, after expiration of the measurement time, to place the backs of your hands on the detectors. If the voice output is enabled in the menu | System (see chapter 7.4) you hear the message “Place your back of hands on the detectors”.

5. At the end of the measurement, the result appears on the display (Fig. 15).

- If no contamination is detected (measured value below the alarm threshold):
  - Green coloration of the display
  - Signal lamp lights up green (optional)
  - Door / Gate opens (optional)
  - If voice output is enabled you hear “Not contaminated”

- If contamination is detected (measured value exceeds the alarm threshold):
  - Red coloration of the display
  - Signal lamp flashes red (optional)
  - Acoustic signal sounds
  - Horn of signal tower sounds (optional)
  - If voice output is enabled you hear “Contaminated”

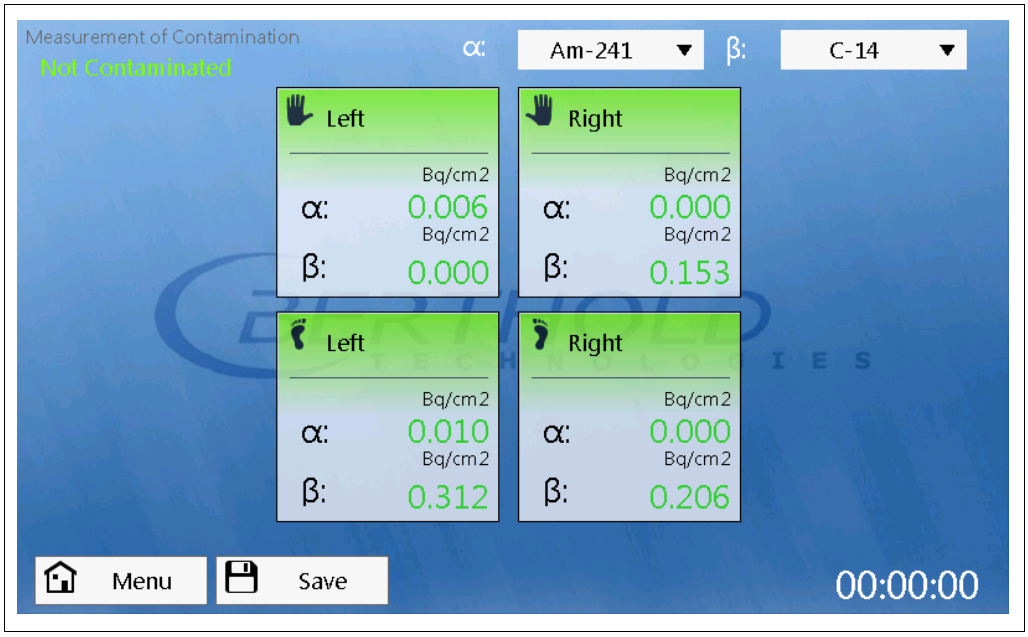


Fig. 15 Performing a contamination measurement

6. If no contamination is detected, leave the Contamination Monitor or perform an optional contamination measurement of the clothing (see next section “Clothing Contamination Measurement”).
7. If contamination is detected, follow the operator’s instructions.

- If “Reset Alarm with Password” is enabled (see chapter 7.6 Parameters), the alarm must be reset using the button <Res.Alarm>, followed by entry of the password.

- If “Save automatically” is not enabled in the menu | Parameters (see chapter 7.6), the value can be saved manually by tapping the <Save> button.

- Upon completion of the measurement, more values (raw data in cps, characteristic limits according to DIN ISO 11929) can be displayed for each detector. The values are then displayed in tabular form by tapping the respective hand or foot symbol.

- After the contamination measurement of hands and feet, the contamination measurement for clothing is optionally carried out.

- The stomach and thyroid measurement runs automatically during the contamination measurement. Two further detectors are shown on the right and left side of the display.

Clothing Contamination Measurement

IMPORTANT

The LB 147 allows you to perform contamination measurement on clothing using the hand detector.

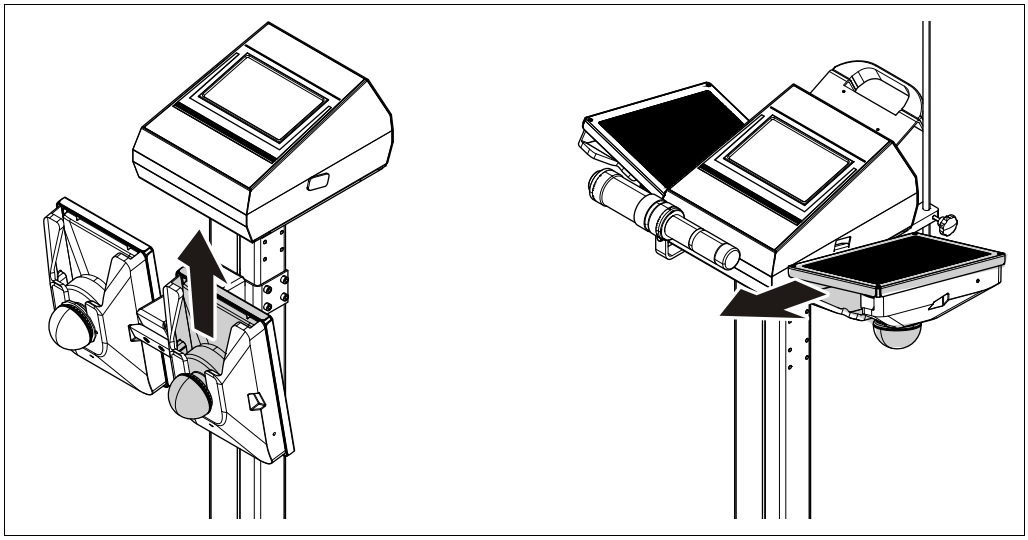


Fig. 16 Contamination measurement on clothing

IMPORTANT

Make sure you are standing on the foot plate when you take off the hand detector.

1. Pull the hand detector on the right sight out of the holder.

- To make measurement easier, you may step off the foot plate after you have removed the hand detector.

2. Move the hand detector across your arms, legs and body to measure contamination.

- In the clothing measurement dialogue, the measurement values of the alpha and beta channel are displayed in counts per second (cps) (Fig. 17).

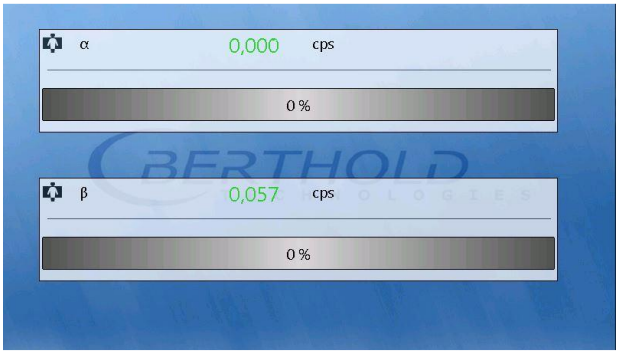


Fig. 17 Clothing contamination measurement

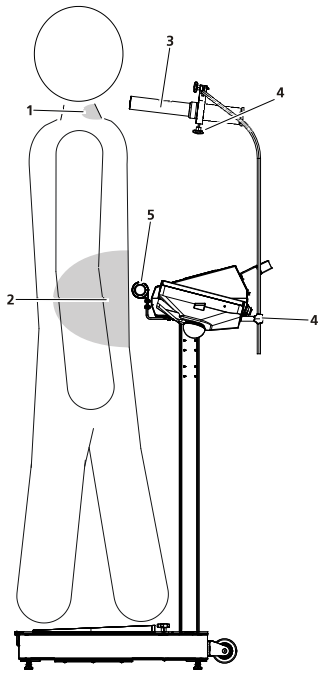
3. After the measurement, hang the hand detector back into the holder.

- The measurement is finished.

- If no contamination is detected (measured value below the alarm threshold):
  - Measured value in green letters on the display
  - Signal lamp lights up green (optional)
  - Door / Gate opens (optional)

- If contamination is detected (measured value exceeds the alarm threshold):
  - Measured value in red letters on the display
  - Signal lamp flashes red (optional)
  - Acoustic signal sounds
  - Horn of signal tower sounds (optional)

Dose rate measurement with the stomach and thyroid probe (optional)



1	**Thyroid measurement position**
2	**Stomach measurement position**
3	**Thyroid probe**
4	**Thumb screws**
5	**Stomach probe**

Fig. 18 Magen - / und Schilddrüsen-Messung

1. Position the thyroid probe for the correct measuring position using the knurled screws below the larynx (Fig. 18, pos. 1 and pos. 4).
2. The stomach probe is fixed in the corresponding holder (Fig. 18, items 2 and 5).
3. Start the measurement.

IMPORTANT

Make sure that the stomach probe is at the level of the stomach.
The position of the stomach probe is not individually adjustable!

Background Check after contamination measurement (optional)

If the background check is enabled in the menu | Parameters (see chapter 7.6), a background measurement is carried out right after completion of the contamination measurement. The check starts automatically when you exit the device.

- The result of the background check is displayed visually (Fig. 19).
- If the result of the background is above the alarm threshold, the device signals an alert. The signal light (optional) switches to red.
- If the voice output is enabled, you will hear “Instrument contaminated” or “Instrument not contaminated”, if the background is below the alarm threshold.

Fig. 19 Background check not contaminated

7 Software

Depending on the user who is logged in (depending on the password entered) individual menu items may be blocked. This means that certain parameters cannot be changed by the standard “user”. These parameters include, for example, the control voltages and calibration factors.

7.1 Display / Touchscreen Operation

The LB 147 is operated via the touchscreen.

NOTE

Damage to the touchscreen

Pointed or sharp objects can damage the plastic surface of the touchscreen.

- Operate the touchscreen with your finger only or with suitable stylus pens.

NOTE

Triggering unintended actions

Touching several control elements simultaneously can trigger unintended actions.

- Always touch only one control element on the screen.

IMPORTANT

The green signal lamp turns off when you tap the <Menu>.

- The device is not operational.

IMPORTANT

The start screen (ready to measure) appears if you do not touch the display in the menus for 60 seconds (Fig. 12).

7.2 Menus

Tap <Menu> on the start screen to display the menu overview. Submenu items can be selected on two screens via icons (Fig. 20). Swipe the touchscreen (right ↔ left) to change screens.

NOTE

Each change in the menus must be confirmed and saved via <Save> at the bottom of the menu page.

Fig. 20 Menus icons

7.3 Background

The background is calculated continuously using the rate meter method and displayed in the submenu Background.

Fig. 21 Background menu

7.4 System

In this submenu you can view and set important system parameters of the overall configuration or hardware features. You can switch between the four screens by sweeping the touch screen (right ↔ left) or by touching the right and left arrows.

Fig. 22 System menu page 1 and 2

Software Version	Version number of the currently installed software.
Kernel Version	Current kernel version.
MAC Address	MAC address of the device
IP Address	IP address of the device (see chapter 7.17).
Serial No.	Serial number of the device.
Device Address	Input field for the device address (see also chapter 7.17 Important InformationConnect).
Date / Time	Input field for the system time and the system date. ▶ Confirm entry by clicking the <Apply>.
Language	Selection field for the displayed language.
Backlight off after (standby)	Input field for the standby mode.

Control Voltage

Input field for the control voltage. Analogue outputs are available for the control of the high voltage in the hand and foot detectors; each can be set to a value between 0 V and 4,095 V.

In this menu you can set the control voltages for the detectors separately for the hand and the foot detectors.

Fig. 23 System menu page 3 and 4

Contrast

Contrast of the display.

Volume

Volume of the system sounds. Alarm sounds are not configurable.

Voice Output

Voice instructions are output by the monitor in the selected language (see above).

Presence Control

A measurement can be started only by personal identification (magnetic card reader or transponder).

Gate activated

The gate is opened after each measurement (with the presence control enabled only after each exit measurement) for a certain time, provided all configured measurements (except the clothing measurement) have been carried out and no contamination has been found.

Gate open [s]

Enter the time the gate is to be opened in seconds.

Personal ID

This line shows the ID number syntax of the magnetic card or the transponder chip.

By marking the desired character, you can select which characters of the respective ID are to be stored in the log files.

Example: From characters: 10
Number: 6

NOTE

Marking of the desired characters is only possible after your magnetic card / chip has been scanned.

Further detectors

Selection field for the stomach and thyroid probe (optional).

7.5 Nuclides

In this submenu the required nuclides for the subsequent measurement are selected. Tick the checkbox <Activated> to select the required nuclides.

A total of 6 alpha-nuclides and 34 beta-nuclides are implemented. Five alpha and 10 beta-nuclides can be named individually to add nuclides that are not included in the default list.

Enable the nuclide <Cps alpha> or <Cps beta> to get uncalibrated values during a contamination measurement. In this case, the measured values of the hands and feet are multiplied by a calibration factor “1” and are displayed in counts per second (cps).

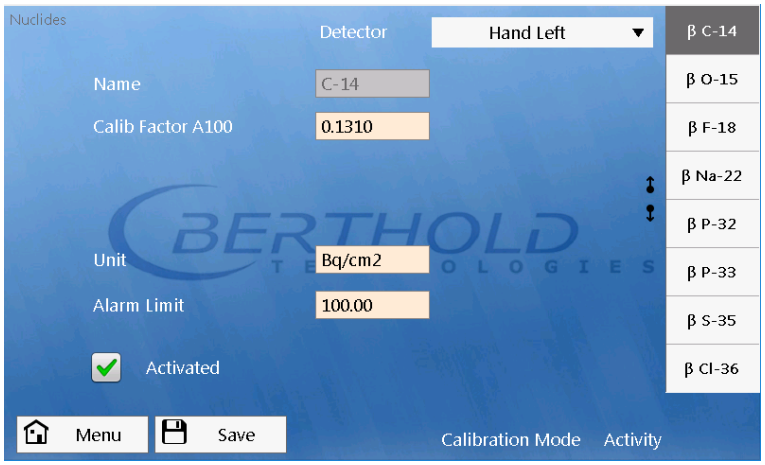


Fig. 24 Nuclides menu with calibration factor according to A100

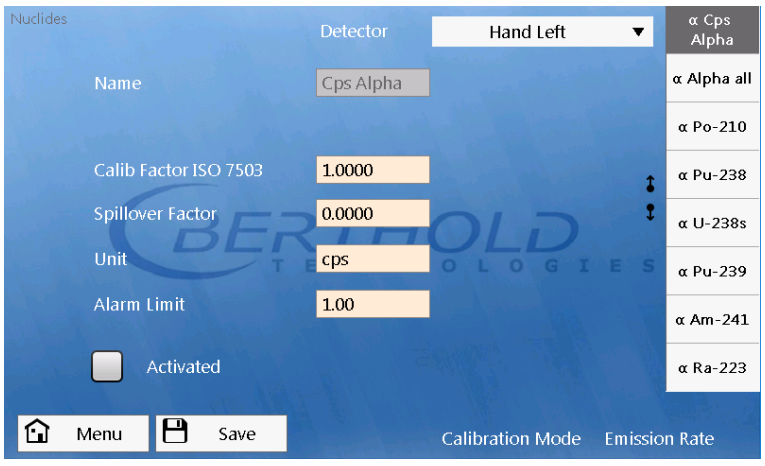


Fig. 25 Nuclides menu with calibration factor according to ISO 7503

IMPORTANT

Only the nuclides activated here can be selected in the measurement mode and in the nuclide preselection in the menu | Parameter (see chapter 7.6).

Detector	Selection of the detector. The settings in the lower input fields only apply to the selected detector.
Calib Factor A100	(Only admin) Input field of the calibration factor (see 10.2 Calibration Factors and Efficiencies according to A-100).
Calib Factor ISO 7503	(Only admin) Input field of the calibration factor ISO 7503 (see 10.1 Calibration Factors and Efficiencies according to ISO 7503-1).
Spillover Factor	Enter the share of the alpha source that causes emissions in the Beta channel. Values from 0 to 1. ▶ Example: Am-241 has a 30% share in the Beta channel. Input value: 0.3. 30% (Am-241 share) are subtracted in the Beta channel.
Unit	(Only admin) Enter the unit.
Alarm Limit	Enter the nuclide-specific alarm limit.

7.6 Parameters

In this submenu, you can set all measurement parameters, e.g. the measuring time, the calibration factors, certain limit values, etc.

Since some of these parameters are nuclide-specific, we recommend to select all required alpha and beta nuclides first in the menu | Nuclides (see chapter 7.5), before you enter the following parameters:

Fig. 26 Parameter menu page 1 and 2

Meas Time [s] Enter the measuring time in seconds for the contamination measurement. This time applies to both the hand-foot measurement and the back of hands measurement.

Activated Channel Here you select the active measuring channel. You can choose Alpha, Beta or Alpha and Beta.

Bkg Average Time [s] Enter the time period for averaging the background in seconds.

Bkg Check after Measurement If this checkbox is ticked, a check if performed after each contamination measurement to see whether the background after the contamination measurement deviates significantly from the background before the measurement. In this manner one can find out whether a detector has been contaminated by a person.

Bkg Check Time [s] Enter the time period for the background measurement in seconds.

Calibration (Only Admin) Selection field to determine the calibration factors of the individual hand and foot detectors according to the standard/method. ISO 7503-1 (emission rate and effective detector area) or A100 (activity and 100 cm² active surface of the calibration source) are available for choice.

Fail Threshold ß [cps]

Enter the minimum background count rates in the Beta channel.

If one of these thresholds is undershot, a message is output on the display, the corresponding relay output (fault) is set and no further measurement is possible any more. Unless the option “Ready to measure - If Detector Failure –” (see chapter 7.14) is enabled.

Threshold Bkg [cps]

Enter the maximum background count rate for the continuous background check.

If one of these thresholds are exceeded, the execution of further contamination measurements may be permitted via a parameter.

Auto Save

The measured values are stored automatically when “After measurement” or “On alarm” is selected.

Fig. 27 Parameter menu page 3 and 4

Measure Back of hands

When this parameter is activated, you are prompted to perform a back of hand measurement following the regular hand-foot measurement.

Display Result / Threshold

If this parameter is enabled, the measured value is displayed relative to the contamination limit value.

Meas Time depending Background	When this function is enabled, the measurement time is automatically extended by the amount of the increased background, so that the same detection limit is reached again. This function should be enabled when higher backgrounds are expected and the detection limits reached with these background values are only slightly below the alarm values. We recommend to set up the device in an environment without high or fluctuating ambient level.
Reset Alarm with Password	Reset after alarm (contamination). When activated, an alarm (contamination) must be reset by pressing the <Res. Alarm> and entry of the password (see chapter 7.13 Password).
Alarm Duration [s]	Duration of the alarm of the internal speaker in case of contamination.
Preset Nuclides	If this checkbox is activated, the nuclide selected here is displayed during the contamination measurement.

NOTE

We recommend to enable the checkbox “Reset Alarm with Password” by default to be able to identify contaminated persons.

7.7 Measurement Data

The measurement data can be viewed, opened and deleted in this submenu. Swiping to the left displays more values (characteristic limits according to DIN ISO 11929).

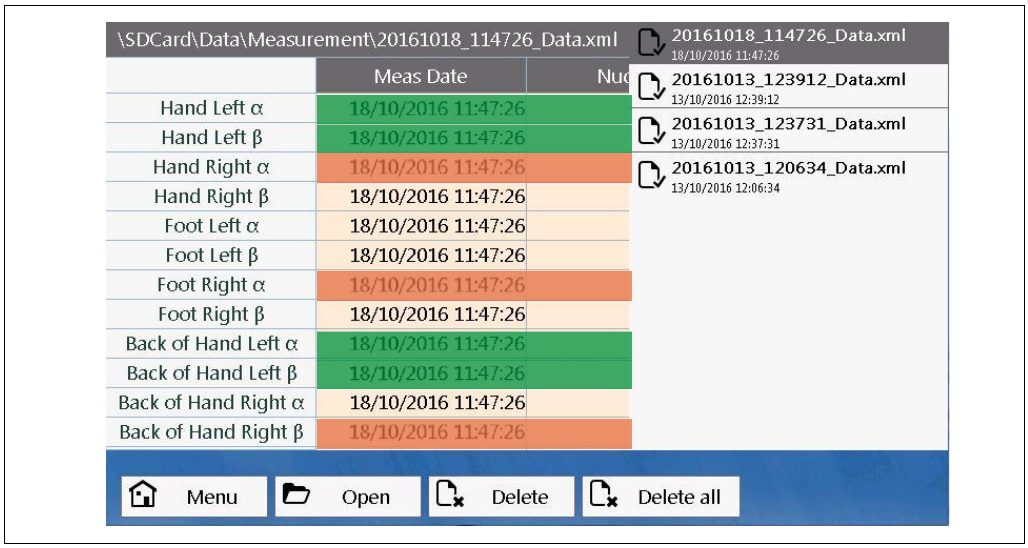


Fig. 28 Measurement Data menu

Green background	Not contaminated.
Red background	Contaminated
Beige background	Not measured.

7.8 Copy to USB

In this submenu, stored measurement data and parameters can be saved to a USB stick or loaded from a USB stick.

- Insert a USB stick into one of the USB ports on the rear panel (Fig. 5, items 8, 9).
- The system automatically detects the USB flash drive.

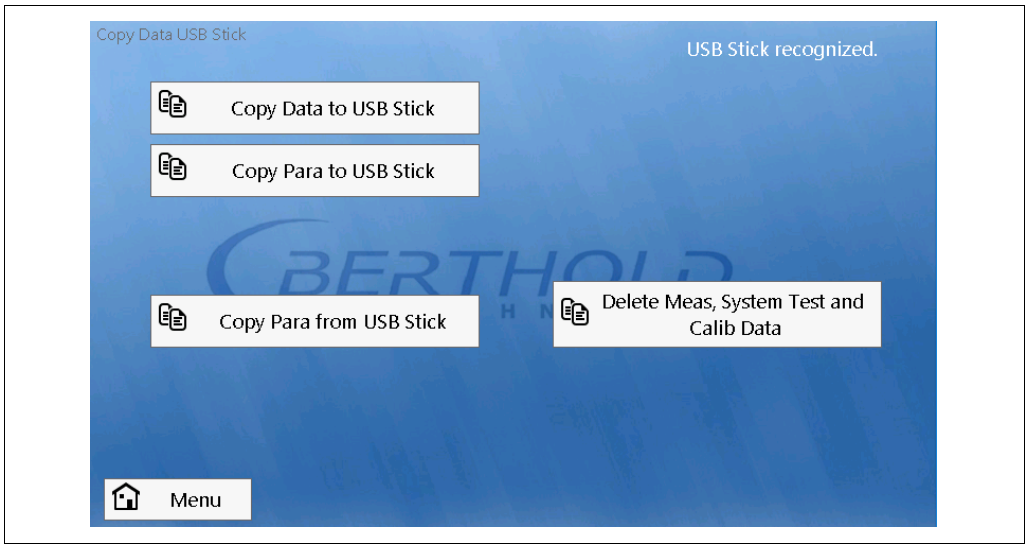


Fig. 29 Copy to USB menu

NOTE

Press <Delete Meas, System Test and Calib Data> to delete the data stored in the system.

7.9 System Test Data

System test protocols can be viewed, opened and deleted in this submenu.

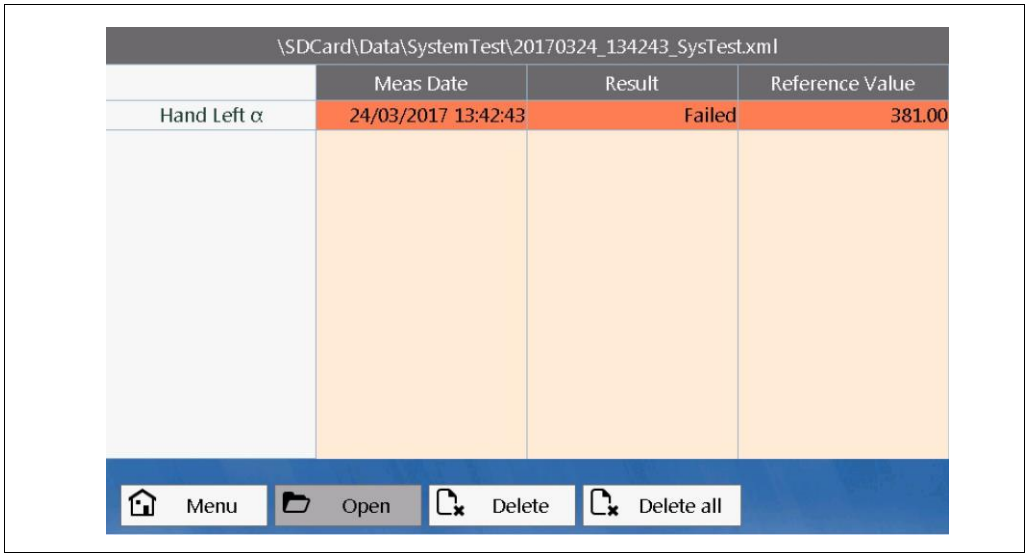


Fig. 30 System Test Data menu

7.10 System Test

The system test allows you to check the correct function of the device. The same parameters and the same measurement geometry must be selected as for the calibration (see chapter 7.11 Calibration). The system test consist a background measurement and a measurement of a reference source. The user is guided step-by-step through the measurement routine (Fig. 31).

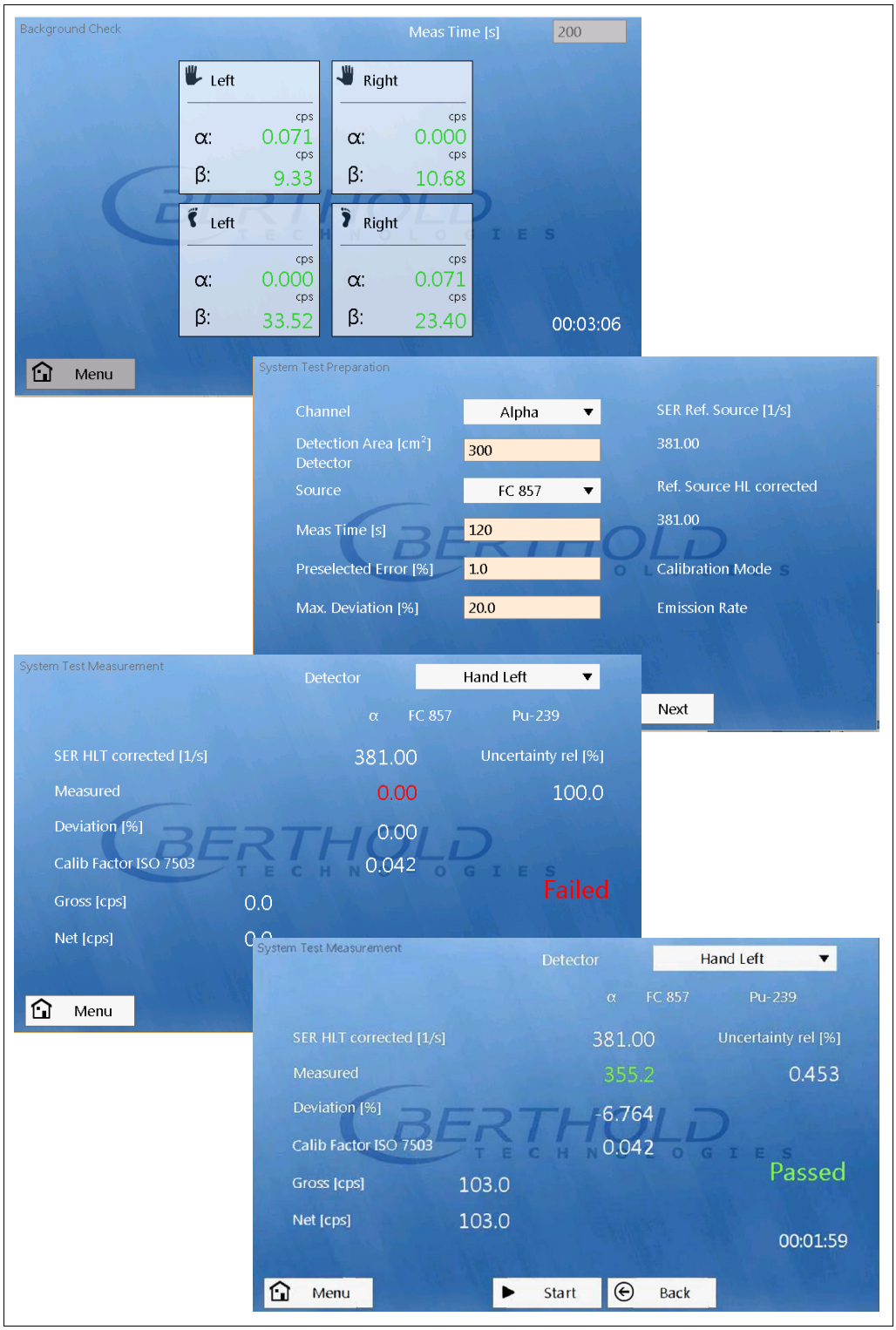


Fig. 31 System Test menu

7.11 Calibration

The calibration is the most important measurement before using the equipment. It requires careful preparations. The results of this measurement have a decisive influence on contamination measurements.

Fig. 32 Calibration menu

The following issues should be clarified in advance:

- Available calibration sources:

The calibration source is first defined in the menu | Test source (see chapter 7.12), here you enter the half-life, the reference date and the emission rate or activity as stated in the calibration sheet of the source. Now you can select this calibration source in the <Source> selection field in the menu | Calibration.

NOTE

Only certified sources may be used for calibration!

It is recommended that the calibration sources have an active area of 10x10 cm^2 and the uncertainty of the calibration sources should be ≤ 5 %.

The calibration mode is automatically preset according to the setting in the menu | Parameters (see chapter 7.6).

NOTE

If no values are given for the emission rate or activity, you may not perform a calibration in the respective mode.

Performing a Calibration

The calibration routine consists of a background measurement and a subsequent calibration measurement.

Both can be interrupted manually at any time using <Stop> and then restarted (<Start>). After the measuring time has elapsed or if you terminate the background measurement with <Stop>, you can define the calibration parameters (Fig. 32 centre).

- Measurement regulations:

Enter your data (e.g. the detection area, the calibration source or the calibration mode) in accordance with your regulations.
The detection area is dependent on the calibration mode and, for example, either on the area of the calibration source or the area of the detector. The duration of the measurements is indicated with the measuring times for the previous background measurement and for the calibration measurement, alternatively the preset error for a premature automatic termination of the calibration measurement.

The calibration measurement can then be started with the <Next>.

NOTE

Influences from neighbouring radiation sources must be prevented in order to avoid errors in the measurement of natural background radiation.

7.12 Test Source

In this submenu, the parameters are defined in accordance with the calibration certificate of the calibration source (Fig. 33). A total of 5 alpha calibration sources and 15 beta calibration sources can be created.

The LB 147 includes an automatic half-life correction of the test source activity. The measured activity A is converted with regard to the date (and time) T0.

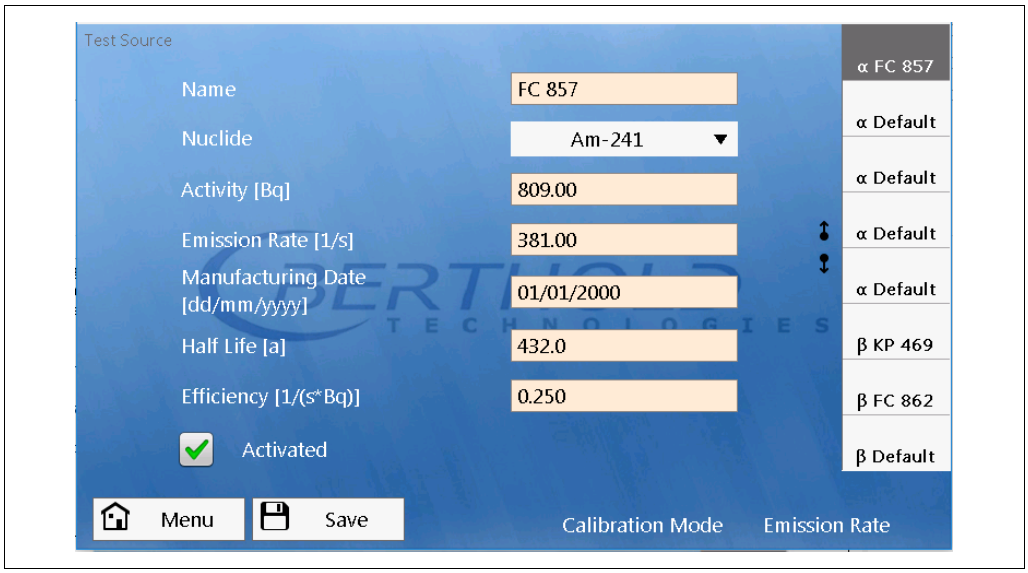


Fig. 33 Test source menu

7.13 Password

In this submenu passwords for different user levels can be created (selection option depends on the currently logged in user).

- Administrator password
- User password
- Password to reset alarms

All parameters of the LB 147 are password protected to protect the device from unauthorized access. To get access to the menus (by tapping <Menu>), you have to log on to the device (Fig. 12, item 1).

Fig. 34 Password menu (with administrator rights)

NOTE

If no password is entered, the password entry is disabled.

- Default password: 1111

7.14 Ready to Measure

Here you can define which error messages / alarms should still allow measurements to be performed.

If the device is still operational despite an error message, the respective message is output on the display; however, a contamination measurement can still be performed after you have stepped onto the monitor or have taken off the hand probe.

In this menu, the execution of contamination measurements can be enabled by ticking the checkbox if

- the measurement data memory is full
- one detector fails
- the background of one detector is too high
- one detector channels supplies a count rate that is too high
- if the background varies

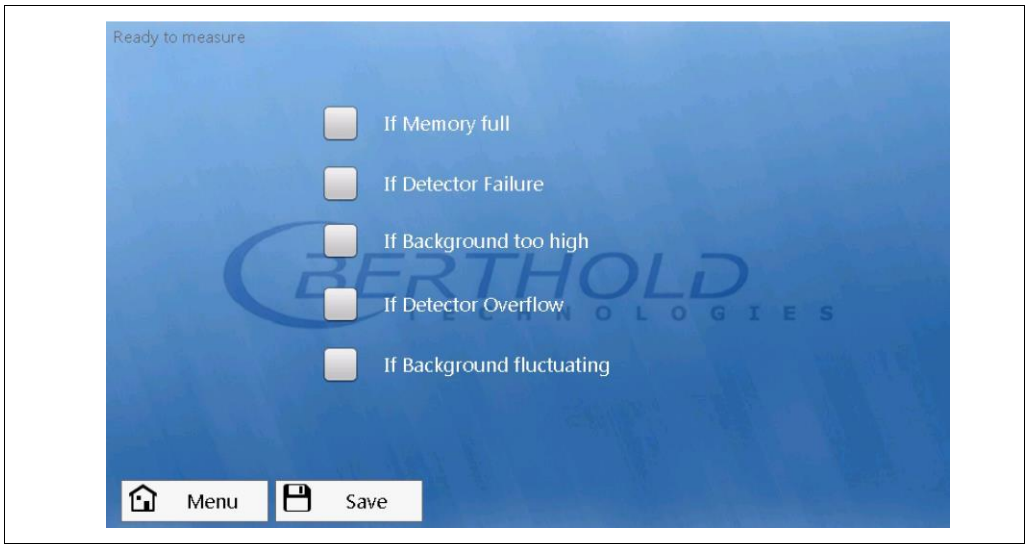


Fig. 35 Ready to measure menu

NOTE

Activating the option “If memory full” means that new measurement data are no longer stored.

7.15 Factory Settings

In this submenu you can reset individual or all instrument parameters to their default values (depending on the rights of the logged in user).

First, either select individual parameters or select all parameters by tapping <Select all>. Then reset them to the factory settings by tapping <Apply>. By touching <Delete Meas, System Test and Calib Data> all measurements, system test and calibration data stored in the system are deleted.

NOTE

Factory settings should be selected only in exceptional cases, because then you have to re-enter all parameters that differ from the factory settings!

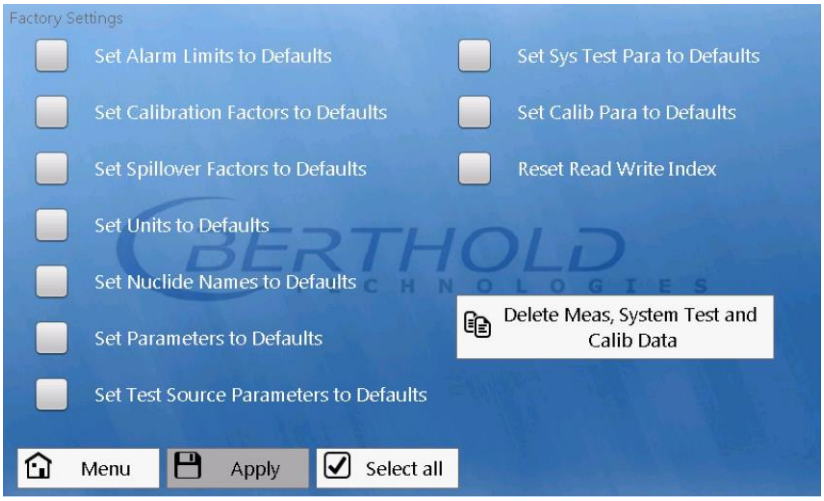


Fig. 36 Factory Settings menu

Set Alarm Limits to Defaults	The entered values are reset to the factory default value.
Set Calibration Factors to Defaults	(Only admin) The entered values are reset to the factory default value.
Set Spillover Factors to Defaults	The entered spillover factors of all nuclides are reset.
Set Units to Defaults	(Only admin) Changed units are reset to their factory setting.
Set Nuclide Names to Defaults	Changed nuclide names are reset to their factory setting.
Set Parameters to Defaults	All parameters are reset to the factory setting.
Set Test Source Parameters to Defaults	The test source parameters are reset to the factory setting.
Set Sys Test Para to Defaults	If a system test was carried out, it will be deleted and the factory settings will be restored.

Set Calib Para to Defaults	All calibration parameters are reset to the factory setting.
Reset Read Write Index	The write and read index for memory access is reset to 0.
Delete Meas, System Test and Calib Data	Tap this button to delete all measurement, system test and calibration data stored in the system.

7.16 Hardware Test

In this submenu, the hardware of the device can be tested for function. With the <Rem Disp> button, the remote control of the display can be enabled via the PC. The internal speaker can be tested with <Play>.

Fig. 37 Hardware Test menu

7.17 Connect

By activating the CE Remote Control via <Rem Disp> in the Hardware menu (Fig. 37), the device can be operated via the network connection.

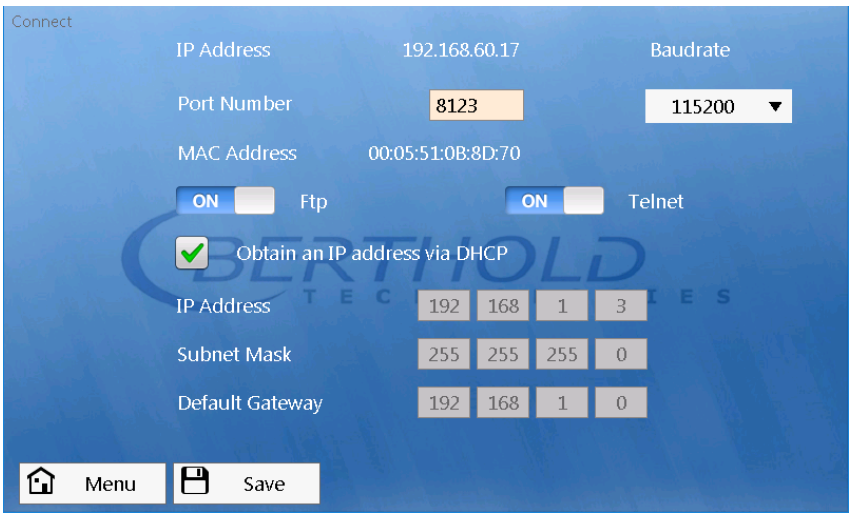
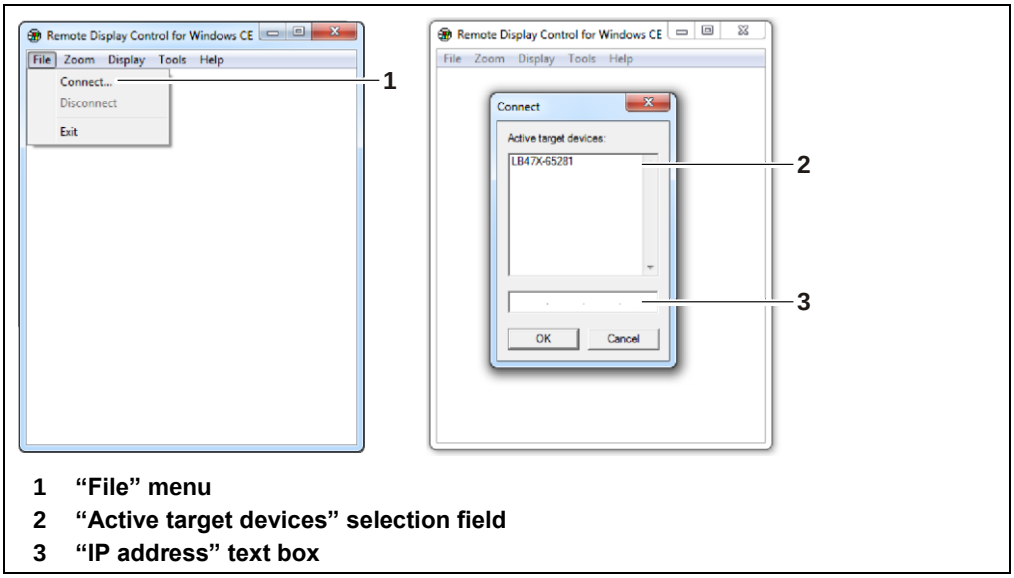


Fig. 38 Connect menu

Remote Control Software

IMPORTANT

Tap <Rem Disp> (see chapter 7.16 Hardware Test) to enable the remote control.



1 "File" menu
2 "Active target devices" selection field
3 "IP address" text box

Fig. 39 Remote Control Software

1. Click **"RemoteControl.exe“** to start the program.

▶ The program is started.

2. Click on the File | Connect… (Fig. 39, item 1) to connect to the LB 147.

▶ A new “Connect” window opens (Fig. 39, item 2).

IMPORTANT

The IP address of the LB 147 must be in the same subnet (Fig. 38) as the network adapter of the computer.

3. Click the detected device in the <Active target devices> selection field (Fig. 39, item 2). In the text box (Fig. 39, item 3), enter the IP address of the LB 147 (Fig. 38), if the device is not listed.

4. Click <OK>.

▶ The connection to the LB 147 is established.

8 Maintenance

This section describes how to replace fuses and how to clean the Contamination Monitor LB 147.

8.1 Safety Instructions

⚠ DANGER

Risk of electric shock when cleaning with a water jet

Injuries from electric shock when cleaning the measuring system with a full water jet or high-pressure cleaner and with the mains voltage connected.

- The measuring system is not suitable for cleaning with a high-pressure cleaner or water jet.

⚠ DANGER

Risk of electric shock when wet

Injury from electric shock if moisture enters the connector strip and you are working on power lines that are connected in the terminal compartment with the power supply turned on.

- Check the plug-in connections regularly for correct locking.

NOTE

Observe the appropriate safety regulations when working on electrical components. In particular, pay attention to the safety instructions in the “Safety” chapter. Disconnect the Contamination Monitor LB 147, possibly connected relay contacts and all inputs and outputs from power.

IMPORTANT

Please observe the relevant national regulations in your country!

Repair and maintenance work on the Contamination Monitor LB 147 may only be carried out by trained personnel (see chapter 2.3). If in doubt, return the complete Contamination Monitor LB 147 to Berthold.

IMPORTANT

To achieve the best accuracy, Berthold recommends to recalibrate the measuring system after maintenance.

8.2 Replacing the Fuse

⚠ DANGER

Risk of fatal injury due to electric shock!

Fuses should be replaced only by a certified electrician.

- Always observe the relevant safety regulations.
- Perform installation/maintenance only when the device is disconnected from power.

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

NOTE

Equipment damage! Short circuit!

The Contamination Monitor LB 147 can be damaged if the wrong fuse is used.

- Only use fuses that match the fuses of the power supply module.

Fuse:

- 2x fine-wire fuses 2A, slow for 250 VAC

Replacing the fuse in the power supply module

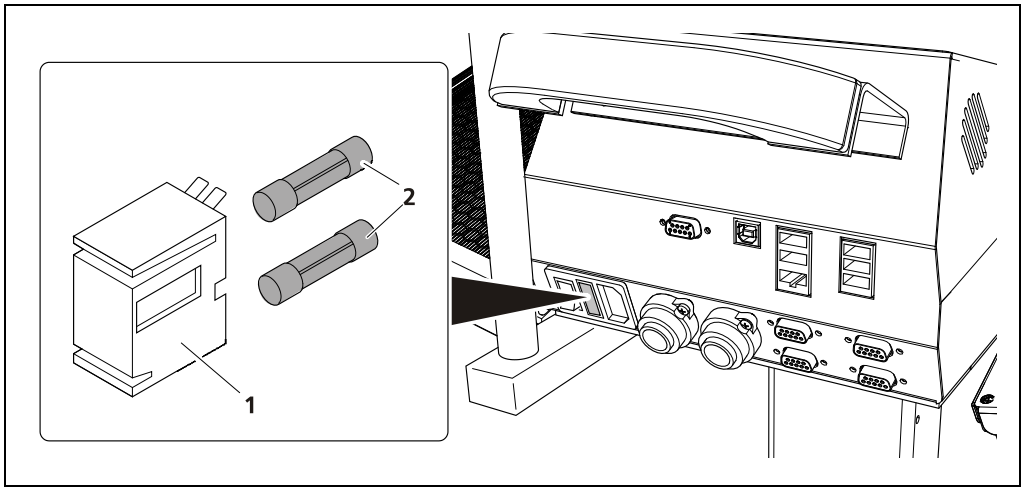


Fig. 40 Fuse replacement

1. Turn off the device and pull the plug of the power cord.
2. Remove the fuse holder (Fig. 40, item 1).
3. Remove the fuses (Fig. 40, item 2).
4. Insert the new fuse and replace the holder again.

8.3 Cleaning the Display

NOTE

Damage to the touch display!
The touch display can be damaged by solvents and abrasive additives.

- Clean touch display with a damp cloth only.

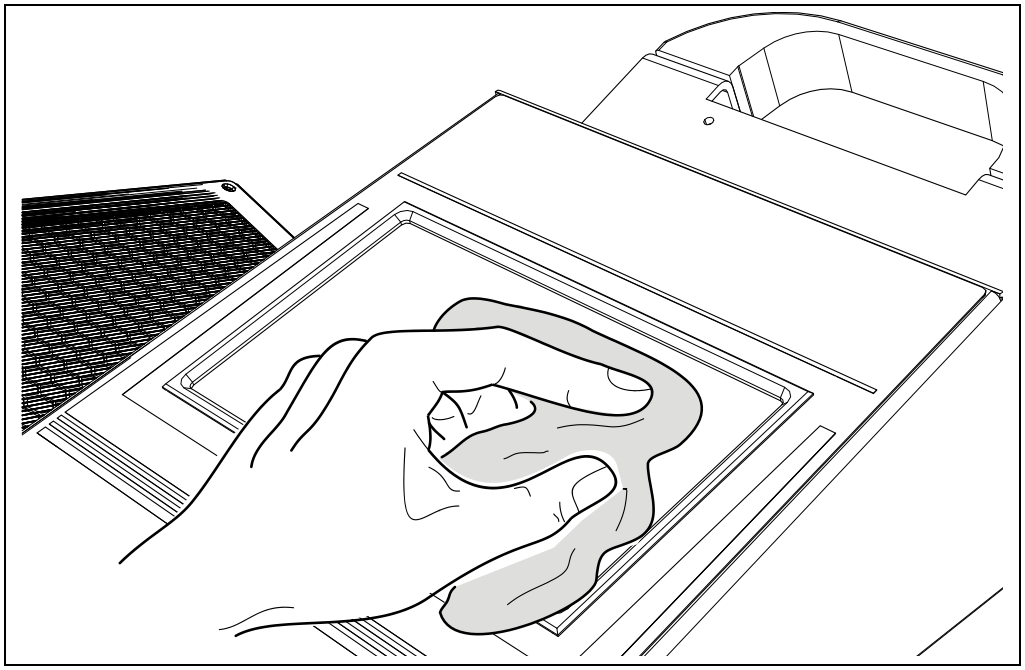


Fig. 41 Cleaning the display

- Clean the front panel and the touch display with a damp cloth.

8.4 Cleaning the Foot Plate

NOTE

Equipment damage! Do not use water!
Make sure the protective foil of the detector is not damaged.

- Use only a brush or vacuum cleaner for cleaning.
- In case of heavy and adhesive pollution, you have to remove the foot plate for cleaning.

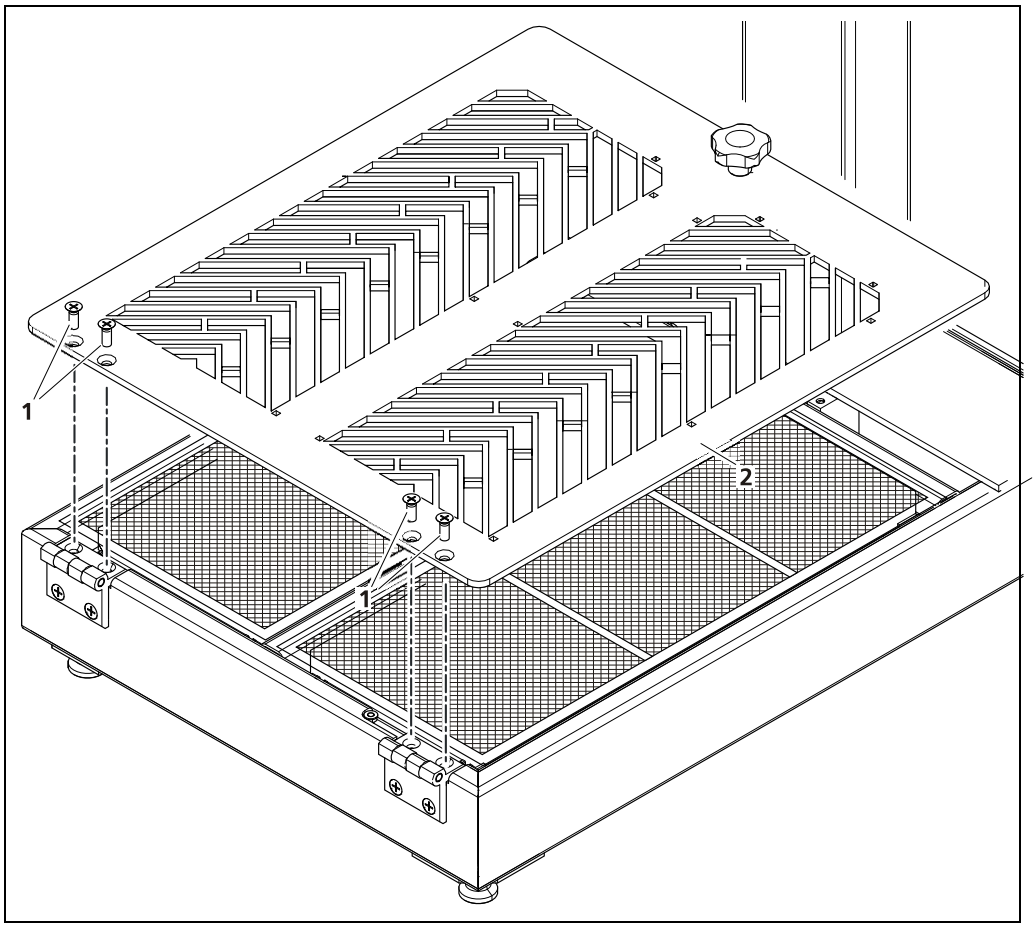


Fig. 42 Cleaning the foot

Cleaning heavy and adhesive pollution

1. Turn off the device and pull the plug of the power cord.
2. Unscrew the four screws (Fig. 42, item 1) at the hinges.
3. Remove the foot plate (Fig. 42, item 2) carefully.
4. Secure the Contamination Monitor against unauthorized use.
5. Clean the foot plate in a suitable location.
   - Allow the foot plate to dry, if necessary.
6. Place the foot plate gently onto the frame and tighten the 4 Phillips screws.

8.5 Cleaning the Foot Detectors

NOTE

Equipment damage! Do not touch the protective foil!

The protective foil is very thin and must not be damaged.

- Clean only with mild air pressure.

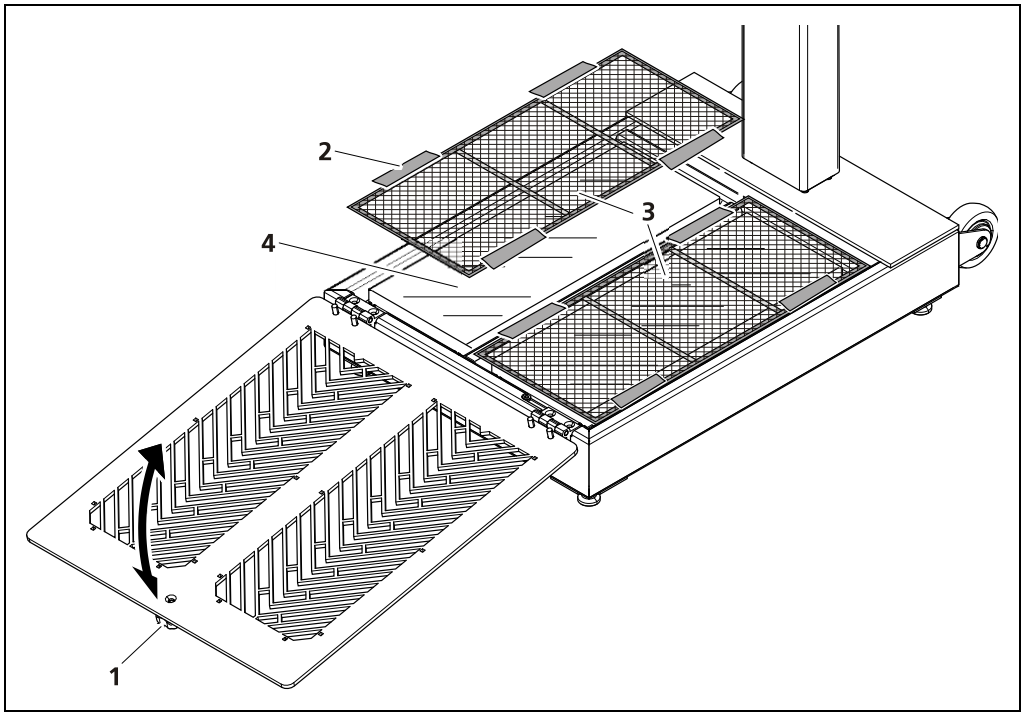


Fig. 43 Cleaning the foot detectors

1. Lift the foot plate (Fig. 43, item 1) at the handle and fold back the foot plate carefully until it rests on the floor.
2. Remove the adhesive tapes (Fig. 43, item 2).
3. Remove both grid foils (Fig. 43, item 2) carefully.
4. Clean the grid foil with a soft brush or use mild air pressure.

- Replace the grid foil, if necessary.

5. Remove the dirt from the protective foil using mild air pressure (Fig. 43, item 4).
6. Install both cleaned or new grid foils and fix both grid foils to the edges with adhesive strips.

8.6 Cleaning the Hand Detectors

NOTE

Equipment damage! Do not touch the protective foil!

The protective foil is very thin and must not be damaged.

- Clean only with mild air pressure.

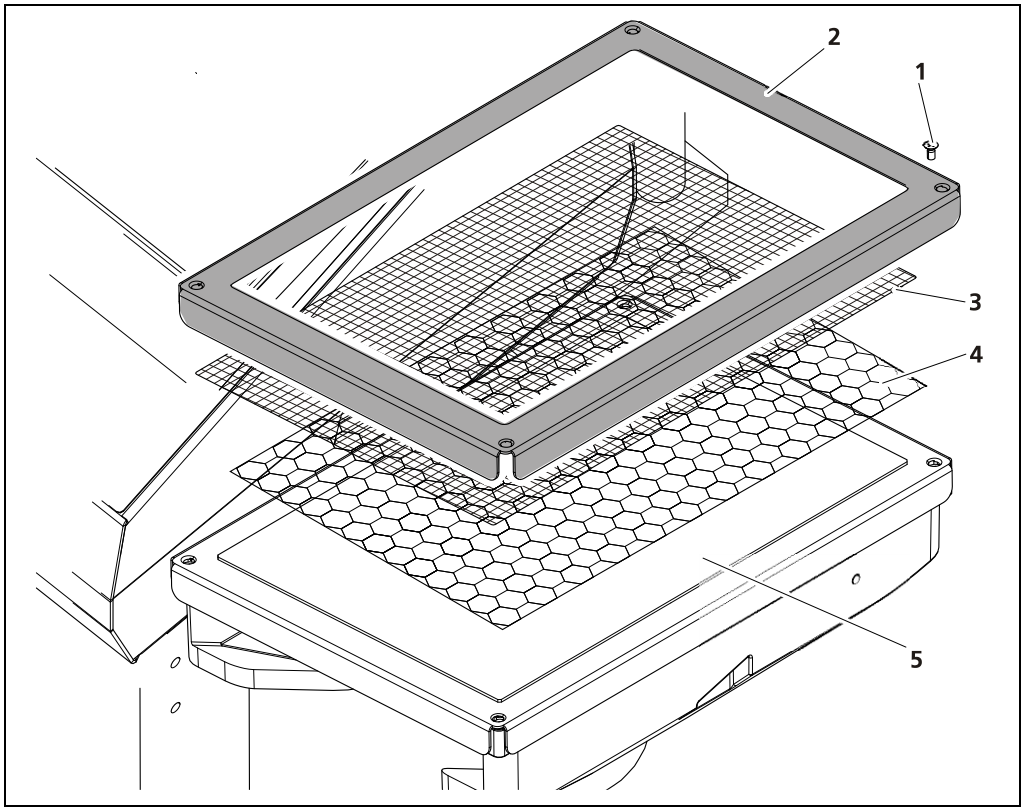


Fig. 44 Cleaning the hand detectors

1. Open the 4 Phillips head screws (Fig. 44, item 1) and remove the frame (Fig. 44, item 2).
2. Remove the grid foil (Fig. 44, item 3) carefully.
3. Clean the grid foil with a soft brush or use mild air pressure.
4. Replace the grid foil, if necessary.
5. Remove the honeycomb grid (Fig. 44, item 2) carefully.
6. Remove the dirt from the protective foil using mild air pressure (Fig. 44, item 5).
7. Insert the honeycomb grid (Fig. 44, item 3) carefully.
8. Insert the cleaned grid foil (Fig. 44, item 2) and attach the frame.
9. Fix the frame with 4 Phillips head screws.
10. Proceed in the same manner with the second hand detector.

9 Technical Information

9.1 Technical Data

Electronics	
CPU	NXP i.MX 6 ARM Cortex-A9 Windows Embedded Compact 2013
Display	Coloured 7" Touch Panel 800 x 480 pixels
Ports	5 USB (Host), 1 USB (Device) 1 Ethernet 10/100/1000Mb, 1 RS232, 1 RS485
External signal transmitters	3 relays max. 50V, 5A

Power supply
100 – 240 VAC wide-range input, 50/60 Hz
Power consumption: about 14.5 W, Fuse: 2A slow

Relay outputs
max. 50 V, 5 A

Ambient conditions	
Temperature range	-5°C to 40°C
Rel. humidity	0 to 90%, non-condensing

Mechanical Specifications	
Dimensions and required floor space without signal tower	65 cm x 125 cm x 80 cm (W x H x D)
Weight	approx. 35 kg

Mechanical Specifications	
Dimensions and required floor space without signal tower	45 cm x 125 cm x 90 cm (W x H x D)
Weight	approx. 25 kg

9.2 Detectors

Radiation detector	ZnS(Ag) scintillator
Material entrance window	2 x 3 µm metallized plastic (0.4mg/cm²)

Hand detectors		
Dimensions entrance window	150 mm x 230 mm	
Sensitive area	345 cm²	
Transmission protective grid	80 %	
Background	α channel β-γ channel	about 0.1 cps about 15 cps
Typical efficiencies (ISO 7503-1):	Am-241 C-14 Cl-36 Sr-90/Y-90	33 % 20 % 49 % 52 %

Foot detectors		
Dimensions entrance window	150 mm x 370 mm	
Sensitive area	555 cm²	
Transmission protective grid	72 %	
Background	α channel β-γ channel	about 0.2 cps about 40 cps
Typical efficiencies (ISO 7503-1):	Am-241 C-14 Cl-36 Sr-90/Y-90	19 % 21 % 54 % 43 %

9.3 Accessories

Description	ID no.
Mobile set	52874
Transponder system (RFID)	66164
Chip / Card	59495 / 59503
Magnetic card reader	66442
Magnetic card	34481
Signal tower LB 147	65252
Calibration source ^{36}Cl / ^{241}Am	29336 / 25509
Stomach probe LB 1236-H10	53516
Thyroid probe LB 1234	53517
Package stomach and thyroid probe	49950
HFC program: Database for measured data	UMAD HFC

10 Appendix

10.1 Calibration Factors and Efficiencies according to ISO 7503-1

(Parameters are stored in the device)

Efficiency, response and calibration factors of HFC Monitor - Berthold LB 147 Foot									
No.	Nuclide	eff_{src}	CH	ISO 7503-1					Limit values[1)]
				Efficiency [%]	Response [s-1Bq-cm2]	Calibration factor [s Bq cm-2]	Decision threshold (DC) [Bq/cm²]	Minimum detectable activity (MDA) [Bq/cm²]	Surface contamination [Bq/cm²]
1	Beta	0.50	b-g	47.8%	71.74	0.014	0.096	0.212	
2	C-11	0.50	b-g	57.3%	85.89	0.012	0.080	0.177	
3	N-13	0.50	b-g	57.7%	86.61	0.012	0.079	0.176	
4	C-14	0.25	b-g	21.4%	16.01	0.063	0.430	0.954	100
5	O-15	0.50	b-g	57.9%	86.79	0.012	0.079	0.176	
6	F-18	0.50	b-g	66.6%	99.86	0.010	0.069	0.153	1
7	Na-22	0.50	b-g	51.8%	77.75	0.013	0.089	0.197	1
8	P-32	0.50	b-g	51.7%	77.48	0.013	0.089	0.199	100
9	P-33	0.25	b-g	37.4%	28.07	0.036	0.244	0.542	100
10	S-35	0.25	b-g	14.0%	10.49	0.096	0.657	1.458	100
11	Cl-36	0.50	b-g	53.7%	80.49	0.013	0.086	0.191	100
12	K-40	0.50	b-g	28.9%	43.30	0.023	0.159	0.353	10
13	K-42	0.50	b-g	57.9%	86.79	0.012	0.079	0.176	10
14	Ca-45	0.25	b-g	29.4%	22.06	0.045	0.312	0.692	100
15	Sc-46	0.25	b-g	41.6%	31.19	0.032	0.221	0.490	1
16	Ca-47+	0.50	b-g	4.8%	7.23	0.138	0.952	2.112	1
17	Cr-51	0.50	b-g	0.05%	0.08	12.953	89.137	197.783	100
18	Mn-54	0.50	b-g	2.3%	3.41	0.294	2.020	4.482	1
19	Fe-55	0.50	b-g	0.3%	0.50	2.467	16.974	37.663	100
20	Co-57	0.50	b-g	6.1%	9.12	0.110	0.757	1.680	10
21	Co-58	0.50	b-g	14.0%	21.00	0.048	0.327	0.725	1
22	Fe-59	0.50	b-g	46.6%	69.92	0.015	0.100	0.221	1
23	Co-60	0.25	b-g	40.0%	30.02	0.033	0.229	0.508	1
24	Ni-63	0.25	b-g	0.03%	0.0	41.594	286.242	635.132	100
25	Ga-67	0.50	b-g	13.7%	20.55	0.049	0.337	0.748	
26	Se-75	0.50	b-g	9.1%	13.64	0.074	0.509	1.130	10
27	Sr-85	0.50	b-g	2.4%	3.62	0.277	1.903	4.222	1
28	Rb-86	0.50	b-g	57.9%	86.79	0.012	0.079	0.176	10

Efficiency, response and calibration factors of HFC Monitor - Berthold LB 147 Foot									
No.	Nuclide	eff_{src}	CH	ISO 7503-1					Limit values[1]
				Efficiency [%]	Response [s-1Bq-cm2]	Calibration factor [s Bq cm-2]	Decision threshold (DC) [Bq/cm²]	Minimum detectable activity (MDA) [Bq/cm²]	Surface contamination [Bq/cm²]
29	Sr-89	0.50	b-g	49.0%	73.46	0.014	0.093	0.206	100
30	Sr-90+	0.50	b-g	42.8%	64.19	0.017	0.115	0.254	1
31	Y-90	0.50	b-g	46.1%	69.18	0.015	0.100	0.221	100
32	Tc-99	0.25	b-g	48.7%	36.54	0.028	0.189	0.420	100
33	Tc-99m	0.50	b-g	11.0%	16.56	0.061	0.416	0.924	10
34	Ru-106+	0.50	b-g	57.9%	86.79	0.012	0.079	0.176	10
35	In-111	0.50	b-g	18.2%	27.36	0.037	0.255	0.565	10
36	Sn-113+	0.50	b-g	35.1%	52.62	0.019	0.131	0.290	10
37	In-114m+	0.50	b-g	1.2%	1.81	0.553	3.806	8.446	10
38	I-123	0.50	b-g	19.6%	29.47	0.034	0.234	0.519	10
39	I-125	0.25	b-g	10.6%	7.93	0.126	0.869	1.928	10
40	I-131	0.50	b-g	67.4%	101.15	0.010	0.068	0.151	10
41	Cs-137+	0.50	b-g	56.2%	84.36	0.012	0.083	0.184	1
42	Pm-147	0.25	b-g	22.3%	16.73	0.060	0.412	0.913	100
43	Sm-153	0.50	b-g	50.2%	75.29	0.013	0.089	0.199	10
44	Er-169	0.25	b-g	39.6%	29.70	0.034	0.231	0.512	100
45	Lu-177	0,50	b-g	51,9%	77,79	0,013	0,057	0,129	100
46	Re-186	0.50	b-g	50.8%	76.25	0.013	0.089	0.199	100
47	Re-188	0.50	b-g	54.0%	80.98	0.013	0.086	0.191	10
48	Au-198	0.50	b-g	57.3%	85.89	0.012	0.080	0.177	10
49	Tl-201	0.50	b-g	1.9%	2.85	0.352	2.419	5.367	10
50	Tl-204	0.50	b-g	52.3%	78.41	0.013	0.086	0.191	100
51	Pu-238	0.25	b-g	14.7%	11.05	0.092	0.630	1.397	0.1
52	U-238sec	0.25	b-g	78.8%	59.09	0.017	0.119	0.263	1
53	Am-241	0.25	b-g	8.6%	9.60	0.133	0.912	2.023	0.1
54	Po-210	0.25	a	16.6%	12.43	0.081	0.019	0.062	1
55	Ra-223+	0,25	a	105,6%	79,22	0,013	0,003	0,010	1
56	Pu-238	0.25	a	14.1%	10.59	0.130	0.031	0.100	0.1
57	U-238sec	0.25	a	3.6%	2.70	0.372	0.090	0.289	1
58	Pu-239	0.25	a	27.7%	20.79	0.048	0.012	0.037	0.1
59	Am-241	0.25	a	18.9%	14.18	0.071	0.017	0.055	0.1
60	Alpha	0.25	a	18.2%	13.65	0.073	0.018	0.057	0.1

1) Limits are from the German Radiation Protection Ordinance 2001, Annex III, Table 1, column 4

Efficiency, response and calibration factors of HFC Monitor - Berthold LB 147 Hand									
No.	Nuclide	eff_{src}	CH	ISO 7503-1					Limit values[1]
				Efficiency [%]	Response [s-1Bq-cm2]	Calibration factor [s Bq cm-2]	Decision threshold (DC) [Bq/cm²]	Minimum detectable activity (MDA) [Bq/cm²]	Surface contamination [Bq/cm²]
1	Beta	0.50	b-g	55.3%	82.97	0.012	0.051	0.118	
2	C-11	0.50	b-g	66.2%	99.34	0.010	0.043	0.099	
3	N-13	0.50	b-g	66.8%	100.17	0.010	0.042	0.098	
4	C-14	0.25	b-g	20.4%	15.31	0.066	0.279	0.649	100
5	O-15	0.50	b-g	66.9%	100.38	0.010	0.042	0.098	
6	F-18	0.50	b-g	60.7%	90.99	0.011	0.046	0.108	1
7	Na-22	0.50	b-g	60.0%	89.93	0.011	0.047	0.109	1
8	P-32	0.50	b-g	43.8%	65.66	0.025	0.106	0.247	100
9	P-33	0.25	b-g	35.4%	26.58	0.038	0.160	0.372	100
10	S-35	0.25	b-g	14.1%	10.56	0.096	0.403	0.935	100
11	Cl-36	0.50	b-g	49.3%	74.01	0.014	0.058	0.135	100
12	K-40	0.50	b-g	66.8%	100.17	0.010	0.042	0.098	10
13	K-42	0.50	b-g	66.9%	100.38	0.010	0.042	0.098	10
14	Ca-45	0.25	b-g	34.0%	25.51	0.039	0.165	0.384	100
15	Sc-46	0.25	b-g	48.1%	36.08	0.028	0.117	0.271	1
16	Ca-47+	0.50	b-g	5.6%	8.37	0.120	0.504	1.170	1
17	Cr-51	0.50	b-g	0.04%	0.06	17.583	74.113	172.196	100
18	Mn-54	0.50	b-g	1.8%	2.70	0.372	1.566	3.638	1
19	Fe-55	0.50	b-g	0.3%	0.38	3.653	15.395	35.770	100
20	Co-57	0.50	b-g	5.2%	7.87	0.128	0.537	1.249	10
22	Fe-59	0.50	b-g	44.6%	66.98	0.015	0.063	0.147	1
23	Co-60	0.25	b-g	36.8%	27.56	0.037	0.154	0.357	1
24	Ni-63	0.25	b-g	0.1%	0.08	12.353	52.068	120.977	100
25	Ga-67	0.50	b-g	13.5%	20.18	0.050	0.211	0.490	
26	Se-75	0.50	b-g	7.4%	11.05	0.091	0.384	0.891	10
27	Sr-85	0.50	b-g	2.8%	4.18	0.239	1.008	2.342	1
28	Rb-86	0.50	b-g	66.9%	100.38	0.010	0.042	0.098	10
29	Sr-89	0.50	b-g	49.5%	74.23	0.014	0.057	0.132	100
30	Sr-90+	0.50	b-g	52.3%	78.39	0.013	0.054	0.126	1
31	Y-90	0.50	b-g	54.1%	81.22	0.013	0.053	0.122	100
32	Tc-99	0.25	b-g	38.1%	28.58	0.036	0.150	0.348	100
33	Tc-99m	0.50	b-g	10.6%	15.93	0.064	0.269	0.624	10
34	Ru-106+	0.50	b-g	66.9%	100.38	0.010	0.042	0.098	10
35	In-111	0.50	b-g	17.0%	25.45	0.039	0.164	0.382	10
36	Sn-113+	0.50	b-g	32.8%	49.16	0.021	0.086	0.201	10
37	In-114m+	0.50	b-g	1.4%	2.09	0.478	2.016	4.683	10
38	I-123	0.50	b-g	19.0%	28.51	0.036	0.150	0.348	10

Efficiency, response and calibration factors of HFC Monitor - Berthold LB 147 Hand									
No.	Nuclide	eff_{src}	CH	ISO 7503-1					Limit values[1]
				Efficiency [%]	Response [s-1Bq-cm2]	Calibration factor [s Bq cm-2]	Decision threshold (DC) [Bq/cm²]	Minimum detectable activity (MDA) [Bq/cm²]	Surface contamination [Bq/cm²]
39	I-125	0.25	b-g	8.6%	6.43	0.175	0.738	1.714	10
40	I-131	0.50	b-g	48.9%	73.30	0.014	0.057	0.132	10
41	Cs-137+	0.50	b-g	50.6%	75.95	0.013	0.056	0.131	1
42	Pm-147	0.25	b-g	25.8%	19.35	0.052	0.218	0.506	100
43	Sm-153	0.50	b-g	52.4%	78.54	0.013	0.055	0.127	10
44	Er-169	0.25	b-g	36.5%	27.38	0.037	0.154	0.357	100
45	Lu-177	0,50	b-g	47,0%	70,56	0,014	0,061	0,139	100
46	Re-186	0.50	b-g	46.9%	70.40	0.014	0.059	0.137	100
47	Re-188	0.50	b-g	56.1%	84.13	0.012	0.048	0.113	10
48	Au-198	0.50	b-g	66.2%	99.34	0.010	0.043	0.099	10
49	Tl-201	0.50	b-g	1.7%	2.56	0.395	1.663	3.863	10
50	Tl-204	0.50	b-g	45.4%	68.06	0.015	0.061	0.142	100
51	Pu-238	0.25	b-g	12.7%	9.55	0.108	0.455	1.058	0.1
52	U-238sec	0.25	b-g	124.2%	93.17	0.011	0.045	0.105	1
53	Am-241	0.25	b-g	7.4%	5.57	0.187	0.788	1.831	0.1
54	Po-210	0.25	a	27.6%	20.68	0.049	0.008	0.031	1
55	Ra-223+	0,25	a	144,1%	108,10	0,009	0,002	0,006	1
56	Pu-238	0.25	a	26.8%	20.12	0.054	0.009	0.034	0.1
57	U-238sec	0.25	a	19.9%	14.95	0.073	0.013	0.046	1
58	Pu-239	0.25	a	32.1%	24.05	0.042	0.007	0.026	0.1
59	Am-241	0.25	a	33.2%	24.94	0.041	0.007	0.026	0.1
60	Alpha	0.25	a	31.7%	23.78	0.042	0.007	0.027	

1) Limits are from the German Radiation Protection Ordinance 2001, Annex III, Table 1, column 4

10.2 Calibration Factors and Efficiencies according to A-100

(Parameters are stored in the device)

Efficiency, response and calibration factors of HFC Monitor - Berthold LB 147 Foot									
No.	Nuclide	eff_{src}	CH	A-100					Limit values[1]
				Efficiency [%]	Response [s-1Bq-cm2]	Calibration factor [s Bq cm-2]	Decision threshold (DC) [Bq/cm²]	Minimum detectable activity (MDA) [Bq/cm²]	Surface contamination [Bq/cm²]
1	Beta	0.50	b-g	30.1%	30.14	0.033	0.227	0.504	
2	C-11	0.50	b-g	28.6%	28.63	0.035	0.241	0.534	
3	N-13	0.50	b-g	28.9%	28.87	0.035	0.241	0.534	
4	C-14	0.25	b-g	8.1%	8.14	0.123	0.848	1.881	100
5	O-15	0.50	b-g	28.9%	28.93	0.035	0.241	0.534	
6	F-18	0.50	b-g	33.3%	33.29	0.030	0.207	0.458	1
7	Na-22	0.50	b-g	25.9%	25.92	0.039	0.268	0.595	1
8	P-32	0.50	b-g	32.2%	32.19	0.031	0.214	0.475	100
9	P-33	0.25	b-g	16.3%	16.28	0.062	0.423	0.939	100
10	S-35	0.25	b-g	6.1%	6.06	0.166	1.140	2.530	100
11	Cl-36	0.50	b-g	33.8%	33.79	0.030	0.204	0.452	100
12	K-40	0.50	b-g	28.9%	28.87	0.035	0.241	0.534	10
13	K-42	0.50	b-g	28.9%	28.93	0.035	0.241	0.534	10
14	Ca-45	0.25	b-g	14.7%	14.71	0.068	0.468	1.038	100
15	Sc-46	0.25	b-g	20.8%	20.79	0.048	0.330	0.732	1
16	C a-47+	0.50	b-g	2.4%	2.41	0.415	2.853	6.332	1
17	Cr-51	0.50	b-g	0.03%	0.03	41.667	286.495	635.735	100
18	Mn-54	0.50	b-g	1.1%	1.14	0.882	6.068	13.464	1
19	Fe-55	0.50	b-g	0.2%	0.17	7.639	52.524	116.552	100
20	Co-57	0.50	b-g	3.0%	3.04	0.331	2.274	5.045	10
21	Co-58	0.50	b-g	7.0%	7.00	0.143	0.985	2.186	1
22	Fe-59	0.50	b-g	23.3%	23.31	0.043	0.296	0.657	1
23	Co-60	0.25	b-g	19.9%	19.86	0.051	0.349	0.774	1
24	Ni-63	0.25	b-g	0.02%	0.02	75.000	515.692	1144.324	100
25	Ga-67	0.50	b-g	6.9%	6.85	0.147	1.008	2.238	
26	Se-75	0.50	b-g	4.5%	4.55	0.221	1.520	3.372	10
27	Sr-85	0.50	b-g	1.2%	1.21	0.830	5.707	12.664	1
28	Rb-86	0.50	b-g	28.9%	28.93	0.035	0.241	0.534	10
29	Sr-89	0.50	b-g	30.8%	30.78	0.033	0.223	0.496	100
30	Sr-90+	0.50	b-g	54.8%	54.79	0.020	0.134	0.298	1
31	Y-90	0.50	b-g	29.1%	29.13	0.034	0.236	0.524	100
32	Tc-99	0.25	b-g	24.0%	24.02	0.042	0.288	0.639	100
33	Tc-99m	0.50	b-g	5.5%	5.52	0.182	1.250	2.773	10
34	Ru-106+	0.50	b-g	28.9%	28.93	0.035	0.241	0.534	10
35	In-111	0.50	b-g	9.1%	9.12	0.110	0.754	1.672	10

Efficiency, response and calibration factors of HFC Monitor - Berthold LB 147 Foot									
No.	Nuclide	eff_{src}	CH	A-100					Limit values[1]
				Efficiency [%]	Response [s-1Bq-cm2]	Calibration factor [s Bq cm-2]	Decision threshold (DC) [Bq/cm²]	Minimum detectable activity (MDA) [Bq/cm²]	Surface contamination [Bq/cm²]
36	Sn-113+	0.50	b-g	17.5%	17.54	0.057	0.392	0.870	10
37	In-114m+	0.50	b-g	0.6%	0.60	1.659	11.407	25.312	10
38	I-123	0.50	b-g	9.8%	9.83	0.102	0.702	1.558	10
39	I-125	0.25	b-g	5.3%	5.29	0.189	1.302	2.890	10
40	I-131	0.50	b-g	33.7%	33.72	0.030	0.206	0.458	10
41	Cs-137+	0.50	b-g	33.7%	33.68	0.030	0.205	0.455	1
42	Pm-147	0.25	b-g	11.1%	11.15	0.090	0.619	1.373	100
43	Sm-153	0.50	b-g	35.2%	35.24	0.028	0.195	0.433	10
44	Er-169	0.25	b-g	20.2%	20.25	0.050	0.340	0.755	100
45	Lu-177	0,50	b-g	25,9%	25,93	0,039	0,276	0,598	100
46	Re-186	0.50	b-g	31.4%	31.39	0.032	0.219	0.487	100
47	Re-188	0.50	b-g	72.2%	72.23	0.014	0.095	0.211	10
48	Au-198	0.50	b-g	28.6%	28.63	0.035	0.241	0.534	10
49	Tl-201	0.50	b-g	1.0%	0.95	1.055	7.251	16.089	10
50	Tl-204	0.50	b-g	29.6%	29.59	0.034	0.233	0.517	100
51	Pu-238	0.25	b-g	6.8%	6.84	0.148	1.018	2.259	0.1
52	U-238sec	0.25	b-g	39.4%	39.40	0.026	0.176	0.390	1
53	Am-241	0.25	b-g	9.1%	9.13	0.110	0.758	1.682	0.1
54	Po-210	0.25	a	8.5%	8.46	0.118	0.029	0.092	1
55	Ra-223+	0,25	a	52,8%	52,82	0,019	0,005	0,015	1
56	Pu-238	0.25	a	6.6%	6.56	0.209	0.051	0.162	0.1
57	U-238sec	0.25	a	3.3%	3.29	0.305	0.074	0.237	1
58	Pu-239	0.25	a	13.9%	13.86	0.072	0.017	0.056	0.1
59	Am-241	0.25	a	8.9%	8.90	0.112	0.027	0.087	0.1
60	Alpha	0.25	a	8.8%	8.78	0.114	0.028	0.088	0.1

1) Limits are from the German Radiation Protection Ordinance 2001, Annex III, Table 1, column 4

Efficiency, response and calibration factors of HFC Monitor - Berthold LB 147 Hand									
No.	Nuclide	eff_{src}	CH	A-100					Limit values[1]
				Efficiency [%]	Response [s-1Bq-cm2]	Calibration factor [s Bq cm-2]	Decision threshold (DC) [Bq/cm²]	Minimum detectable activity (MDA) [Bq/cm²]	Surface contamination [Bq/cm²]
1	Beta	0.50	b-g	34.9%	34.86	0.029	0.121	0.281	
2	C-11	0.50	b-g	33.1%	33.11	0.030	0.127	0.296	
3	N-13	0.50	b-g	33.4%	33.39	0.030	0.126	0.293	
4	C-14	0.25	b-g	7.8%	7.78	0.131	0.550	1.278	100
5	O-15	0.50	b-g	33.5%	33.46	0.030	0.126	0.293	
6	F-18	0.50	b-g	30.3%	30.33	0.033	0.140	0.324	1
7	Na-22	0.50	b-g	30.0%	29.98	0.033	0.141	0.327	1
8	P-32	0.50	b-g	32.5%	32.48	0.031	0.130	0.302	100
9	P-33	0.25	b-g	15.4%	15.41	0.065	0.274	0.637	100
10	S-35	0.25	b-g	6.1%	6.10	0.165	0.695	1.614	100
11	Cl-36	0.50	b-g	31.2%	31.20	0.032	0.135	0.314	100
12	K-40	0.50	b-g	33.4%	33.39	0.030	0.126	0.293	10
13	K-42	0.50	b-g	33.5%	33.46	0.030	0.126	0.293	10
14	Ca-45	0.25	b-g	17.0%	17.01	0.059	0.248	0.575	100
15	Sc-46	0.25	b-g	24.0%	24.05	0.042	0.175	0.407	1
16	Ca-47+	0.50	b-g	2.8%	2.79	0.359	1.511	3.510	1
17	Cr-51	0.50	b-g	0.02%	0.02	50.000	210.727	489.347	100
18	Mn-54	0.50	b-g	0.9%	0.90	1.113	4.692	10.896	1
19	Fe-55	0.50	b-g	0.1%	0.13	10.965	46.212	107.313	100
20	Co-57	0.50	b-g	2.6%	2.63	0.382	1.611	3.742	10
21	Co-58	0.50	b-g	6.1%	6.07	0.165	0.695	1.614	1
22	Fe-59	0.50	b-g	22.3%	22.33	0.045	0.190	0.442	1
23	Co-60	0.25	b-g	18.2%	18.24	0.055	0.232	0.538	1
24	Ni-63	0.25	b-g	0.1%	0.06	18.333	77.267	179.427	100
25	Ga-67	0.50	b-g	6.7%	6.73	0.150	0.633	1.470	
26	Se-75	0.50	b-g	3.7%	3.68	0.273	1.152	2.675	10
27	Sr-85	0.50	b-g	1.4%	1.39	0.717	3.023	7.020	1
28	Rb-86	0.50	b-g	33.5%	33.46	0.030	0.126	0.293	10
29	Sr-89	0.50	b-g	31.1%	31.10	0.032	0.136	0.315	100
30	Sr-90+	0.50	b-g	64.9%	64.92	0.015	0.065	0.151	1
31	Y-90	0.50	b-g	34.2%	34.19	0.029	0.123	0.286	100
32	Tc-99	0.25	b-g	18.8%	18.79	0.054	0.226	0.524	100
33	Tc-99m	0.50	b-g	5.3%	5.31	0.191	0.806	1.871	10
34	Ru-106+	0.50	b-g	33.5%	33.46	0.030	0.126	0.293	10
35	In-111	0.50	b-g	8.5%	8.49	0.118	0.498	1.156	10
36	Sn-113+	0.50	b-g	16.4%	16.39	0.061	0.258	0.598	10
37	In-114m+	0.50	b-g	0.7%	0.70	1.435	6.046	14.039	10
38	I-123	0.50	b-g	9.5%	9.50	0.106	0.446	1.035	10

Efficiency, response and calibration factors of HFC Monitor - Berthold LB 147 Hand									
No.	Nuclide	eff_{src}	CH	A-100					Limit values[1]
				Efficiency [%]	Response [s-1Bq-cm2]	Calibration factor [s Bq cm-2]	Decision threshold (DC) [Bq/cm²]	Minimum detectable activity (MDA) [Bq/cm²]	Surface contamination [Bq/cm²]
39	I-125	0.25	b-g	4.3%	4.29	0.263	1.108	2.572	10
40	I-131	0.50	b-g	28.0%	27.97	0.036	0.151	0.351	10
41	Cs-137+	0.50	b-g	30.2%	30.21	0.033	0.140	0.326	1
42	Pm-147	0.25	b-g	12.9%	12.90	0.078	0.327	0.758	100
43	Sm-153	0.50	b-g	36.8%	36.76	0.027	0.115	0.267	10
44	Er-169	0.25	b-g	18.7%	18.67	0.054	0.226	0.526	100
45	Lu-177	0,50	b-g	23,5%	23,52	0,043	0,186	0,422	100
46	Re-186	0.50	b-g	29.0%	28.98	0.035	0.146	0.339	100
47	Re-188	0.50	b-g	75.0%	75.04	0.013	0.056	0.131	10
48	Au-198	0.50	b-g	33.1%	33.11	0.030	0.127	0.296	10
49	Tl-201	0.50	b-g	0.9%	0.86	1.181	4.978	11.561	10
50	Tl-204	0.50	b-g	25.6%	25.61	0.039	0.165	0.383	100
51	Pu-238	0.25	b-g	6.4%	6.36	0.162	0.684	1.588	0.1
52	U-238sec	0.25	b-g	62.1%	62.11	0.016	0.068	0.159	1
53	Am-241	0.25	b-g	3.5%	3.50	0.298	1.256	2.916	0.1
54	Po-210	0.25	a	14.1%	14.08	0.071	0.012	0.045	1
55	Ra-223+	0,25	a	72,1%	72,06	0,014	0,003	0,009	1
56	Pu-238	0.25	a	12.5%	12.46	0.087	0.015	0.055	0.1
57	U-238sec	0.25	a	18.2%	18.25	0.060	0.010	0.038	1
58	Pu-239	0.25	a	16.0%	16.03	0.062	0.011	0.039	0.1
59	Am-241	0.25	a	15.7%	15.66	0.064	0.011	0.040	0.1
60	Alpha	0.25	a	15.2%	15.24	0.066	0.011	0.041	

1) Limits are from the German Radiation Protection Ordinance 2001, Annex III, Table 1, column 4

Alpha measurement: R_0 = 0.1 cps (Hand) or
R_0 = 0.2 cps (Foot)

Beta measurement: R_0 =15 cps (Hand) or
R_0 = 40 cps (Foot)

Measuring times: Background time constant τ = 60 s
Person measurement t_b = 10 s

Values from Annex III of the Radiation Protection Ordinance 2001 were taken as limit values for surface contamination (objects, clothing and underwear outside of operational monitoring areas).

10.2.1 Explanatory Notes to the Tables

- Calibration factors are valid for direct measurements on a detector surface or foot grate.
- The radioactive sources are flat sources with an area of 100 cm².
- The calibration factors relate either to the surface emission rate (ISO 7503-1) and the sensitive detector area of 300 cm² (according to § 44 German RPO) or to the activity and 100 cm² source area .
- The results have been corrected for background and half-life.
- The detection limit was calculated according to DIN ISO 11929.

Alpha:

$$EG_\alpha = K * k_{1-\alpha} * \sqrt{R_{0,\alpha} * \left(\frac{1}{t_b} + \frac{1}{2 * \tau}\right)}$$

$$NWG_\alpha = K * \frac{(k_{1-\alpha} + k_{1-\alpha}) * \sqrt{R_{0,\alpha} * \left(\frac{1}{t_b} + \frac{1}{2 * \tau}\right)} + \frac{{k_{1-\alpha}}^2}{t_b}}{1 - {k_{1-\alpha}}^2 * {U_{K,rel}}^2}$$

*The decision threshold/minimum detectable activity was calculated taking into account an uncertainty $U_{k,rel}$ of 10% for the calibration source; 5% error probability corresponds to a quantile $k_{1-\alpha}$ of 1.6449;

Without taking into account the uncertainty of the calibration source, $U_{k,rel}$ is set to zero

Beta:

$$EG_\beta = K * k_{1-\alpha} * \sqrt{{K_{SCINT}}^2 * \left[R_{0,\beta} * \left(\frac{1}{t_b} + \frac{1}{2 * \tau}\right) + S * \left(\frac{R_{B,\alpha} - R_{0,\alpha}}{t_b}\right)\right] + S^2 * \left(\frac{R_{B,\alpha}}{t_b} + \frac{R_{0,\alpha}}{2 * \tau}\right)}$$

$$NWG_\beta = K * \frac{(k_{1-\alpha} + k_{1-\alpha}) * \sqrt{{K_{SCINT}}^2 * \left[R_{0,\beta} * \left(\frac{1}{t_b} + \frac{1}{2 * \tau}\right) + S * \left(\frac{R_{B,\alpha} - R_{0,\alpha}}{t_b}\right)\right] + S^2 * \left(\frac{R_{B,\alpha}}{t_b} + \frac{R_{0,\alpha}}{2 * \tau}\right)} + \frac{{K_{SCINT}}^2 * {k_{1-\alpha}}^2}{t_b}}{1 - {k_{1-\alpha}}^2 * {U_{K,rel}}^2}$$

*The decision threshold/minimum detectable activity was calculated taking into account a spillover correction S of 30% for the hand and 45% for the foot, and taking into account an uncertainty $U_{k,rel}$ of 10% for the calibration source; $R_{B,\alpha}$ = 1 cpm, 5% error probability corresponds to a quantile $k_{1-\alpha}$ of 1.6449;

K_{SCINT} factor of 2.01 (see Technical Note No.328) for correction of the count rate in the Beta channel.

Without taking into account the uncertainty of the calibration source and the spillover correction, $U_{k,rel}$ or S are set to zero.

Subject to changes due to technical improvements.

08/2018
Language: English
Rev.- No.: 16
Printed in Germany

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Id.-No. 45356BA2