



Detectors FracSENS

LB 6770

**Operating Manual
63038BA2**

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1

About this Operating Manual

1.1 Some Prior Remarks

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

This operating manual illustrates how to:

- set up/install the product
- establish the connections to the power supply
- perform measurements
- apply software settings
- carry out maintenance on the product
- fix errors
- disassemble the product
- dispose of the product

Read these instructions thoroughly and completely before working with the product. We have tried to compile all information for safe and proper operation for you.

However, should questions arise which are not answered in this operating manual, please contact BERTHOLD TECHNOLOGIES GmbH & Co. KG.

Store the instructions where they are accessible for all users at all times.

1.2 Storage Place

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

1.3 Target Group

This operating manual is directed at qualified specialist personnel who are familiar with handling electrical and electronic assemblies as well as with communication and measuring techniques.

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

1.4 Validity of the Operating Manual

The operating manual is valid from the delivery of the Berthold product to the user until its disposal. Version and release date of this operating manual can be found in the bottom of each page. Modification service is not performed by the manufacturer BERTHOLD TECHNOLOGIES GmbH & Co. KG.

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

NOTICE



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

1.5 Structure of the Operating Manual

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

1.6 Copyright

This operating manual contains copyright-protected information. None of the chapters may be copied or reproduced in any other form without prior authorisation from the manufacturer.

1.7 Representation

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

1.8 Symbols Used

1.8.1 Structure of Warnings

Signal Word



Source and consequence

Explanation, if required

- ▶ Prevention
- In case of emergency

- **Warning symbols:** (warning triangle) draws attention to the hazard.
- **Signal word:** indicates the severity of danger.
- **Source:** specifies the type or source of danger.
- **Consequence:** describes the consequences of non-compliance.
- **Prevention:** states how one can avoid the hazard.
- **In case of emergency:** specifies which actions are required in the event of the occurrence of risk.

1.8.2 Symbols Used in the Operating Manual

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

DANGER



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

WARNING



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

CAUTION



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

NOTICE

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

IMPORTANT

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

Tip

Provides tips on application and other useful information.

1.8.3 Symbols Used on the Device

Read the operating manual



Please observe the instructions in this operating manual.

Direct voltage



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

No domestic waste



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

1.9 Conformity

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

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

For the original declaration of conformity, please refer to document "Technical Information".

2

Safety

2.1 Proper use

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

The following constitutes proper use:

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

The following constitutes improper use and is to be avoided:

- Failing to observe the instructions on safety, operation, maintenance and disposal given in the manual.
- Applying conditions and requirements which do not conform to those stated in the technical documents, data sheets, operation and assembly instructions and other specific guidelines of the manufacturer.
- Use of the product if parts of it are damaged or corroded. This also applies for seals and used cables.
- Restructuring or changing the system components.

Avoid the following circumstances:

- Using the product in systems in which explosive gases may escape into the surroundings. The product is not explosion-proof.
- The device is not approved according to IEC 61508 "Functional safety of safety-related electric/electronic/programmable electronic systems".
- Using the product with
 - improperly closed connections,
 - improperly tightened or damaged screw connections, i.e. screw-type cable fittings, adapters or blind plugs.

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

BERTHOLD TECHNOLOGIES GmbH & Co. KG shall only accept liability for / guarantee the correspondence of the device to its publicised specifications.

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

2.2 Qualification of the Personnel

NOTICE



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

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

These three groups of people are:

- Employees with general knowledge
- Experts
- Authorised Persons.

Employees with General Knowledge

NOTICE



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

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

Experts

- Experts are persons who have sufficient knowledge in the required area due to their specialist training and who are familiar with the relevant national health and safety regulations, accident prevention regulations, guidelines and recognised technical rules.
- Expert personnel must be capable of safely assessing the results of their work and they must be familiar with the content of this manual.

Authorised Persons

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

2.3 Operator's Obligations

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

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

3

System Description

3.1 Measuring Principle

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

A complete measuring system includes the following components:

- Radiation emitter inside shielding
- Mounting fixture for radiation emitter and detector
- Detector for radioactivity

This operating manual refers to the operation of the detector unit.

The operation of the remaining system components is subject of the independent operating manuals of the particular system components.

NOTICE



This is a class A device (industrial area). This device may cause radio interference in residential areas.

System Integration

- The Signal output is proportional to the measured count rate or the natural logarithm of the count rate.
- Adjustable signal output: 0 ... 10V (Voltage) or 0/4 ... 20 mA (Current).
- Alternative method of process connection: direct via RS 485 Modbus RTU to a suitable control system or control device.
- The evaluation of the density resp. pounds proppant per gallon (PPG) or pounds proppant added (PPA) has to occur in the control system.

3.2 System Components

3.2.1 Overview

The detectors consist of the following components

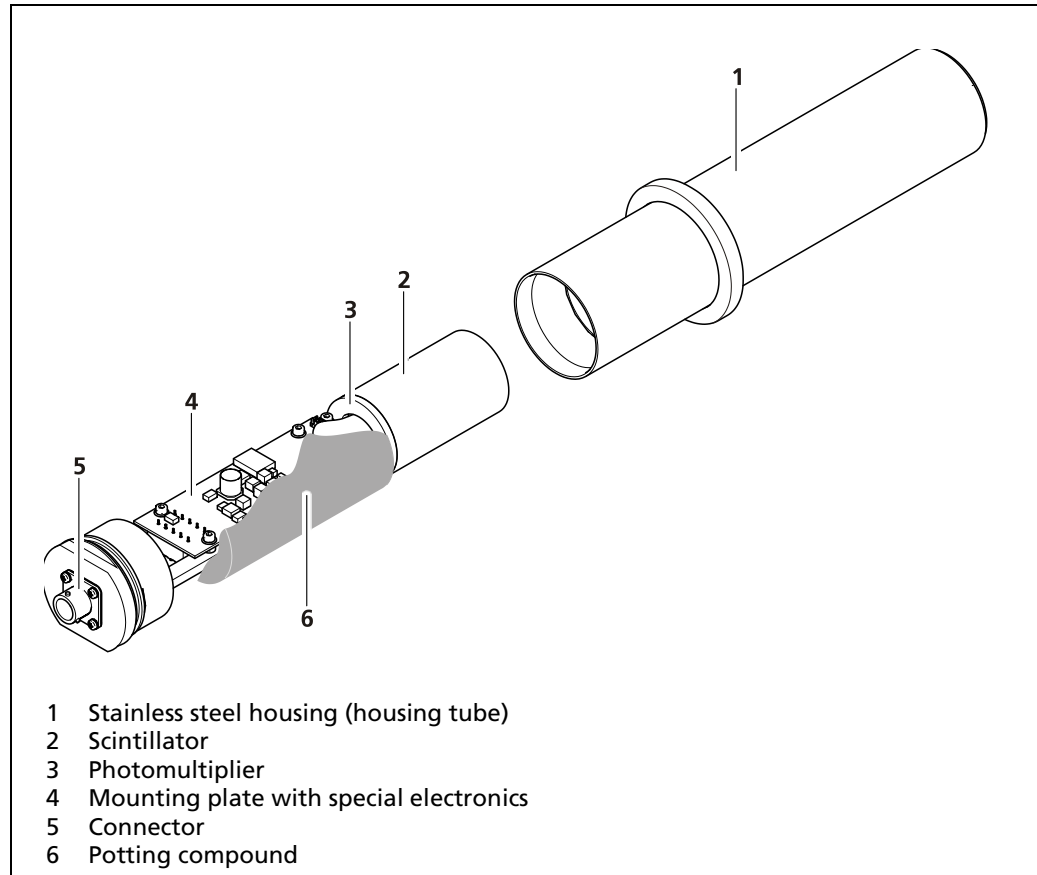


Fig. 1 Components of FracSENS Detectors

3.2.2 Software

The LB 6770 detectors are distributed with software already installed.

3.3 Storage

Store the devices in a dry area (no dew), in the dark (no direct sunlight) in a clean locked room. Bear in mind the permissible temperature range when storing.

4 Installation

4.1 Safety Instructions

WARNING



Danger of injury by falling loads



- ▶ Never stand underneath a lifted or suspended load, keep at a safe distance.
- ▶ Only use tested sling gear components appropriate for the transport weight.
- ▶ Exclusively use the provided fixing possibilities (lifting brackets) for attaching the sling gear.
- ▶ Observe the marking for the centre of gravity on the outer packaging, if applicable.
- ▶ Wear head protection and safety shoes.

CAUTION



Danger of injury caused by heavy and bulky system components

- ▶ Heavy and bulky system components should only be handled using aids and by at least 2 persons.
- ▶ Observe the guidelines for safe handling of heavy loads.
- ▶ Ensure stability and use the provided fixing possibilities.

NOTICE



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

NOTICE



Only clamping devices approved by Berthold Technologies GmbH & Co. KG should be used to install the device.

NOTICE



The device may only be operated if permanently installed.

4.2 Unpacking/Scope of Delivery

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

4.3 Operation site

The detector is suitable for outdoor use. For the ambient conditions, please refer to the document "Technical Information".

4.4 Installation on a Pipeline

There are clamping devices for different pipe diameters and irradiation angles for installing a detector on a pipeline. An example is shown in Fig. 2. For the detailed description of the clamping devices and the associated dimension drawings, refer to the operating manual of the corresponding clamping device.

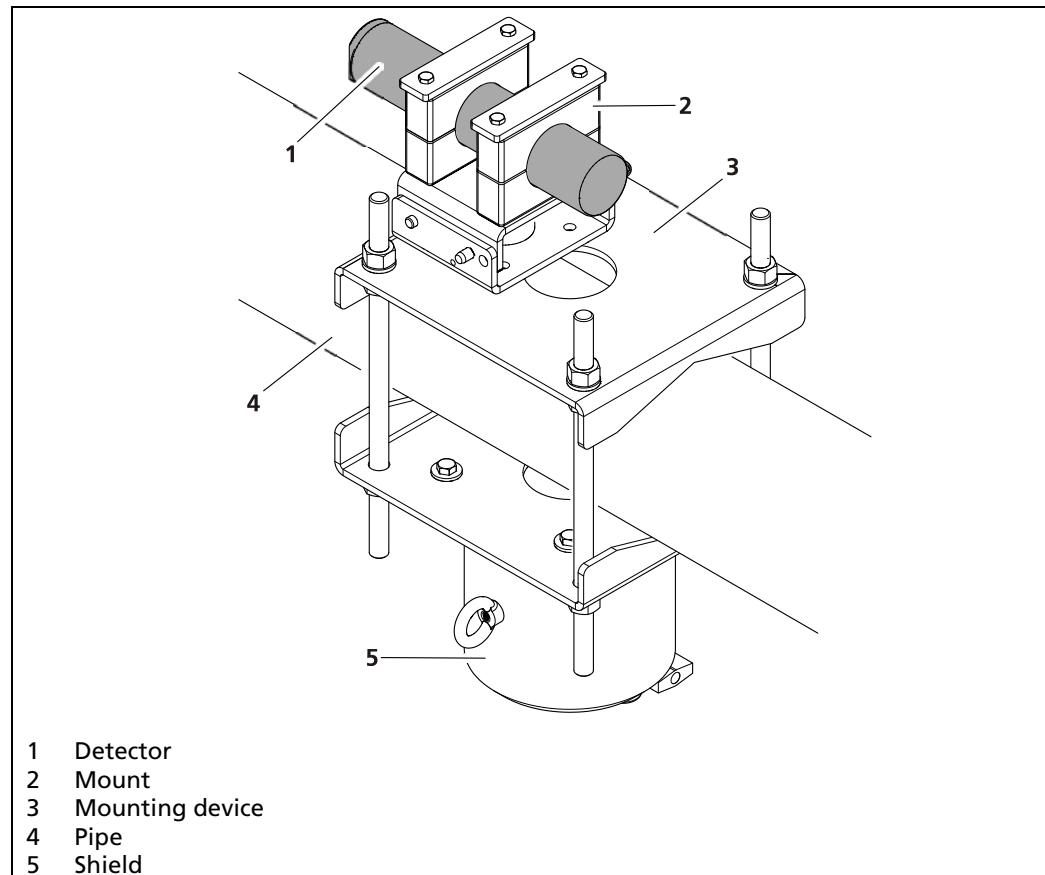


Fig. 2 Pipeline Installation

NOTICE



The clamping device used must be designed for a minimum weight of 12 kg.

NOTICE



Make sure that the sensitive part of the detector is fully in the radiation beam. Otherwise the measurement accuracy will decrease.

The sensitive part is where the scintillator is located. Refer to the drawing for details.

NOTICE



A limit of 200,000 CPS should not be exceeded. In case higher count rates are likely to appear, additional shielding has to be used to keep the count rate below 200,000 CPS.

5

Electric Installation

NOTICE



The detector FracSENS LB 6770 is not explosion protected and is not designed for hazardous environments.

5.1 Cables and Lines

- The supply source of the 24 VDC product version has to comply with the requirements (limit values for accessible parts) of the Low-voltage Directive (DIN EN 61010-1) and be equipped with a double or reinforced insulation.
- The voltage parameters of all devices connected to the outputs of the product (e.g. relay circuit, 3.3 V output, RS-485, current output) have to comply with the limit values (limit values for accessible parts) of the Low-voltage Directive (DIN EN 61010-1) and be equipped with a double or reinforced insulation.
- These protective measures are necessary to avoid the risk of contact with life-threatening voltages. Changing the installation without precise knowledge of this operating manual is not permitted.
- Observe local regulations and install in accordance with manufacturer's specifications and the relevant standards and rules.
- Do not operate the device outside of its electrical, thermal and mechanical parameters.
- The base must be completely screwed to the housing.
- The detector is designed that it does not need to be connected to the local potential equalization. If electrostatic charging cannot be excluded, the detector must be connected to earth according local requirements.
- Connection lines and routing must comply with the applicable regulations.
- Connecting cables (conductors and insulation) must be suitable for a continuous service temperature $\geq T_a + 20 \text{ K}$.
- Lines are to be connected with special care.
- When routing the cables, make sure that the cable insulation cannot be mechanically damaged by sharp edges or movable metal parts.
- The detectors are to be used exclusively for fixed location installation.
- When routing the connection lines, make sure that
 - o no dirt and humidity gets into the connector,
 - o the permissible bending radius for the respective line cross-section is not exceeded and
 - o the cables are laid out in a strain-relieved and friction-free manner.

5.2 Connector

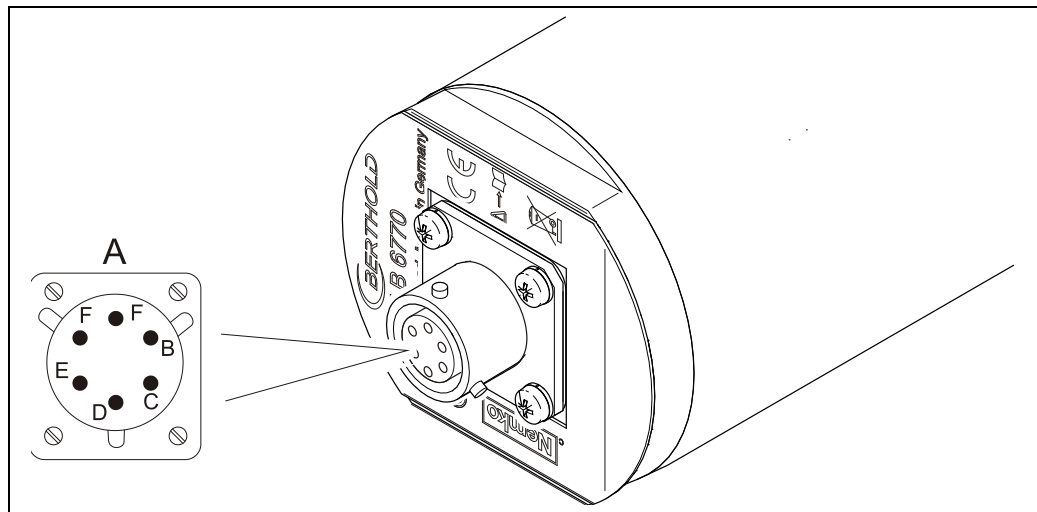


Fig. 3 Connector

Connector	
A	0 – 10 V / 4 – 20mA +
B	0 – 10 V / 4 – 20mA –
C	RS485A ¹
D	RS485B ¹
E	Supply +24V
F	GND

¹ Max. Output 3,3V, 250mA

5.2.1 Connection to evaluation unit LB 47x

The LB 6770 detector is connected to the evaluation unit LB 47x via the RS485 terminals. Connect the lines according to assignment to the terminal panel (Fig. 4) or clamp blocks (Fig. 5).

NOTICE



Use an external RS485 repeater (specified by Berthold) when communication errors occur.

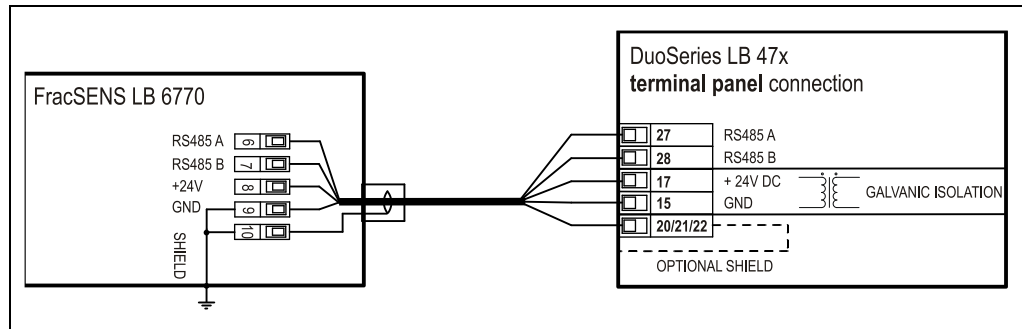


Fig. 4 Connection to LB 47x with terminal panel

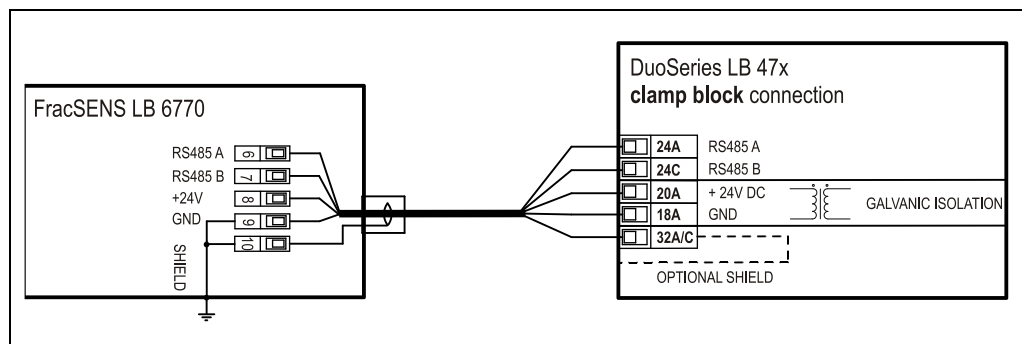


Fig. 5 Connection to LB 47x with clamp block

6

Operation

The LB 6770 detector can be configured via the LB 47x evaluation unit or via the service modem.

IMPORTANT



Note the operating manual LB 475 for the configuration via the evaluation unit LB 47x.

6.1 Detector Device Modem

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

NOTICE



The service modem can only be used with detector software 1.1.3 or higher.

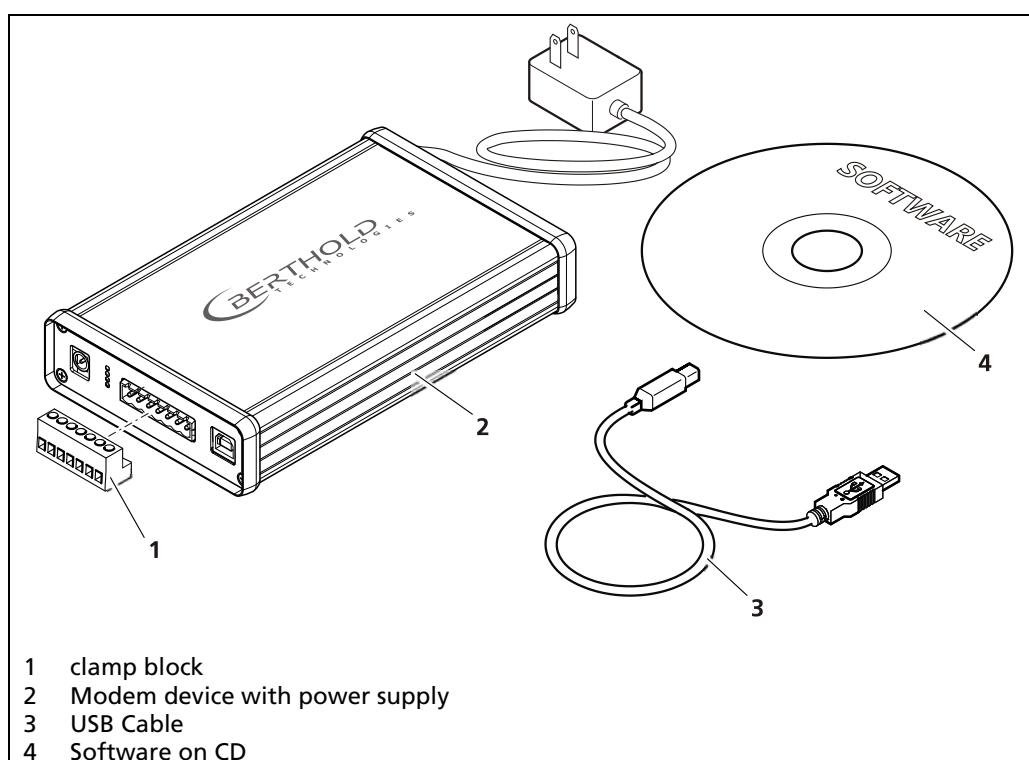


Fig. 6 Scope of supply Detector Device Modem

PC System requirements

System requirements	Windows XP or higher 512 MB RAM, 1 GHz processor, USB port
Connections	USB port, RS 485 to detector

6.2 Software installation

The PC software provides access to the software of the detector. The setup file stored is located on the CD.

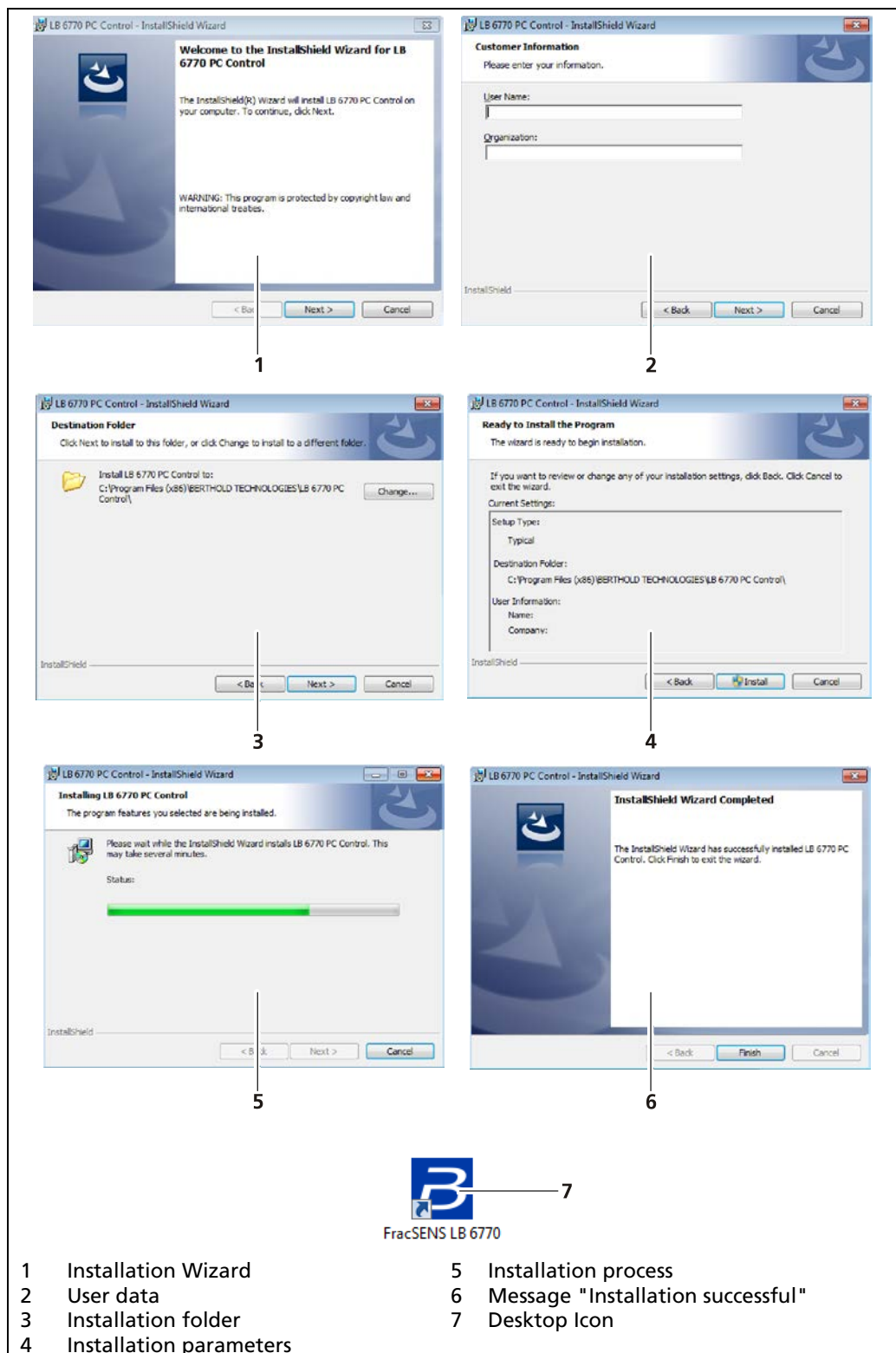


Fig. 7 Setup Wizard

Install Software:

1. Double-click "setup.exe" to start the installation.
 - ▶ The installation wizard opens (item 1).
2. Click on <Next>.
3. Enter a user name or company name and click on <Next>.
4. Click the <Change> button to change the installation folder (item 3).
5. Click on <Next>.
 - ▶ The installation parameters are displayed (item 4).
6. Click on <Install> to start the installation.
 - ▶ The installation is carried out (item 5).
7. Click on <Finish> to complete the installation (item 6).
 - ▶ The software was successfully installed and an icon (item 7) is created on the desktop.

6.3 Install Service Modem

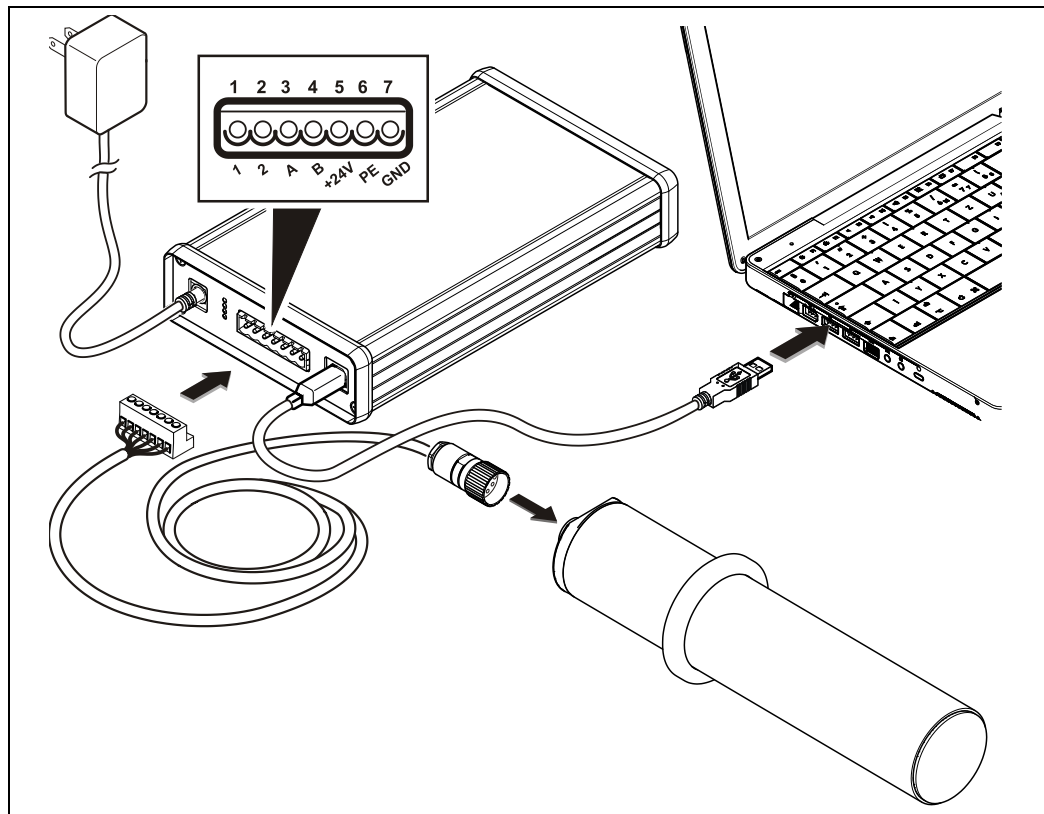


Fig. 8 Install Service Modem

1. Install the drivers by executing the driver file "BertholdRS485.exe" before connecting the Detector Service Modem.
2. Connect the Service Modem transformer to a power supply.
3. Connect the Service Modem with the PC.
 - ▶ The Service Modem is installed.
4. Connect the detector with the Service Modem.

PIN Configuration Service Modem

Connector at the Detector	Cable Color	Configuration	Service Modem
A	yellow	0-10 V + / 4-20 mA	N/C
B	black	0-10 V - / 4-20 mA	N/C
C	white	RS 485A	3
D	brown	RS 485B	4
E	red	+24 V DC	5
F	violet	GND	6
	grey	Shield	7

6.4 Software

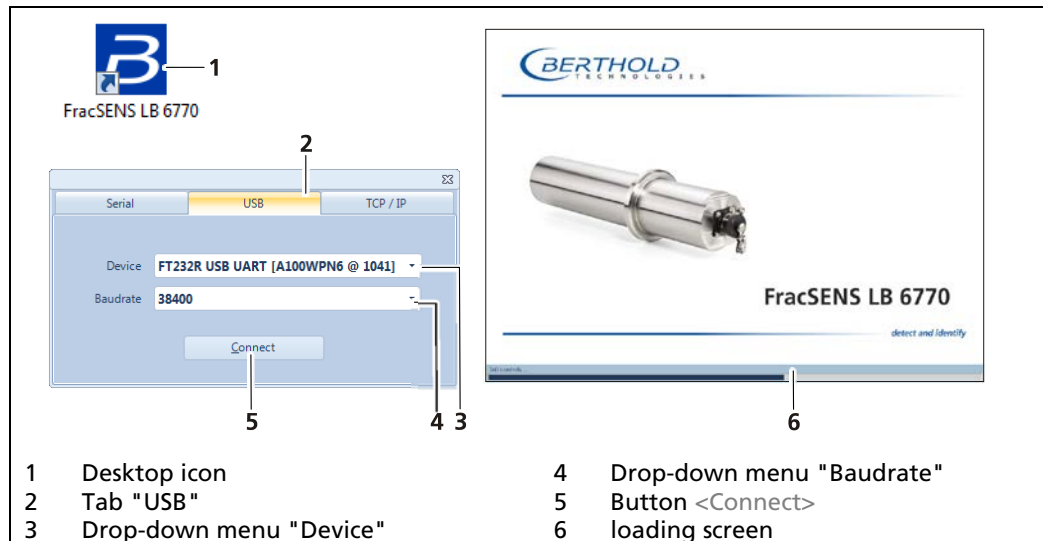


Fig. 9 Start software

5. Double-click on the desktop icon "FracSENS LB 6770" (item 1).
 - ▶ The connection window opens.
6. 2. Click on the "USB" tab (item 2).
 - ▶ The modem is displayed in the drop-down menu "Device" (item 3) if the hardware is connected correctly.
7. Select a baud rate of 38400 from the drop-down menu (item 4).
8. Click the <Connect> button.
 - ▶ The loading screen (item 6) appears and the software interface is displayed.

In case the communication settings of the detector are not the standard EROA settings the following window will appear.

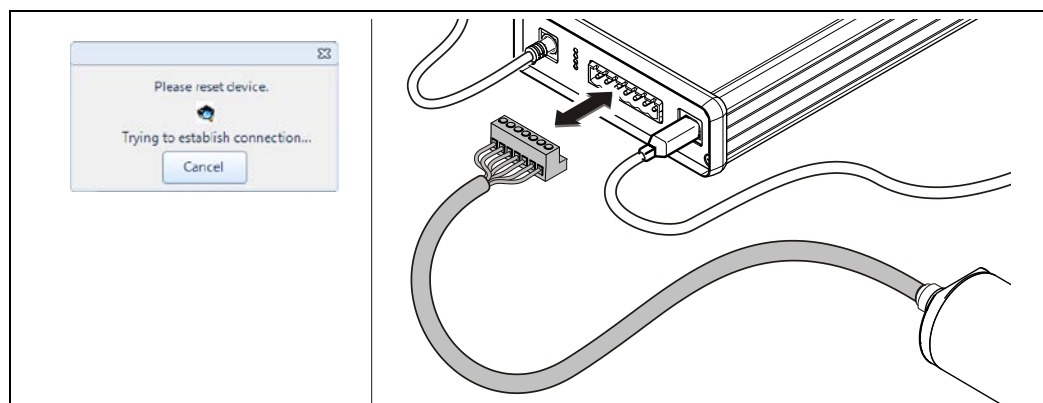


Fig. 10 Connection attempt, Restart Detector

1. Disconnect and reconnect the detector from the detector service modem in order to initiate a reboot of the detector.
 - ▶ The program establishes a connection to the detector. Communication settings will remain unchanged after detector reboot.

6.4.1 AppFracturing

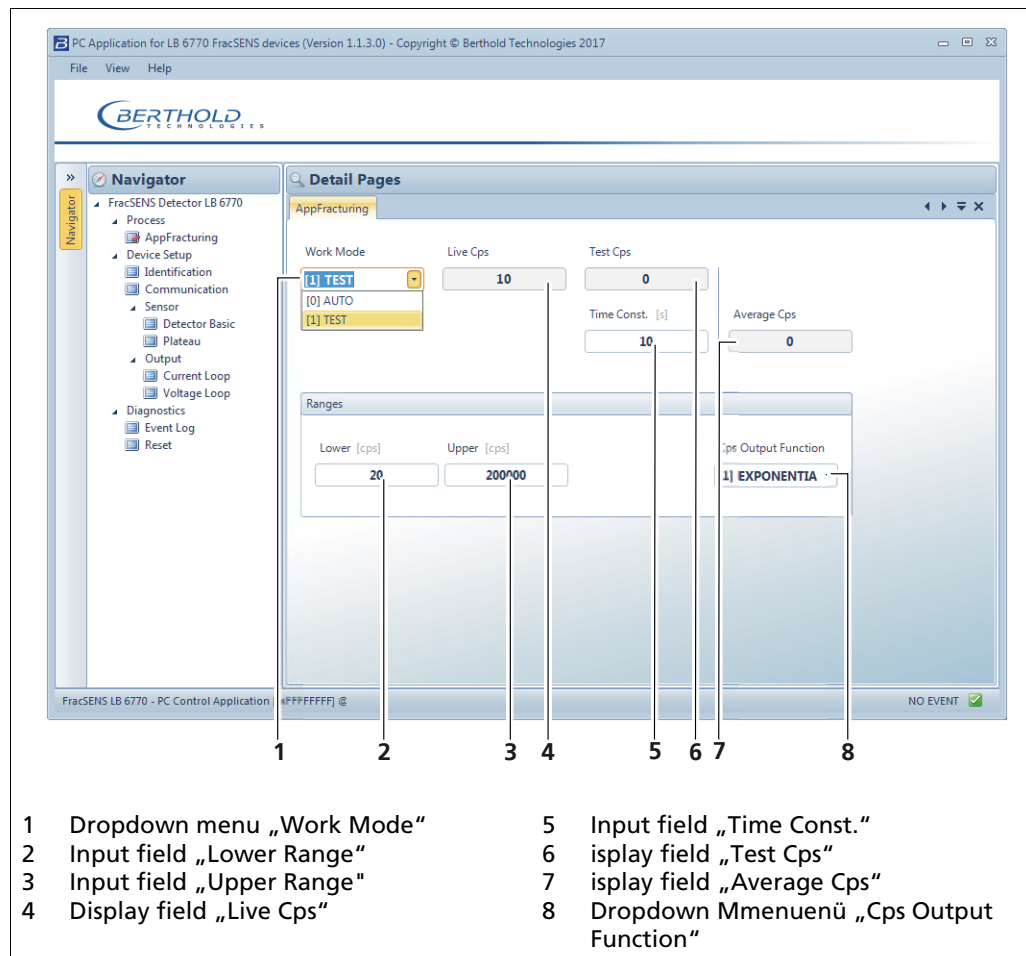


Fig. 11 Page „AppFracturing“

Work Mode

Working mode of the application (restart deactivates the test mode automatically).

Time Const.

Time constant used when averaging the "Live Cps" in normal mode.

Lower Range

Count rate of the lower range of the current / voltage output.

Upper Range

Count rate of the upper range of the current / voltage output.

Cps Output Function

Transmission of the application result to the output signal. 0 = linear; 1 = exponential.

6.4.2 Identification

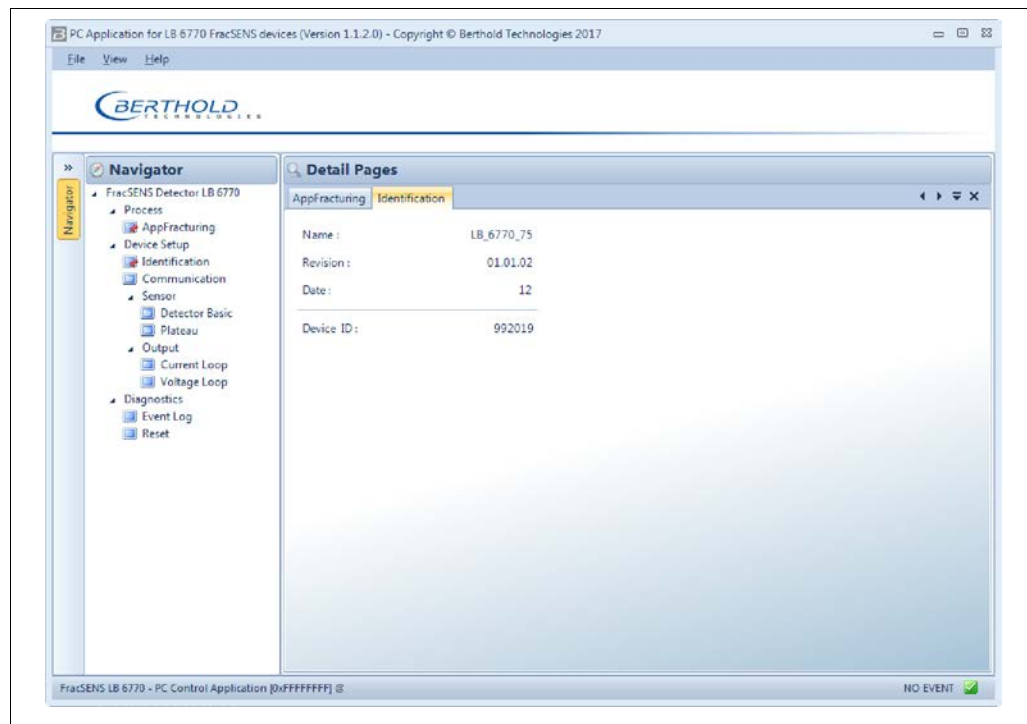


Fig. 12 Page "Identification"

6.4.3 Communication

NOTICE



It is not recommended to change any parameters in this window unless you really know what you are doing. Wrong settings can cause malfunction of the detector communication.

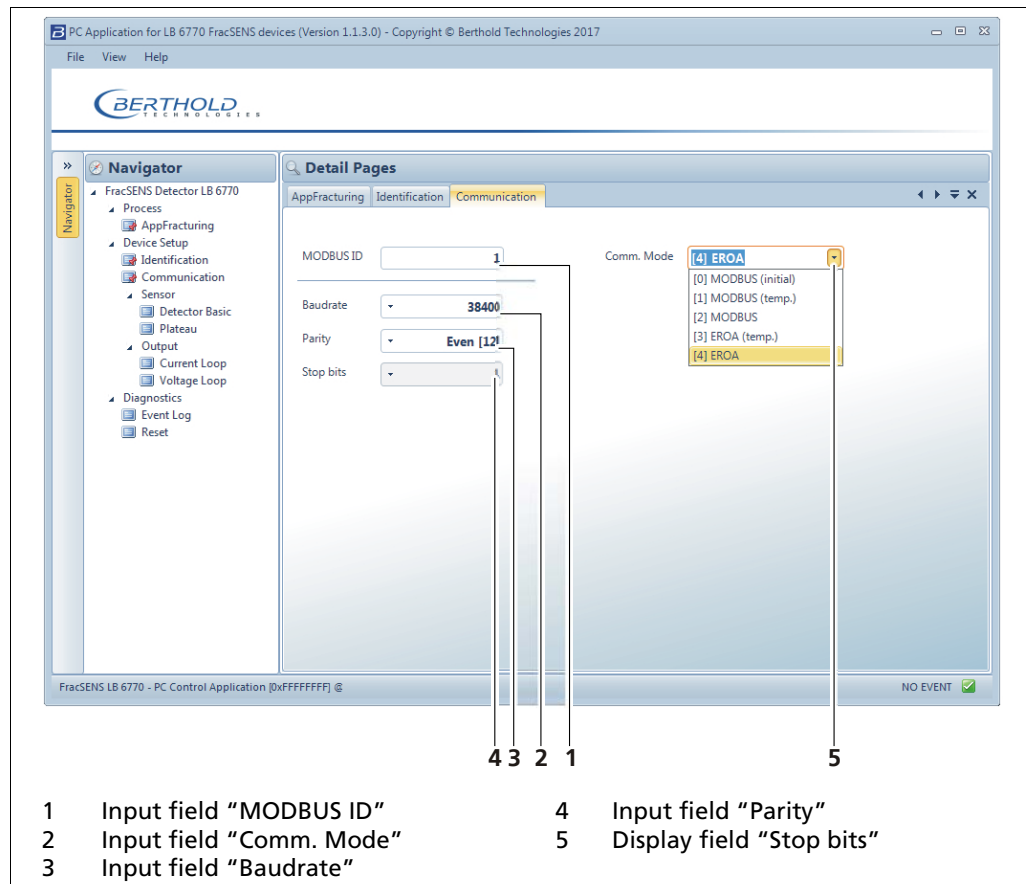


Fig. 13 Page "Communication"

MODBUS ID

Modbus slave address (1 – 247)

Comm. Mode

This is to set-up the communication mode of the RS485 line. It can either use Modbus RTU or a Berthold proprietary protocol "EROA" which must be activated for software updates.

"Temp." means, after rebooting the detector will start in selected mode for one time.

Baudrate

9600
19200 (standard)
38400
56700

Parity

0 = None
4 = Odd
12 = Even (standard)

Stop bits

Number of stop bits

6.4.4 Detector Basic

IMPORTANT



Usually there are no changes required in this window if the detector is in normal operation. Changes of the below parameters can cause detector malfunction!

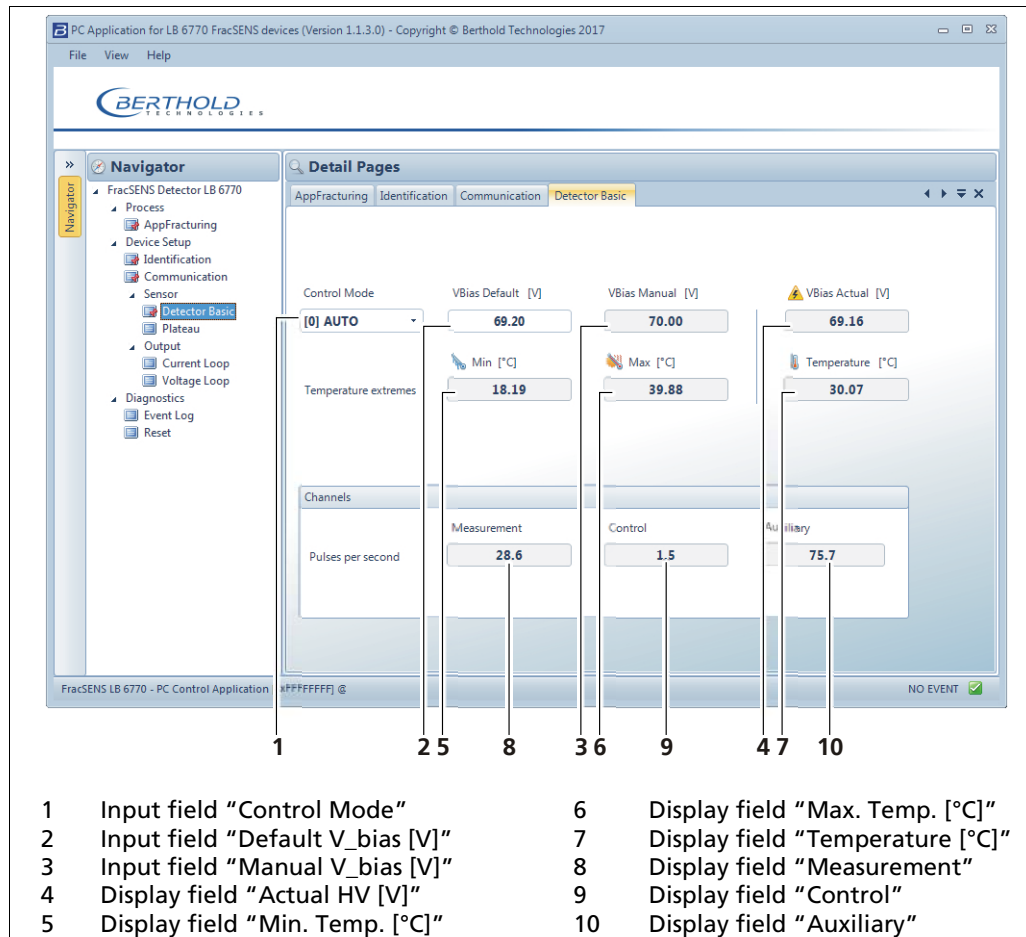


Fig. 14 Page "Detector Basic"

Control Mode

Detector Work Mode

0 = AUTO (recommended)

1 = Manual

2 = Plateau

IMPORTANT



Do not use "Manual" Control Mode unless directed otherwise. It can cause malfunction of the detector.

Default V_bias [V]

Standard bias voltage in automatic mode.

IMPORTANT



Do not use change bias voltage default value unless directed otherwise. It can cause malfunction of the detector.

Manual V_bias [V]	Fixed HV if "Manual" (60 - 80 V).
Actual V_bias [V]	Actual bias voltage.
Temperature [°C]	Actual measured electronic temperature.
Max [°C]	Maximal measured electronic temperature.
Min [°C]	Minimal measured electronic temperature.
Pulses per Second Auxiliary	Pulses counted and averaged in auxiliary channel.
Pulses per Second Control	Pulses counted and averaged in control channel.
Pulses per Second Measurement	Pulses counted and averaged in measurement channel.

6.4.5 Plateau

The plateau shows if the detector is working stably. A plateau measurement is therefore only carried out when the measured value drifts, or other doubts exist about the function of the detector. A plateau measurement can help narrow down the possible cause of the problem.

IMPORTANT



Usually there are no changes required in this window if the detector is in normal operation. Changes of the below parameters can cause detector malfunction!

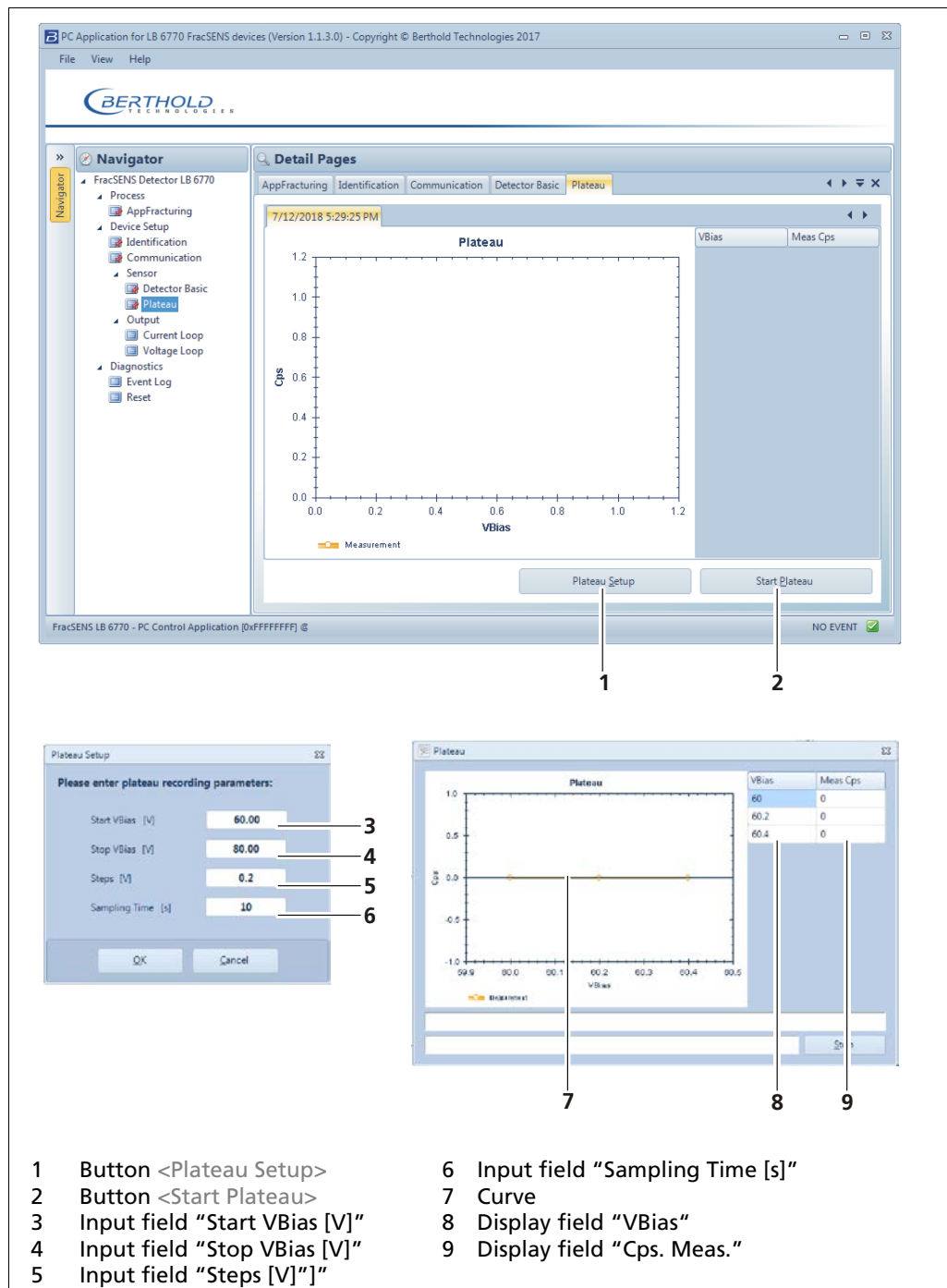


Fig. 15 Page "Plateau"

Start VBias [V]	Lower voltage for plateau curve. At this voltage the plateau recording will start.
Stop VBias [V]	Upper voltage for plateau curve. At this voltage the plateau recording will stop.
Sampling Time [s]	Time used for sampling of each point. Should not be smaller than 20s.
Steps [V]	Voltage between two points for plateau sampling.
Cps Meas.	Pulse Rate of actual indexed plateau entry in plateau table.
VBias [V]	V_{bias} of actual indexed plateau entry in plateau table.

NOTICE

The Sampling a plateau curve is only needed for checking the correct function of the detector. When operated in automatic voltage control mode the plateau is not needed otherwise.

NOTICE

Record plateau curves at room temperature only. The assembled plateau will not be comparable to other plateaus otherwise.

Record Plateau

The values in the window "Plateau Setup" are pre-set by Berthold on delivery and can be used in most situations.

2. Place source in front of detector.
3. Click on the Button <Start Plateau>.
 - ▶ The Plateau measurement is started.
4. The plateau record is complete when the progress bar is complete and the window closes automatically.
 - ▶ The recorded values are displayed in the table and the characteristic curve is displayed.

The determined plateau curve is displayed in a diagram. The pulse rate increases with increasing voltage. This must form a unique plateau. If a too short or too steep plateau is detected, the detector is operating in an unstable manner.

6.4.6 Current Loop

NOTICE



The detector output is either a voltage or a current output. It is pre-configured according to your order. If the measurement is operated according to Namur, the standard current values 3.8 and 20.5 mA must be set.

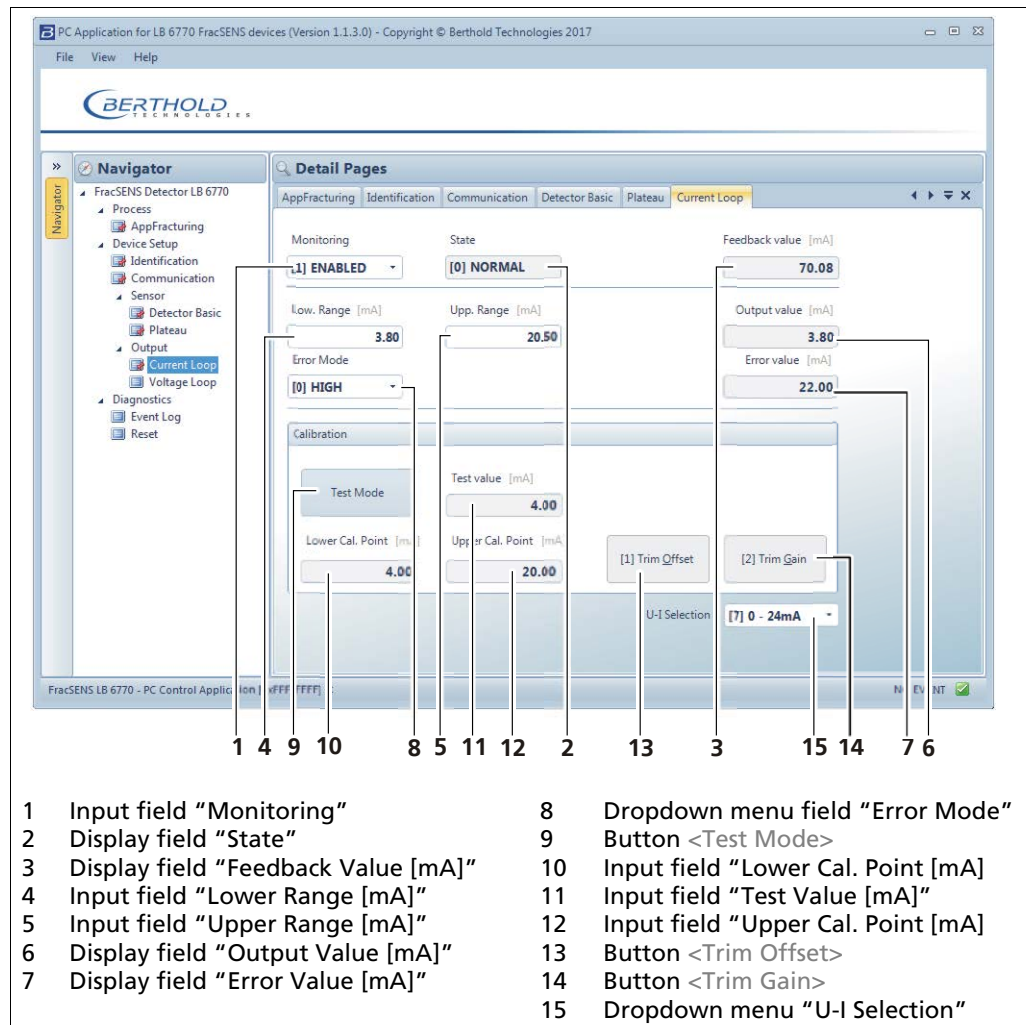


Fig. 16 Page "Current Loop"

Monitoring

Activates/deactivates monitoring of current loop. If set to "ON" there will be an alarm in case feedback current and output current differ.

0 = OFF (DISABLED)

1 = ON (ENABLED)

State

Actual state of current output.

(Reboot deactivates test mode automatically).

0 = NORMAL

1 = TEST

2 = CHECK HIGH

3 = CHECK LOW

4 = ERR. HIGH

5 = ERR. LOW

6 = ERR. LOW OFF

Feedback Value [mA]	Actual measured output current (2 – 22 mA).
Lower Range [mA]	Set the lower range value of the current output (default 3.8 mA).
Upper Range [mA]	Set the upper range value of the current output (default 20.5 mA).
Output Value [mA]	Calculated current to output (0/4 – 20 mA).
Error Mode	Error Current selection. 0 = HIGH (22 mA) 1 = LOW (2 mA)
Error Value [mA]	Current outputted if error events is detected (2 ; 22 mA).
U – I Selection	0 – 10 V (activate voltage output) 0 – 24 mA (activate current output)

Field Calibration

Calibration Test Mode	Activates/deactivates test mode of current loop. If activated, the “Test Current” is output. (Reboot deactivates test mode automatically).
Calibration Test Value [mA]	Set the output current in test mode (2 – 23.9 mA)
Trim Offset (Calibration)	Current Loop calibration.
Trim Gain (Calibration)	Current Loop calibration.
Upper Cal. Point	Value measured with external amperemeter and usually used for gain calibration of current loop.
Lower Cal. Point	Value measured with external amperemeter and usually used for offset calibration of current loop.

NOTICE



To calibrate the current output follow the calibration instructions in chapter 6.4.8.

6.4.7 Voltage Loop

NOTICE



The detector output is either a voltage or a current output. It is pre-configured according to your order.

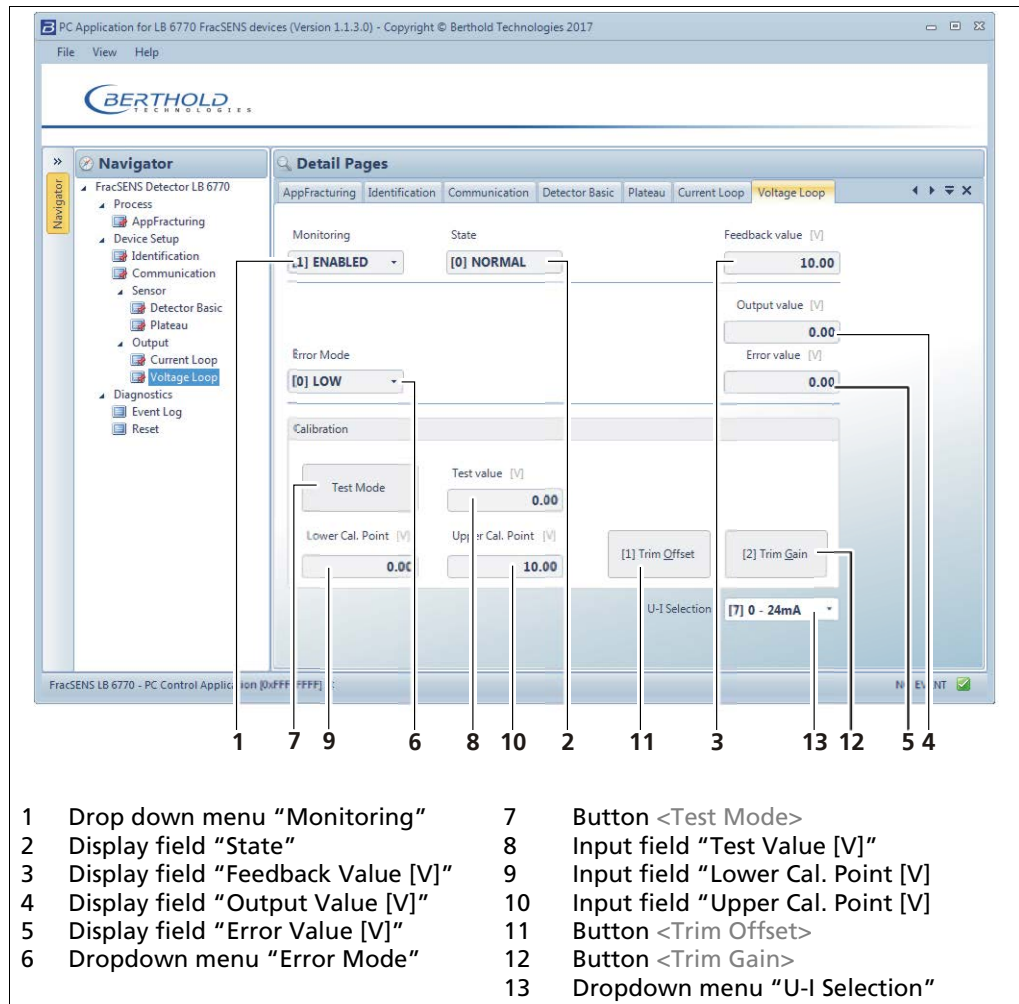


Fig. 17 File VoltageLoop

Monitoring

Activates/deactivates monitoring of voltage loop. If set to "ON" there will be an alarm in case feedback voltage and output voltage differ.

0 = OFF

1 = ON

State

Actual state of Voltage Output.
(Reboot deactivates test mode automatically).

0 = NORMAL

1 = TEST

2 = CHECK HIGH

3 = CHECK LOW

4 = ERR. HIGH

5 = ERR. LOW

6 = ERR. LOW OFF

Feedback Value [V]	Actual measured output voltage 0 – 10 V.
Output Value [V]	Calculated voltage to output 0 – 10 V (setpoint).
Error Value [V]	Voltage outputted if failure is detected (0 10 V).
Error Mode	Sets the voltage in case there is an error event detected. 0 = 0 V 1 = 10 V
U – I Selection	0 – 10 V (activate voltage output) 0 – 24 mA (activate current output)

Field Calibration

Calibration Test Mode	Activates/deactivates test mode of voltage loop. If activated, the "Test Voltage" is output. (Reboot deactivates test mode automatically). 0 = OFF 1 = ON
Calibration Test Value	Voltage outputted if test of Voltage Loop is activated.
Trim Offset (Calibration)	Voltage Loop calibration.
Trim Gain (Calibration)	Voltage Loop calibration.
Upper Cal. Point	Value measured with external voltmeter and usually used for gain calibration of voltage loop.
Lower Cal. Point	Value measured with external voltmeter and usually used for offset calibration of voltage loop.

6.4.8 Calibrate output

NOTICE



For calibration of the output, a voltage measurement device (not included in the scope of delivery) is required, which is connected to the output.

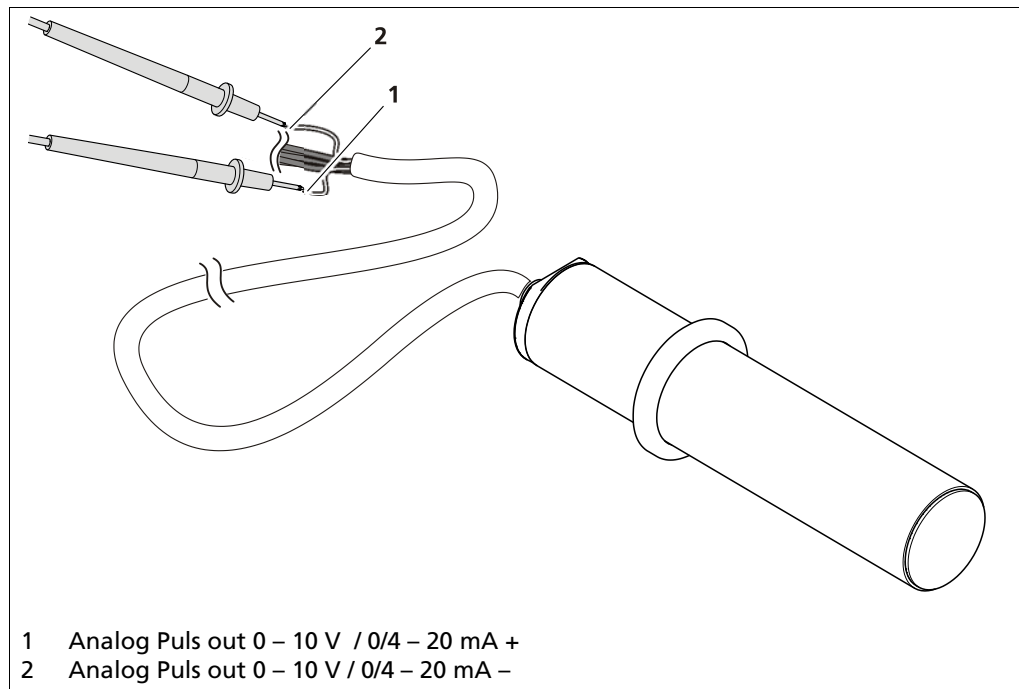


Fig. 18 Calibrate output

Determine lower calibration point:

5. Click on the button <Test Mode>.
6. Set "**Test Value**" somewhere into the lower part of scale (e.g. 3,8 mA or 1 V)
 - ▶ the "**Feedback Value**" shows now the internally measured value
7. Measure the output value (mA / V) with a voltmeter (item 1 / item 2).
8. Write measured value to "**Lower Cal. Point**".
9. Click on the button <Trim Offset>.
10. New check the "**Feedback Value**". It should now display the voltage you entered as test value. (a few oscillations around the "**Test Value**" are normal)
 - ▶ The calibration of the lower calibration point has been performed.

Determine upper calibration point:

11. Click on the button <Test Mode>.
12. Set "**Test Value**" somewhere into the upper part of scale (e.g. 3,8 mA or 9 V)
 - ▶ the "**Feedback Value**" shows now the internally measured value
13. Measure the output value (mA / V) with a voltmeter (item 1 / item 2).

14. Write measured value to **"Upper Cal. Point"**.
15. Click on the button **<Trim Gain>**.
16. Now check the **"Feedback Value"**. It should now display the voltage you entered as test value. (a few oscillations around the **"Test Value"** are normal)
 - ▶ The calibration of the upper calibration point has been performed.

6.4.9 Event Log

The Event Log page displays all reportable events in chronological and tabular form. If an event occurs the event with the highest priority is displayed. Click the <Acknowledge> button to confirm an event requiring manual confirmation.

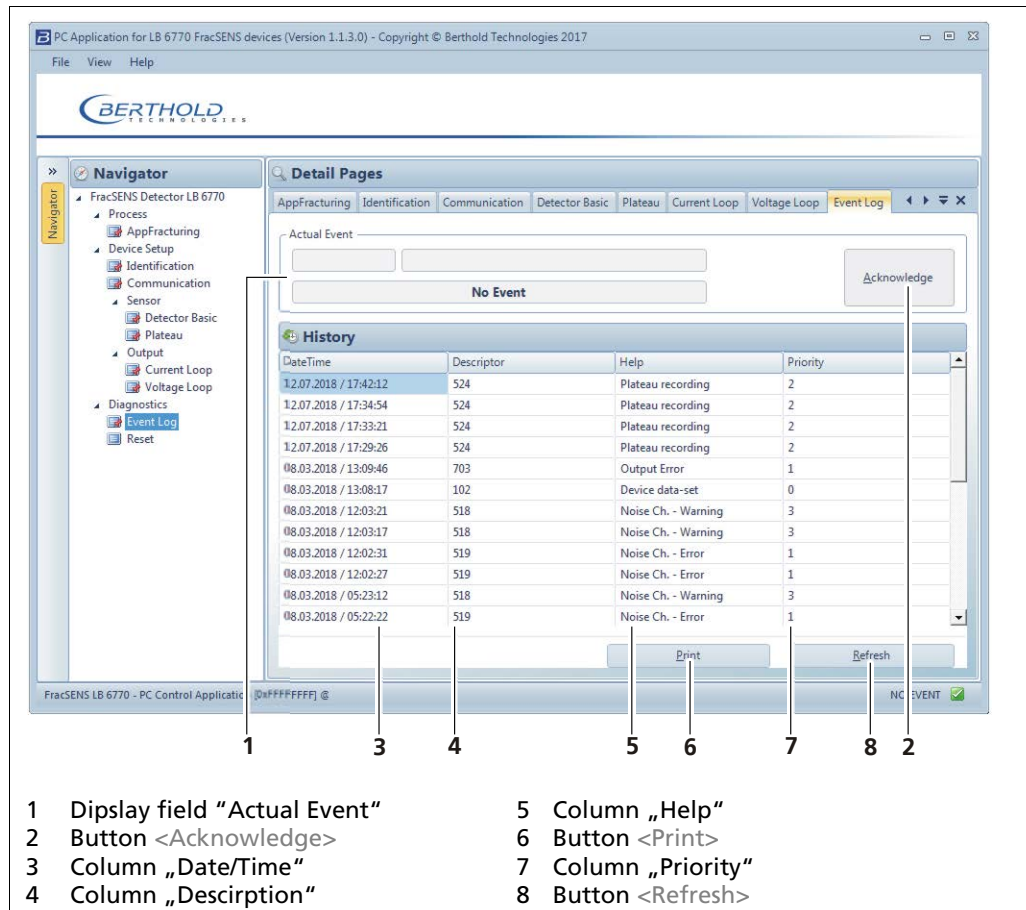


Fig. 19 Page "EventEntries"

Day	Date of indexed event (DD.MM.YYY / hh.mm.ss).
Description	Code of actual indexed event entry in event log. (Writing to this value causes acknowledge of event).
Help	Description of actual indexed event entry in event log.
Priority	Priorität des Ereignisses.
Print	Button to print the displayed table.
Refresh	Button to reload events.

Event List

System events are classified in

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

FAILURE (F)

Fatal device error. Usually, the current output is set to fault current.

Out of specification (S)

The detector, one of its components or the process itself, are out of normal specification.

Function Check (C)

Indicates that entries are made at the detector or a function check/simulation is being performed.

(EVENT)Number	Description	Cause	Action	Class
F 101-106, F 202, F 204-207, F 516, F 517, F 600, F 700	System Failure	Internal system failure	Powercycle device. If not successful perform factory reset. If the event remains it could be caused by a defective hardware. Contact BERTHOLD service.	0 / 1
S 208, S 209	Temp. Sensor CPU / Amp.	The temperature sensor on the main board / on the amplifier board is not working correctly.	Powercycle device. If not successful perform factory reset. If the event remains it could be caused by a defective hardware. Contact Berthold service.	3
S 210	Temperature too high	Internal Temperature is high	Check ambient temperature	3
F 211	Quartz synchronization	Internal system failure.	Powercycle device. If not successful perform factory reset. If the event remains it could be caused by a defective hardware. Contact Berthold service.	1

Event List (Continued)

(EVENT)Number	Description	Cause	Action	Class
S 501	DAC calibration	Internal system failure.	Powercycle device. If not successful perform factory reset. If the event remains it could be caused by a defective hardware. Contact Berthold service.	3
F 502	Impulse reception	Internal system failure.	Powercycle device. If not successful perform factory reset. If the event remains it could be caused by a defective hardware. Contact Berthold service.	0
S 503, S 506	Threshold	Incorrect threshold of measurement or control channel.	Powercycle device. If not successful perform factory reset. If the event remains it could be caused by a defective hardware. Contact Berthold service.	3
S 507	Impulse difference	Difference in the cps reading of two redundant channels.	Record plateau curve and enter correct V_bias. Reboot device. If not successful perform factory reset. If the event remains it could be caused by a defective hardware. Contact Berthold service.	3
F 508	Zero impulses	No pulses in measurement channel. Possible malfunction of the photo-multiplier.	Record plateau curve and enter correct V_bias. Reboot device. If not successful perform factory reset. If the event remains it could be caused by a defective hardware. Contact Berthold service.	1
S 511	V_bias set failure	V_bias setpoint and measured voltage differ	Check V_bias settings. Reboot device. If not successful perform factory reset. If the event remains it could be caused by a defective hardware. Contact Berthold service.	3

Event List (Continued)

(EVENT)Number	Description	Cause	Action	Class
F 512	V_bias failure	Error in generation of V_bias	Check V_bias settings. Reboot device. If not successful perform factory reset. If the event remains it could be caused by a defective hardware. Contact Berthold service.	1
S 518	Noise Ch. Warning	Noise detection channel is close to measurement threshold.	Check thresholds and ambient temperature.	3
F 519	Noise Ch. - Error	Noise detection channel is too close to measurement threshold. No reliable count rate can be determined.	Check thresholds and ambient temperature.	1
S 520	Noise Ch. - Cps	None or too many counts in the noise detection channel	Check thresholds and ambient temperature.	3
S 521	Temperature sensors	The temperature sensor on the front-end board is not working correctly.	Powercycle device. If not successful perform factory reset. If the event remains it could be caused by a defective hardware. Contact Berthold service.	3
S 522	Temperature too high	Internal Temperature on front-end board is high	Check ambient temperature	3
C 524	Plateau recording	A plateau recording is running. The measured CPS cannot be used for a measurement.	Wait until plateau recording is finished or abort.	2
F 703	Output Error	Problems with current / voltage output	Powercycle device and calibrate output. If the event remains it could be caused by a defective hardware. Contact Berthold service.	1

6.4.10 Reset

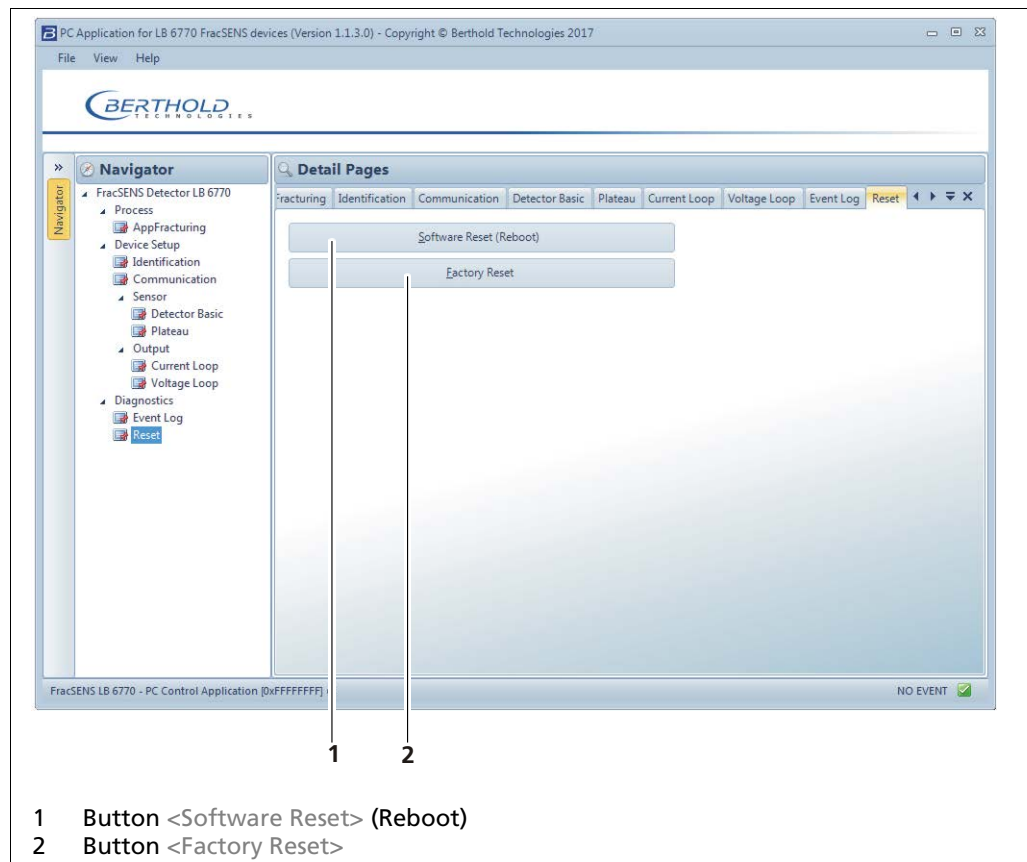


Fig. 20 Page "Reset"

Reboot

The device will be rebooted.

Reset

All device's parameters will be set to their default values.

6.5 System Setup and Calibration Procedure

If you are using FracSENS LB 6770 directly with your control system a calibration of the detector has to be performed in the control system. This chapter describes one example how to correctly set-up the measurement. These settings only have to be performed once and can be preset by the manufacturer or in the workshop.

1. Assign CPS range to analog output (4...20 mA / 0...10 V).
 - ▶ These are the count rate limits for the system.
2. Decide if output is proportional to CPS or log [CPS] (recommended).
3. Enter value for time constant.
 - ▶ This time constant will be used for calibration and measurement.

IMPORTANT



The time constant entered is an exponential filter that averages out the statistical decay of the radioisotope. Shorter values of time constant yield a faster reaction but a noisier signal. Larger values calm down the signal but increase reaction time. The detector will output new (filtered) count rate values every 0.1 s regardless of the time constant setting.

Example Setup:

Detector Setup	CPS	lnCPS	mA
Upper Count Rate Limit	100000 ²	11.513	4.00
Lower Count Rate Limit	20000 ³	9.903	20.00

Calibration in customer controls:

Calibration has to be performed at least every time the measurement has been mounted/dismounted.

- Calibrate AI (Analog Input) of control system (4...20mA/0...10V) with known density in the pipe. Two point calibration needed, e.g. empty pipe (density 0.0 SGU) and pure water (density 1.0 SGU) or two different liquid densities (if known).

In case LB 6770 output is set-up to be log [CPS] it is very easy. Simply assign the analog input value to the known densities.

Calibration	mA	Density [SGU]
Cal. point 1 (e.g. empty pipe)	4.8 ⁴	0.000
Cal. point 2 (e.g. pure water)	14.1	1.000

² Approx. expected count rate at empty pipe plus 20%.

³ Approx. count rate at highest density minus 20%.

⁴ If the output value for empty pipe is much higher than 6.0 mA (or 1.5 V) it is recommended to adjust the count rate limit assignment in the detector for better resolution of the measurement.

NOTICE**Proper calibration of the analog input is very critical!**

Averaging of count rate is mandatory for at least 30s. If there is no possibility in the customer control system to average the input, the time constant in the LB 6770 should be increased. In this case the measurement is running with the same time constant.

Calculating Density and Pounds Proppant/Sand Added during measurement:

- From Analog Input calculate density (SGU). In this example a current of 15.97 mA is equal to a density of 1.2010 SGU.
- Use this density to calculate desired PPG/PPA/PPS value:

Example:

$$PPA = \frac{\rho_{mix} - \rho_{water}}{1 - \frac{\rho_{mix}}{\rho_{propp}}} \cdot 8.35 = \frac{\rho_{mix} - \rho_{water}}{\rho_{propp} - \rho_{mix}} \cdot \rho_{propp} \cdot 8.35$$

PPA/PPG calculation

Density (mix, SGU)	1.2010
SGU (water)	1
SGU (propp)	2.590
conversion factor (imperial units)	8.350
PPG / PPA	3.129

In case LB 6770 output is set-up to be proportional to CPS one more calculation step has to be performed:

Calibration	mA	CPS	ln[CPS]	Density
Cal. point 1 (e.g. empty pipe)	9.1	74500	11.22	0.000
Cal. point 2 (e.g. pure water)	16.3	38500	10.56	1.000

7

Maintenance

7.1 Visual Inspection

Regularly perform a visual inspection. Check the housing of the detector for damage visible outside and for proper seating of the plug. Initiate immediate appropriate measures if you discover damage during visual inspection.

7.2 Cleaning

Use fat/grease dissolving cleaning agents or special stainless steel cleaners to clean the surface of dirt. Make sure that the connector and the name plate are not damaged during cleaning. Cleaning measures that may cause damage, such as grinding, filing, etc., are not permitted.

NOTICE



There is a risk of damage if the detector is cleaned with a full jet of water or a high-pressure cleaner.

- ▶ The detector must not be cleaned with a high-pressure cleaner.
- ▶ The detector must not be immersed in water.

8

Decommissioning

WARNING



Danger of injury by falling loads



- ▶ Never stand underneath a lifted or suspended load, keep at a safe distance.
- ▶ Only use tested sling gear components appropriate for the transport weight.
- ▶ Exclusively use the provided fixing possibilities (lifting brackets) for attaching the sling gear.
- ▶ Observe the marking for the centre of gravity on the outer packaging, if applicable.
- ▶ Wear head protection and safety shoes.

CAUTION



Danger of injury caused by heavy and bulky system components

- ▶ Heavy and bulky system components should only be handled using aids and by at least 2 persons.
- ▶ Observe the guidelines for safe handling of heavy loads.
- ▶ Ensure stability and use the provided fixing possibilities.

Follow this sequence for decommissioning:

1. Remove all cables from the detector.
2. Remove the detector out of its holder.

8.1 Disposal

CAUTION

**Toxic!**

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

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

If the product has been used, you can dispose of it through a waste management company in accordance with the statutory provisions.

Modifications due to technical advancement reserved.



Detectors FracSENS

LB 6770

**Informations sur la sécurité
63038BA59**

Rev. No.: 00, 07/2018

1

A propos de ce manuel d'utilisation

1.8 Avertissement

1.8.1 Les avertissements sont identifiés comme suit

Signalement



Source et conséquence
Explication si requise

► Prévention
En cas de danger

- **Symboles d'alerte :** (triangle d'alerte) attire l'attention sur le risque.
- **Signalement :** Indique la sévérité du danger.
- **Source :** Précise le type ou la source de danger.
- **Conséquence :** Décrit les conséquences d'un non respect.
- **Prévention :** Précise comment le risque peut être écarté.
- **En cas de danger :** Précise quelles actions sont requises en cas d'occurrence du risque

1.8.2 Symboles employés dans le manuel d'utilisation

Dans ce manuel, les avertissements indiqués avant les instructions d'utilisation se réfèrent aux risques de blessures ou de dégâts matériels. Les mesures de prévention de danger décrites doivent être respectées.

DANGER



Indique un danger majeur imminent, qui entraînera certainement des blessures sérieuses ou la mort s'il n'est pas évité.

AVERTISSEMENT



Indique un danger potentiel qui peut entraîner des blessures sérieuses ou la mort s'il n'est pas évité.

PRUDENCE

Se réfère à une situation potentiellement dangereuse qui peut entraîner des blessures physiques mineures ou graves, ou des dégâts matériels si elle n'est pas évitée.

RECOMMANDATION

Si cette information n'est pas appliquée, un dysfonctionnement et/ou un dégât matériel peuvent apparaître.

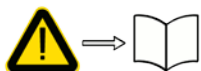
IMPORTANT

Les sections identifiées avec ce symbole signalent des informations importantes du produit ou de son fonctionnement.

Tip

Fournit des conseils sur l'application ou d'autres informations utiles.

1.8.3 Symboles utilisés sur l'appareil

**Lire le manuel d'utilisation**

Veuillez suivre les instructions dans ce manuel d'utilisation.

**Tension continue**

L'appareil fonctionne en tension continue et ne doit être raccordé qu'à une source de tension continue.

**Déchets non domestique**

Cet appareil électrique ne doit pas être éliminé avec les déchets domestiques

1.9 Conformité

La société BERTHOLD déclare par la présente, sous son entière responsabilité, que la conception de ce produit mis sur le marché par BERTHOLD est conforme aux directives EU indiquées dans la déclaration de conformité originale.

Cette disposition devient nulle en cas de modifications non autorisées par Berthold ou dans le cas d'une utilisation impropre.

Pour la déclaration de conformité originale, se référer au document d'information technique.

2

Sécurité

2.1 Utilisation appropriée

Le produit est utilisé en association avec une source de rayonnement afin de déterminer l'intensité du rayonnement au cours d'une mesure radiométrique. Cette mesure (de densité, par exemple) peut être effectuée sans contact au niveau de cuves ou de tuyauteries.

Définition d'une utilisation correcte :

- Respect strict des instructions et procédures et absence de recours à des pratiques autres non autorisées susceptibles de compromettre votre sécurité et la fiabilité opérationnelle du produit.
- Respect des consignes de sécurité ci-incluses.
- Réalisation des opérations de maintenance prescrites.
- Recours exclusif aux accessoires de mesure proposés par BERTHOLD TECHNOLOGIES.

Définition d'une utilisation incorrecte à éviter :

- Non-respect des consignes de sécurité et instructions d'utilisation, de maintenance et d'élimination ci-incluses.
- Non-respect des conditions et exigences stipulées dans les documents techniques, fiches techniques, instructions d'utilisation et de montage et autres directives spécifiques du fabricant.
- Utilisation du produit partiellement endommagé ou corrodé, y compris au niveau des joints et câbles.
- Restructuration ou modification des composants du système.

Situations à éviter :

- Utilisation du produit dans des systèmes desquels pourraient s'échapper des gaz explosifs, le produit n'étant pas antidéflagrant.
- Appareil non homologué conformément à la norme CEI 61508, « Sécurité fonctionnelle des systèmes électriques/électroniques/électroniques programmables relatifs à la sécurité ».
- Utilisation du produit avec...
 - o des raccords incorrectement obturés

des raccords vissés (fixations de câbles, adaptateurs ou bouchons d'obturation) mal serrés ou endommagés.

2.2 Qualification du personnel

RECOMMANDATION



Le minimum requis pour intervenir sur nos appareils ou pour les utiliser est un personnel avec des connaissances générales complétées par une formation d'un expert ou d'une personne autorisée.

A plusieurs endroits dans ce manuel d'utilisation, il est fait références à des groupes de personnes avec des qualifications particulières et à qui différentes tâches peuvent être confiées pendant l'installation, l'utilisation et la maintenance.

Les trois groupes de personnes sont :

- Employés avec des connaissances générales
- Experts
- Personnes autorisées

Employés avec connaissances générales

RECOMMANDATION



Les employés avec des connaissances générales doivent être guidés par un expert pour le moins. Lors de la mise en œuvre de matières radioactives, la personne compétente en radioprotection doit être consultée.

Les employés avec connaissances générales sont, par exemple, des techniciens, des soudeurs, qui vont assurer différentes tâches lors du transport, de l'assemblage et de l'installation de l'appareil sous l'encadrement d'une personne autorisée. Il peut s'agir aussi de personnel de montage du site. Les personnes concernées doivent posséder une expérience dans la manipulation du produit.

Experts

- Les experts sont des personnes avec des compétences suffisantes dans le domaine requis, dues à leur formation spécialisée et qui sont familiers avec les lois nationales relatives à la santé et la sécurité, les règlements concernant la prévention des accidents, et les usages techniques applicables.
- Le personnel expert doit être capable de déterminer et d'évaluer le résultat de ses tâches et doit être très familier avec le contenu de ce manuel d'utilisation.

Personnes autorisées

Les personnes autorisées sont celles désignées pour les tâches correspondantes dans le cadre de dispositions réglementaires, ou celles dûment autorisées par BERTHOLD pour des tâches particulières. Lors de la mise en œuvre de matières radioactives, la personne compétente en radioprotection doit être consultée.

2.3 Les obligations de l'opérateur

L'opérateur de ces appareils doit régulièrement former son personnel sur les sujets suivants :

- Connaissance et utilisation **du manuel d'utilisation et des clauses légales.**
- Utilisation prévue de l'appareil.
- Respect des instructions de sécurité du site et des conditions d'utilisation de l'opérateur.
- Gestion régulière de la maintenance du produit.

3

Description du système

RECOMMANDATION



C'est un appareil de classe A (zone industrielle). L'appareil peut causer des interférences radio dans les zones résidentielles.

4 Installation

4.1 Instructions de sécurité

AVERTISSEMENT



Danger de blessure par chute d'éléments lourds



- ▶ Ne jamais stationner sous une charge suspendue, rester à une distance de sécurité suffisante.
- ▶ Utiliser uniquement du matériel d'élinguage testé et approprié à la charge à porter.
- ▶ Utiliser exclusivement les points de fixation et d'ancrage prévus (anneaux de levage) pour attacher les élingues.
- ▶ Observer le marquage du centre de gravité sur l'emballage extérieur si disponible.
- ▶ Porter les équipements de protection appropriés.

PRUDENCE



Danger de blessures causées par les éléments lourds et volumineux

- ▶ Les éléments lourds et volumineux doivent être portés et manipulés par deux personnes au moins.
- ▶ Observer les instructions pour la manipulation des objets lourds.
- ▶ S'assurer de la stabilité et utiliser les possibilités de fixation disponibles.

RECOMMANDATION



Les réglementations en vigueur dans le pays d'utilisation de l'instrument doivent être respectées

RECOMMANDATION



Pour l'installation de l'appareil, utilisez exclusivement les supports de montage approuvés par BERTHOLD TECHNOLOGIES.

RECOMMANDATION



L'appareil ne peut être utilisé que s'il est installé de manière correcte et définitive.

4.2 Site d'utilisation

Le détecteur est destiné à une utilisation extérieure. Pour les conditions ambiantes, se référer au chapitre 9.1 Caractéristiques techniques.

4.4 Installation sur tuyauterie

RECOMMANDATION



Le support mécanique utilisé doit être conçu pour un poids minimum de 12 kg.

RECOMMANDATION



Vérifier que la partie sensible du détecteur est totalement dans le faisceau de rayonnement. Dans le cas contraire, la précision de la mesure sera affectée. La partie sensible est située vers le photomultiplicateur. Voir le plan pour plus de détails.

5

Installation électrique

5.1 Câbles et conducteurs

- ▶ La connexion des conducteurs doit être réalisée avec précaution.
- ▶ Les lignes de liaison et leur cheminement doivent être conformes aux réglementations en vigueur.
- ▶ Lors du passage des câbles, assurez-vous qu'aucune pièce à arêtes vives ou mobiles ne puisse endommager mécaniquement l'isolation des câbles.
- ▶ Lors du passage des lignes de liaison, veillez à :
 - o éviter toute pénétration de saleté et d'humidité dans le boîtier de raccordement.
 - o ne pas dépasser le rayon de courbure admissible de la section de câble
 - o éviter toute contrainte et friction dans la pose des câbles.

Les câbles connectés doivent supporter des températures au moins 10 °C supérieures à la température ambiante maximale admissible

La source d'alimentation de la version 24 VDC du produit doit être conforme aux exigences (valeurs limites des pièces accessibles) de la Directive sur les équipements basse tension (DIN EN 61010-1) et dotée d'une isolation double ou renforcée.

Tous les appareils connectés aux sorties du produit (par ex. circuit de relais, sortie 3,3 V, RS-485, sortie courant) doivent présenter des paramètres de tension conformes aux valeurs limites (des pièces accessibles) stipulées dans la Directive sur les équipements basse tension (DIN EN 61010-1) et être dotés d'une isolation double ou renforcée.

Ces mesures de protection sont nécessaires pour éviter le risque de contact avec des tensions potentiellement mortelles.

Ne pas modifier l'installation électrique si vous ne disposez pas d'une connaissance précise du présent manuel d'utilisation.

7 Maintenance

RECOMMANDATION



Il y a risqué d'endommager l'appareil si le nettoyage est effectué avec un jet d'eau ou un nettoyeur haute pression.

- ▶ Le détecteur ne doit pas être nettoyé avec un nettoyeur haute pression.
- ▶ Le détecteur ne doit pas être immergé

8

Mise hors service

AVERTISSEMENT

Danger de blessure par chute d'éléments lourds



- ▶ Ne jamais stationner sous une charge suspendue, rester à une distance de sécurité suffisante.
- ▶ Utiliser uniquement du matériel d'élinguage testé et approprié à la charge à porter.
- ▶ Utiliser exclusivement les points de fixation et d'ancrage prévus (anneaux de levage) pour attacher les élingues.
- ▶ Observer le marquage du centre de gravité sur l'emballage extérieur si disponible.
- ▶ Porter les équipements de protection appropriés.

PRUDENCE



Danger de blessures causées par les éléments lourds et volumineux

- ▶ Les éléments lourds et volumineux doivent être portés et manipulés par deux personnes au moins.
- ▶ Observer les instructions pour la manipulation des objets lourds.
- ▶ S'assurer de la stabilité et utiliser les possibilités de fixation disponibles.

8.1 Elimination

PRUDENCE



Risque d'intoxication !

Le produit contient des composants électroniques comportant des substances toxiques nocives pour la santé.

L'appareil doit être éliminé conformément aux réglementations en vigueur par une entreprise de traitement des déchets spécialisée.

9 Informations techniques

9.1 Caractéristiques techniques

Conception mécanique	
Boîtier	Acier Inox 1.4301 (304)
Scintillateur	Cristal NaI; Ø 40 mm, H: 50 mm
Gain	Par semi-conducteur
Température d'utilisation	-40...+60 °C (-40...140 °F) température ambiante
Température de stockage	-40...+70 °C (-40...158 °F)
Classe de protection IP	IP 66
Connexion	Amphenol PT02 E10-6P
Poids	Env. 3 kg
Altitude	Max. 5000 m au dessus du niveau de la mer
Humidité	Max. 99%
Environnement	L'appareil est conçu pour une utilisation en environnement humide

Conception électrique	
Electriques	15...28 V  (+-10% tolérance de l'alimentation) 2.6 W
Signal de sortie	Le signal de sortie proportionnel à taux de comptage ou de taux de comptage logarithmique. 0...10 V sortie (min. 1000 Ohm, max. 1µF) 0/4...20 mA sortie (max. 400 Ohm)
Câble	6 fils, 1.5 mm², blindés
Communication	RS 485 – Modbus RTU (Baud Rate: 2 9600, 19200, 38400, 57600. Default Value: 19200). Max. sortie 3.3 V, 250 mA. Détecteur température, Actuel haute tension et réglage (Auto, Fixed), tous mesurer seuils, voir et de reconnaître des erreurs de détection et avertissements, constante d'amortissement de temps interne, Modbus adresse, part no., HW et SW version, numéro de série.

Performance	
Temps de cycle interne	100 ms
Amortissement	0.1 ... 99 s
Régularité	A taux de comptage constante $\leq 0.1\%$ ($\leq 0.002\%$ / °C), sur le système de température complète
Approbations	• Conditions d'essai environnemental selon ISO 13628-6 (norme de sous-marin) concernant la température, vibrations et des chocs. • CE certificate • UL/CSA certificat (cNEMCOus)

Sous réserve de modifications dans le cadre du progrès technique.



LB 6770

Technical Information

63038TI
Rev. No.: 00, 07/2018

FracSENS LB 6770 Detector

Densitometer for Hydraulic Fracturing and Cementing Applications

The FracSENS LB 6770 densitometer is specifically developed for the harsh environments that are typical for hydraulic fracturing and cementing.

- State-of-the-art SiPM technology instead of Vacuum PMT
- Best repeatability and temperature stability on the market $\leq 0.2\%$ over 100°C temperature regime
- Rugged design ensures long availability (tested according to subsea standard ISO 13628-6)
- High sensitive scintillation technology
- Various output options available (0/4...20mA, 0...10V, pulses, Modbus)
- Condensed to lowest energy consumption
- Short response time
- Adjustable thresholds for individual selection of energy spectrum
- Configurable via the LB 47x evaluation unit or via the service modem

Technical Data

NOTICE / HINWEIS



The detector FracSENS LB 6770 is not explosion protected and is not designed for hazardous environments

Mechanical Design

Housing	Stainless Steel 1.4301 (304)
Scintillator	Nal-crystal; Ø 40 mm, H: 50 mm
Gain	Semi-conductor based
Operating Temp.	-40...+60°C (-40...140°F) ambient temperature
Storage Temp.	-40...+70°C (-40...158°F)
IP class	IP 66
Connection	Amphenol PT02 E10-6P
Weight	Approx. 3 kg
Altitude	Max. 5000 m above sea level
Humidity	Max. 99%
Environment	The device is designed for wet environments

Electrical Design

Power	15...28 V  (+-10% supply tolerance) 2.6 W
Output Signals	Output signal proportional to count rate or logarithmic count rate. 0...10 V output 0/4...20 mA output (max. 400 Ohm)
Cable	6 wires, 1.5 mm², shielded
Communication	RS 485 – Modbus RTU (Baud Rate: 9600, 19200, 38400, 57600. Default Value: 19200). Max. Output 3,3 V, 250 mA. Detector Temperature, Actual High Voltage and setting (Auto, Fixed), All measurement thresholds, see and acknowledge detector errors and warnings, internal damping time constant, Modbus address, part no., HW and SW version, serial number.

Performance

Internal Cycle Time	100 ms
Damping	0.1 ... 99 s
Stability	At constant count rate $\leq 0.1\%$ ($\leq 0.002\%$ / °C), over complete temperature regime

Approvals

- Environmental test conditions acc. to ISO 13628-6 (subsea standard) concerning temperature, vibration and shock.
- CE certification
- UL/CSA certification (cNEMCOus)

Supported Modbus Function Codes

Command	Codes
Read Coils	01
Read Holding Registers	03
Read Input Registers	04
Write Single Coil	05
Write Single Register	06
Diagnostics	08 / 0, 11, 12, 13, 14, 15, 16, 17, 18
Write Multiple Registers	16

Modbus Communication Settings

Command	Codes
Automatic Baudrate Detection	No
Supported Baudrates	9600, 19200, 38400, 57600
Parity Mode	None, Even, Odd
Stop Bits	1 – 2
Modbus slave addressing range	1 – 247

Parameter List

Coil	Adress	Description	Value
Reboot	0	If set to 1, the device will be rebooted. Afterwards returns this value back to 0.	0 = OFF 1 = ON
Reset	1	If set to 1, all device's parameters will be set to their defaults values. Device restarts and this value will be set to 0 again.	0 = OFF 1 = ON
Reserved	2		
Reserved	3		
Voltage Loop Monitoring	4	Activates/deactivates monitoring of voltage loop.	0 = OFF 1 = ON
Voltage Loop Error Mode	5	„Error Voltage“selection.	0 = 0 V 1 = 10 V
Voltage Loop Test Mode	6	Activates/deactivates test mode of voltage loop. If activated, the "Test Voltage" is output. (Reboot deactivates test mode automatically).	0 = OFF 1 = ON
Current Loop Monitoring	7	Activates/deactivates monitoring of current loop.	0 = OFF 1 = ON
Current Loop Error Mode	8	„Error Current“ selection.	0 = 22 mA 1 = 2 mA
Current Loop Test Mode	9	Activates/deactivates test mode of current loop. If activated, the "Test Current" is output. (Reboot deactivates test mode automatically).	0 = OFF 1 = ON
Reserved	10-12		

Input Register	Adress	Reg.Size	Type	Description	Value
V _{bias} Actual	0	2	Float	Actual calculated V _{bias} value	
Min. Temperature	2	2	Float	Minimal measured electronic temperature	
Max. Temperature	4	2	Float	Maximal measured electronic temperature	
Temperature	6	2	Float	Actual measured electronic temperature	

Input Register	Adress	Reg.Size	Type	Description	Value
Measurement Cps	8	2	Float	Pulses counted and averaged in measurement channel. (Used for detector controlling)	
Control Cps	10	2	Float	Pulses counted and averaged in control channel. (Used for detector controlling)	
Auxiliary Cps	12	2	Float	Pulses counted and averaged in auxiliary channel. (Used for detector controlling)	
Live Cps	14	2	Float	Pulses counted in measured channel. (Used for application)	
Average Cps	16	2	Float	Averaged „Live Cps“	
Stop Bits	18	1	Int	Number of stop bits for Modbus communication..	1 - 2
Event Date	19	2	Int	Date of occurrence of actual indexed event entry in event log. (Number of days since last known date / device restart)	0
Event Time	21	2	Int	Time of occurrence of actual indexed event entry in event log.	0
Event Priority	23	8	ASCII	Priority of actual indexed event entry in event log. (NAMUR NE-107)	No Event
Event Description	31	16	ASCII	Description of actual indexed event entry in event log.	No Event
Plateau V _{bias}	47	2	Float	V _{bias} of actual indexed plateau entry in plateau table.	
Plateau Cps	49	2	Float	Pulse Rate of actual indexed plateau entry in plateau table.	
Application Name	51	8	ASCII	Application's name.	

Application Version	59	4	ASCII	Application's version number.	[xx.xx.xx]
Application Date	63	4	ASCII	Application's date.	[mm.tt.yy]
Unique Id.	67	2	Int	Device's unique identification number.	

Input Register	Adress	Reg.Size	Type	Description	Value
Voltage Loop State	69	1	Short	Actual state of Voltage Loop state machine. (Reboot deactivates test mode automatically).	0 = NORMAL 1 = TEST 2 = CHECK HIGH 3 = CHECK LOW 4 = ERR. HIGH 5 = ERR. LOW 6 = ERR. LOW OFF
Actual Voltage	70	2	Float	Calculated voltage to output.	0 - 10 V
Error Voltage	72	2	Float	Voltage outputted if failure is detected.	0 10 V
Feedback Voltage	74	2	Float	Actual measured output voltage.	0 – 10 V
Current Loop State	76	1	Short	Actual state of Current Loop state machine. (Reboot deactivates test mode automatically).	0 = NORMAL 1 = TEST 2 = CHECK HIGH 3 = CHECK LOW 4 = ERR HIGH 5 = ERR LOW 6 = ERR LOW OFF
Actual Current	77	2	Float	Calculated current to output.	4 - 20 mA
Error Current	79	2	Float	Current outputted if failure is detected.	2 22 mA
Feedback Current	81	2	Float	Actual measured output current	2 - 22 mA
Reserved	83-89	7	-		

Holding Register:	Adress	Reg.Size	Type	Description	Value
Reserved	0	1	-		
Detector Work Mode	1	1	Short	HV controlling method	0 = AUTO 1 = MANUAL 2 = PLATEAU
Vbias Default	2	2	Float	Start V_{bias} if AUTO	60 - 80 V
Vbias Manual	4	2	Float	Fixed V_{bias} if MANUAL	60 - 80 V
Reserved	6-11	6	-		
Application Work Mode	12	1	Short	Application's work mode. (Reboot deactivates test mode automatically).	0 = NORMAL 1 = TEST

Holding Register:	Adress	Reg.Size	Type	Description	Value
Lower Range	13	2	Float	Pulse Rate related to lower range of voltage/current output	
Upper Range	15	2	Float	Pulse Rate related to upper range of voltage/current output	
Test Cps	17	2	Float	Pulse Rate used if application's work mode is test.	
Time Constant	19	2	Float	Time constant used for averaging of „Live Cps“ if application's work mode is normal	0.1 s
Communication Work Mode	21	1	Short	Communication selector	0 – MODBUS initial 1 – MODBUS temp. 2 – MODBUS fixed 3 – EROA temp.
Modbus Id.	22	1	Short	Modbus slave address	1 - 247
Baudrate	23	2	Int	Baudrate <i>Baudrate</i>	9600 19200 38400 56700
Parity	25	1	Short	Parity <i>Parität</i>	0 = None 4 = Odd 12 = Even
Event Index	26	1	Short	Index of event entry in event log.	0 = Aktuelles Ereignis
Event Code	27	1	Short	Code of actual indexed event entry in event log. (Writing to this value causes acknowledge of event).	

Plateau Start	28	2	Float	V _{bias} voltage used as start point for plateau recording	60 - Plateau Stop
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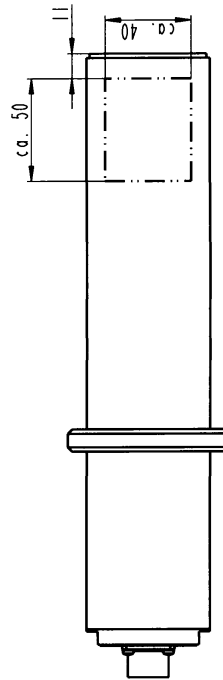
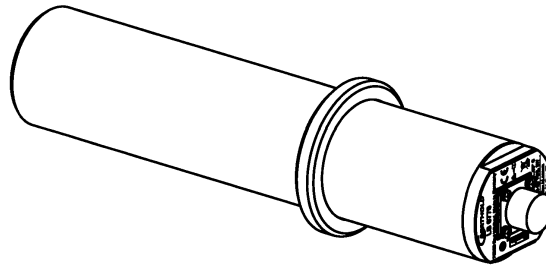
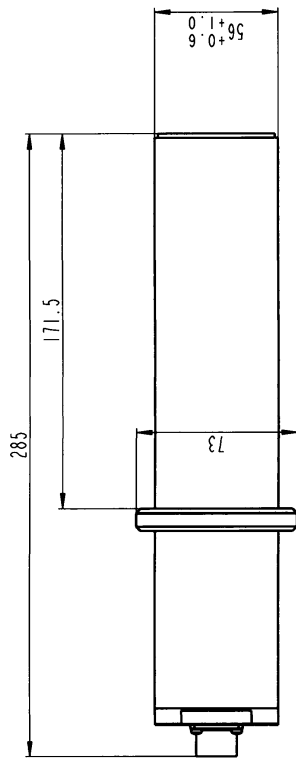
Holding Register:	Adress	Reg.Size	Type	Description	Value
Lower Range (Current Loop)	51	2	Float	Extension of output current range according to NAMUR NE-43. <i>Wertebereich der Ausgangsspannungs gemäß NAMUR NE-43.</i>	3,8 - 4.0 mA
Upper Range (Current Loop)	53	2	Float	Extension of output current range according to NAMUR NE-43. <i>Wertebereich der Ausgangsspannungs gemäß to NAMUR NE-43.</i>	20,0 - 20.5 mA
Reserved	55	2	-		
Cps Output Function	57	1	Short	Function transfers application's result to output signal	0 = Linear 1 = Exponential
Reserved	58	1	-		

Holding Register:	Adress	Reg.Size	Type	Description	Value
Plateau Stop	30	2	Float	V _{bias} voltage used as stop point for plateau recording	Plateau Start - 80
Plateau Step	32	2	Float	Voltage use to increment V _{bias} during plateau recording	
Plateau Time	34	2	Float	Time used for cps averaging during plateau recording	
Plateau Index	36	1	Short	Index of plateau entry in plateau table.	0 – 40
Test Voltage	37	2	Float	Voltage outputted if test state of Voltage Loop state machine is activated	0 V
Lower Cal. Point (Voltage Loop)	39	2	Float	Value measured with external voltmeter and usually used for offset calibration of voltage loop.	0 V
Upper Cal. Point (Voltage Loop)	41	2	Float	Value measured with external voltmeter and usually used for gain calibration of voltage loop	0 V
Calibration Type (Voltage Loop)	43	1	Short	Voltage Loop calibration. After calibration, the value returns back to 0 again	0 = Idle 1 = Offset 2 = Gain

Test Current	44	2	Float	Current outputted if test state of Current Loop state machine is activated	4 mA 2 – 23.9 mA
Lower Cal. Point (Current Loop)	46	2	Float	Value measured with external ampermeter and usually used for offset calibration of current loop.	0 mA
Upper Cal. Point (Current Loop)	48	2	Float	Value measured with external ampermeter and usually used for gain calibration of current loop.	0 mA
Calibration Type (Current Loop)	50	1	Short	Current Loop calibration. After calibration, the value returns back to 0 again.	0 = Idle 1 = Offset 2 = Gain

Holding Register:	Adress	Reg.Size	Type	Description	Value
Lower Range (Current Loop)	51	2	Float	Extension of output current range according to NAMUR NE-43	3.8 - 4.0 mA
Upper Range (Current Loop)	53	2	Float	Extension of output current range according to NAMUR NE-43	20.0 - 20.5 mA
Reserved	55	2	-		
Cps Output Function	57	1	Short	Function transfers application's result to output signal	0 = Linear 1 = Exponential
Reserved	58	1	-		

Drawing

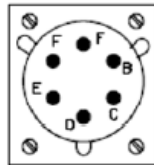
[illegible]

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Connection plan

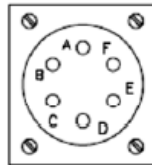
Connector

cable side



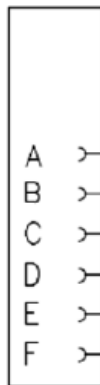
Connector

solder side



○ 6	○ 1
○ 7	○ 2
○ 8	○ 3
○ 9	○ 4
○ 10	○ 5
LP Signalprocessing-Modul Id. 61497	

Connector



LP Signalprocessing-Modul Id. 61497

- ⊙ Pin 1 = Impuls + = gelb / Yellow
- ⊙ Pin 2 = Impuls - = Schwarz / black
- ⊙ Pin 3 N.C.
- ⊙ Pin 4 = 0-10V+ / 4-20mA +
- ⊙ Pin 5 = 0-10V- / 4-20mA -
- ⊙ Pin 6 = RS485A = weiss / white
- ⊙ Pin 7 = RS485B = braun / brown
- ⊙ Pin 8 = Supply + 24V = rot / red
- ⊙ Pin 9 = GND = violet
- ⊙ Pin 10 = PE (Cabine)

Declaration of Conformity



BERTHOLD TECHNOLOGIES GmbH & Co. KG
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 Fax +49 7081 177-100
 info@Berthold.com
 www.Berthold.com

EU-Declaration of Conformity

We, hereby declare under our sole responsibility that the design of the following products / systems / units brought into circulation by us comply with the relevant harmonized rules of the EU.

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

Description: **detector for radiometrical measurement system**

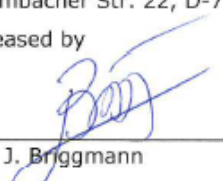
Typ: **LB 6760 / LB6770**

	directive	applied standards
EMC	2014/30/EU	EN 61326-1 2013
		EN 55011 2011
		EN 61000-4-2 2009
		EN 61000-4-3 2010
		EN 61000-4-4 2010
		EN 61000-4-5 2006
		EN 61000-4-6 2009
RoHS	2011/65/EG	Namur NE 21

This declaration is issued by the manufacturer

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

released by


 Dr. J. Briggmann

Head of R&D
 Bad Wildbad, 04th of November, 2015

Registergericht / Court of Registration
 Persönlich haftende Gesellschafterin / Fully liable Associates
 Registergericht / Court of Registration
 Geschäftsführung / Management
 USt.-Id.-Nr. / VAT Reg. No.
 Deutsche Steuernummer / German Tax No.
 WEEE-Reg. No.

Stuttgart HRA 330991
 BERTHOLD TECHNOLOGIES Verwaltungs-GmbH
 Stuttgart HRB 331520
 Horst Knauff, Dr. Dirk Mörmann
 DE813050511
 49036/08038
 DE99466690

Sparkasse PF-CW	75323 Bad Wildbad	Konto/Account No. 8 045 003 (BLZ 666 500 85)	SWIFT-BIC PZHSDE66	IBAN: DE37 6665 0085 0008 0450 03
Volksbank	75119 Pforzheim	Konto/Account No. 957 004 (BLZ 666 900 00)	SWIFT-BIC VSPFDE56	IBAN: DE85 6669 0080 0000 9570 04
Commerzbank	75105 Pforzheim	Konto/Account No. 6 511 120 (BLZ 666 500 13)	SWIFT-BIC COFGDE33	IBAN: DE05 6668 0013 0651 1120 00

NRTL Certificate



Nemko-CCL, Inc.

Certificate of Compliance

Certificate: NA201610546

Date Issued: March 7, 2016

Project: 289999-5.1

Issued to: Berthold Technologies GmbH & Co. KG
Calmbacher Straße 22
75323 Bad Wildbad
Germany

The products listed below have been certified as being compliant with all applicable requirements of the specifications listed and are eligible to bear the following certification mark



Issued by:

Robert Keller, Senior Engineer/Safety Supervisor

Authorized by:

Thomas Jackson, Certification Manager

PRODUCTS

MEASUREMENT, CONTROL, OR LABORATORY EQUIPMENT – Certified to US and Canada Standards

Product: Radiometric density measurement device

Model: LB 6770-1I-Z0-.1-01-11(Where the character “.” can be “A” or “B”)

Ratings: 2.6W, 15-28V d.c., for building in

APPLICABLE REQUIREMENTS

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

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

This certificate is issued on condition that the holder complies and will continue to comply with the requirements of the above mentioned specifications and pursuant to the terms and conditions specified in the Certification Agreement.

The certification system, as described in ISO/IEC Guide 67 (Conformity Assessment – Fundamentals of Product Certification), most closely resembles System 3

Nemko-CCL, Inc. 1940 West Alexander Street Salt Lake City, Utah 84119-2039 Tel (801) 972-6146 Fax (801) 972-8432



Supplement to Certificate of Compliance

Certificate: NA201610546

Project: 289999-5.1

Nemko-CCL grants a license to the applicant to apply the Certification Mark to the certified products and that the mark shall only be affixed at the following factory locations

Factory Information

Factory Name	Location
Berthold Technologies GmbH & Co. KG	Calmbacher Straße 22 75323 Bad Wildbad Germany

The products listed, including the latest revision described below, are eligible to be marked in accordance with the referenced Certificate.

Product Certification History

Project	Date	Description
289999-5.1	March 7, 2016	Original Certification: Model: LB 6770-1I-Z0-.1-01-11(Where the character "." can be "A" or "B") Ratings: 2.6W, 15-28V d.c., for building in

This Supplement forms an integral part of the Certificate of Compliance

The certification system, as described in ISO/IEC Guide 67 (Conformity Assessment – Fundamentals of Product Certification), most closely resembles System 3

Nemko-CCL, Inc. 1940 West Alexander Street Salt Lake City, Utah 84119-2039 Tel (801) 972-6146 Fax (801) 972-8432

NFCC-002 Issue 2 May 2014



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