Leuze

Original Operating Instructions

LBK SBV System

Safe Radar System

The Sensor People

We reserve the right to make technical changes
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1 Glossary of terms

1oo2	(one out of two) Type of multi-channel architecture where one area is monitored by two sensors at the same time.
Activated output (ON-state)	Output that switches from OFF to ON-state.
Angular coverage	Property of the field of view that corresponds to the coverage on the horizontal plane.
Dangerous area	Area to be monitored because it is dangerous for people.
Deactivated output (OFF-state)	Output that switches from ON to OFF-state.
Detection distance x	Depth of the field of view configured for detection field x.
Detection signal x	Output signal that describes the monitoring status of the detection field x.
ESPE (Electro-Sensitive Protective Equipment)	Device or system of devices used for the safety-related detection of people or parts of the body. ESPEs provide personal protection at machines and plants/systems where there is a risk of physical injury. These devices/systems cause the machine or plant/system to switch over to a safe status before a person is exposed to a dangerous situation.
Field of view	Sensor area of vision characterized by a specific angular coverage.
Fieldset	Structure of the field of view which can be composed of up to four detection fields.
FMCW	Frequency Modulated Continuous Wave
Inclination	Sensor rotation around the x-axis. The sensor inclination is the angle between the center of the field of view of the sensor and a line parallel to the ground.
Machinery	The system for which the dangerous area is monitored.
Monitored area	Area that is monitored by the system. It is composed of all the fields of all the sensors.
Detection field x	Portion of the field of view of the sensor. Detection field 1 is the field closer to the sensor.
OSSD	Output Signal Switching Device
RCS	Radar Cross-Section. Measure of how detectable an object is by radar. It depends, among other factors, on the material, dimension and position of the object.
Tolerance area	Area of the field of view where detection or not of a moving object/person depends on the characteristics of the same object itself.

2 This manual

2.1 Information on this manual

2.1.1 Objectives of this instruction manual

This manual explains how to integrate LBK SBV System for safeguarding machinery operators and how to install it, use it and maintain it safely.

This document includes all the information as Safety Manual according to IEC 61508-2/3 Annex D. Please refer in particular to Safety parameters on page 92 and to System software on page 114.

The functioning and safety of the machinery to which LBK SBV System is connected is out of the scope of this document.

2.1.2 Obligations with regard to this manual

NOTICE

This manual is an integral part of the product and must be kept for its entire working life. It must be consulted for all situations related to the life cycle of the product, from its delivery to decommissioning. It must be stored so that it is accessible to operators, in a clean location and in good condition. In the event of manual loss or damage, contact Technical Support. Always enclose the manual when the equipment is sold.

2.1.3 Provided documentation

Document	Code	Date	Distribution format
Original Operating Instructions (this manual)	UM_LBK-SBV200_en_50149156	2022-12-15	online PDF PDF downloadable from the site www.leuze.com
PROFIsafe communication Original Operating Instructions	SAF-RG-PROFIsafe-en-v18	APR 2022	online PDF PDF downloadable from the site www.leuze.com (available in English)
Modbus communication Original Operating Instructions	UM_LBK-MODBUS_en_50149166	2022-12-15	online PDF PDF downloadable from the site www.leuze.com (available in English, German)
RCS Reader Tool instructions	UM_RCS-Reader-Soft_en-50149169	2022-12-15	online PDF PDF downloadable from the site www.leuze.com (available in English)
Cable validator	-	-	online Excel Excel downloadable from the site www.leuze.com

2.1.4 Intended users of this instruction manual

The recipients of the instruction manual are:

- the machinery manufacturer onto which the system will be installed
- system installer
- machinery maintenance technician

3 Safety

3.1 Safety information

3.1.1 Safety messages

Warnings related to the safety of the user and of the equipment as envisaged in this document are as follows:

⚠ WARNING
Indicates a hazardous situation which, if not avoided, may cause death or serious injury.

NOTICE
Indicates obligations that if not observed may cause harm to the equipment.

3.1.2 Safety symbols on the product

This symbol marked on the product indicates that the manual must be consulted. In particular, pay attention to the following activities:

- wiring of the connections (see Terminal blocks and connector pin-outs on page 96 and Electrical connections on page 99)
- cable operating temperature (see Terminal blocks and connector pin-outs on page 96)
- controller cover, which was subjected to a low energy impact test (see Technical data on page 92)

3.1.3 Personnel skills

The recipients of this manual and the skills required for each activity presented herein are as follows:

Recipient	Assignments	Skills
Machinery manufacturer	• Defines which protective devices should be installed and sets the installation specifications	• Knowledge of significant hazards of the machinery that must be reduced based on risk assessment. • Knowledge of the entire machinery safety system and the system on which it is installed.
Protection system installer	• Installs the system • Configures the system • Prints configuration reports	• Advanced technical knowledge in the electrical and industrial safety fields • Knowledge of the dimensions of the dangerous area of the machinery to be monitored • Receives instructions from the machinery manufacturer
Machinery maintenance technician	• Performs maintenance on the system	• Advanced technical knowledge in the electrical and industrial safety fields

3.1.4 Safety assessment

Before using a device, a safety assessment in accordance with the Machinery Directive is required.

The product as an individual component fulfills the functional safety requirements in accordance with the standards stated in Standards and Directives on page 17. However, this does not guarantee the functional safety of the overall plant/machine. To achieve the relevant safety level of the overall plant/machine's required safety functions, each safety function needs to be considered separately.

3.1.5 Intended use

LBK SBV System is certified SIL 2 according to IEC/EN 62061, PL d according to EN ISO 13849-1 and Performance Class D according to IEC/TS 62998-1.

It performs the following safety functions:

- **Access detection function**: access of one or more persons to a hazardous area deactivates the safety outputs to stop the moving parts of the machinery.
- **Restart prevention function**: prevents unexpected starting or restarting of the machinery. Detection of motion within the dangerous area maintains the safety outputs deactivated to prevent machinery starting.

It performs the following additional safety functions:

- Stop signal: force all the safety outputs to OFF-state.
- Restart signal: enables the controller to switch to ON-state the safety outputs related to all the detection fields with no motion detected.
- Muting (see Muting on page 47).

LBK SBV System is suitable for protecting the entire body for the following applications:

- dangerous area protection
- mobile dangerous area protection
- indoor and outdoor applications

LBK SBV System meets requirements of applications safety functions that require a risk reduction level of:

- up to SIL 2, HFT = 0 according to IEC/EN 62061
- up to PL d, Category 3 according to EN ISO 13849-1
- up to Performance Class D according to IEC/TS 62998-1

LBK SBV System, in combination with additional risk reduction means, can be used for applications safety functions that require higher risk reduction levels.

The following is deemed improper use in particular:

- any component, technical or electrical modification to the product
- use of the product outside the areas described in this document
- use of the product outside the technical details, see Technical data on page 92

3.1.6 EMC-compliant electrical installation

NOTICE	
	The product is designed for use in an industrial environment. The product may cause interference if installed in other environments. If installed in other environments, measures should be taken to comply with the applicable standards and directives for the respective installation site with regard to interference.

3.1.7 General warnings

- Incorrect installation and configuration of the system decreases or inhibits the protective function of the system. Follow the instructions provided in this manual for correct installation, configuration and validation of the system.
- Changes to the system configuration may compromise the protective function of the system. After any changes made to the configuration, validate correct functioning of the system by following the instructions provided in this manual.
- If the system configuration allows access to the dangerous area without detection, implement additional safety measures (e.g. guards).
- The presence of static objects, in particular metallic objects, within the field of view may limit the efficiency of sensor detection. Keep the sensor field of view unobstructed.
- The system protection level (SIL 2, PL d) must be compatible with the requirements set forth in the risk assessment.
- Check that the temperature of the areas where the system is stored and installed is compatible with the storage and operating temperatures indicated in the technical data of this manual.
- Radiation from this device does not interfere with pacemakers or other medical devices.

3.1.8 Warnings for the restart prevention function

- The restart prevention function is not guaranteed in blind spots. If required by the risk assessment, implement adequate safety measures in those areas.
- Machinery restarting must be enabled only in safe conditions. The button for the restart signal must be installed:
  - outside of the dangerous area
  - not accessible from the dangerous area
  - in a point where the dangerous area is fully visible

3.1.9 Responsibility

The machinery manufacturer and system installer are responsible for the operations listed below:

- Providing adequate integration of the safety output signals of the system.
- Checking the monitored area of the system and validating it based on the needs of the application and risk assessment. Following the instructions provided in this manual.

3.1.10 Limits

- The system cannot detect the presence of people who are immobile and not breathing or objects within the dangerous area.
- The system does not offer protection from pieces ejected from the machinery, from radiation, and objects falling from above.
- The machinery command must be electronically controlled.

3.1.11 Disposal

In safety-related applications, comply with the mission time reported in General specifications on page 92.

For decommissioning follow the instructions reported in Disposal on page 115.

3.2 Conformity

3.2.1 Standards and Directives

Directives	2006/42/EC (MD - Machinery) 2014/53/EU (RED - Radio equipment)
Standards	IEC/EN 62061: 2005, A1:2013, A2:2015, AC:2010 SIL 2 EN ISO 13849-1: 2015 PL d EN ISO 13849-2: 2012 IEC/EN 61496-1: 2013 IEC/EN 61508: 2010 Part 1-7 SIL 2 IEC/EN 61000-6-2:2019 ETSI EN 305 550-1 V1.2.1 ETSI EN 305 550-2 V1.2.1 ETSI EN 301 489-1 v2.2.3 (only emissions) ETSI EN 301 489-3 v2.1.1 (only emissions) IEC/EN 61326-3-1:2017 IEC/EN 61010-1: 2010 IEC/TS 62998-1:2019 UL 61010-1 * CAN/CSA 61010-1 * UL 61496-1 * CRD of IEC 61496-3 * IEC/EN 61784-3-3 for the PROFIsafe Fieldbus

Note *: valid only for LBK ISC BUS PS, LBK ISC-02, LBK ISC-03 and LBK SBV-01.

Note: no type of failure has been excluded during the system analysis and design phase.

The EU Declaration of Conformity can be downloaded from www.leuze.com (from product download area).

3.2.2 CE

The manufacturer, Inxpect SpA, states that LBK SBV System (Safety Radar Equipment) complies with the 2014/53/EU and 2006/42/EC directives. The full EU declaration of conformity text is available on the company's website at the address: www.leuze.com (from the product download area).

At the same address all updated certifications are available for download.

3.2.3 Other conformities and national configurations

For a complete, up-to-date list of product conformities and any national configurations, please refer to the National configuration addendum document. The PDF can be downloaded from the site www.leuze.com.

4 Get to know LBK SBV System

Product label description

The following table describes the information contained in the product label:

Part	Description
SID	Sensor ID
DC	"yy/ww" : year and week of the product manufacture
SRE	Safety Radar Equipment
Model	Product model (e.g. LBK SBV-01, LBK ISC BUS PS)
Type	Product variant, used for commercial purposes only
S/N	Serial number

4.1 LBK SBV System

4.1.1 Definition

LBK SBV System is an active protection radar system that monitors the dangerous areas of machinery.

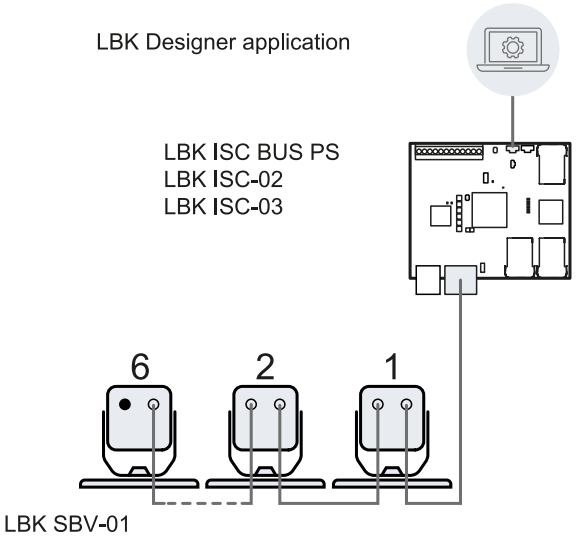
4.1.2 Special features

Some of the special features of this protection system are the following:

- detection of current distance and angle of the targets detected by each sensor
- up to four safe detection fields to define different behaviors of the machines
- programmable coverage angle for each detection field
- rotation on three axes during installation to allow better coverage of detection areas
- Ethernet safety Fieldbus to safely communicate with the PLC of the machinery (if available)
- possibility to switch dynamically between different preset configurations (max. 32 through Fieldbus, if available, and max. 4 with digital inputs) to adapt to the surrounding reality
- muting on the entire system or only on some sensors
- immunity to dust and smoke
- reduction of undesired alarms caused by the presence of water or processing waste
- communication and data exchange through MODBUS (if available)

4.1.3 Main components

LBK SBV System is composed of a controller and up to six sensors. The LBK Designer application allows system operation configuration and checks.



4.1.4 Controller - sensor communication

The sensors communicate with the controller via CAN bus using diagnostic mechanisms in compliance with standard EN 50325-5 to guarantee SIL 2 and PL d.

For correct functioning, each sensor must be assigned an identification number (Node ID).

Sensors on the same bus must have different Node IDs. By default, the sensor does not have a pre-assigned Node ID.

4.1.5 Controller - machinery communication

The controllers communicate with the machinery via I/O (see Inputs on page 23 and Outputs on page 24).

LBK ISC BUS PS is provided with a safety communication on a Fieldbus interface. The Fieldbus interface allows LBK ISC BUS PS to communicate in real-time with the PLC of the machinery in order to do the following:

- send information about the system to the PLC (e.g. the position of the detected target)
- receive information from the PLC (e.g. to change the configuration dynamically)

For details, see Fieldbus communication on page 30.

LBK ISC BUS PS and LBK ISC-02 controllers are provided with an Ethernet port that allows an unsafe communication on a Modbus interface (see MODBUS communication on page 32).

4.1.6 Applications

LBK SBV System integrates with the machinery control system: when performing safety functions or detecting failures, LBK SBV System deactivates the safety outputs and keeps them deactivated, so the control system can put the area into a safe condition and/or prevent restarting of the machinery.

In the absence of other control systems, LBK SBV System can be connected to the devices that control the power supply or machinery start-up.

LBK SBV System does not perform normal machinery control functions.

For connection examples, see Electrical connections on page 99.

4.2 LBK SBV System controllers

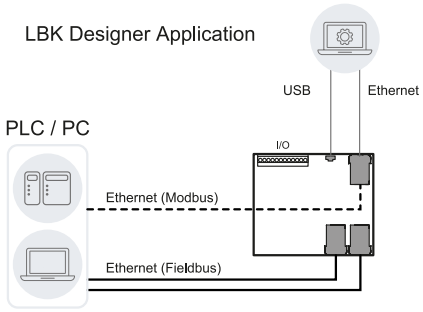
4.2.1 Controller supported

The LBK SBV System supports three different controllers. The main difference among them are the connection ports and therefore the communication interfaces available:

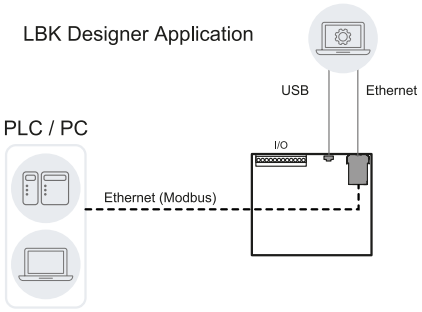
- LBK ISC BUS PS: two Ethernet ports for Fieldbus, an Ethernet port for system configuration and MODBUS communication and a micro-USB port (micro-B type)
- LBK ISC-02: an Ethernet port for system configuration and MODBUS and a micro-USB port (micro-B type)
- LBK ISC-03: a micro-USB port (micro-B type)

Safe

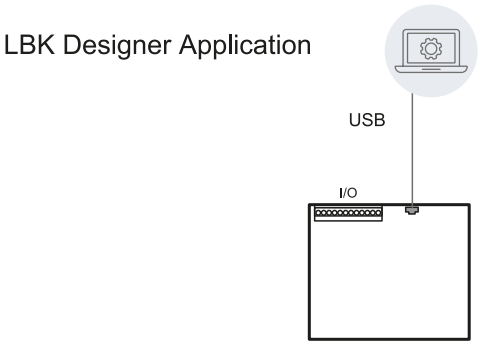
Unsafe



LBK ISC BUS PS communication architecture.



LBK ISC-02 communication architecture.



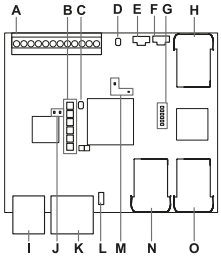
LBK ISC-03 communication architecture.

4.2.2 Functions

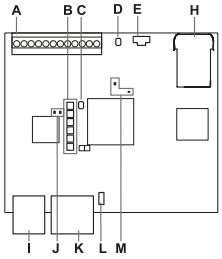
The controller performs the following functions:

- Collects information from all the sensors via CAN bus.
- Compares the position of detected motion with the set values.
- Deactivates the selected safety output when at least one sensor detects motion in the detection field.
- Deactivates all the safety outputs if a failure is detected in one of the sensors or the controller.
- Manages the inputs and outputs.
- Communicates with the LBK Designer application for all configuration and diagnostic functions.
- Allows dynamically switching between different configurations.
- Communicates with a safety PLC through the safe Fieldbus connection (if available)
- Communicates and exchanges data through MODBUS protocol (if available)

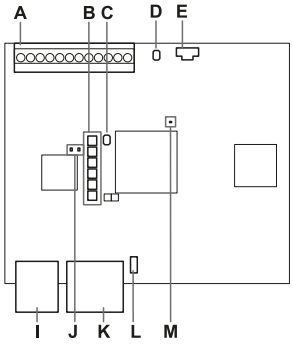
4.2.3 Structures



LBK ISC BUS PS



LBK ISC-02



LBK ISC-03

Part	Description	Controller
A	I/O terminal block	LBK ISC BUS PS, LBK ISC-02, LBK ISC-03
B	System status LEDs	LBK ISC BUS PS, LBK ISC-02, LBK ISC-03
C	Network parameter reset button	LBK ISC BUS PS, LBK ISC-02, LBK ISC-03
D	Reserved for internal use. Output reset button	LBK ISC BUS PS, LBK ISC-02, LBK ISC-03
E	Micro-USB port (micro-B type) for connecting the PC and communicating with the LBK Designer application	LBK ISC BUS PS, LBK ISC-02, LBK ISC-03
F	Micro-USB port (reserved)	LBK ISC BUS PS
G	Fieldbus status LEDs See Fieldbus status LEDs on the next page	LBK ISC BUS PS
H	Ethernet port with LEDs for connecting the PC, communicating with the LBK Designer application, and for MODBUS communication	LBK ISC BUS PS, LBK ISC-02
I	Power supply terminal block	LBK ISC BUS PS, LBK ISC-02, LBK ISC-03
J	Power supply LEDs (steady green)	LBK ISC BUS PS, LBK ISC-02, LBK ISC-03
K	CAN bus terminal block for connecting the first sensor	LBK ISC BUS PS, LBK ISC-02, LBK ISC-03
L	DIP switch to turn on/off the bus termination resistance: • On (top position, default) = resistance included • Off (bottom position)= resistance excluded	LBK ISC BUS PS, LBK ISC-02, LBK ISC-03

Part	Description	Controller

M	CPU LEDs:
	• on the right: status of hardware functions of the primary micro-controller
	  • off: normal behavior
	  • steady red: contact Technical Support
	• only for LBK ISC BUS PS and LBK ISC-02, on the left: status of hardware functions of the secondary micro-controller
	  ◦ slow flashing orange: normal behavior
	  ◦ other status: contact Technical Support
		LBK ISC BUS PS, LBK ISC-02, LBK ISC-03

N	Ethernet Fieldbus port n. 1 with LEDs	LBK ISC BUS PS
O	Ethernet Fieldbus port n. 2 with LEDs	LBK ISC BUS PS

4.2.4 System status LEDs

The LEDs are each dedicated to a sensor, and can display the following statuses:

Status	Meaning
Steady green	Normal sensor function and no motion detected
Orange	Normal sensor function and some motion detected
Flashing red	Sensor in error (see Controller LED on page 76)
Steady red	System error (see Controller LED on page 76)
Flashing green	Sensor in boot status (see Controller LED on page 76)

4.2.5 Fieldbus status LEDs

The LEDs reflect the status of the PROFINET/PROFIsafe Fieldbus and their meaning is reported below.

Note: F1 is the LED at the top, F6 is the LED at the bottom.

LED	Status	Meaning
F1 (power)	Steady green	Normal behavior
	Flashing green or off	Contact Technical Support
F2 (boot)	Off	Normal behavior
	Steady or flashing yellow	Contact Technical Support
F3 (link)	Off	Data exchange is running with the host
	Flashing red	No data exchange
	Steady red	No physical link
F4 (not used)	-	-
F5 (diagnosis)	Off	Normal behavior
	Flashing red	DCP signal service is initiated via the bus
	Steady red	diagnostic error at PROFIsafe layer (wrong F Dest Address, watchdog timeout, wrong CRC) or diagnostic error at PROFINET layer (watchdog timeout; channel, generic or extended diagnosis present; system error)
F6 (not used)	-	-

4.2.6 Inputs

The system has two type 3 digital inputs (according to IEC/EN 61131-2). Each digital input is dual channel, and the ground reference is common for all the inputs (see Technical references on page 92).

When using digital inputs, it is mandatory that the additional SNS input "V+ (SNS)" is connected to 24 V DC and that the GND input "V- (SNS)" is connected to the ground in order to:

- perform the correct input diagnostic
- assure the system safety level

The function of each digital input must be programmed through the LBK Designer application. The available functions are the following:

- **Stop signal**: additional safety function, manages a specific signal to force all the safety outputs (detection signals, if present) to OFF-state.
- **Restart signal**: additional safety function, manages a specific signal which enables the controller to switch to ON-state the safety outputs related to all the detection fields with no motion detected.
- **Muting group "N"**: additional safety function, manages a specific signal which allows the controller to ignore the information coming from a selected group of sensors.
- **Activate dynamic configuration**: allows the controller to select a specific dynamic configuration.
- **Fieldbus controlled** (if available): monitors the input status through Fieldbus communication. For example, a generic ESPE can be connected to the input, respecting electrical specifications.

For details about digital input signals, see Digital input signals on page 110.

4.2.7 Input variable behavior

If neither digital input nor OSSD is configured as **Fieldbus controlled**, the behavior of the input variables is as described below:

Condition	Input variable behavior	Output behavior
IOPS (PLC provider status) = bad	the last valid value of the input variable is retained	the system keeps working in its normal operating state
Connection loss	the last valid value of the input variable is retained	the system keeps working in its normal operating state
After power-up	the initial values (set to 0) are used for the input variables	the system keeps working in its normal operating state

If at least one digital input or OSSD is configured as **Fieldbus controlled**, the behavior of the input variables is as described below:

Condition	Input variable behavior	Output behavior
IOPS (PLC provider status) = bad	the last valid value of the input variable is retained	the system keeps working in its normal operating state
Connection loss	the last valid value of the input variable is retained	the system transits to safe state, deactivating the OSSDs, until the connection is re-established.
After power-up	the initial values (set to 0) are used for the input variables	the system remains in a safe state with the OSSDs deactivated, until the input data are passivated.

4.2.8 SNS input

The controller also has an **SNS** input (high logic level (1) = 24 V) to check the correct functioning of the chip that detects the status of the inputs.

NOTICE	
	If at least one input is connected, the SNS input "V+ (SNS)" and the GND input "V- (SNS)" must also be connected.

4.2.9 Outputs

The system has four digital OSSD short-circuit protected outputs that can be used individually (non safe) or can be programmed as dual channel safety outputs (safe) in order to ensure the system safety level.

An output is activated when it switches from OFF to ON-state and it is deactivated when it switches from ON to OFF-state.

The function of each digital output must be programmed through the LBK Designer application.

The available functions are the following:

- **System diagnostic signal**: switches the selected output to OFF-state when a system fault is detected and switches all the OSSD related to detection signals, if any, to OFF-state.
- **Muting enable feedback signal**: switches the selected output to ON-state in the following cases:
  - when a muting signal is received over the configured input and at least one group is in muting
  - when a muting command is received through Fieldbus communication (if available) and at least one sensor is in muting
- **Detection signal 1**: (e.g. alarm signal) switches the selected output to OFF-state when a sensor detects a motion in detection field 1, when a stop signal is received from the related input or when there is a system failure. The selected output remains in OFF-state for at least 100 ms.

Note: when an OSSD is configured as detection signal 1, a second OSSD is automatically assigned to it to provide a safe signal.

- **Detection signal 2**: switches the selected output to OFF-state when a sensor detects a motion in detection field 2, when a stop signal is received from the related input or when there is a system failure. The selected output remains in OFF-state for at least 100 ms.

Note: when an OSSD is configured as detection signal 2, a second OSSD is automatically assigned to it to provide a safe signal.

- **Detection signal 3**: switches the selected output to OFF-state when a sensor detects a motion in detection field 3 or when a stop signal is received from the related input or when there is a system failure. The selected output remains in OFF-state for at least 100 ms.

Note: when an OSSD is configured as detection signal 3, a second OSSD is automatically assigned to it to provide a safe signal.

- **Detection signal 4**: switches the selected output to OFF-state when a sensor detects a motion in detection field 4 or when a stop signal is received from the related input or when there is a system failure. The selected output remains in OFF-state for at least 100 ms.

Note: when an OSSD is configured as detection signal 4, a second OSSD is automatically assigned to it to provide a safe signal.

- **Fieldbus controlled** (if available): allows the specific output to be set through the Fieldbus communication.
- **Restart feedback signal**: switches the selected output to ON-state when it is possible to restart at least one detection field (Restart signal).

    - If all the used detection fields are configured as automatic restart prevention (in **Settings** > **Restart function**), the selected output is always in OFF-state;
    - If at least one detection field in use is configured as manual or safe manual restart prevention (in **Settings** > **Restart function**), the selected output remains in OFF-state as long as motion is detected; then it is activated (ON-state) if there is no more motion within at least one detection field. The ON-state lasts as long as the absence of motion within one or more detection field does and until the restart signal is activated on the selected input.
- **Static object detection feedback signal**: switches the selected output to ON-state when at least one sensor detects a static object and no moving targets in one of its detection fields. The selected output remains in ON-state for at least 100 ms.

Each output status can be retrieved by Fieldbus communication (if available).

The system installer can decide to configure the system as follows:

- two dual channel safety outputs (e.g. **Detection signal 1** and **Detection signal 2**, usually alarm and warning signals)
- one dual channel safety output (e.g. **Detection signal 1**) and two single channel output (e.g. **System diagnostic signal** and **Muting enable feedback signal**)
- each output as a single output (e.g. **System diagnostic signal**, **Muting enable feedback signal** and **Restart feedback signal**)

WARNING	
	To use LBK SBV System for a category 3 safety system, both the channels of a safety output must be connected to the safety system. Configuring a safety system with only one channel safety output may result in serious injuries due to an output circuit fault and a failure of the machine to stop.

The dual channel safety output is automatically obtained by the LBK Designer application and it only matches the single OSSD outputs as follows:

- OSSD 1 with OSSD 2
- OSSD 3 with OSSD 4

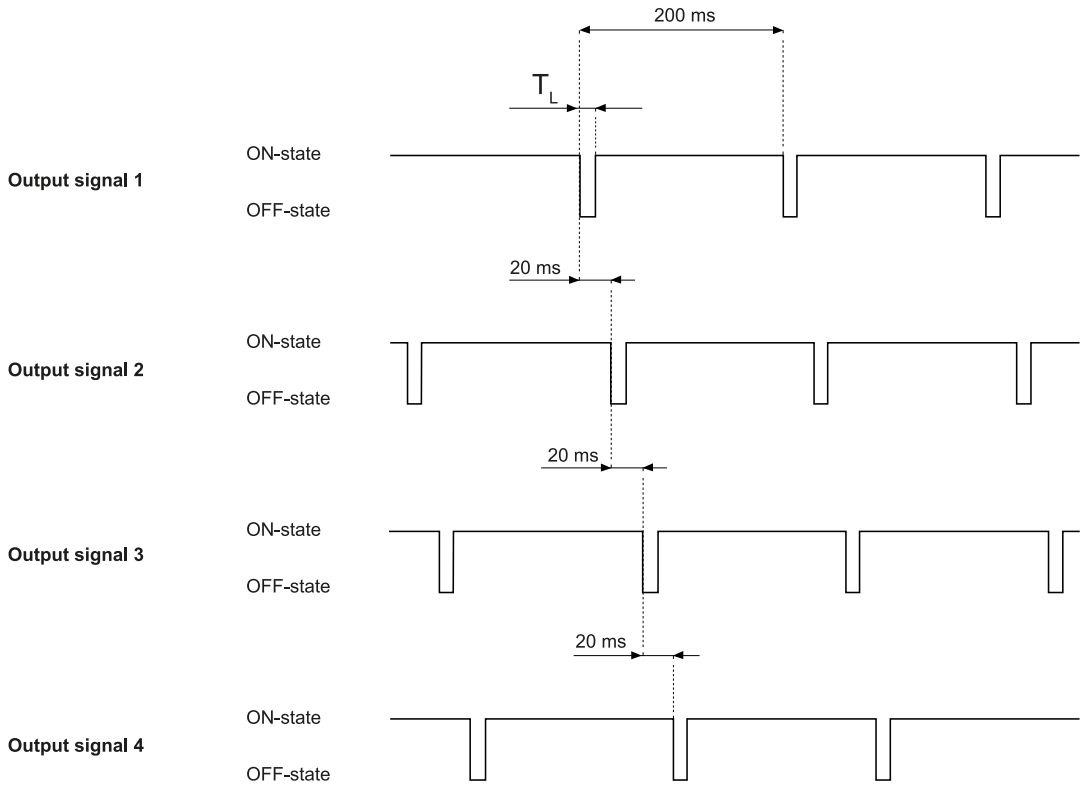
In the dual channel safety output, the output status is the following:

- activated output (24 V DC): no motion detected and normal functioning
- deactivated output (0 V DC): motion detected in the detection field or failure detected in the system

Idle signal is 24 V DC, periodically shortly pulsed to 0 V (pulses are not synchronous) for the receiver to detect shortcut to either 0 V or 24 V.

The pulse duration at 0 V (T_L) can be set at 300 µs or 2 ms through the LBK Designer application (**Settings** > **Digital Input-Output** > **OSSD Pulse width**).

Note: the devices connected to the OSSD should not respond to these temporary, self-diagnostic 0 V pulses of the signal.



For details, see Technical references on page 92.

4.2.10 OSSD diagnostic checks

Per default, the OSSD Diagnostic check (e.g. for short circuits) is deactivated. This check can be activated through the LBK Designer application (**Settings** > **Digital Input-Output**).

If activated, the controller will monitor:

- Short-circuit between OSSDs
- 24V short-circuit (only trips on demand, i.e. when the safety function is activated on the transition from 24 V to GND)
- Open circuit

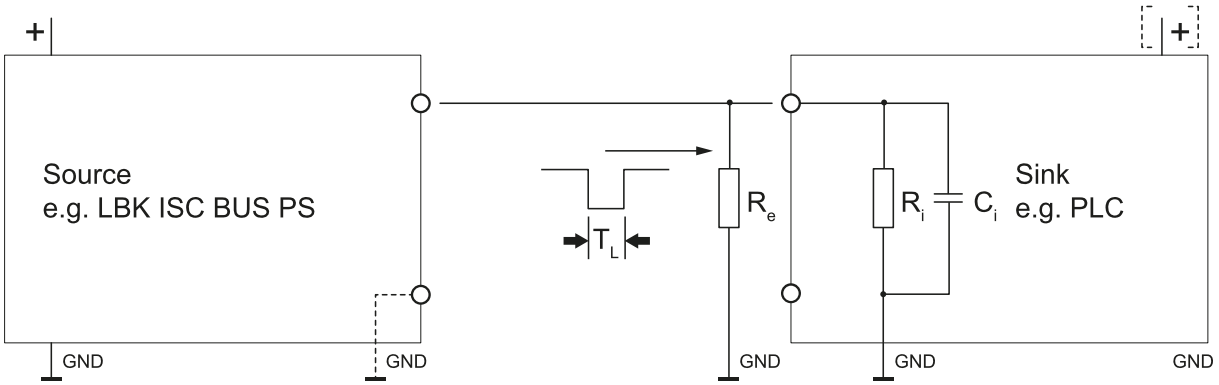
4.2.11 External resistor for OSSD outputs

To guarantee the correct connection between the OSSDs of the controller and an external device, it may be necessary to add an external resistor.

If the pulse width set (**OSSD Pulse width**) is 300 µs, it is strongly recommended to add an external resistor to guarantee the discharge time of the capacitive load. If it is set at 2 ms, an external resistance must be added if the resistor of the external load is greater than the maximum resistive load allowed (see Technical data on page 92).

Below are some standard values for the external resistor:

OSSD Pulse width value	External resistor (R_e)
300 µs	1 kΩ
2 ms	10 kΩ



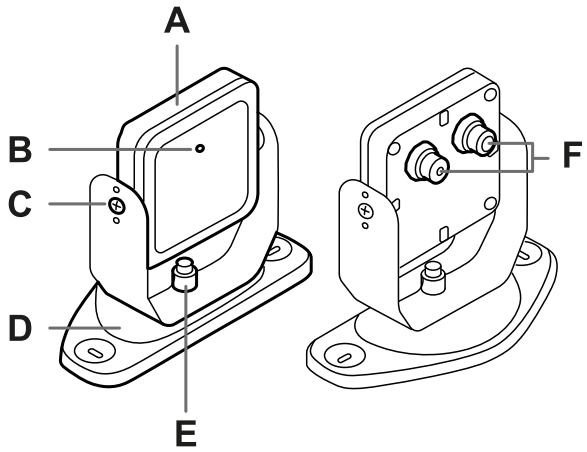
4.3 LBK SBV-01 sensors

4.3.1 Functions

The sensors perform the following functions:

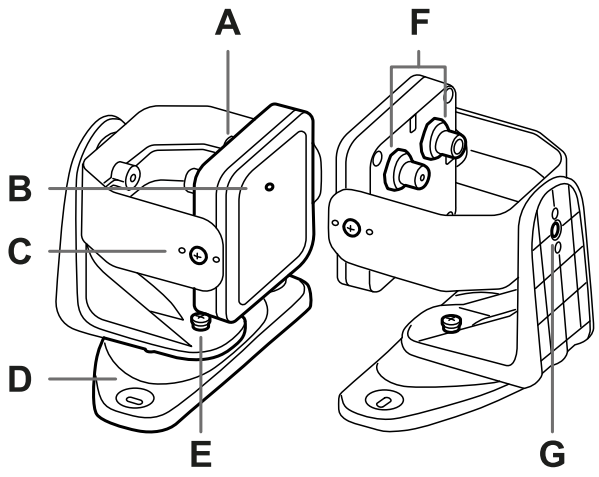
- Detect motion in their field of view.
- Send the motion detection signal to the controller through CAN bus.
- Signal to the controller through CAN bus the failures or faults detected on the sensor during diagnostics.

4.3.2 2-axes structure



Part	Description
A	Sensor
B	Status LED
C	Tamper-proof screws to position the sensor at a specific angle around x-axis (tilt 10° steps)
D	Mounting bracket
E	Screw to position the sensor at a specific angle around y-axis (pan 10° steps)
F	Connectors for connecting the sensors in a chain and to the controller

4.3.3 3-axes structure



Part	Description
A	Sensor
B	Status LED
C	Tamper-proof screws to position the sensor at a specific angle around x-axis (tilt 10° steps)
D	Mounting bracket
E	Tamper-proof screw to position the sensor at a specific angle around y-axis (pan 10° steps)
F	Connectors for connecting the sensors in a chain and to the controller
G	Tamper-proof screw to position the sensor at a specific angle around z-axis (roll 10° steps)

4.3.4 Status LED

Status	Meaning
Steady blue	Sensor is working. No motion detected.
Flashing blue	Sensor is detecting motion. Not available if the sensor is in muting.
Purple	Firmware update conditions (see Sensor LED on page 78)
Red	Error conditions (see Sensor LED on page 78)

4.4 LBK Designer application

4.4.1 Functions

The application permits the following main functions to be performed:

- Configure the system.
- Create the configuration report.
- Check system functioning.
- Download system log.

4.4.2 LBK Designer application usage

To use the application, the controller must be connected to a computer with a data USB cable or, if the Ethernet port is available, an Ethernet cable. The USB cable allows to configure the system locally, whereas the Ethernet cable allows to do it remotely.

The Ethernet communication between the controller and the LBK Designer application is secured by the most advanced security protocols (TLS).

4.4.3 Authentication

The application can be downloaded free of charge at www.leuze.com.

Some functions are password protected. The admin password can be set through the application and then saved on the controller. The available functions according to authentication type are presented as follows:

Available functions	Authentication type
• Display the system status (**Dashboard**) • Display the sensors configuration (**Configuration**) • Restore factory default settings, if not using Ethernet connection (**Settings** > **General**) • Back up the configuration (**Settings** > **General**) • Check the current checksum for each dynamic configuration (**Settings** > **Configuration checksums**)	without password
• Configure the system (**Configuration**) • Restore a configuration (**Settings** > **General**) • Restore factory default settings, if using Ethernet connection (**Settings** > **General**) • Manage node IDs (**Settings** > **Node ID Assignment**) • Configure digital I/O (**Settings** > **Digital Input/Output**) • Configure muting function (**Settings** > **Muting**) • Choose the restart function (**Settings** > **Restart function**) • Configure the anti-tampering functions (**Settings** > **Anti-tampering**) • Show and change the network parameters - if available (**Settings** > **Network Parameters**) • Show and change the Fieldbus parameters - if available (**Settings** > **Fieldbus Parameters**) • Show and change the MODBUS parameters - if available (**Settings** > **MODBUS Parameters**) • Synchronize more controllers (**Settings** > **Advanced**) • Set the detection fields dependency (**Settings** > **Advanced**) • Assign the labels (**Settings** > **Labels**) • Download the system log and display reports (**Settings** > **Activity History**) • Change the admin password (**Settings** > **Account**)	with password

4.4.4 Main menu

Page	Function
Dashboard	Display main information on the configured system. **Note**: the messages shown are those in the log file. To know the meaning of the messages, see the chapters on logs in Maintenance and troubleshooting on page 76.
Configuration	Define the monitored area. Configure the sensors and the detection fields. Define the dynamic configurations.
Settings	Configure the sensors. Choose the detection fields dependency. Enable the anti-tampering functions. Synchronize more controllers. Configure the inputs and outputs function. Set labels for controllers and sensors. Configure, show and change the network parameters (if available). Configure, show and change the MODBUS parameters (if available). Configure, show and change the Fieldbus parameters (if available). Perform the configuration backup and load a configuration. Download the log. Other general functions.
Validation	Start the validation procedure. **Note**: the messages shown are those in the log file. To know the meaning of the messages, see the chapters on logs in Maintenance and troubleshooting on page 76.
REFRESH CONFIGURATION	Refresh configuration or ignore unsaved changes.
User	Enable access to the configuration functions. Admin password required.
Disconnect	Close the connection with the device and allow to connect to another device.
	Change the language.

4.5 Fieldbus communication

4.5.1 Fieldbus support

The safety communication on the Fieldbus interface is supported only in the LBK ISC BUS PS controller.

4.5.2 Communication with the machinery

The Fieldbus makes the following actions possible:

- to choose from 1 to 32 preset configurations dynamically
- to read the status of the inputs
- to control the outputs

- to mute the sensors
- to enable the restart signal

For details, see the PROFIsafe communication Original Operating Instructions.

4.5.3 Data exchanged through Fieldbus

The following table details the data exchanged through the Fieldbus communication:

⚠ WARNING

The system is in alarm if the "controller status" byte of the "System configuration and status" module PS2v6 or PS2v4 is different from "0xFF".

Data type	Description	Communication direction
Safe	SYSTEM STATUS DATA LBK ISC BUS PS controller: • internal status • status of each of the four outputs • status of each of the two inputs LBK SBV-01 sensor: • status of each detection field (target detected or not) or error status • muting status	from the controller
Safe	SYSTEM SETTING COMMAND LBK ISC BUS PS controller: • set the ID of the dynamic configuration that shall be activated • set the status of each of the four outputs • save the reference for the anti-rotation around axes • enable the restart signal LBK SBV-01 sensor: • set the muting status	to the controller
Safe	DYNAMIC CONFIGURATION STATUS • ID of the dynamic configuration currently active • signature (CRC32) of the dynamic configuration ID currently active	from the controller
Safe	TARGET DATA • Current distance and angle of the targets detected by each sensor. For each detection field of each sensor, only the closest target to the sensor is considered.	from the controller
Unsafe	DIAGNOSTIC DATA LBK ISC BUS PS controller: • internal status with an extended description of the error condition LBK SBV-01 sensor: • internal status with an extended description of the error condition	from the controller
Unsafe	SYSTEM STATUS AND TARGET DATA	from the controller

4.6 MODBUS communication

4.6.1 MODBUS support

The MODBUS communication uses the Ethernet port (MODBUS TCP) and consequently is only available for LBK ISC BUS PS and LBK ISC-02 controllers.

4.6.2 MODBUS communication enabling

In the LBK Designer application, click on **Settings** > **MODBUS Parameters** > **ON** to enable the feature.

Within the Ethernet network, the controller acts like a server. The client must send requests to the IP address of the server on the MODBUS listening port (default port is 502).

To show and change the address and the port, click on **Settings** > **Network Parameters** and **Settings** > **MODBUS Parameters**.

4.6.3 Data exchanged through MODBUS

The following table details the data exchanged through the MODBUS communication:

Data type	Description	Communication direction
Unsafe	SYSTEM STATUS DATA LBK ISC BUS PS or LBK ISC-02 controller: • internal status • status of each of the four outputs • status of each of the two inputs LBK SBV-01 sensor: • status of each detection field (target detected or not) or error status • muting status	from the controller
Unsafe	DYNAMIC CONFIGURATION STATUS • ID of the dynamic configuration currently active • signature (CRC32) of the dynamic configuration ID currently active	from the controller
Unsafe	TARGET DATA • Current distance and angle of the targets detected by each sensor. For each detection field of each sensor, only the closest target to the sensor is considered.	from the controller
Unsafe	DIAGNOSTIC DATA LBK ISC BUS PS or LBK ISC-02 controller: • internal status with an extended description of the error condition LBK SBV-01 sensor: • internal status with an extended description of the error condition	from the controller

4.7 System configuration

4.7.1 System configuration

The controller parameters have their own default values that can be modified via the LBK Designer application (see Configuration application parameters on page 106).

When a new configuration is saved, the system generates the configuration report.

Note: after a physical change of the system (e.g. new sensor installed), the system configuration must be updated and a new configuration report must be generated, too.

4.7.2 Dynamic system configuration

LBK SBV System allows a real-time adjustment of the most important system parameters, providing the means to switch dynamically among different preset configurations. Via the LBK Designer application, once the first system configuration (default configuration) has been set, it is possible to set alternative presets to allow a dynamic real-time reconfiguration of the monitored area. The alternative presets are 3 through digital input and 31 through Fieldbus (if available).

These are the programmable parameters for each sensor:

- detection field (from 1 to 4)

These are the programmable parameters for each detection field:

- angular coverage
- detection distance
- safety working mode (**Both (default)**, **Always-on access detection** or **Always-on restart prevention**) (see Safety working modes and safety functions on page 41)
- status of the static object detection option (see Restart prevention function: static object detection option on page 43)
- restart timeout

All the remaining system parameters cannot be changed dynamically and are considered static.

4.7.3 Dynamic system configuration activation

The dynamic system configuration can be activated through the digital inputs or the safety Fieldbus (if available). One activation method excludes the other and activation through digital inputs has priority over activation through Fieldbus.

4.7.4 Dynamic configuration through the digital inputs

To activate the dynamic system configuration, one or both the digital inputs of the controller can be used. The result is the following:

If...	**Then it is possible to dynamically switch between...**
only **one** digital input is used for the dynamic configuration	**two** preset configurations (see Example 1 on the next page and Example 2 on the next page)
both digital inputs are used for the dynamic configuration	**four** preset configurations (see Example 3 on the next page)

Note: the change of configuration is safe because it is activated by two-channel inputs.

Example 1

The first digital input has been linked to the dynamic configuration.

Dynamic configuration number	Input 1	Input 2
#1	**0**	-
#2	**1**	-

0 = signal deactivated; 1 = signal activated

Example 2

The second digital input has been linked to the dynamic configuration.

Dynamic configuration number	Input 1	Input 2
#1	-	**0**
#2	-	**1**

0 = signal deactivated; 1 = signal activated

Example 3

Both digital inputs have been linked to the dynamic configuration.

Dynamic configuration number	Input 1	Input 2
#1	**0**	**0**
#2	**1**	**0**
#3	**0**	**1**
#4	**1**	**1**

0 = signal deactivated; 1 = signal activated

4.7.5 Dynamic configuration through the safety Fieldbus

To activate the dynamic system configuration, connect an external safety PLC that communicates through the safety Fieldbus to the controller. This makes it possible to dynamically switch between all the preset configurations, therefore up to 32 different configurations. For all the parameters used for each configuration (see Dynamic system configuration on the previous page).

For details about the supported protocol, please refer to the Fieldbus manual.

⚠ WARNING

Before activating the dynamic system configuration through the safety Fieldbus, ensure it has not already been activated through the digital inputs. If the activation is set for both the digital inputs and the safety Fieldbus, LBK SBV System uses the digital input data and ignores the dynamic changes made through the safety Fieldbus.

4.7.6 Safe configuration change

The change of the configuration takes place safely both on stationary and moving machinery. The sensor always monitors the entire monitored area and when it receives a request to change to a configuration with a longer detection field, it immediately reverts to safe state if people are present in such a field.

5 Functioning principles

5.1 Sensor functioning principles

5.1.1 Introduction

LBK SBV-01 is an FMCW (Frequency Modulated Continuous Wave) radar device based on a proprietary detection algorithm. LBK SBV-01 is also a multi-target sensor that sends pulses and receives information, analyzing the reflection of the nearest moving target that it encounters within each detection field.

The sensor can detect the current distance and the angle of the target.

Each sensor has its own fieldset. The fieldset corresponds to the structure of the field of view, which is composed of detection fields (see Detection fields below).

5.1.2 Factors that influence the sensor field of view and object detection

⚠ WARNING
The presence of conductive material on the sensor could affect its field of view and thus object detection. For proper and safe operation of the system, validate the system under this condition.

5.1.3 Factors that influence the reflected signal

The signal reflected by the object depends on several characteristics of the same object:

- material: metallic objects have a very high reflection coefficient, while paper and plastic reflect only a small portion of the signal
- surface exposed to the sensor: the greater the surface exposed to the radar, the greater the reflected signal
- position with respect to the sensor: all other factors being equal, objects positioned directly in front of the radar generate a greater signal with respect to objects to the side
- motion speed
- inclination

All these factors have been analyzed for a human body during the safety validation of LBK SBV System and cannot lead to a dangerous situation. These factors may occasionally influence the behavior of the system causing spurious activation of the safety function.

5.1.4 Detected and missed objects

The signal analysis algorithm takes into consideration only those objects that move within the field of view, ignoring completely static objects.

Furthermore, a *falling objects* filtering algorithm allows ignoring undesired alarms generated by small work waste products that fall within the field of view of the sensor.

5.2 Detection fields

5.2.1 Introduction

The field of view of each sensor can be composed of up to four detection fields. Each of the four detection fields have a dedicated detection signal.

WARNING
Configure the detection fields and associate them with the dual channel safety outputs according to the risk assessment requirements.

5.2.2 Detection field parameters

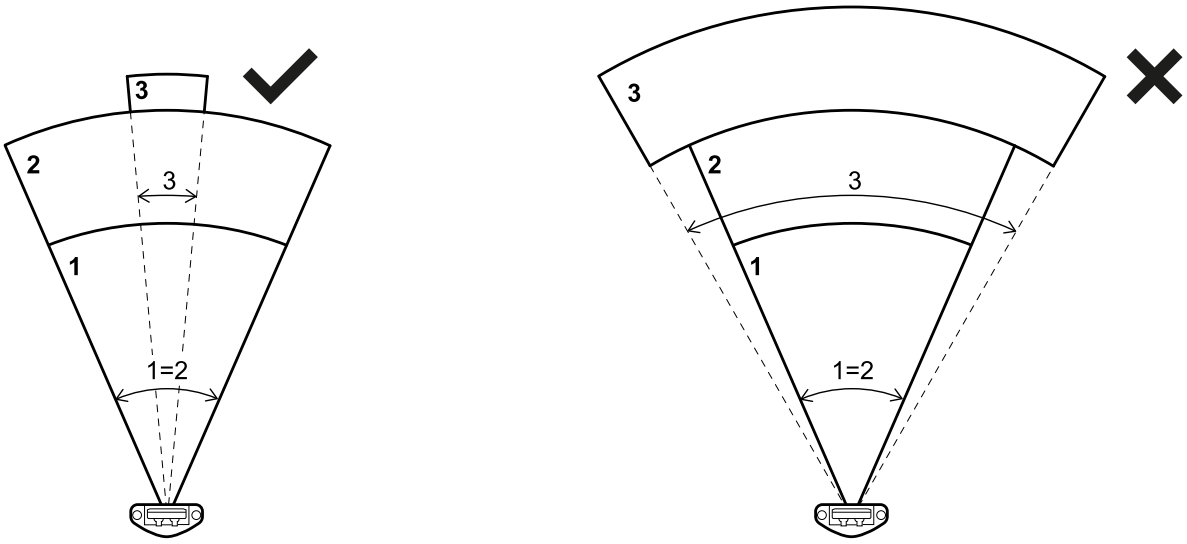
These are the programmable parameters for each detection field:

- angular coverage
- detection distance
- safety working mode (**Both (default)**, **Always-on access detection** or **Always-on restart prevention**) (see Safety working modes and safety functions on page 41)
- restart timeout
- static object detection option

5.2.3 Angular coverage

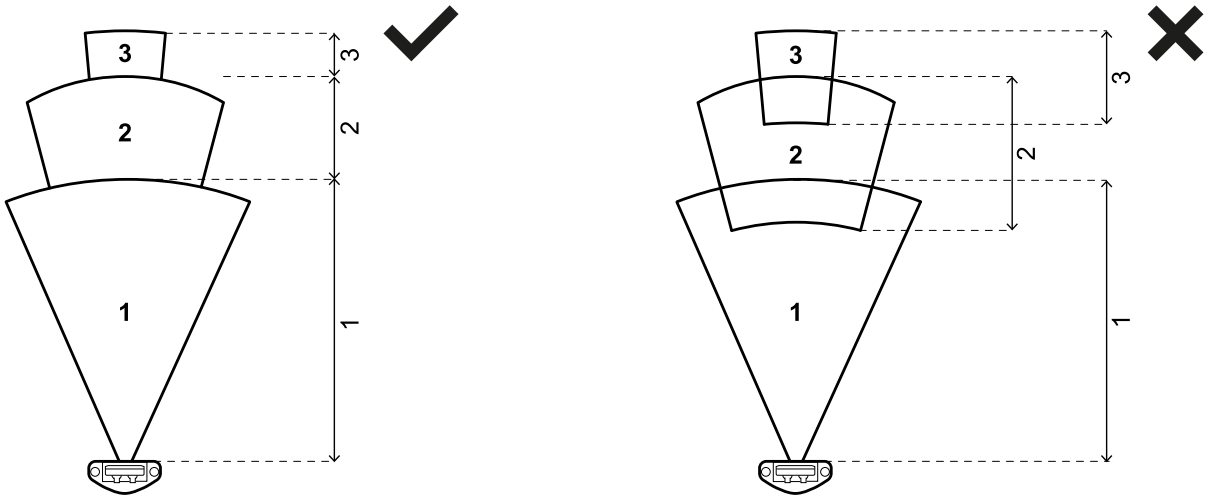
The angular coverage has a fixed value in a range from 10° to 100°.

The angular coverage of the detection field must be wider than, or equal to, the angular coverage of the following detection fields.

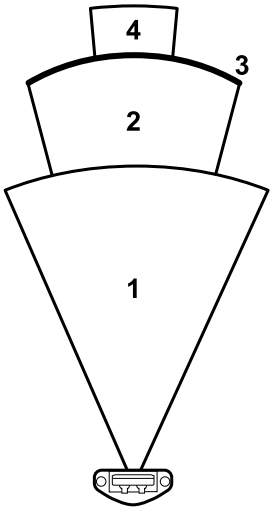


5.2.4 Detection distance

The detection distance of the first detection field must start from the sensor. The detection distance of one field starts where the one of the previous field ends.



The detection distance of one or more fields can be 0 (e.g. detection field 3). The first detection field with a detection distance other than 0 (e.g. detection field 1) must have a minimum detection distance of 500 mm.



5.2.5 Detection fields dependency and detection signal generation

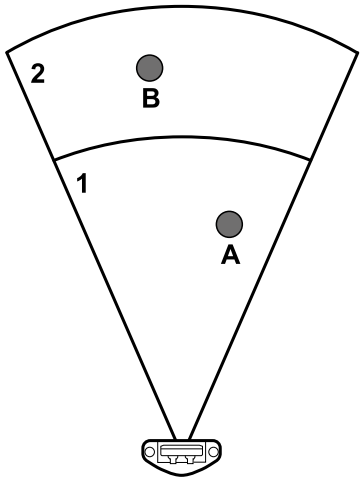
If a sensor detects motion within a detection field, its detection signal changes status and, when configured, the related safety output is deactivated. The behavior of the outputs related to the following detection fields depends on the detection field dependency set:

If...	Then...
the **Dependent mode** is set and thus detection fields are dependent on each other	if a sensor detects motion within a detection field, all the outputs related to its following detection fields are deactivated too. Example Detection field configured: 1, 2, 3 Detection field with target detected: 2 Detection field in alarm status: 2, 3
the **Independent mode** is set and thus detection fields are independent from each other	if a sensor detects motion within a detection field, only the output related to that detection field is deactivated. Example Detection field configured: 1, 2, 3 Detection field with target detected: 2 Detection field in alarm status: 2

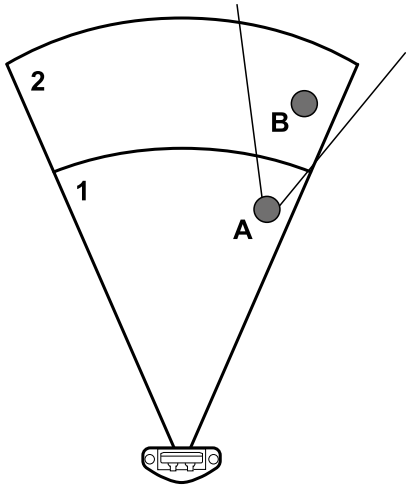
⚠ WARNING

Configure the detection fields and associate them with the dual channel safety outputs according to the risk assessment requirements.

In this example, both detection field 1 and 2 generate a detection signal, for target **[A]** and **[B]** respectively.



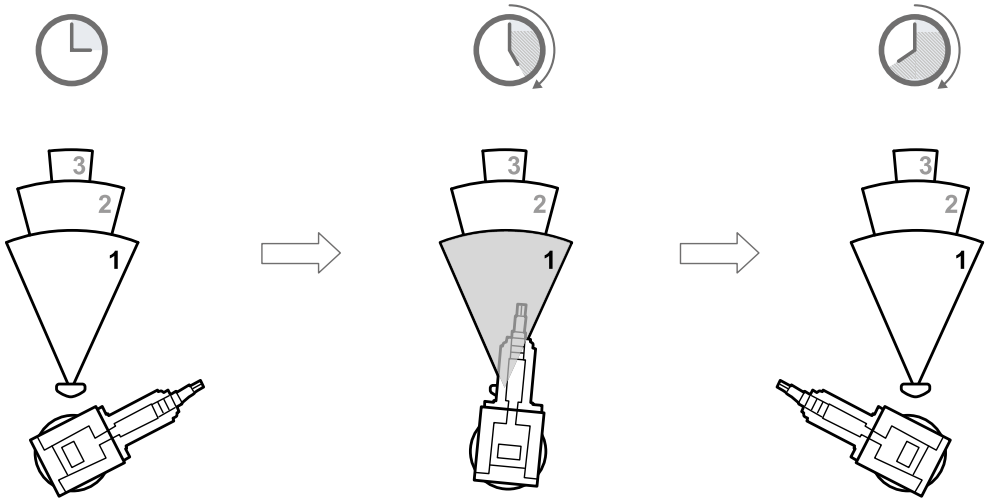
In this example, detection field 1 generates a detection signal for target **[A]** but target **[B]** could not be detected.



In the **LBK Designer** application, click on **Settings** > **Advanced** > **Detection field dependency** to set the dependency mode of the detection fields.

5.2.6 Independent detection fields: a use case

It can be useful to set the detection fields as independent, for example, if there is a scheduled temporary motion of an object in a detection field. An example can be a robotic arm moving from right to left within the detection field 1 only during a specific phase of the operative cycle.



In this case, it is possible to ignore the detection signal in the detection field 1, thus avoiding unnecessary downtime.

⚠ WARNING
Evaluate the safety of the monitored area during risk assessment before deciding to ignore the detection signal of the detection field 1.

⚠ WARNING
The blind area generated by the moving robotic arm can prevent the sensor from detecting targets in the following other detection fields for an interval of time. This time must be considered when defining the detection distance for detection field 2.

5.3 Safety working modes and safety functions

5.3.1 Introduction

Each detection field of each sensor can perform the following safety working modes:

- **Both (default)**
- **Always-on access detection**
- **Always-on restart prevention**

Each safety working mode is composed of one or both of the following safety functions:

Function	Description
Access detection	The machinery is reverted into a safe status when one or more persons enter the dangerous area.
Restart prevention	The machinery is prevented from restarting if people are in the dangerous area.

5.3.2 Safety working modes

Via the LBK Designer application, you can select which safety working mode each sensor will employ for each of its detection fields:

- **Both (default)**:
  - The sensor performs the access detection function when it is in normal operation (**No alarm** status).
  - The sensor performs the restart prevention function when it is in alarm status (**Alarm** status).
- **Always-on access detection**:
  - The sensor always performs the access detection function (**No alarm** status + **Alarm** status).
- **Always-on restart prevention**:
  - The sensor always performs the restart prevention function (**No alarm** status + **Alarm** status).

5.4 Safety working mode: Both (default)

5.4.1 Introduction

This safety working mode is composed of the following safety functions:

- access detection
- restart prevention

5.4.2 Safety function: access detection

Access detection allows what follows:

When...	Then...
no motion is detected in the detection field	the safety outputs remain active
motion is detected in the detection field	• the safety outputs are deactivated • the restart prevention function is activated

5.4.3 Safety function: restart prevention

The restart prevention function remains active and the safety outputs deactivated as long as motion is detected in the detection field, or, with the static object detection option enabled (see Restart prevention function: static object detection option on page 43), as long as a static object is detected in the detection field.

The sensor can detect micro-movements of just a few millimeters, such as breathing movements (with normal breathing or a short apnea) or the movements necessary for a person to remain in balance in an

upright or squatting position.

The system sensitivity is higher than the sensitivity that characterizes the access detection function. For this reason, the system reaction to vibrating and moving parts is different.

WARNING

When the restart prevention function is active the monitored area may be affected by the position and inclination of the sensors, as well as by their installation height and angular coverage (see Sensor position on page 52).

5.4.4 Restart timeout parameter

When the system does not detect motion anymore or, with static object detection option enabled, no static object is detected, the OSSD outputs remain in OFF-state for the time set in the **Restart timeout** parameter.

The default value is 4 s, the maximum is 60 s, and the minimum is the CRT (Certified Restart timeout).

WARNING

The static object detection option affects the value range of the Restart timeout parameter and therefore affects the operation of the restart prevention function (see Restart timeout parameter on page 44).

The parameter is valid only for the restart prevention function.

5.5 Safety working mode: Always-on access detection

5.5.1 Safety function: access detection

This is the only safety function available for the **Always-on access detection**. Access detection allows what follows:

When...	Then...
no motion is detected in the detection field	the safety outputs remain active
motion is detected in the detection field	• the access detection function remains active • the safety outputs are deactivated • the sensitivity remains as it was before the motion detection

WARNING

If the **Always-on access detection** is selected, additional safety measures must be introduced to ensure the restart prevention function.

5.5.2 T_{OFF} parameter

If the safety working mode is **Always-on access detection**, when the system does not detect motion anymore, the OSSD outputs remain in OFF-state for the time set in the **T_{OFF}** parameter.

The T_{OFF} value can be set from 0.1 s to 60 s.

5.6 Safety working mode: Always-on restart prevention

5.6.1 Safety function: restart prevention

This is the only safety function available for the **Always-on restart prevention**.

The restart prevention allows what follows:

When...	Then...
• no motion is detected in the detection field, and • with the static object detection option enabled (see Restart prevention function: static object detection option below), no static object is detected in the detection field	the safety outputs remain active
• motion is detected in the detection field, or • with the static object detection option enabled (see Restart prevention function: static object detection option below), a static object is detected in the detection field	• the safety outputs are deactivated • the restart prevention function remains active • the sensitivity remains as it was before motion/static object detection

The sensor can detect micro-movements of just a few millimeters, such as breathing movements (with normal breathing or a short apnea) or the movements necessary for a person to remain in balance in an upright or squatting position.

The system sensitivity is higher than the sensitivity that characterizes the access detection function. For this reason, the system reaction to vibrating and moving parts is different.

⚠ WARNING

When the restart prevention function is active the monitored area may be affected by the position and inclination of the sensors, as well as by their installation height and angular coverage (see Sensor position on page 52).

5.6.2 Restart timeout parameter

When the system does not detect motion anymore or, with static object detection option enabled, no static object is detected, the OSSD outputs remain in OFF-state for the time set in the **Restart timeout** parameter.

The default value is 4 s, the maximum is 60 s, and the minimum is the CRT (Certified Restart timeout).

⚠ WARNING

The static object detection option affects the value range of the Restart timeout parameter and therefore affects the operation of the restart prevention function (see Restart timeout parameter on the next page).

5.7 Restart prevention function: static object detection option

5.7.1 Introduction

The static object detection option allows the restart prevention function also to detect static objects in the dangerous area.

NOTICE

The ability to detect an object depends on the RCS of the object. The static object detection option does not guarantee 100% detection of static objects.

5.7.2 Availability

The static object detection option is available for:

- controller firmware version 1.5.0 or later, and
- sensor firmware version 3.0 or later.

5.7.3 Possible applications

This option can be useful if the sensor is installed on moving elements (see Installations on moving elements on page 58) or to prevent the restart of a robot that could bump into a static object in the area temporarily.

5.7.4 Operation

The option can be enabled for each detection field of each sensor with the safety working mode set to **Both (default)** or **Always-on restart prevention**. Enable the option only if the detection field is free of static objects; otherwise, the system would never reactivate the detection signals after a motion is detected in the area.

The option is active in the detection field area, defined by the angular coverage and detection distance set.

5.7.5 Restart timeout parameter

With the static object detection option enabled, the **Restart timeout** parameter's minimum value is 0.1 s.

⚠ WARNING

If the **Restart timeout** is set to a value less than 4 s, the sensor is no longer able to detect breathing movement or the movements necessary for a person to remain in balance in an upright or a squatting position. Set a value less than 4 s only for areas where people have no access.

5.8 Features of the restart prevention function

5.8.1 Cases of non-guaranteed function

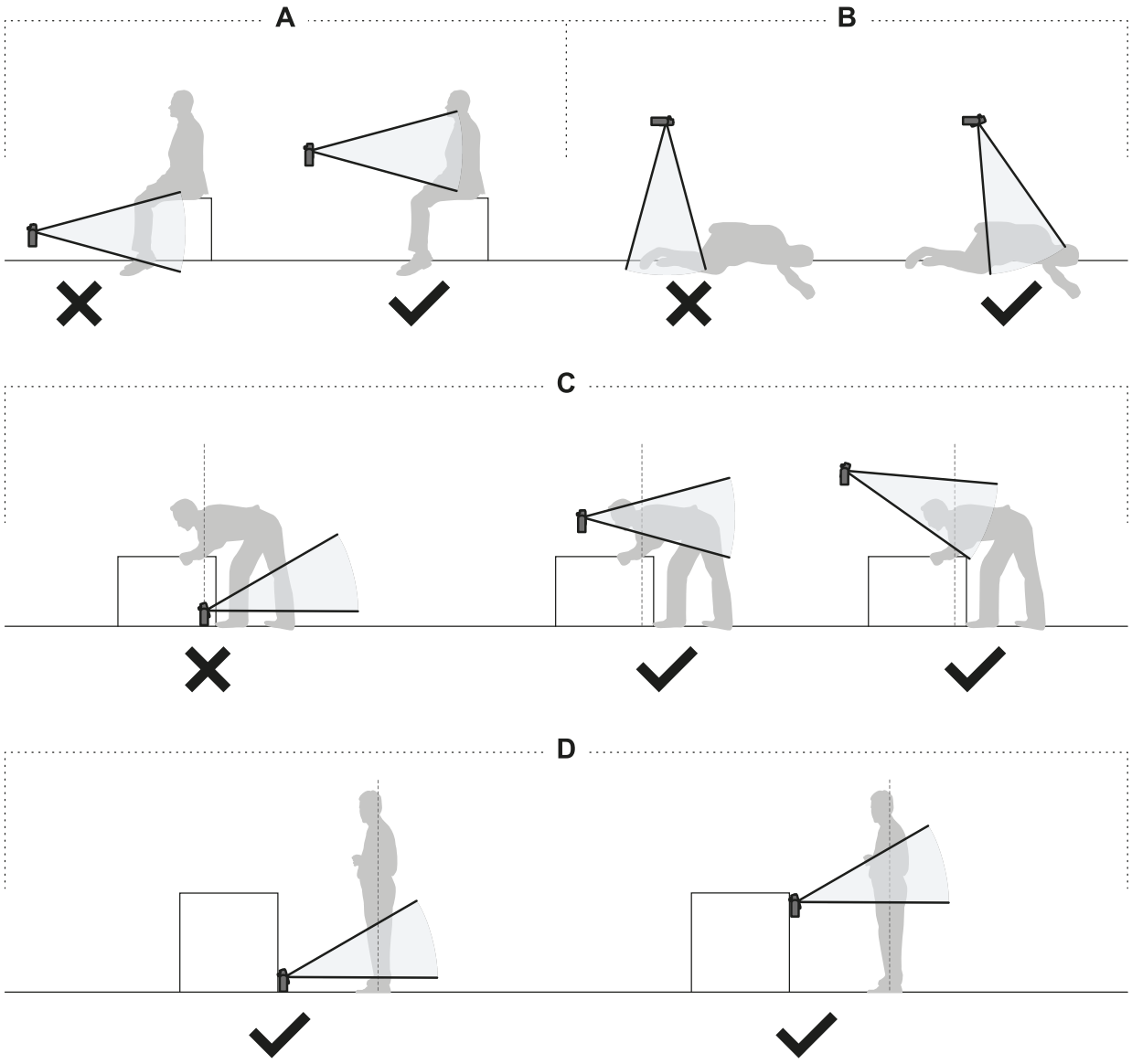
The function is not guaranteed in the following cases:

- There are objects that limit or prevent the sensor from detecting motion.
- The person is lying on the floor and the sensor is installed at a height below 2.5 m (8.2 ft) or with an inclination lower than 60° downward.
- The sensor does not detect a sufficient portion of the body, for example if it detects the limbs but not the torso of a person sitting **[A]**, lying down **[B]** or leaning **[C]**.

⚠ WARNING

The position of the person is determined by the position of his or her center of gravity. This function is not guaranteed if a person has body parts within the sensor field of view but the axis of the person’s center of gravity is outside that field.

Only when there are no restrictions does the function ensure that a person is detected when standing up **[D]**.



5.8.2 Types of managed restart

NOTICE	
	It is the responsibility of the machinery manufacturer to assess if automatic restart prevention can guarantee the same level of safety as manual restart (as defined in standard EN ISO 13849-1:2015, section 5.2.2).

For each detection field independently, the system manages three types of restart prevention:

Type	Conditions for enabling machinery restart	Safety working mode allowed
Automatic	The time interval set through the LBK Designer application (**Restart timeout**) has passed since the last motion detection*.	All
Manual	The **Restart signal** was received correctly** (see Restart signal on page 112).	**Always-on access detection**

Type	Conditions for enabling machinery restart	Safety working mode allowed
Safe manual	1. The time interval set through the LBK Designer application (**Restart timeout**) has passed since the last motion detection* and 2. the status of the restart signal indicates that the restart is now possible (see Restart signal on page 112).	**Both (default)** and **Always-on restart prevention**

Note*: machinery restart is enabled if no motion is detected up to 35 cm (13.8 in) beyond the detection field.

Note**: (for all types of restart) other dangerous system statuses may prevent the restart of the machinery (e.g. diagnostic fault, sensor masking, etc.)

5.8.3 Precautions for preventing unexpected restarting

To prevent unexpected restarting, if the sensor is installed at a height of less than 30 cm (11.8 in) from the ground, a minimum distance of 50 cm (20 in) from the sensor must be guaranteed.

Note: if the sensor is installed at a height of less than 30 cm (11.8 in) from the ground, an option is to enable the masking function to generate a system error if a person stands in front of the sensor.

5.8.4 Configure the restart prevention function

Type	Procedure
Automatic	1. In the LBK Designer application in **Settings** > **Restart function**, select **Automatic**. 2. In the LBK Designer application, in **Configuration** for each detection field in use with automatic restart, select the desired **Safety working mode** and set the **Restart timeout** (or the T_{OFF} parameter, if present).
Manual	1. In the LBK Designer application in **Settings** > **Restart function**, select **Manual**. 2. If there is a digital input configured as **Restart signal** (**Settings** > **Digital Input-Output**), connect the machinery button for the restart signal as convenient (see Electrical connections on page 99). 3. To use the Fieldbus communication for the restart signal, make sure that no digital input is configured as **Restart signal** (**Settings** > **Digital Input-Output**). See the Fieldbus protocol for details. 4. In the LBK Designer application, in **Configuration** for each detection field in use with manual restart, set the T_{OFF} parameter value. **Note**: the **Safety working mode** is automatically set to **Always-on access detection** for all the detection fields in use with manual restart.
Safe manual	1. In the LBK Designer application in **Settings** > **Restart function**, select **Safe manual**. 2. If there is a digital input configured as **Restart signal** (**Settings** > **Digital Input-Output**), connect the machinery button for the restart signal as convenient (see Electrical connections on page 99). 3. To use the Fieldbus communication for the restart signal, make sure that no digital input is configured as **Restart signal** (**Settings** > **Digital Input-Output**). See the Fieldbus protocol for details. 4. In the LBK Designer application, in **Configuration** for each detection field in use with safe manual restart, select the **Safety working mode** among those allowed and set the **Restart timeout** parameter value.

5.9 Muting

5.9.1 Description

Muting is an additional safety function that temporarily suspends the safety functions. Motion detection is disabled and therefore the controller maintains the safety outputs activated even when the sensors detect motion in a detection field.

The muting function must be enabled so that it is automatically activated when conditions permit.

5.9.2 Muting enabling

The muting function can be enabled through digital input (see Enable muting signal characteristics on the next page) or safety Fieldbus (if available).

⚠ WARNING

If the muting function has been enabled both through the safety Fieldbus and the digital inputs, the digital inputs prevail over the Fieldbus.

Through the safety Fieldbus (if available) the muting function can be enabled for each sensor individually.

Through digital inputs the muting function can be enabled for all the sensors simultaneously or only for a group of sensors. Up to two groups can be configured, each associated with a digital input.

Through the LBK Designer application, the following must be defined:

- for each input, the group of managed sensors
- for each group, the sensors that belong to it
- for each sensor, whether it belongs to a group or not

Note: if the muting function is enabled for one sensor, it is enabled for all the detection fields of the sensor, regardless if the detection fields are dependent or independent and the anti-tampering functions are disabled for that sensor.

See Configure the inputs and outputs on page 63.

5.9.3 Muting activation conditions

The muting function is activated on a specific sensor only in the following conditions:

- all the detection fields involved have no active detection signal, no active static object detection signal, and the restart timeout has expired for all of them
- there is no tampering signal or fault signal for that sensor

When the muting is enabled for a group of sensors, the function is activated for each sensor as soon as there is no detection in its monitored area, independent of the other sensors.

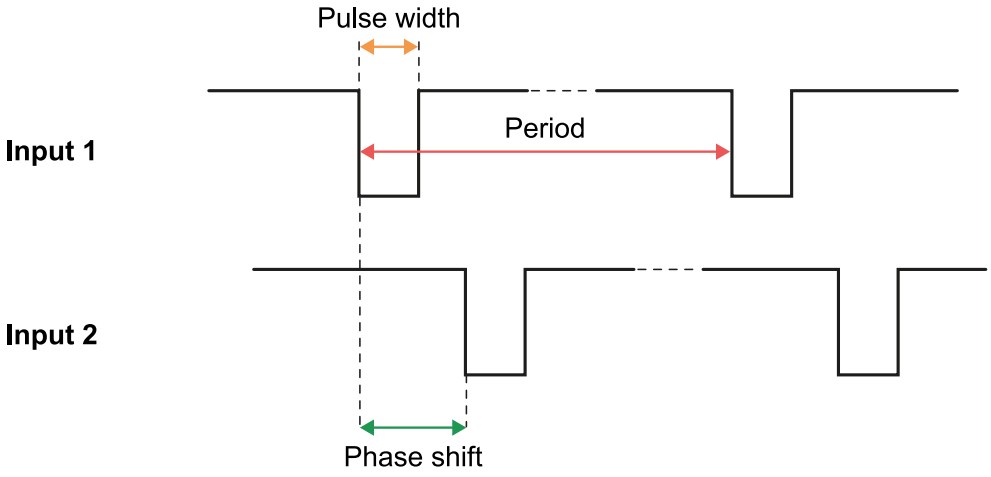
⚠ WARNING

Enable the muting signal only when the detection signals of all the sensors of the group are in ON-state. Or if the sensors belonging to different groups, but monitoring the same area, are in ON-state.

5.9.4 Enable muting signal characteristics

The muting function is enabled only if both logic signals of the dedicated input meet certain characteristics.

Below is a graphic representation of the signal characteristics.



In the **LBK Designer** application, in **Settings** > **Digital Input-Output** it is necessary to set the parameters that define the signal characteristics.

Note: with pulse duration = 0, it is sufficient that the input signals are at high logic level (1) to enable muting.

5.9.5 Muting status

Any output dedicated to the muting status (Muting enable feedback signal) is activated if at least one of the groups of sensors is in muting.

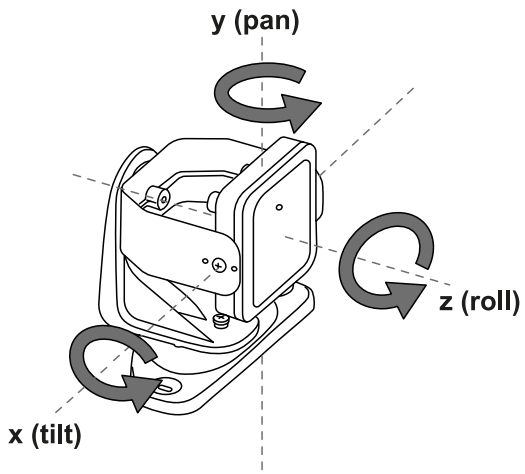
NOTICE	
	It is the responsibility of the machinery manufacturer to assess whether the indication of the muting status is necessary (as defined in section 5.2.5 of EN ISO 13849-1:2015 standard).

5.10 Anti-tampering functions: anti-rotation around axes

5.10.1 Anti-rotation around axes

The sensor detects rotation around its axes.

Note: the axes are those represented in the figure below, regardless of the installation position of the sensor.



When the system configuration is saved, the sensor also saves its position. If the sensor subsequently detects changes in rotation around these axes, it sends a tamper alert to the controller. Upon reception of a tampering signal, the controller deactivates the safety outputs.

The sensor can detect changes in rotation around the x-axis and the z-axis even if it is switched off. The tamper alert is sent to the controller at the following switch on.

A change in rotation around the y-axis is detected only if it is faster than 5° every 10 s and if the system is on.

⚠ WARNING
The tamper alert due to a rotation around the y-axis is reset at the next switch on. For proper and safe operation of the system, validate the system again.

5.10.2 Enable the anti-rotation around axes function

The anti-rotation around axes function is disabled by default.

⚠ WARNING
If the function is disabled, the system cannot signal a change in the rotation of the sensor around the axes and therefore any changes in the monitored area. See Checks when the anti-rotation around axes function is disabled below.

⚠ WARNING
Take precautions to prevent tampering, if the function is disabled for at least one axis of one sensor and if the rotation around that axis is not protected with tamper-proof screws.

The function can be enabled and configured for each axis of each sensor individually. In the LBK Designer application, in **Settings** > **Anti-tampering**, click on the specific option to enable the function for a sensor.

5.10.3 When to enable

Enable the anti-rotation around axes function only if it is necessary to detect a change in the rotation of a sensor around a specific axis.

It is strongly suggested not to enable the function if the sensor is installed on a moving object (e.g. carriage, vehicle) whose motion could change the sensor inclination (e.g. motion on a slope or in a curve).

5.10.4 Checks when the anti-rotation around axes function is disabled

When the anti-rotation around axes function is disabled, perform the following checks.

Safety function	Schedule	Action
Access detection function	Before each machinery restart	Check that the sensor is positioned as defined in the configuration. Check that the monitored area is the same as defined by the configuration. See Validate the safety functions on page 70.
Restart prevention function	Each time the safety outputs are deactivated	

5.11 Anti-tampering functions: anti-masking

5.11.1 Masking signal

The sensor detects the presence of objects that could obstruct the field of view. When the system configuration is saved, the sensor memorizes the surrounding environment. If the sensor subsequently detects variations in the environment that could influence the field of view, it sends a masking signal to the controller. The sensor monitors from -50° to 50° on the horizontal plane regardless of the angular coverage set. Upon receiving a masking signal, the controller deactivates the safety outputs.

Note: the masking signal is not guaranteed in the presence of objects which cause reflection effects that bring their RCS below the minimum detectable threshold.

5.11.2 Environment memorization process

The sensor starts the surrounding environment memorization process when the LBK Designer application configuration is saved. From that moment, it waits for the system to exit the alarm status and for the scene to be static up to 20 seconds, then scans and memorizes the environment.

NOTICE	
	If the scene is not static during the 20 seconds interval, the system remains in a fault status (Signal error) and the system configuration must be saved again.

It is recommended to start the memorization process after at least 3 minutes from turning on the system to guarantee that the sensor has reached the operating temperature.

Only at the conclusion of the memorization process it is possible for the sensor to send masking signals.

5.11.3 Causes of masking

Possible causes of masking signals are the following:

- An object that obstructs the field of view of the sensor has been placed in the detection field.
- The environment in the detection field changes significantly, for example, if the sensor is installed on moving parts or if there are moving parts inside of the detection field.
- The configuration was saved with sensors installed in an environment that is different from the working environment.
- There were temperature fluctuations.

5.11.4 Masking signal when the system is turned on

If the system was off for several hours and there were temperature fluctuations, the sensor might send a false masking signal when it is turned on. The safety outputs activate automatically within 3 minutes when the sensor reaches its working temperature. This does not happen if this temperature is still very far from the reference temperature.

5.11.5 Settings

For each sensor, the anti-masking settings are the following:

- maximum distance from the sensor (range [20 cm/7.87 in, 100 cm/3.28 ft], 10 cm/3.94 in steps) in which the function is active
- sensitivity

These are the four levels of sensitivity:

Note: the function has a tolerance area where the actual detection of a masking object depends on the RCS of the object and on the sensitivity level set. The high sensitivity level has the largest area, about 10-20 cm (3.94-7.87 in).

Level	Description	Example application
High	The sensor has the highest sensitivity to changes in the environment. (Suggested level when the field of view is empty up to the set masking distance)	Installations with an empty environment and a height of less than one meter, where objects could occlude the sensor.
Medium	The sensor has low sensitivity to changes in the environment. Occlusion must be evident (deliberate tampering).	Installations with a height of more than one meter, where masking is likely to occur only if voluntary.
Low	The sensor detects masking only if the sensor occlusion is complete and the objects are highly reflective (e.g. metal, water) near the sensor.	Installations on moving parts, where the environment is changing continuously, but where static objects may be near the sensor (obstacles on the route).
Disabled	The sensor does not detect changes in the environment. **⚠ WARNING** If the function is disabled the system cannot signal the presence of objects that might impede normal detection (see Checks when the anti-masking function is disabled below).	See When to disable below.

To change the sensitivity level or disable the function, in the LBK Designer application, click **Settings** > **Anti-tampering** and search for **Anti-masking sensitivity**.

To set the distance, in the LBK Designer application, click **Settings** > **Anti-tampering** and search for **Anti-masking distance**.

5.11.6 Checks when the anti-masking function is disabled

When the anti-masking function is disabled, perform the following checks.

Safety function	Schedule	Action
Access detection function	Before each machinery restart	Remove any objects that obstruct the field of view of the sensor. Reposition the sensor according to the initial installation.
Restart prevention function	Each time the safety outputs are deactivated	

5.11.7 When to disable

The anti-masking function should be disabled under the following conditions:

- (With restart prevention function) The monitored area includes moving parts that stop in different and unpredictable positions.
- The monitored area includes moving parts that vary their position while the sensors are in muting.
- The sensor is positioned on a part that can be moved.
- The presence of static objects is tolerated in the monitored area (e.g. loading/unloading area).

6 Sensor position

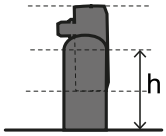
6.1 Basic concepts

6.1.1 Determining factors

The sensor installation height and inclination should be decided together with the angular coverage and the detection distances in order to have optimal coverage of the dangerous area.

6.1.2 Sensor installation height

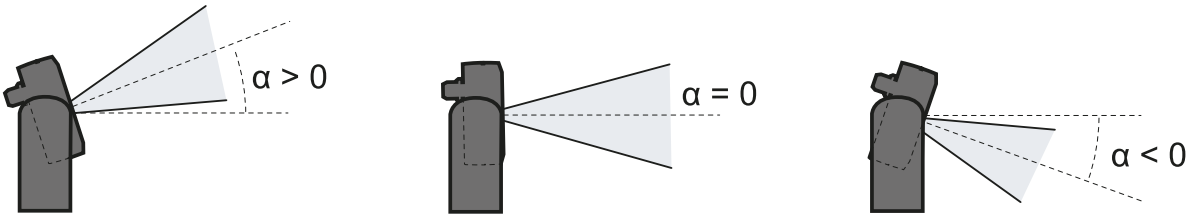
The installation height (h) is the distance between the center of the sensor and the ground or reference plane of the sensor.



6.1.3 Sensor inclination

Sensor inclination is the rotation of the sensor around its x-axis. Inclination is defined as the angle between a line perpendicular to the sensor and a line parallel to the ground. Three examples are presented as follows:

- sensor tilted upwards: α positive
- straight sensor: α = 0
- sensor tilted downwards: α negative



6.2 Sensor field of view

6.2.1 Types of field of view

During the configuration phase, for each sensor it is possible to select the angular coverage (see Angular coverage on page 37).

The actual detection field of the sensor also depends on the sensor installation height and inclination. See Calculation of range of distances on page 55.

6.2.2 Areas and dimensions of the field of view

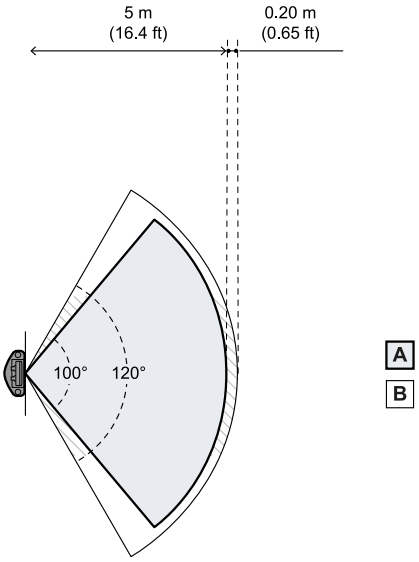
The sensor field of view is composed of two areas:

- detection field **[A]**: where detection of objects similar to humans in any position is guaranteed.
- tolerance area **[B]**: where the actual detection of a moving object/person depends on the characteristics of the object itself (see Factors that influence the reflected signal on page 36).

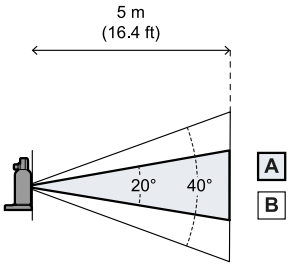
6.2.3 Dimensions for the access detection function

Note: the tolerance area dimensions described are related to the detection of humans.

The tolerance area is 20° greater than the angular coverage set.



Top view

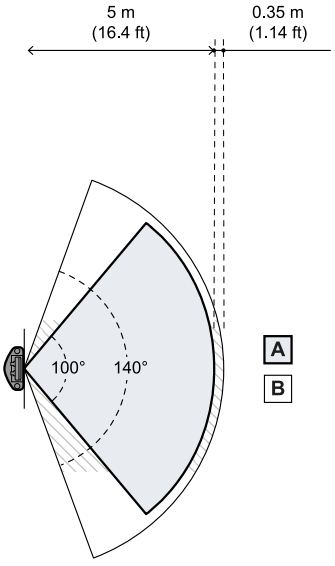


Side view

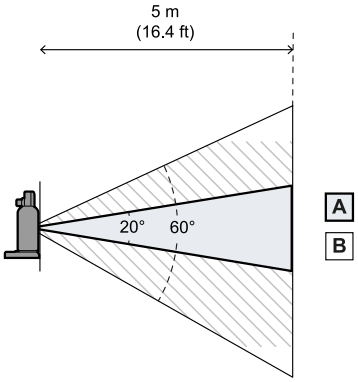
6.2.4 Dimensions for the restart prevention function

Note: the tolerance area dimensions described are related to the detection of humans.

The tolerance area is 40° greater than the angular coverage set.



Top view

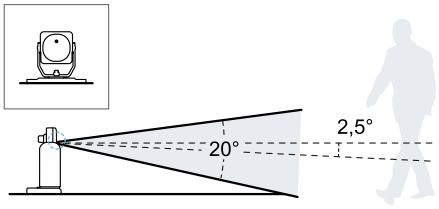


Side view

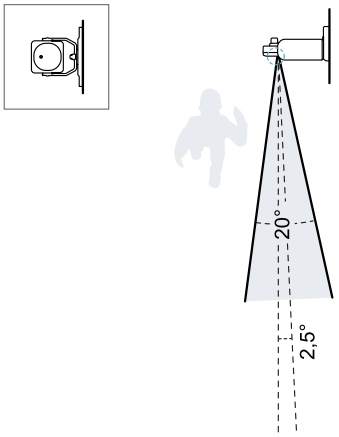
6.2.5 Position of the field of view

The field of view is shifted of 2.5°. To understand the actual position of the sensor field of view consider the LED position:

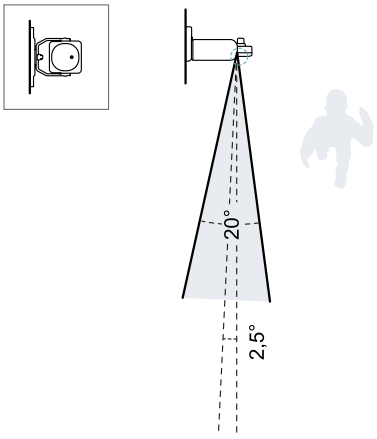
- downward with sensor LED up
- right with sensor LED on the left (with respect to the sensor center, facing the sensor)
- left with sensor LED on the right (with respect to the sensor center, facing the sensor)



Side view with sensor inclination 0°.



Top view with sensor inclination 0°.



Top view with sensor inclination 0°.

6.3 Dangerous area calculation

6.3.1 Introduction

The dangerous area of the machinery to which LBK SBV System is applied must be calculated as indicated in standards ISO 13855:2010.

6.3.2 Formula

To calculate the depth of the dangerous area (S), use the following formula:

Table Cell Outside Table: $S = K * T + C$

Where:

Variable	Description	Value	Measurement unit
K	For static installation. Maximum dangerous area access speed	1600	mm/s
	For mobile installation. Maximum vehicle/part of machinery speed *.	≤ 2000	mm/s
T	Total system stopping time (LBK SBV System + machinery)	0.1 + Machinery stopping time (calculated in accordance with standard ISO 13855:2010)	s
C	Corrective constant according to standard ISO 13855:2010	850	mm

Note*: only the speed of the vehicle or of the part of machinery is considered. This is based on the assumption that the person recognizes the hazard and stands still.

Note: when using PROFIsafe, add the communication and processing time required for the signal to reach the machine after the safety output is activated.

Example 1 (static installation)

- Machinery stopping time = 0.5 s

T = 0.1 s + 0.5 s = **0.6 s**

S = 1600 * **0.6** + **850** = **1810 mm**

Example 2 (mobile installation with maximum vehicle speed = 2000 mm/s)

- Machinery stopping time = 0.5 s

T = 0.1 s + 0.5 s = **0.6 s**

S = 2000 * **0.6** + **850** = **2050 mm**

6.4 Calculation of range of distances

6.4.1 Introduction

The range of detection distances for a sensor depends on the inclination (**α**) and the installation heights (**h**) of the sensor. The detection distance of each detection field (**Dalarm**) depends on a distance **d** that must be within the range of distances allowed.

The formulas for calculating the distances are reported as follows.

⚠ WARNING

Define the optimum sensor position according to the risk assessment requirements.

6.4.2 Legend

Element	Description	Measurement unit
α	Sensor inclination	degrees
h	Sensor installation height	m
d	Detection distance (linear) Must be within the range of distances allowed (see Installation configurations below).	m
Dalarm	Detection distance (real)	m
D_1	Start detection distance (for configuration 2 and 3); end detection distance (for configuration 1)	m
D_2	End detection distance (for configuration 3)	m

6.4.3 Installation configurations

Three configurations are possible, according to the inclination of the sensor (**α**):

- ≥ +20°: configuration 1, the field of view of the sensor never intersects the ground
- 0° or 10°: configuration 2, the upper portion of the field of view of the sensor never intersects the ground
- ≤ -10°: configuration 3, the upper portion and the bottom portion of the field of view always intersect the ground

6.4.4 Calculate the range of distances

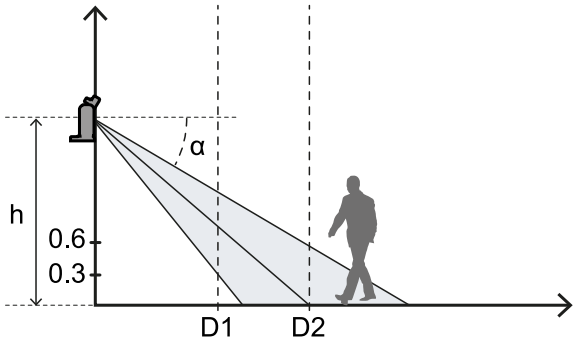
The range of detection distances for a sensor depends on the configuration:

Configuration	Range of distances
1	From 0 m to D_1
2	From D_1 to 5 m
3	From D_1 to D_2

$$D_1 = \frac{h-0.3}{tan((-\alpha)+2.5^\circ+10^\circ)}$$

$$D_2 = \frac{h-0.6}{tan((-\alpha)+2.5^\circ-10^\circ)}$$

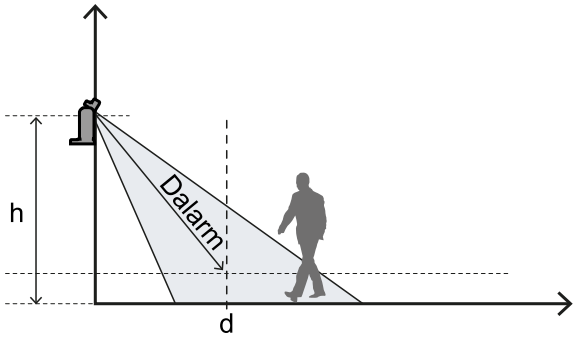
Below is an example for configuration 3, with D_1 = 0.9 m and D_2 = 1.6 m.



6.4.5 Calculate the real detection distance

The actual detection distance **Dalarm** is the value to be entered on the **Configuration** page of the LBK Designer application.

Dalarm indicates the maximum distance between the sensor and the object to be detected.



$$Dalarm = \sqrt{d^2 + (h - 0.3)^2}$$

6.5 Sensor position recommendations

6.5.1 For access detection function

Below are some recommendations for the sensor positioning for the access detection function:

- If the distance between the ground and the bottom portion of the field of view is greater than 30 cm (11.8 in), take precautions area to make sure that even a person entering the dangerous area by crawling on the floor is still detected.
- If the height above the ground is less than 30 cm (11.8 in), install the sensor with an inclination of minimum 10° upwards.

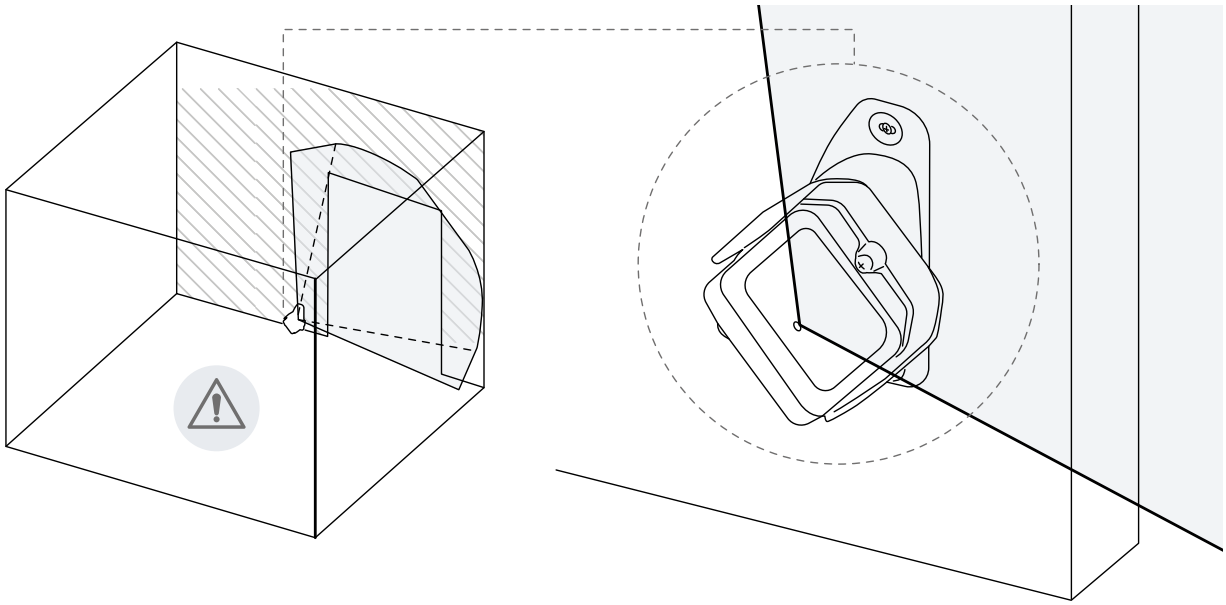
6.5.2 For access control of an entrance

Note: this static installation is applicable only for LBK SBV-01.

Below are some recommendations for the sensor positioning if it is installed for controlling an entrance:

- height above the ground: 30 cm (11.8 in)
- angular coverage: 90°
- inclination: 40° upwards
- rotation around z-axis: 90°

Below is an example:



6.6 Installations on moving elements

6.6.1 Introduction

LBK SBV-01 sensor can be mounted on moving vehicles or moving parts of the machinery.

The characteristics of the detection field and of the response time are the same as in static installations.

6.6.2 Speed limits

The detection is guaranteed only if the speed of the vehicle or part of the machinery is from 0.1 m/s (0.66 ft/s) to 2 m/s (6.56 ft/s)

Note: only the speed of the vehicle or of the part of machinery is considered. This is based on the assumption that the person recognizes the hazard and stands still.

6.6.3 Detection signal generation conditions

When the sensor is mounted on moving parts, it will detect static objects as moving objects.

The sensor will trigger a detection signal if the following conditions are met:

- The RCS (Radar Cross-Section) of static objects is greater than or equal to the RCS of a human body
- The relative speed between the objects and the sensor is greater than the minimum speed necessary for detection.

6.6.4 Prevention of unexpected restart

As for static installations, when the moving part where the sensor is installed is arrested because of a detection, the system will switch to restart prevention safety function (if **Safety working mode** is not **Always-on access detection**), and the sensor will detect the presence of a human body (see Cases of non-guaranteed function on page 44). Static objects are then automatically filtered out and no longer detected.

The restart of the moving vehicle or moving part of the machinery in the presence of static objects can be prevented using the following methods:

- Static object detection option enabled (see Restart prevention function: static object detection option on page 43).

- Anti-masking function: if the function is enabled, an error will occur when the static object will be close enough to limit the detection of the sensor.

Note: if the anti-masking function is active when the sensor is moving also, this could generate false alarms since the environment change during movement could be detected as tampering.

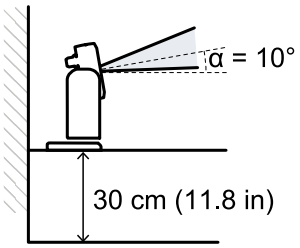
- Manual restart: the restart is triggered externally and only once the static object is removed from the trajectory of the moving vehicle or moving part.
- Application logic on PLC/controller that permanently stops the moving part if multiple stops occur immediately after the restart of the part. If the vehicle or the part stops very quickly after the restart, this probably means that there is a static obstacle. Once the moving part is stopped, the sensor does not detect the object anymore and therefore the part moves but it stops again as soon as it detects the object again.

6.6.5 Recommendations for positioning the sensor

When the sensor is moving, the floor should be treated as a static object. The sensor must be positioned so that the floor is excluded from the sensor's detection area.

Below are some recommendations for the sensor positioning:

- as low as possible, but not below 30 cm (11.8 in) above the ground
- with a suggested inclination of 10°



If the sensor is facing downwards, the detection distance and the inclination of the sensor needs to be adjusted so that the floor is excluded from the detection field. Moreover, it is suggested that 30 cm (11.8 in) be left between the end of the detection field and the floor, to avoid false alarms due to the tolerance area.

6.7 Outdoor installations

6.7.1 Position exposed to precipitation

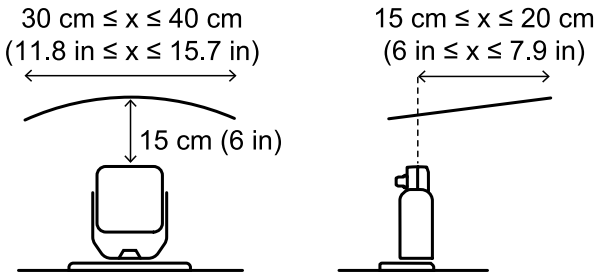
If the sensor installation position might be exposed to precipitation that can cause undesired alarms, it is recommended to take the following precautions:

- Make a cover to protect the sensor from rain, hail or snow.
- Position the sensor so that it does not frame the ground where puddles might form.

6.7.2 Recommendations for covering the sensor

Below are some recommendations for creating and installing a sensor cover:

- height from sensor: 15 cm (6 in)
- width: minimum 30 cm (11.8 in), maximum 40 cm (15.7 in)
- protrusion from the sensor: minimum 15 cm (6 in), maximum 20 cm (7.9 in)
- water outflow: at the sides or behind but not in front of the sensor (the cover should be arched and/or tilted backwards)



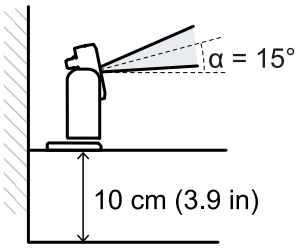
6.7.3 Recommendations for positioning the sensor

Below are some recommendations for defining the sensor position:

- height above the ground: minimum 10 cm (3.9 in)
- suggested inclination: minimum 15°

Before installing a sensor facing downwards, make sure there are neither liquids nor radar reflective materials on the floor.

Note: if the above recommendations are followed and the monitored area is free of static objects, the system is robust against a rainfall rate up to 45 mm/h.



6.7.4 Position not exposed to precipitation

If the installation position of the sensor is not exposed to precipitation, no special precautions are required.

7 Installation and use procedures

7.1 Before installation

7.1.1 Materials required

- Two tamper-proof screws (see Tamper-proof screws specifications on page 95) to mount each sensor.
- Cables to connect the controller to the first sensor and the sensors to one another, see CAN bus cables recommended specifications on page 95.
- A data USB cable with a micro-USB connector (micro-B type) or, only if the Ethernet port is available, an Ethernet cable to connect the controller to the computer.
- A bus terminator (product code: 50040099) with resistance of 120 Ω for the last sensor of the CAN bus.
- A screwdriver for tamper-proof screws (see Tamper-proof screws specifications on page 95) to be used with the Hex pin security bit supplied in the controller package.

7.1.2 Operating system required

- Microsoft Windows 10 or later
- Apple OS X 11.0 or later

7.1.3 Install the LBK Designer application

Note: if the installation fails, the dependencies needed by the application may be missing. Update your operating system or contact our Technical Support to receive assistance.

1. Download the application from the www.leuze.com website (from the product download area) and install it on the computer.
2. With Microsoft Windows operating system, download and install from the same site also the driver for USB connection.
3. Start the application.
4. Choose the connection mode (USB or Ethernet).

   Note: the default IP address for the Ethernet connection is 192.168.0.20. The computer and the controller must be connected to the same network.

5. Set a new admin password, memorize it and provide it only to people who are authorized to change the configuration.
6. Select the sensor type and the number of sensors.
7. Set the country in which the system is installed.

   Note: this setting does not have any effect on system performance.

8. Only for LBK SBV-01, select the application type (Fixed or Vehicle mount).

   Note: the two algorithms are optimized to minimize the interference between sensors based on the installation conditions. Even though this choice does not affect the performance and the robustness, it is mandatory to select the correct application type.

7.1.4 Initiate LBK SBV System

1. Calculate the position of the sensor (see Sensor position on page 52) and the depth of the dangerous area (see Dangerous area calculation on page 54).
2. Install the controller on the next page.
3. Open the LBK Designer application.
4. Optional: Synchronize the controllers on the next page.
5. Define the area to be monitored on page 63.
6. Configure the inputs and outputs on page 63.
7. Optional: Mount bracket for z-axis rotation (roll) on page 65.

8. Install the sensors on the next page
9. Connect the controller to the sensors on page 68.

   Note: connect the sensors to the controller off-site if access to the connectors becomes difficult once they are installed.

10. Assign the Node IDs on page 68
11. Save and print the configuration on page 69.
12. If available, Set the controller Ethernet parameters on page 69
13. Validate the safety functions on page 70.

7.2 Install and configure LBK SBV System

7.2.1 Install the controller

⚠ WARNING
To prevent tampering, make sure the controller is only accessible to authorized personnel (e.g. key-locked electrical panel).

1. Mount the controller on the DIN rail.
2. Make electrical connections (see Terminal blocks and connector pin-outs on page 96 and Electrical connections on page 99).

NOTICE
If at least one input is connected, the SNS input "V+ (SNS)" and the GND input "V- (SNS)" must also be connected.

NOTICE
When powered, the system takes about 20 s to start. During that period the outputs and the diagnostic functions are deactivated, and the green sensor status LEDs of the connected sensors flash.

Note: to correctly connect the digital inputs, see Voltage and current limits for digital inputs on page 97.

7.2.2 Synchronize the controllers

If there are more than one controller in the area, perform the following steps:

1. In the LBK Designer application, click **Settings** > **Advanced** > **Multi-controller synchronization**.
2. Assign a different **Controller channel** to each controller.

Note: if there are more than four controllers, the controllers with the same channel must have their monitored areas as far from each other as possible.

7.2.3 Define the area to be monitored

WARNING

The system is disabled during configuration. Prepare opportune safety measures in the dangerous area protected by the system before configuring the system.

1. In the LBK Designer application click **Configuration**.
2. Add the desired number of sensors in the plane.
3. Define the position and inclination of each sensor.
4. Define the safety working modes, the detection distance, the angular coverage, and the restart timeout for each detection field of each sensor

7.2.4 Configure the inputs and outputs

1. In the LBK Designer application, click **Settings**.
2. Click **Digital Input-Output** and define the input and output functions.
3. If the muting is managed, click **Muting** and assign the sensors to the groups according to the logic of the digital inputs.
4. Click **APPLY CHANGES** to save the configuration.

7.2.5 Install the sensors

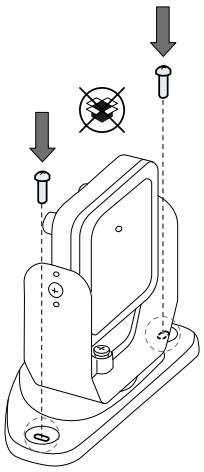
Note: for an example of sensor installation, see Examples of sensor installation on page 66.

Note: the usage of a thread-locking fluid on the threads of fasteners is suggested, especially when the sensor is installed on a moving or vibrating part of the machinery.

1. Position the sensor as indicated in the configuration report and fasten the bracket with two tamper-proof screws directly onto the floor or another support.

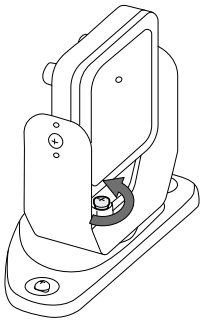
NOTICE

Make sure the support does not inhibit machinery commands.



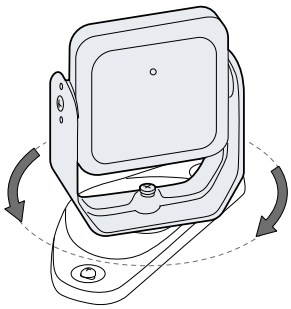
2. With an Allen key, loosen the screw at the bottom to pan the sensor.

   Note: to avoid damaging the bracket, loosen the screw completely before panning the sensor.

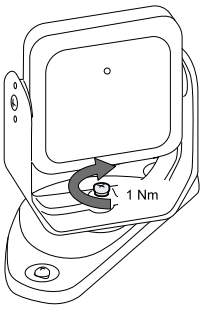


3. Pan the sensor until it reaches the desired position.

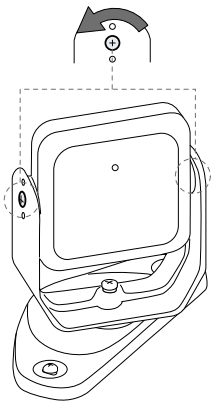
   Note: a notch is equal to 10° of rotation.



4. Tighten the screw.

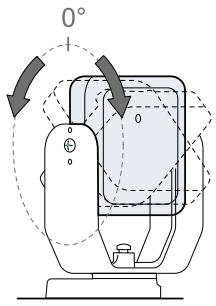


5. Loosen the tamper-proof screws to tilt the sensor.

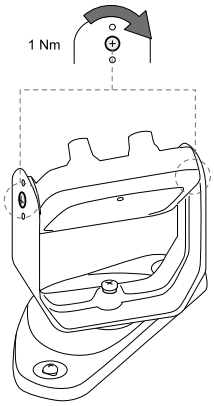


6. Direct the sensor up to the desired inclination (see Sensor position on page 52).

   Note: a notch is equal to 10° of inclination.



7. Tighten the screws.

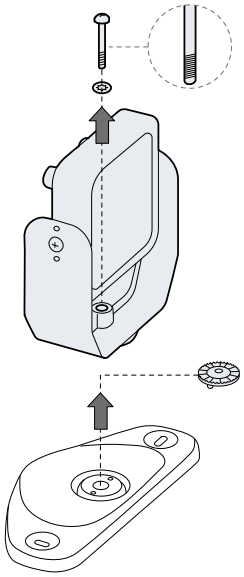


7.2.6 Mount bracket for z-axis rotation (roll)

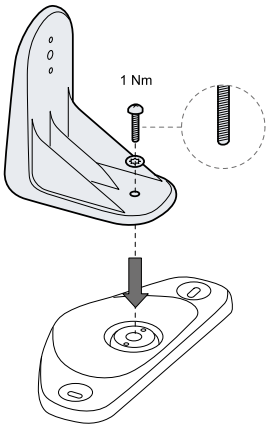
Note: for an example of sensor installation, see Examples of sensor installation on the next page.

The bracket that allows rotation around the z-axis (roll) is an accessory in the package. To mount it:

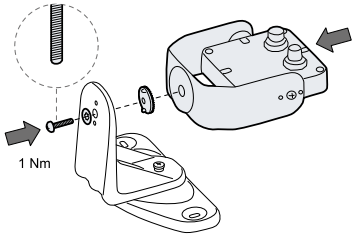
1. Unscrew the screw at the bottom and remove the bracket with the sensor and the aligning ring.



2. Attach the roll bracket to the base. Use the tamper-proof screw provided with the bracket.

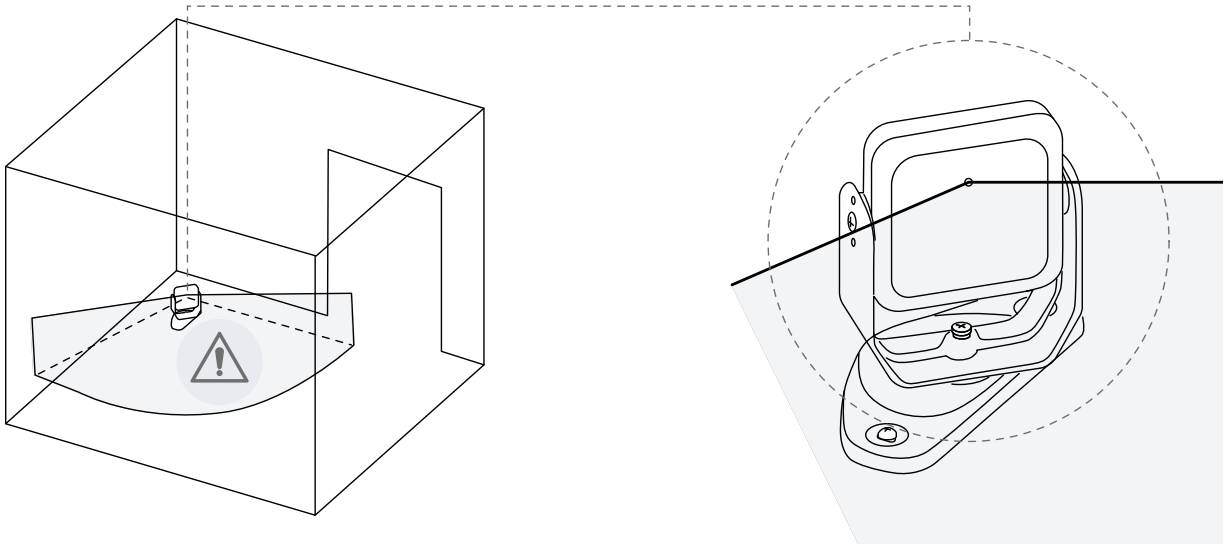


3. Mount the bracket with the sensor and the aligning ring. Use the tamper-proof screw provided with the bracket.

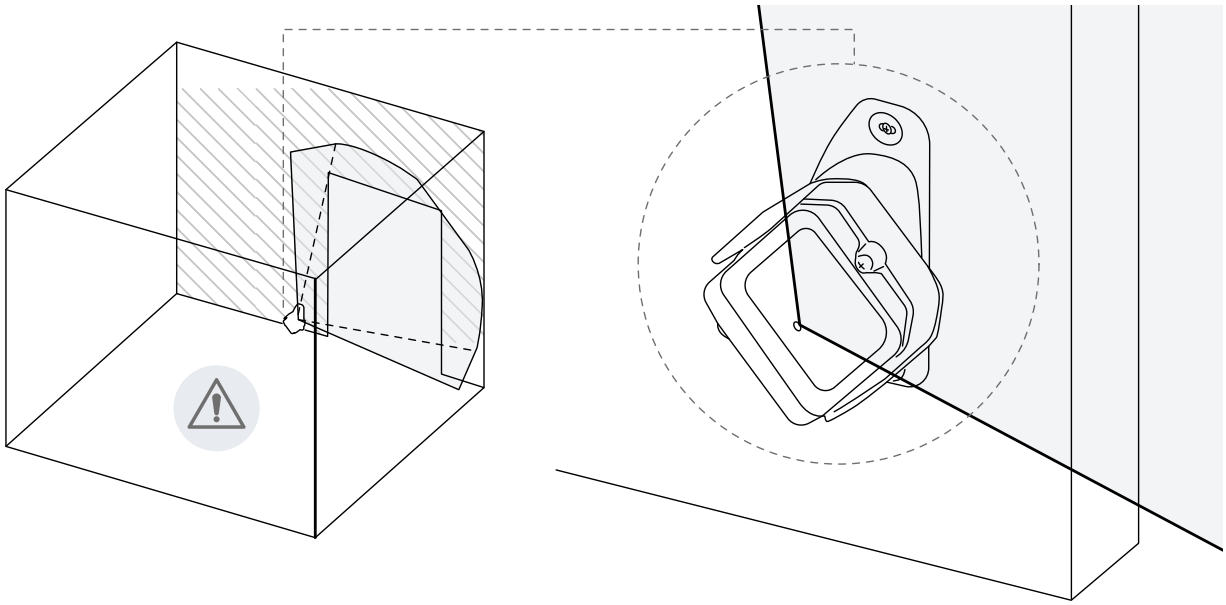


7.2.7 Examples of sensor installation

NOTICE	
	Refer to the sensor LED position to identify the sensor field of view (see Position of the field of view on page 54).

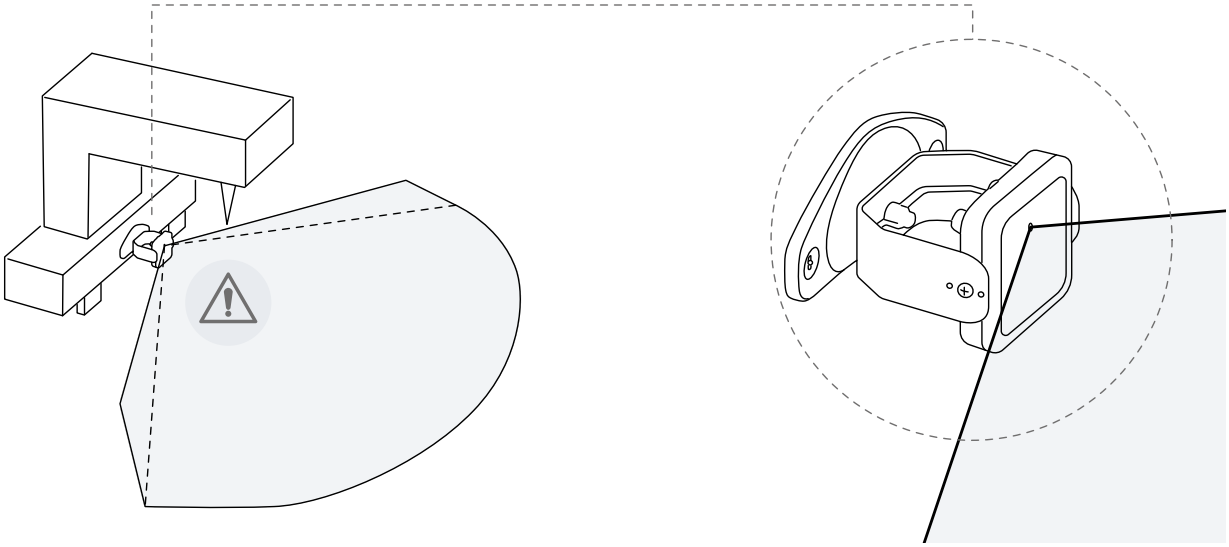


Floor installation



Wall installation (for example for access control of an entrance).

Note: install the sensor so that the field of view is shifted towards the outside of the hazardous area to avoid false alarms (see Position of the field of view on page 54).



Installation on the machinery.

7.2.8 Connect the controller to the sensors

Note: the maximum length of the CAN bus line from the controller to the last sensor in the chain is 100 m (328.1 ft).

Note: when replacing a sensor, in the LBK Designer application, click **APPLY CHANGES** to confirm the change.

1. With the cable validator tool (downloadable from the site www.leuze.com), decide if the controller will be positioned at the end of the chain or inside it (see Chain examples on the next page).
2. Set the DIP switch of the controller based on its position in the chain.
3. Connect the desired sensor directly to the controller.
4. To connect another sensor, connect it to the last sensor in the chain or directly to the controller to start a second chain.
5. Repeat step 4 for all the sensors to be installed.
6. Insert the bus terminator (product code: 50040099), into the free connector of the last sensor of the chain (s).

7.2.9 Assign the Node IDs

Type of assignment

Note: if the connected sensors do not already have a Node ID assigned (e.g., at first startup), the system automatically assigns them a Node ID during the installation procedure.

Three types of assignment are possible:

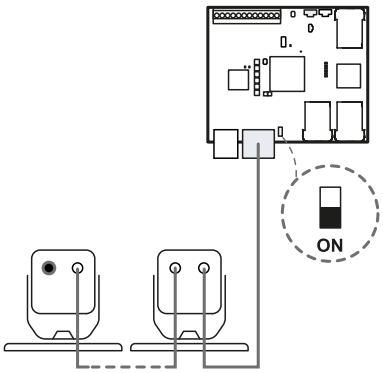
- Manual: to assign the Node ID to a sensor at a time. Can be performed with all the sensors already connected or after each connection. Useful for adding a sensor or to change Node ID to a sensor.
- Automatic: to assign the Node IDs to all sensors at once. To be performed when all the sensors are connected.
- Semi-automatic: wizard for connecting the sensors and assign the Node ID one sensor at a time.

Procedure

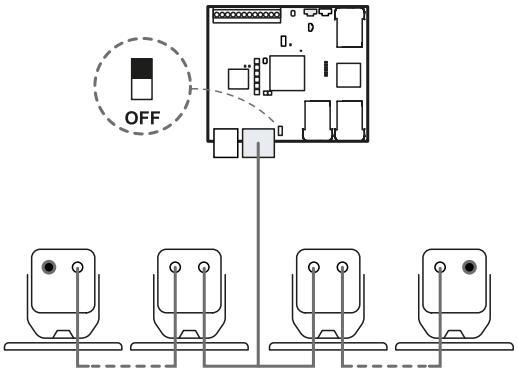
1. Start the application.
2. Click **User** > **Configuration** and verify that the number of sensors in the configuration is the same of the sensors installed.
3. Click **Settings** > **Node ID Assignment**.
4. Proceed according to the type of assignment:

If the assignment is...	Then...
manual	1. Click **DISCOVER CONNECTED SENSORS** to display the connected sensors. 2. To assign a Node ID, click **Assign** for the unassigned Node ID in the **Configured sensors** list. 3. To change a Node ID, click **Change** for the already assigned Node ID in the **Configured sensors** list. 4. Select the SID of the sensor and confirm.
automatic	1. Click **DISCOVER CONNECTED SENSORS** to display the connected sensors. 2. Click **ASSIGN NODE IDS** > **Automatic**.
semi-automatic	Click **ASSIGN NODE IDS** > **Semi-automatic** and follow the instructions displayed.

7.2.10 Chain examples



Chain with controller at the end of the chain and a sensor with bus terminator



Chain with controller inside the chain and two sensors with bus terminator

7.2.11 Save and print the configuration

1. In the application, click **APPLY CHANGES**: the sensors will save the inclination set and the surrounding environment. The application will transfer the configuration to the controller, and once transfer is complete it will generate a configuration report.
2. Click to save and print the report.

   Note: to save the PDF, a printer must be installed on the computer.

3. Ask the authorized person for a signature.

7.2.12 Set the controller Ethernet parameters

1. Ensure the controller is turned on.
2. Press the Network parameter reset button and hold it down during steps 3 and 4.
3. Wait for five seconds.
4. Wait until all the six LEDs on the controller turns steady green: the Ethernet parameters are set to their default values (see Ethernet connection (if available) on page 93).
5. Configure the controller again.

7.3 Validate the safety functions

7.3.1 Validation

Once the system has been installed and configured, check that the safety functions are activated/deactivated as expected and that the dangerous area is monitored by the system.

WARNING
The LBK Designer application facilitates installation and configuration of the system, but the validation process described below is still required.

7.3.2 Validate the access detection function

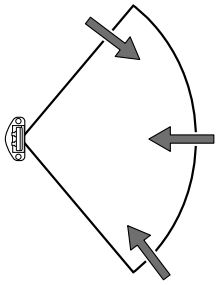
Example 1

Starting conditions	• **Detection field dependency**: **Dependent mode** • All the safety outputs activated
Validation procedure	1. Access the first detection field . 2. Check that the system deactivates the safety output related to this detection field and to the following fields (see Validate the system with LBK Designer on page 72). 3. Move inside the area and check that the target position moves in the LBK Designer app. 4. Repeat step 1 and 3 for each detection field . 5. If the safety outputs are not deactivated (see Troubleshooting validation on page 72).
Specifications	• Access from several points with particular attention to the side areas of the field of view and the limit areas (e.g. intersection with any side guards), see Example of access points on the next page. • Access standing as well as crawling. • Access moving slowly and quickly.

Example 2

Starting conditions	• **Detection field dependency**: **Independent mode** • All the safety outputs activated
Validation procedure	1. Access the first detection field . 2. Check that the system deactivates only the safety output related to this detection field (see Validate the system with LBK Designer on page 72). 3. Move inside the area and check that the target position moves in the LBK Designer app. 4. Repeat step 1 and 3 for each detection field . 5. If the safety outputs are not deactivated (see Troubleshooting validation on page 72).
Specifications	• Access from several points with particular attention to the side areas of the field of view and the limit areas (e.g. intersection with any side guards), see Example of access points on the next page. • Access standing as well as crawling. • Access moving slowly and quickly.

7.3.3 Example of access points



Access points for 100° field of view

7.3.4 Validate the restart prevention function

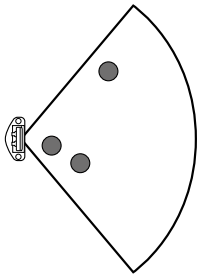
Example 1

Starting conditions	• **Detection field dependency**: **Dependent mode** • Machinery in safe conditions • Two detection fields configured (detection field 1 and detection field 2) • Both the safety outputs (detection signal 1 and detection signal 2) deactivated
Validation procedure	1. Stand still in detection field 1. 2. Check that the system maintains both related safety outputs deactivated (see Validate the system with LBK Designer on the next page). 3. Stand still in detection field 2. 4. Check that the system maintains only the second safety output deactivated (see Validate the system with LBK Designer on the next page). 5. If the safety outputs do not remain deactivated (see Troubleshooting validation on the next page).
Specifications	• Stop longer than the restart timeout (LBK Designer > **Configuration**). • Stop in several different points, with special attention to the areas in close proximity to the sensor and any blind spots (see Example of stopping points on the next page). • Stop standing as well as laid down.

Example 2

Starting conditions	• **Detection field dependency**: **Independent mode** • Machinery in safe conditions • Two detection fields configured (detection field 1 and detection field 2) • Both the safety outputs (detection signal 1 and detection signal 2) deactivated
Validation procedure	1. Stand still in detection field 1. 2. Check that the system maintains only the specific safety output deactivated (see Validate the system with LBK Designer on the next page). 3. Repeat step 1 and 2 for detection field 2. 4. If the safety outputs do not remain deactivated (see Troubleshooting validation on the next page).

7.3.5 Example of stopping points



Stopping points for 100° field of view

7.3.6 Validate the system with LBK Designer

⚠ WARNING

When the validation function is active, the system response time is not guaranteed.

The LBK Designer application is helpful during the safety functions validation phase and allows the actual field of view of the sensors to be checked based on their installation position.

1. Click **Validation**: the validation starts automatically.
2. Move in the monitored area as indicated in Validate the access detection function on page 70 and Validate the restart prevention function on the previous page.
3. Check that the sensor behaves as expected.

   Note: if the static object detection option is enabled, the empty dot represents a moving target, and the full dot represents a static target.

4. Check that the distance and the angle where the motion is detected are the expected values.

7.3.7 Troubleshooting validation

Cause	Solution
Presence of objects obstructing the field of view	If possible, remove the object. Otherwise, implement additional safety measures in the area where the object is present.
Position of sensors	Position the sensors to ensure that the monitored area is adequate for the dangerous area (see Sensor position on page 52).
Inclination and installation height of one or more sensors	1. Change the inclination and installation height of the sensors to ensure that the monitored area is adequate for the dangerous area, (see Sensor position on page 52). 2. Note or update the inclination and installation height of the sensors in the printed configuration report.
Only with the static object detection option enabled, inadequate restart timeout	Change the restart timeout through the LBK Designer application (**Configuration** > select the affected sensor and detection field)

7.4 Manage the configuration

7.4.1 Configuration checksums

In the LBK Designer application in **Settings** > **Configuration checksums**, it is possible to consult:

- the configuration report hash, a unique alphanumeric code associated with a report. It is computed considering the entire configuration, plus the time of the commit and the name of the computer which did it.
- dynamic configuration checksum, associated with a specific dynamic configuration. It considers both common and dynamic parameters.

7.4.2 Configuration reports

After changing the configuration, the system generates a configuration report with the following information:

- configuration data
- unique hash
- date and time of configuration change
- name of computer in which the change was inserted

The reports are documents that cannot be changed and can only be printed and signed by the machinery safety manager.

Note: to save the PDF, a printer must be installed on the computer.

7.4.3 Change the configuration

⚠ WARNING	
	The system is disabled during configuration. Prepare opportune safety measures in the dangerous area protected by the system before configuring the system.

1. Start the LBK Designer application.
2. Click **User** and enter the admin password.

   Note: after five wrong password entries, application authentication is blocked for one minute.

3. Depending on what you want to change, follow the instructions below:

To change...	Then...
Monitored area and sensors configuration	Click **Configuration**
Node ID	Click **Settings** > **Node ID Assignment**
Function of inputs and outputs	Click **Settings** > **Digital Input-Output**
Muting	Click **Settings** > **Muting**
Sensor inclination	Loosen the side screws on the sensor and orient the sensors to the desired inclination.
Sensor number and positioning	Click **Configuration**

4. Click **APPLY CHANGES**.
5. Upon conclusion of transfer of the configuration to the controller, click to print the report.

   Note: to save the PDF, a printer must be installed on the computer.

7.4.4 Back up the configuration

The current configuration can be backed up, including the input/output settings. The configuration is saved in a .cfg file, which can be used to restore the configuration or to facilitate configuration of several LBK SBV System.

1. In **Settings** > **General**, click **BACKUP**.
2. Select the file destination and save.

7.4.5 Load a configuration

1. In **Settings** > **General**, click **RESTORE**.
2. Select the previously saved .cfg file (see Back up the configuration above) and open it.

Note: a re-imported configuration requires new downloading onto the controller and approval according to the safety plan.

7.4.6 Display previous configurations

In **Settings**, click **Activity History** and then click **Configuration reports page**: the reports archive opens.

In **Configuration** click .

7.5 Other functions

7.5.1 Change language

1. Click .
2. Select the desired language. The language changes automatically.

7.5.2 Application type selection

In **Settings** > **General** > **Application type selection**.

7.5.3 Locate the area with detected motion

Click **Validation**: the area with detected motion turns red. The detection position appears on the left.

7.5.4 Restore factory default settings

In **Settings** > **General** click **FACTORY RESET**: the configuration parameters are restored to the default settings and the admin password is reset.

⚠ WARNING	
⚠	The factory configuration is not a valid configuration. Therefore, the system goes into an alarm status. The configuration must be validated, and if necessary modified, through the LBK Designer application by clicking APPLY CHANGES.

For the default values of the parameters, see Configuration application parameters on page 106.

7.5.5 Identify a sensor

In **Settings** > **Node ID Assignment** or **Configuration**, click **Identify** near the desired sensor Node ID: the LED on the sensor flashes for 5 seconds.

7.5.6 Change network parameters

In **Settings** > **Network Parameters** change the IP address, the netmask and the gateway of the controller as desired.

7.5.7 Change Modbus parameters

In **Settings** > **MODBUS Parameters** enable/disable the Modbus communication and modify the listening port.

7.5.8 Change Fieldbus parameters

In **Settings** > **Fieldbus Parameters** change the F-addresses and the Fieldbus Endianness of the controller.

7.5.9 Set labels

In **Settings** > **Labels** choose the desired labels for the controller and the sensors.

8 Maintenance and troubleshooting

Machinery maintenance technician

The machinery maintenance technician is a qualified person, with the administrator privileges required to modify the configuration of LBK SBV System through the software and to perform maintenance.

8.1 Troubleshooting

8.1.1 Controller LED

LED	Status	LBK Designer application messages	Problem	Solution
S1*	Steady red	CONTROLLER POWER ERROR	At least one voltage value on the controller is wrong	If at least one digital input is connected, check that the SNS input and the GND input are connected. Check that the input power supply is the specified type (see General specifications on page 92).
S2	Steady red	CONTROLLER TEMPERATURE ERROR	Controller temperature value is wrong	Check that the system is operating at the correct operating temperature (see General specifications on page 92).
S3	Steady red	OSSD ERROR or INPUT REDUNDANCY ERROR	At least one input or output is in error	If at least one input is used, check that both the channels are connected and that there is no short circuit on the outputs. If the problem persists, please contact Technical Support.
S4	Steady red	PERIPHERAL ERROR	At least one of the controller peripherals is in error	Check the status of the terminal block and connections. If the problem persists, please contact Technical Support.
S5	Steady red	CAN ERROR	Communication error with at least one sensor	Check connections of all sensors in the chain starting from the last sensor in error. Check that all the sensors have an assigned ID (in LBK Designer **Settings** > **Node ID Assignment**). Check that the firmware of the controller and sensors are updated to the compatible versions.

LED	Status	LBK Designer application messages	Problem	Solution
S6	Steady red	FEE ERROR, FLASH ERROR or RAM ERROR	Configuration saving error, configuration not performed or memory error	Reconfigure or configure the system (see Manage the configuration on page 73). If the error persists, please contact Technical Support.
S1–S6 together	Steady red	FIELDBUS ERROR	Communication error on the Fieldbus	At least one input or output is configured as **Fieldbus controlled**. Check that the cable is correctly connected, communication with the host is correctly established, watchdog timeout is configured correctly, and exchanged data are not maintained passivated.
S1–S5 together	Steady red	DYNAMIC CONFIGURATION ERROR	Error in the selection of the dynamic configuration: invalid ID	Check the preset configurations within the LBK Designer application.
S1–S4 together	Steady red	SENSOR CONFIGURATION ERROR	Error during the configuration of the sensors	Check the sensors connected and try again to perform the configuration of the system via the LBK Designer application. Check that the firmware of the controller and sensors are updated to compatible versions.
At least one LED	Flashing red	See Sensor LED on the next page	Sensor corresponding to the flashing LED in error ** (seeSensor LED on the next page)	Check the problem through the LED on the sensor.
At least one LED	Flashing green	See Sensor LED on the next page	Sensor corresponding to the flashing LED in error ** (seeSensor LED on the next page)	If the issue persists longer than one minute, please contact Technical Support.
All the LEDs	Steady orange	-	The system is starting up.	Wait for a few seconds.
All the LEDs	Flashing green one after the other in sequence	-	The controller is in boot state.	Open the latest available version of the LBK Designer application, connect to the device and proceed with the automatic recovery procedure. If the issue persists, please contact Technical Support.

LED	Status	LBK Designer application messages	Problem	Solution
All LEDs	Off	In **Dashboard** > **System status** ⚠ icons	Configuration not yet applied to the controller.	Configure the system.
All LEDs	Off	Progress icon	Configuration transfer to the controller in progress.	Wait for the transfer to be completed.

Note: fault signal on the controller (steady LED) takes priority over a faulty sensor signal. For the status of the single sensor, check the sensor LED.

Note*: S1 is the first from the top.

Note**: S1 corresponds to the sensor with ID 1, S2 corresponds to the sensor with ID 2 and so on.

8.1.2 Sensor LED

Status	LBK Designer application messages	Problem	Solution
Steady purple	-	Sensor in boot state	Contact Technical Support.
Flashing purple *	-	Sensor receiving a firmware update	Wait for the update to be completed without disconnecting the sensor.
Flashing red. Two flashes followed by a pause **	CAN ERROR	Sensor without a valid identifier assigned	Assign a Node ID to the sensor (see Connect the controller to the sensors on page 68).
Flashing red. Three flashes followed by a pause **	CAN ERROR	Sensor does not receive valid messages from the controller	Verify the connection of all the sensors in the chain and check that the number of sensors configured in the LBK Designer application is equal to the number of the sensors physically connected
Flashing red. Four flashes followed by a pause **	SENSOR TEMPERATURE ERROR or SENSOR POWER ERROR	Sensor in temperature error or is receiving an incorrect supply voltage	Check the sensor connection and that the cable length is within the maximum limits. Verify that the temperature of the environment in which the system is operating conforms to the operating temperatures listed in the technical data in this manual.

Status	LBK Designer application messages	Problem	Solution
Flashing red. Five flashes followed by a pause **	MASKING, SIGNAL PATTERN ERROR	Sensor detected a masking (tampering) or there are radar signal errors	Not available if the sensor is in muting. Check that the sensor is installed correctly and that the area is clear of objects that obstruct the sensor's field of view.
	MASKING REFERENCE MISSING	Sensor is not able to save the monitored area reference for occlusion	Repeat the system configuration making sure no movement is present inside the monitored area
	MSS ERROR/DSS ERROR	Error detected by diagnostics relative to the internal micro-controllers (MSS and DSS), their internal peripherals or memories	If the issue persists, please contact Technical Support.
Flashing red. Six flashes followed by a pause **	TAMPER ERROR	Sensor detected a variation in rotation around the axes (tampering)	Not available if the sensor is in muting. Check if the sensor has been tampered with or if the side or mounting screws have loosened.

Note *: flashes at 100 ms intervals without pause

Note **: flashes at 200 ms intervals and then with a 2 s pause.

8.1.3 Other problems

Problem	Cause	Solution
Undesired alarms	Transit of people or objects in close proximity to the detection field	Change the configuration (see Change the configuration on page 73).
Machinery in safe status without motion in the detection field	No power supply	Check electrical connection. Contact Technical Support if necessary.
	Failure of the controller or one or more sensors	Check the status of the LEDs on the controller (see Controller LED on page 76). Access the application LBK Designer, on the **Dashboard** page, mouse-over on ⊗ in correspondence with the controller or the sensor.
The voltage value detected on the SNS input is zero	The chip that detects inputs is faulty	Contact Technical Support.

Problem	Cause	Solution
The system does not function correctly	Controller error	Check the status of the LEDs on the controller (see Controller LED on page 76). Access the application LBK Designer, on the **Dashboard** page, mouse-over on ⊗ in correspondence with the controller or the sensor.
	Sensor error	Check the status of the LEDs on the sensor (see Sensor LED on page 78). Access the application LBK Designer, on the **Dashboard** page, mouse-over on ⊗ in correspondence with the controller or the sensor.

8.2 Event log management

8.2.1 Introduction

The event log recorded by the system can be downloaded from the LBK Designer application in a PDF file. The system saves up to 4500 events, divided in two sections. In each section the events are displayed from the most recent to the least recent. Above this limit, the oldest events are overwritten.

8.2.2 Download the system log

1. Start the LBK Designer application.
2. Click **Settings** and then **Activity History**.
3. Click **DOWNLOAD LOG**.

Note: to save the PDF, a printer must be installed on the computer.

8.2.3 Log file sections

The first line of the file reports the NID (Network ID) of the device and the date of the download.

The rest of the file log is divided in two sections:

Section	Description	Content	Size	Reset
1	Event log	Information events Error events	3500	At every firmware update or on demand using the LBK Designer application
2	Diagnostic event log	Error events	1000	Not possible

8.2.4 Log line structure

Each line in the log file reports the following information, separated by tab character:

- Timestamp (seconds counter from the latest boot)
- Timestamp (absolute/relative value)
- Event type:
  - [ERROR]= diagnostic event
  - [INFO]= information event
- Source
  - CONTROLLER = if the event is generated by the controller
  - SENSOR ID = if the event is generated by a sensor. In this case is provided also the node ID of the sensor.
- Event description

8.2.5 Timestamp (seconds counter from the latest boot)

An indication of the instant when the event occurred is provided as relative time from the latest boot, in seconds.

Example: 92

Meaning: the event occurred 92 seconds after the latest boot

8.2.6 Timestamp (absolute/relative value)

An indication of the instant when the event occurred is provided.

- After a new system configuration, it is provided as absolute time.

  Format: *YYYY/MM/DD hh:mm:ss*

  Example: 2020/06/05 23:53:44

- After a reboot of the device, it is provided as relative time from the latest boot.

  Format: *Rel. x d hh:mm:ss*

  Example: Rel. 0 d 00:01:32

Note: when a new system configuration is performed, even the older timestamps are updated in absolute time format.

Note: during system configuration, the controller is receiving the local time of the machine where the software is running.

8.2.7 Event description

A complete description of the event is reported. Whenever possible, depending on the event, additional parameters are reported.

In case of a diagnostic event, an internal error code is also added, useful for the purpose of debug. If the diagnostic event disappears, the label “(Disappearing)” is reported as an additional parameter.

Examples

Detection access (field #3, 1300 mm/40°)

System configuration #15

CAN ERROR (Code: 0x0010) COMMUNICATION LOST

CAN ERROR (disappearing)

8.2.8 Log file example

Event logs of ISC NID UP304 updated 2020/11/18 16:59:56

[Section 1 - Event logs]

380 2020/11/18 16:53:49 [ERROR] SENSOR#1 CAN ERROR (Disappearing)

375 2020/11/18 16:53:44 [ERROR] SENSOR#1 CAN ERROR (Code: 0x0010) COMMUNICATION LOST

356 2020/11/18 16:53:25 [INFO] CONTROLLER System configuration #16

30 2020/11/18 16:53:52 [ERROR] SENSOR#1 ACCELEROMETER ERROR (Disappearing)

27 2020/11/18 16:47:56 [ERROR] SENSOR#1 ACCELEROMETER ERROR (Code: 0x0010) TILT ANGLE ERROR

5 2020/11/18 16:47:30 [ERROR] SENSOR#1 Signal error (Code: 0x0012) MASKING

0 2020/11/18 16:47:25 [INFO] CONTROLLER Dynamic configuration #1

0 2020/11/18 16:47:25 [INFO] CONTROLLER System Boot #60

92 Rel. 0 d 00:01:32 [INFO] CONTROLLER Detection exit (field #2)

90 Rel. 0 d 00:01:30 [INFO] CONTROLLER Detection exit (field #1)

70 Rel. 0 d 00:01:10 [INFO] SENSOR#1 Detection access (field #2, 3100 mm/20°)

61 Rel. 0 d 00:01:01 [INFO] SENSOR#1 Detection access (field #1, 1200 mm/30°)

0 Rel. 0 d 00:00:00 [INFO] CONTROLLER Dynamic configuration #1

0 0 d 00:00:00 [INFO] CONTROLLER System Boot #61

[Section 2 - Diagnostic events log]

380 Rel. 0 d 00:06:20 [ERROR] SENSOR #1 CAN ERROR (Disappearing)

375 Rel. 0 d 00:06:15 [ERROR] SENSOR #1 CAN ERROR (Code: 0x0010) COMMUNICATION LOST

356 Rel. 0 d 00:05:56 [INFO] CONTROLLER System configuration #16

30 Rel. 0 d 00:00:30 [ERROR] SENSOR #1 ACCELEROMETER ERROR (Disappearing)

27 Rel. 0 d 00:00:27 [ERROR] SENSOR #1 ACCELEROMETER ERROR (Code: 0x0012) TILT ANGLE ERROR

5 Rel. 0 d 00:00:05 [ERROR] SENSOR #1 Signal error (Code: 0x0014) MASKING

8.2.9 Event list

The event logs are listed below:

Event	Type
Diagnostic errors	ERROR
System Boot	INFO
System configuration	INFO
Factory reset	INFO
Stop signal	INFO
Restart signal	INFO
Detection access	INFO
Detection exit	INFO
Dynamic configuration in use	INFO

Event	Type
Muting status	INFO
Fieldbus connection	INFO
MODBUS connection	INFO
Session authentication	INFO
Validation	INFO
Log download	INFO

For further information about the events, see INFO events on the next page and ERROR events (controller) on page 87.

8.2.10 Verbosity level

There are six verbosity levels for the log. The verbosity can be set during the configuration of the system via the LBK Designer application (**Settings** > **Activity History** > **Log verbosity level**).

Depending on the selected verbosity level, the events are logged in accordance to the following table:

Event	Level 0 (default)	Level 1	Level 2	Level 3	Level 4	Level 5
Diagnostic errors	x	x	x	x	x	x
System Boot	x	x	x	x	x	x
System configuration	x	x	x	x	x	x
Factory reset	x	x	x	x	x	x
Stop signal	x	x	x	x	x	x
Restart signal	x	x	x	x	x	x
Detection access	-	See Verbosity level for detection access and exit events below				
Detection exit	-	See Verbosity level for detection access and exit events below				
Dynamic configuration in use	-	-	-	-	x	x
Muting status	-	-	-	-	-	x

8.2.11 Verbosity level for detection access and exit events

Depending on the selected verbosity level, the detection access and exit events are logged as follows:

- LEVEL 0: no detection info is logged
- LEVEL 1: the events are logged at controller level and the additional information are the detection distance (in mm) and the detection angle (in °) in detection access.

  Format:

  CONTROLLER Detection access (distance mm/azimuth°)

  CONTROLLER Detection exit

- LEVEL 2: the events are logged in a single field at controller level and the additional information are: detection field, detection distance (in mm) and detection angle (in °) in access, and detection field at exit.

  Format:

  CONTROLLER Detection access (field #n, distance mm/azimuth°)

  CONTROLLER Detection exit (field #n)

- LEVEL 3 / LEVEL 4 / LEVEL 5 The events are logged:
  - in a single field at controller level and the additional information are: detection field, detection distance (in mm) and detection angle (in °) in access, and detection field at exit;
  - at sensor level and the additional information read by the sensor are: detection distance (in mm) and detection angle (in °) in access, and detection field at exit.

Format:

CONTROLLER #k Detection access (field #n, distance mm/azimuth°)

SENSOR #k Detection access (distance mm/azimuth°)

CONTROLLER Detection exit (field #n)

SENSOR #k Detection exit

8.3 INFO events

8.3.1 System Boot

Every time the system is powered up, the event is logged reporting the incremental count of the boot from the beginning of the life of the device.

Format: *System Boot #n*

Example:

0 2020/11/18 16:47:25 [INFO] CONTROLLER SYSTEM BOOT #60

8.3.2 System configuration

Every time the system is configured, the event is logged reporting the incremental count of the configuration from the beginning of the life of the device.

Format: *System configuration #3*

Example:

20 2020/11/18 16:47:25 [INFO] CONTROLLER System configuration #3

8.3.3 Factory reset

Every time a factory reset is required, the event is logged.

Format: *Factory reset*

Example:

20 2020/11/18 16:47:25 [INFO] CONTROLLER Factory reset

8.3.4 Stop signal

If configured, every change of the Stop Signal is logged as ACTIVATION or DEACTIVATION.

Format: *Stop signal ACTIVATION/DEACTIVATION*

Example:

20 2020/11/18 16:47:25 [INFO] CONTROLLER Stop signal ACTIVATION

8.3.5 Restart signal

If configured, every time the system is waiting for the restart signal or the restart signal is received, the event is logged as WAITING or RECEIVED.

Format: *Restart signal WAITING/RECEIVED*

Example:

20 2020/11/18 16:47:25 [INFO] CONTROLLER Restart signal RECEIVED

8.3.6 Detection access

Every time motion is detected, a detection access is logged with additional parameters depending on the selected verbosity level: the detection field number, the sensor which detected the motion, the detection distance (in mm) and the detection angle (°) (see Verbosity level for detection access and exit events on page 83).

Format: *Detection access (field #n, distance mm/azimuth°)*

Example:

20 2020/11/18 16:47:25 [INFO] SENSOR #1 Detection access (field #1, 1200 mm/30°)

8.3.7 Detection exit

After at least one detection access event, a detection exit event related to the same field is logged when the detection signal returns to its default no-motion status.

Depending on the selected verbosity level additional parameters are logged: the detection field number, the sensor which detected the motion.

Format: *Detection exit (field #n)*

Example:

20 2020/11/18 16:47:25 [INFO] CONTROLLER Detection exit (field #1)

8.3.8 Dynamic configuration in use

At every change of the dynamic configuration, the new ID of the dynamic configuration selected is logged.

Format: *Dynamic configuration #1*

Example:

20 2020/11/18 16:47:25 [INFO] CONTROLLER Dynamic configuration #1

8.3.9 Muting status

Every change of the muting status of each sensor is logged as disabled or enabled.

Note: the event indicates a change of the muting status of the system. It does not correspond to the muting request.

Format: *Muting disabled/enabled*

Example:

20 2020/11/18 16:47:25 [INFO] SENSOR#1 Muting enabled

8.3.10 Fieldbus connection

The Fieldbus communication status is logged as CONNECTED, DISCONNECTED or FAULT.

Format: *Fieldbus connection CONNECTED/DISCONNECTED/FAULT*

Example:

20 2020/11/18 16:47:25 [INFO] CONTROLLER Fieldbus connection CONNECTED

8.3.11 MODBUS connection

The MODBUS communication status is logged as CONNECTED or DISCONNECTED.

Format: *MODBUS connection CONNECTED/DISCONNECTED*

Example:

20 2020/11/18 16:47:25 [INFO] CONTROLLER MODBUS connection CONNECTED

8.3.12 Session authentication

The status of the session authentication and the interface used (USB/ETH) are logged.

Format: *Session OPEN/CLOSE/WRONG PASSWORD/UNSET PASSWORD/TIMEOUT/CHANGE PASSWORD via USB/ETH*

Example:

20 2020/11/18 16:47:25 [INFO] CONTROLLER Session OPEN via USB

8.3.13 Validation

Every time a validation activity starts or ends on the device, it is logged. The interface used (USB/ETH) is logged as well.

Format: *Validation STARTED/ENDED via USB/ETH*

Example:

20 2020/11/18 16:47:25 [INFO] CONTROLLER Validation STARTED via USB

8.3.14 Log download

Every time a log download is performed on the device, it is logged. The interface used (USB/ETH) is logged as well.

Format: *Log download via USB/ETH*

Example:

20 2020/11/18 16:47:25 [INFO] CONTROLLER Log download via USB

8.4 ERROR events (controller)

8.4.1 Introduction

A diagnostic error is logged every time the periodic diagnostic functions detect a coming or going fault on the controller.

8.4.2 Temperature errors (TEMPERATURE ERROR)

Error	Meaning
BOARD TEMPERATURE TOO LOW	Board temperature below minimum
BOARD TEMPERATURE TOO HIGH	Board temperature above maximum

8.4.3 Controller voltage errors (POWER ERROR)

Error	Meaning
Controller voltage UNDERVOLTAGE	Undervoltage error for the indicated voltage
Controller voltage OVERVOLTAGE	Overvoltage error for the indicated voltage
ADC CONVERSION ERROR	ADC conversion error in the micro-controller

The following table describes the controller voltage:

Screen printing	Description
VIN	Power supply voltage (+24 V DC)
V12	Internal supply voltage
V12 sensors	Sensors power supply voltage
VUSB	USB port voltage
VREF	Inputs reference voltage (**VSNS Error**)
ADC	Analog-digital converter

8.4.4 Peripheral error (PERIPHERAL ERROR)

Error detected by diagnostics relative to the micro-controller, its internal peripherals or memories.

8.4.5 Configuration errors (FEE ERROR)

Indicates that the system must still be configured. This message can appear when the system is first turned on or after reset to default values. It can also represent another error on the FEE (internal memory).

8.4.6 Output errors (OSSD ERROR)

Error	Meaning
OSSD 1 SHORT CIRCUIT	Short-circuit error on MOS output 1
OSSD 2 SHORT CIRCUIT	Short-circuit error on MOS output 2
OSSD 3 SHORT CIRCUIT	Short-circuit error on MOS output 3
OSSD 4 SHORT CIRCUIT	Short-circuit error on MOS output 4

8.4.7 Flash errors (FLASH ERROR)

A flash error represents an error on the external flash.

8.4.8 Dynamic configuration error (DYNAMIC CONFIGURATION ERROR)

A dynamic configuration error indicates an invalid dynamic configuration ID.

8.4.9 Internal communication error (INTERNAL COMMUNICATION ERROR)

Indicates that there is an internal communication error.

8.4.10 Input redundancy error (INPUT REDUNDANCY ERROR)

Error	Meaning
INPUT 1	Error in the redundancy on Input 1
INPUT 2	Error in the redundancy on Input 2

8.4.11 Fieldbus error (FIELDBUS ERROR)

At least, one of the inputs and outputs has been configured as “Fieldbus controlled”, but the fieldbus communication is not established or not valid.

Error	Meaning
NOT VALID COMMUNICATION	Error on the Fieldbus

8.4.12 RAM error (RAM ERROR)

Error	Meaning
INTEGRITY ERROR	Wrong integrity check on the RAM

8.4.13 Sensor configuration errors (SENSOR CONFIGURATION ERROR)

Error occurred on the sensors during the configuration process or at the system power up. At least one of the connected sensors did not get the correct configuration.

As details, the list of sensors not configured is reported.

8.5 ERROR events (sensor)

8.5.1 Introduction

A diagnostic error is logged every time the periodic diagnostic functions detect a coming or going fault on the LBK SBV-01 sensor.

8.5.2 Misconfiguration error (MISCONFIGURATION ERROR)

The misconfiguration error occurs when the sensor does not have a valid configuration or it has received an invalid configuration from the controller.

8.5.3 Status error and fault (STATUS ERROR/FAULT ERROR)

The status error occurs when the sensor is in an internal invalid status or it has reached an internal fault condition.

8.5.4 Protocol error (PROTOCOL ERROR)

The protocol error occurs when the sensor receives commands with an unknown format.

8.5.5 Sensor voltage errors (POWER ERROR)

Error	Meaning
Sensor voltage **UNDERVOLTAGE**	Undervoltage error for the indicated voltage
Sensor voltage **OVERVOLTAGE**	Overvoltage error for the indicated voltage

The following table describes the sensor voltage:

Screen printing	Description
VIN	Power supply voltage (+12 V DC)
V3.3	Internal chip power supply voltage
V1.2	Micro-controller power supply voltage
V1.8	Internal chip power supply voltage (1.8 V)
V1	Internal chip power supply voltage (1 V)

8.5.6 Anti-tampering sensor (TAMPER ERROR)

Error	Meaning
TILT ANGLE ERROR	Sensor rotation around the x-axis
ROLL ANGLE ERROR	Sensor rotation around the z-axis
PAN ANGLE ERROR	Sensor rotation around the y-axis

Note: the information of the angle (in degrees) is reported.

8.5.7 Signal error (SIGNAL ERROR)

The signal error occurs when the sensor detected an error in the RF signals part, in particular:

Error	Meaning
MASKING	The sensor is obstructed
MASKING REFERENCE MISSING	During the configuration process, it was not possible to get the masking reference
SIGNAL PATTERN ERROR	Radar internal fault or unexpected signal pattern

8.5.8 Temperature errors (TEMPERATURE ERROR)

Error	Meaning
BOARD TEMPERATURE TOO LOW	Board temperature below minimum
BOARD TEMPERATURE TOO HIGH	Board temperature above maximum
CHIP TEMPERATURE TOO LOW	Internal chip below minimum
CHIP TEMPERATURE TOO HIGH	Internal chip above maximum
IMU TEMPERATURE TOO LOW	IMU below minimum
IMU TEMPERATURE TOO HIGH	IMU above maximum

8.5.9 MSS error and DSS error (MSS ERROR/DSS ERROR)

Error detected by diagnostics relative to the internal micro-controllers (MSS and DSS), their internal peripherals or memories

8.6 ERROR events (CAN bus)

8.6.1 Introduction

A diagnostic error is logged every time the periodic diagnostic functions detect a coming or going fault on the CAN bus communication.

Depending on the communication bus side, the logged source can be the controller or a single sensor.

8.6.2 CAN errors (CAN ERROR)

Error	Meaning
TIMEOUT	Timeout on message to sensor/controller
CROSS CHECK	Two redundant messages do not coincide
SEQUENCE NUMBER	Message with sequence number different from the expected number
CRC CHECK	Packet control code does not match
COMMUNICATION LOST	Impossible to communicate with the sensor
PROTOCOL ERROR	Controller and sensors have different and incompatible firmware versions
POLLING TIMEOUT	Timeout on data polling

8.7 Cleaning and spare parts

8.7.1 Cleaning

Keep the sensor clean and free of any work residues and conductive material to prevent masking and/or poor system operation.

8.7.2 Spare parts

Part	Product code
Sensor	LBK SBV-01
Controller	LBK ISC BUS PS, LBK ISC-02, LBK ISC-03

9 Technical references

9.1 Technical data

9.1.1 General specifications

Detection method	Motion detection algorithm based on FMCW radar
Frequency	Working band: 60.6–62.8 GHz Maximum radiated power: 16 dBm mean EIRP Modulation: FMCW
Detection interval	From 0 to 5 m (from 0 to 16.4 ft), depending on the installation conditions.
Detectable target RCS	0.17 m^2
Field of view	Programmable: from 10° to 100° horizontal plane and 20° vertical plane.
Decision probability	> 1-(2.5E-07)
CRT (Certified Restart Timeout)	4 s
Guaranteed response time	< 100 ms
Total consumption	Max. 33.2 W (controller and six sensors)
Electrical protections	Polarity inversion Overcurrent through resettable integrated fuse (max. 5 s @ 8 A)
Overvoltage category	II
Altitude	Max. 1500 m ASL
Air humidity	Max. 95%
Noise emission	Negligible

9.1.2 Safety parameters

SIL (Safety Integrity Level)	2
HFT	0
SC*	2
TYPE	B
PL (Performance Level)	d
ESPE Type (EN 61496-1)	3
Category (EN ISO 13849)	3 equivalent for LBK SBV-01, LBK ISC BUS PS, LBK ISC-02 and LBK ISC-03
Class (IEC TS 62998-1)	D
Communication protocol (sensors-controller)	CAN complies with standard EN 50325-5
Mission time	20 years
$MTTF_D$	38 years
PFH_D	With PROFINET/PROFIsafe communication: • Access detection: 1.66E-08 [1/h] • Restart prevention: 1.66E-08 [1/h] • Muting: 6.13E-09 [1/h] • Stop signal: 6.14E-09 [1/h] • Restart signal: 6.14E-09 [1/h] Without PROFINET/PROFIsafe communication: • Access detection: 1.56E-08 [1/h] • Restart prevention: 1.56E-08 [1/h] • Muting: 5.13E-09 [1/h] • Stop signal: 5.14E-09 [1/h] • Restart signal: 5.14E-09 [1/h]
SFF	≥ 99.89%
DCavg	≥ 99.48%

MRT**	< 10 min
Safe state when a fault occurs	At least one OSSD is in OFF-state. Stop message sent on fieldbus (if available) or communication interrupted

Note*: the systematic capability is guaranteed only if the user uses the product according to the instructions of this manual and uses the product in the appropriate environment.

Note**: the MRT considered is the Technical Mean Repair Time, i.e. it takes in consideration availability of skilled personnel, adequate tools and spare parts. Considering the type of device, the MRT corresponds to the time necessary for the device replacement.

9.1.3 Ethernet connection (if available)

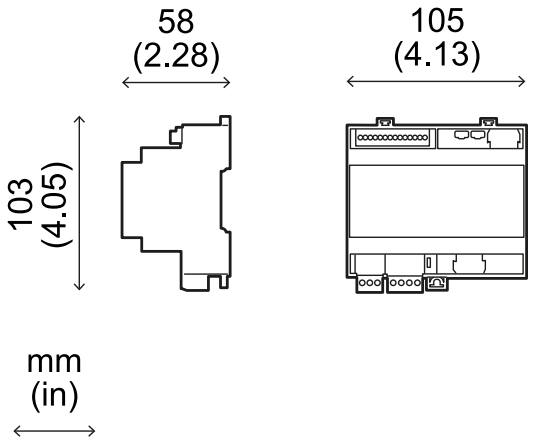
Default IP address	192.168.0.20
Default TCP port	80
Default netmask	255.255.255.0
Default gateway	192.168.0.1

9.1.4 Controller features

Outputs	Configurable as follows: • 4 Output Signal Switching Devices (OSSDs) (used as single channels) • 2 dual channel safety outputs • 1 dual channel safety output and 2 Output Signal Switching Devices (OSSDs)
OSSD characteristic	• Maximum resistive load: 100 K Ω • Minimum resistive load: 70 Ω • Maximum capacitive load: 1000 nF • Minimum capacitive load: 10 nF
Safety outputs	High-side outputs (with extended protection function) • Maximum current: 0.4 A • Maximum power: 12 W The OSSDs provide what follows: • ON-state: from Uv-1V to Uv (Uv = 24V +/- 4V) • OFF-state: from 0 V to 2.5 V r.m.s.
Inputs	2 dual channel type 3 digital inputs with common GND See Voltage and current limits for digital inputs on page 97.
Fieldbus interface (if available)	Ethernet based interface with different standard Fieldbus (e.g. PROFIsafe)
Power supply	24 V DC (20–28 V DC) * Maximum current: 1 A
Consumption	Max. 5 W
Assembly	On DIN rail
Weight	with cover: 170 g (6 oz)
Degree of protection	IP20
Terminals	Section: 1 mm^2 (16 AWG) max. Maximum current: 4 A with 1 mm^2 cables (16 AWG)
Impact test	0.5 J, 0.25 kg ball from a 20 cm height
Shock/Bump	10 g, 1000 times for X, Y, and Z directions (IEC 60068-2-27)
Vibration	10-55 Hz double-amplitude of 0.7 mm (0.3 in), 20 sweeps in the X, Y and Z directions (IEC 60068-2-6)
Pollution degree	2
Outdoor use	No
Operating temperature	From -30 to +60 °C (from -22 to +140 °F)
Storage temperature	From -40 to +80 °C (from -40 to +176 °F)

Note*: the unit shall be supplied by an isolated power source which fulfils the requirements of:

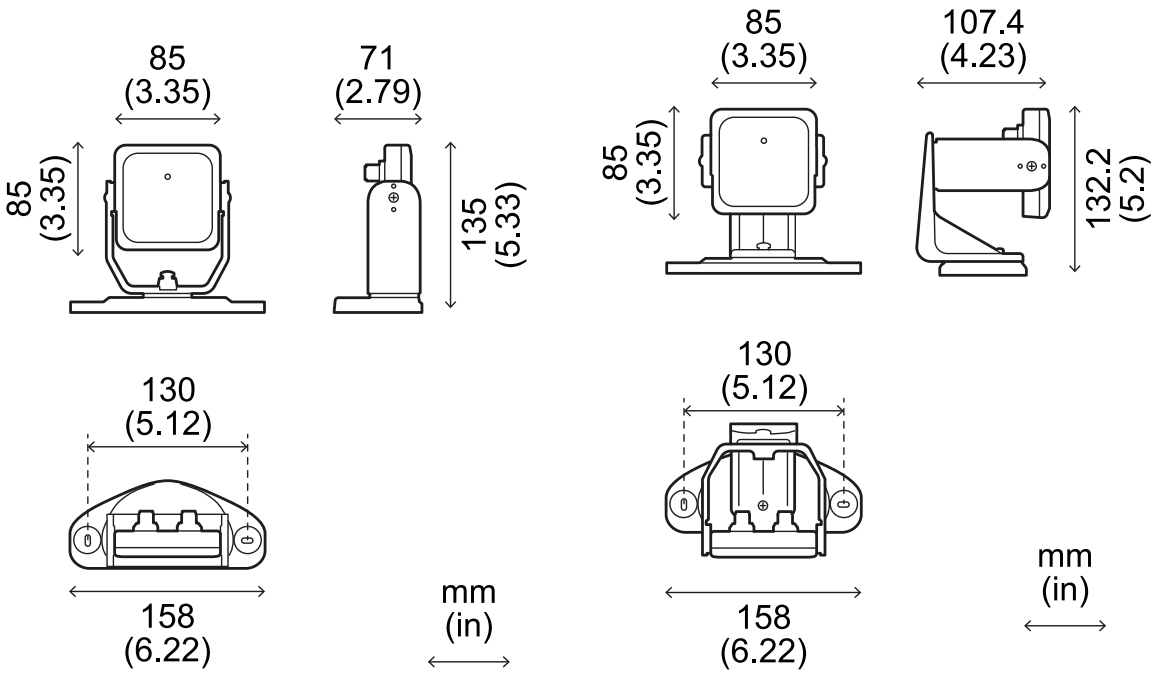
- Limited-Energy Circuit in accordance with IEC/UL/CSA 61010-1/ IEC/UL/CSA 61010-2-201 or
- Limited Power Source (LPS) in accordance with IEC/UL/CSA 60950-1 or
- (For North America and/or Canada only) a Class 2 supply source which complies with the National Electrical Code (NEC), NFPA 70, Clause 725.121 and Canadian Electrical Code (CEC), Part I, C22.1. (typical examples are a Class 2 transformer or a Class 2 power sources in compliance with, UL 5085-3/ CSA-C22.2 No. 66.3 or UL 1310/CSA-C22.2 No. 223).



9.1.5 Sensor features

Connectors	2 5-pin M12 connectors (1 male and 1 female)
CAN bus termination resistance	120 Ω (not supplied, to be installed with a bus terminator)
Power supply	12 V DC ± 20%, through controller
Consumption	Max. 4.7 W
Degree of protection	Type 3 enclosure, according to UL 50E, in addition to IP 67 rating
Material	Sensor: PA66 Bracket: PA66 and glass fiber (GF)
Frame rate	62 fps
Weight	With 2-axes bracket: 300 g (10.6 oz) With 3-axes bracket: 355 g (12.5 oz)
Pollution degree	4
Outdoor use	Yes
Operating temperature	From -30 to +60 °C (from -22 to +140 °F)
Storage temperature	From -40 to +80 °C (from -40 to +176 °F)

Note *: possible leaks along the wiring are considered.

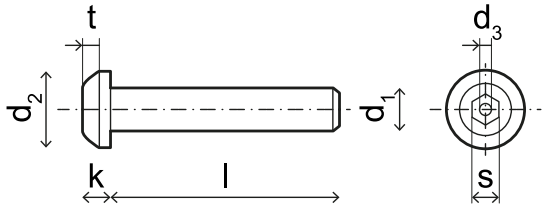


9.1.6 CAN bus cables recommended specifications

Section	2 x 0.50 mm2 (46 AWG) power supply 2 x 0.25 mm^2 (23 AWG) data line
Type	Two twisted pairs (power supply and data) and one drain wire (or shield)
Connectors	5-pole M12 (see Connectors M12 CAN bus on page 98) Connectors shall be type 3 (raintight)
Impedance	120 Ω ±12 Ω (f = 1 MHz)
Shield	Shield with twisted wires in tin-plated copper. To be connected to ground circuit on the power supply terminal block of the controller.
Standards	Cables shall be listed in accordance with application as described in the National Electrical Code, NFPA 70, and in the Canadian Electrical Code, C22.1. Maximum length of each line (from the controller to the last sensor): 100 m (328.1 ft)

9.1.7 Tamper-proof screws specifications

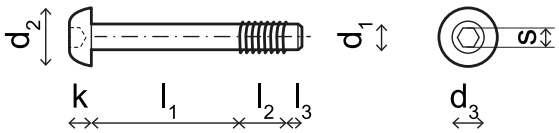
Pin Hex button head security screw



d_1	M4
l	10 mm (0.39 in)
d_2	7.6 mm (0.30 in)
k	2.2 mm (0.09 in)
t	min 1.3 mm (0.05 in)
s	2.5 mm (0.10 in)
d_3	max. 1.1 mm (0.04 in)

9.1.8 Non tamper-proof screws specifications

Hex button head screw



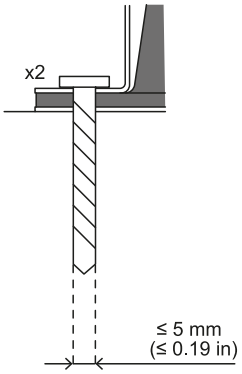
d_1	M4
l_1	19 mm (0.74 in)
l_2	6 mm (0.23 in)
l_3	2 mm (0.07 in)
d_2	7.6 mm (0.30 in)
k	3 mm (0.11 in)
s	2.5 mm (0.10 in)
d_3	4 mm (0.15 in)

9.1.9 Bottom screws specifications

The bottom screws can be:

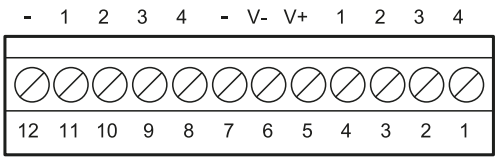
- cheese head
- button head

Note: avoid using countersunk head screws.



9.2 Terminal blocks and connector pin-outs

9.2.1 Digital inputs and outputs terminal block



Note: facing the controller so that the terminal block is on the top left, number 12 is the closest to the controller corner.

Terminal block	Symbol	Description	Pin
Digital In	**4**	Input 2, Channel 2, 24 V DC type 3 - INPUT #2-2	1
	3	Input 2, Channel 1, 24 V DC type 3 - INPUT #2-1	2
	2	Input 1, Channel 2, 24 V DC type 3 - INPUT #1-2	3
	1	Input 1, Channel 1, 24 V DC type 3 - INPUT #1-1	4
	V+	V+ (SNS), 24 V DC for diagnostics of the digital inputs (mandatory if at least one input is used)	5
	V-	V- (SNS), common reference for all digital inputs (mandatory if at least one input is used)	6
Digital Out	**-**	GND, common reference for all digital outputs	7
	4	Output 4 (OSSD4)	8
	3	Output 3 (OSSD3)	9
	2	Output 2 (OSSD2)	10
	1	Output 1 (OSSD1)	11
	-	GND, common reference for all digital outputs	12

Note: the cables used must have a maximum length of 30 m (98.4 ft) and the maximum operating temperature must be at least 80 °C.

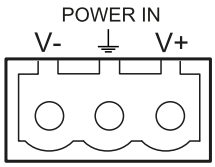
Note: use only copper wires with a minimum gauge of 18 AWG and a torque of 0.62 Nm (5,5 lbs in).

9.2.2 Voltage and current limits for digital inputs

The digital inputs (input voltage 24 V DC) adhere to the following voltage and current limits, in accordance with standard IEC/EN 61131-2:2003.

	Type 3
Voltage limits	
0	from - 3 to 11 V
1	from 11 to 30 V
Current limits	
0	15 mA
1	from 2 to 15 mA

9.2.3 Power supply terminal block



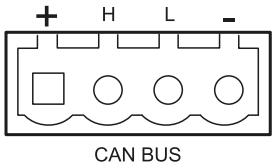
Note: connector front view.

Symbol	Description
V-	GND
⏚	Earth
V+	+ 24 V DC

Note: the maximum operating temperature of the cables must be at least 70 °C.

Note: use only copper wires with a minimum gauge of 18 AWG and a torque of 0.62 Nm (5,5 lbs in).

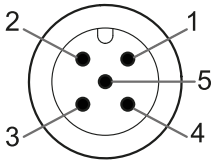
9.2.4 CAN bus terminal block



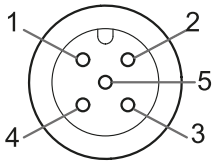
Symbol	Description
+	+ 12 V DC output
H	CAN H
L	CAN L
-	GND

Note: the maximum operating temperature of the cables must be at least 70 °C.

9.2.5 Connectors M12 CAN bus



Male connector

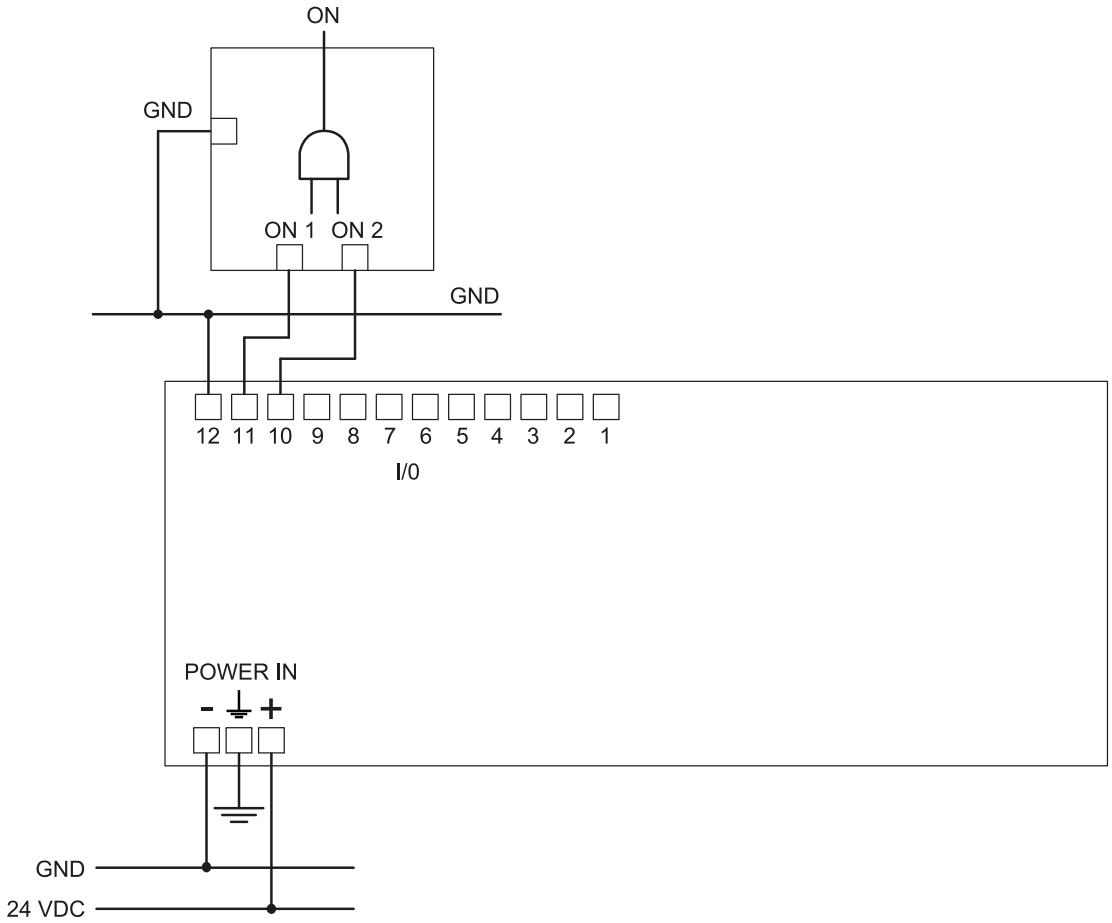


Female connector

Pin	Function
1	Shield, to be connected to ground circuit power supply terminal block of the controller.
2	+ 12 V DC
3	GND
4	CAN H
5	CAN L

9.3 Electrical connections

9.3.1 Connection of safety outputs to the machinery control system



Digital I/O settings (through the LBK Designer application)

Digital input #1 Not configured

Digital input #2 Not configured

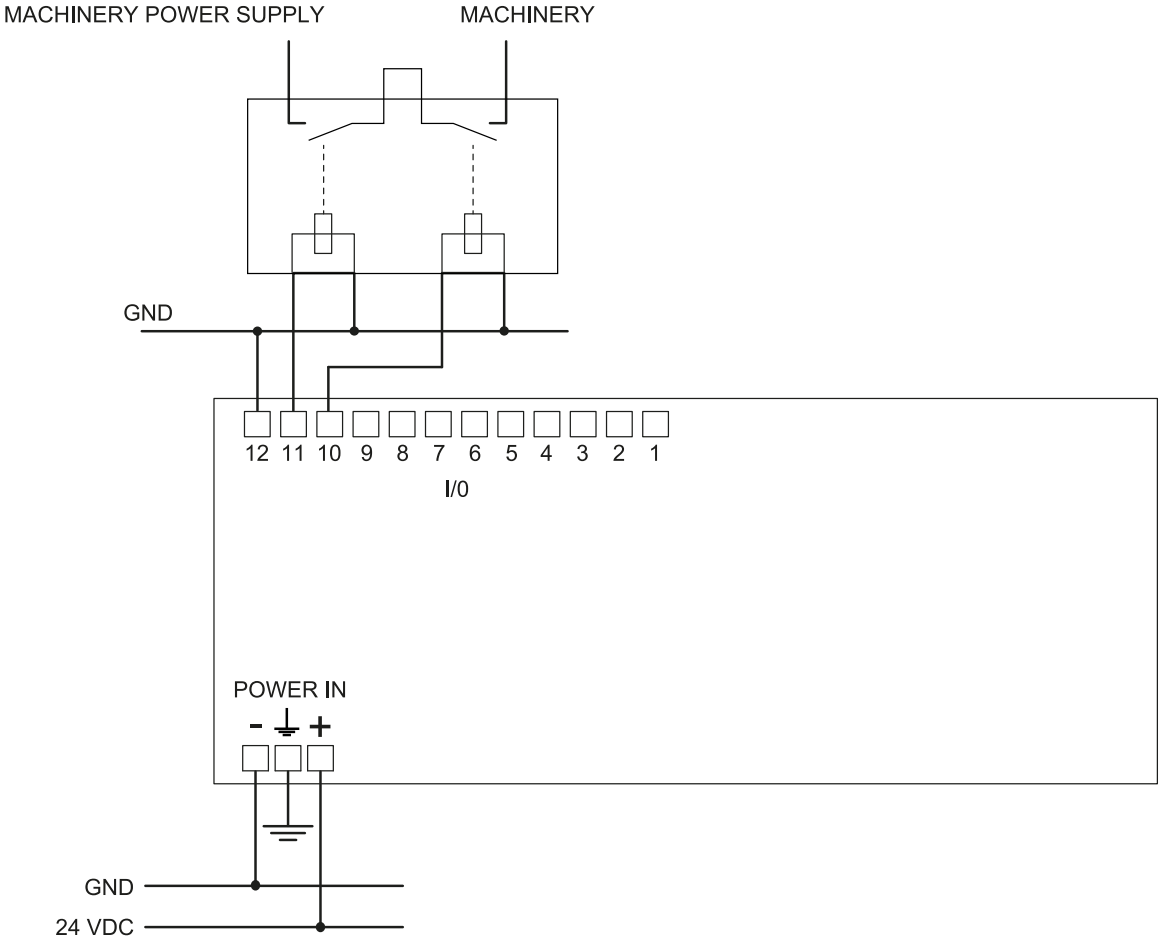
Digital output #1 Detection signal 1

Digital output #2 Detection signal 1

Digital output #3 Not configured

Digital output #4 Not configured

9.3.2 Connection of safety outputs to an external safety relay



Digital I/O settings (through the LBK Designer application)

Digital input #1 Not configured

Digital input #2 Not configured

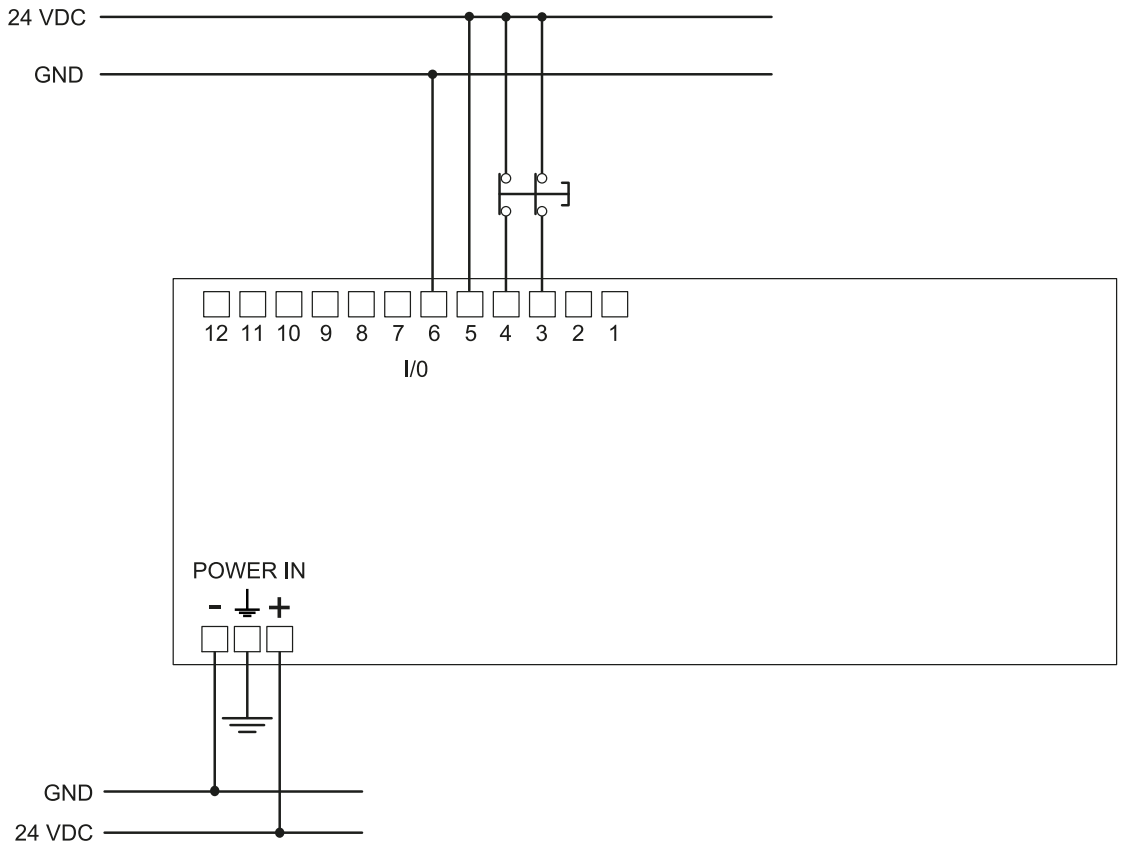
Digital output #1 Detection signal 1

Digital output #2 Detection signal 1

Digital output #3 Not configured

Digital output #4 Not configured

9.3.3 Connection of stop signal (emergency button)



Note: the indicated emergency button opens the contact when pressed.

Note: the cables used for wiring the digital inputs must have a maximum length of 30 m (98.4 ft).

Digital I/O settings (through the LBK Designer application)

Digital input #1 Stop signal

Digital input #2 Not configured

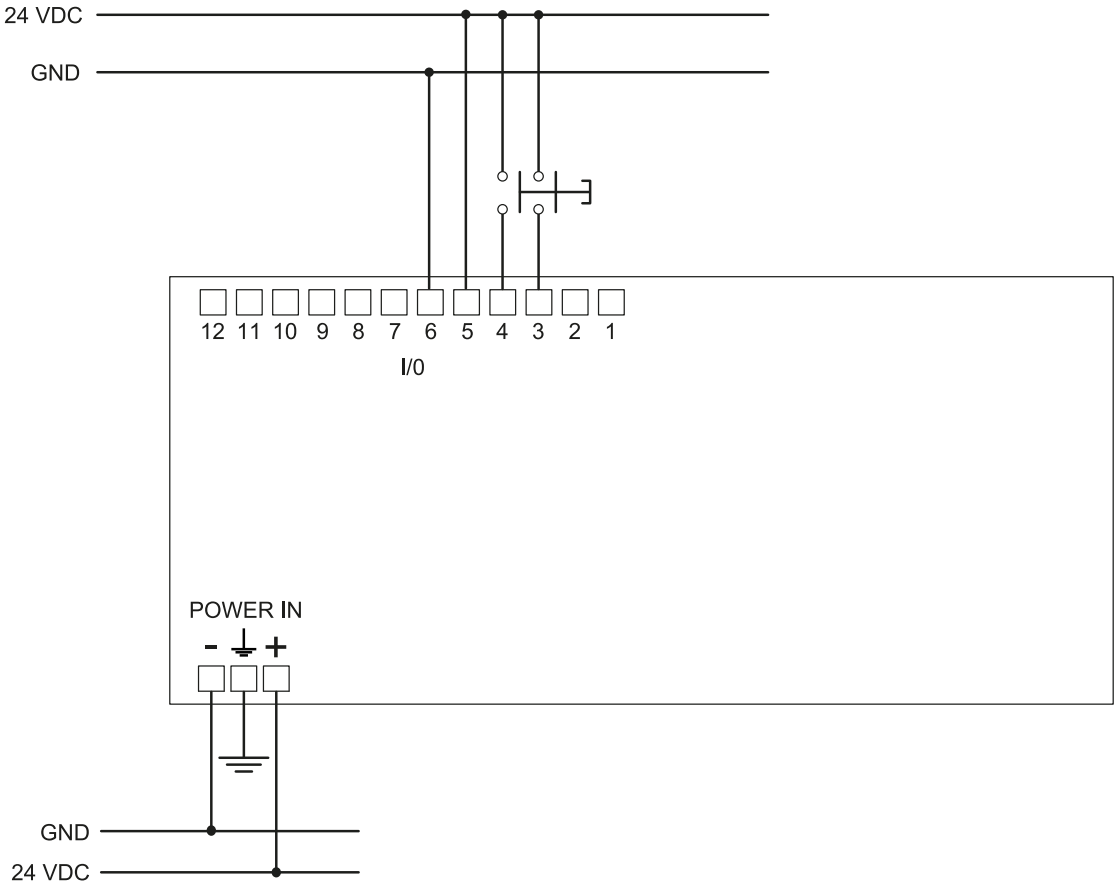
Digital output #1 Not configured

Digital output #2 Not configured

Digital output #3 Not configured

Digital output #4 Not configured

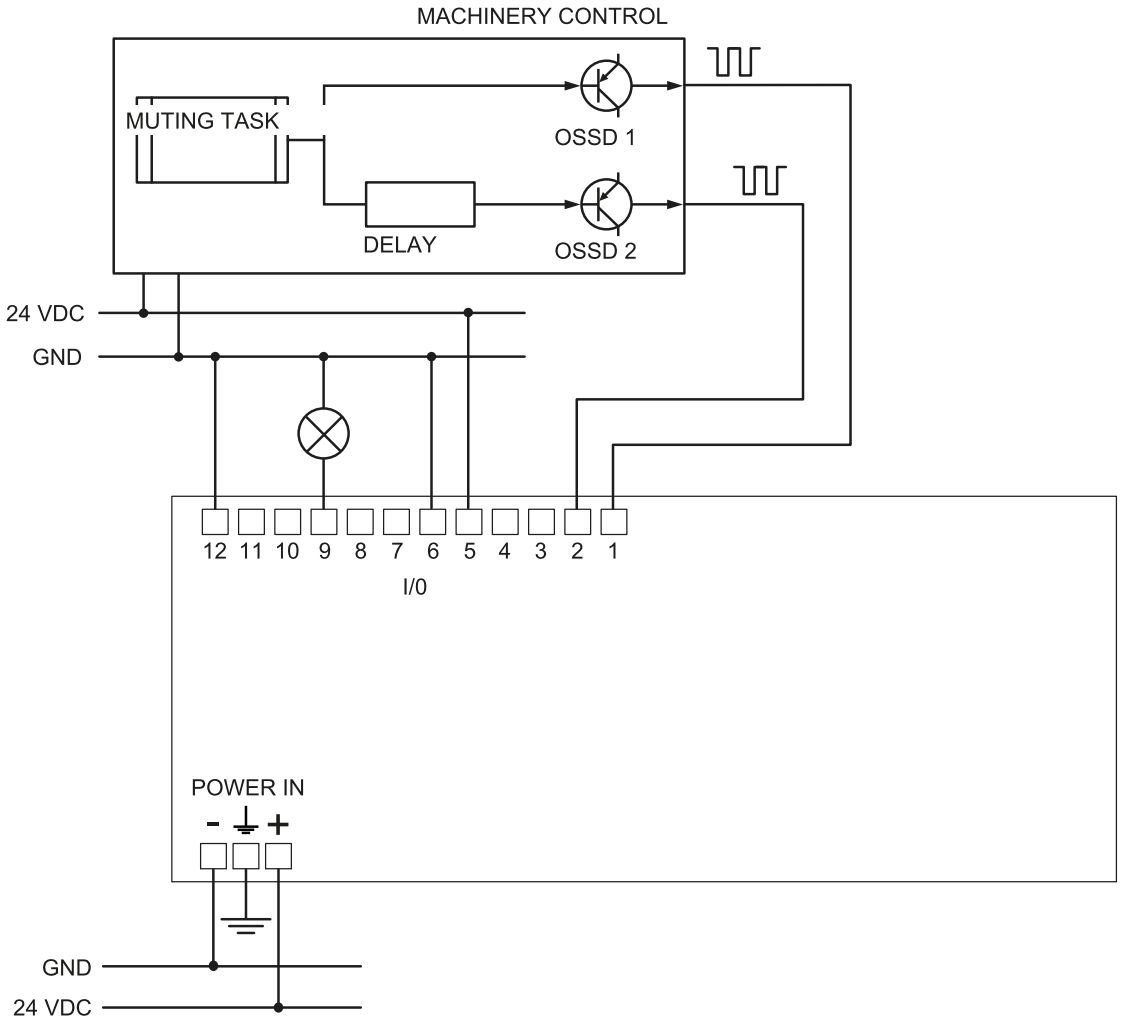
9.3.4 Connection of restart signal



Note: the button indicated for the restart signal closes the contact when pressed.

Note: the cables used for wiring the digital inputs must have a maximum length of 30 m (98.4 ft).

9.3.5 Connection of the muting input and output (one group of sensors)



Note: the cables used for wiring the digital inputs must have a maximum length of 30 m (98.4 ft).

Digital I/O settings (through the LBK Designer application)

Digital input #1 Not configured

Digital input #2 Muting group 1

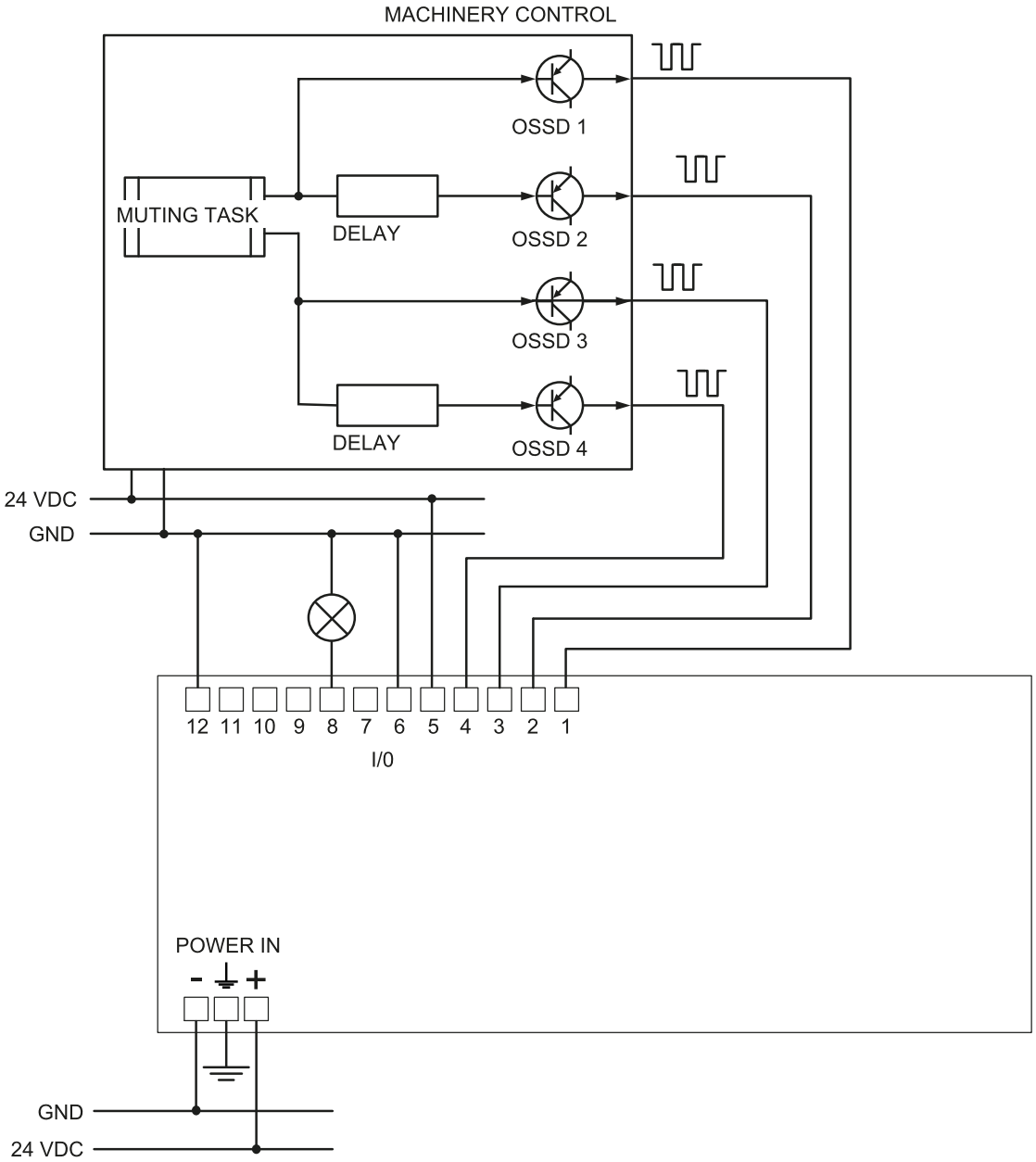
Digital output #1 Not configured

Digital output #2 Not configured

Digital output #3 Muting enable feedback signal

Digital output #4 Not configured

9.3.6 Connection of the muting input and output (two groups of sensors)



Note: the cables used for wiring the digital inputs must have a maximum length of 30 m (98.4 ft).

Digital I/O settings (through the LBK Designer application)

Digital input #1 Muting group 1

Digital input #2 Muting group 2

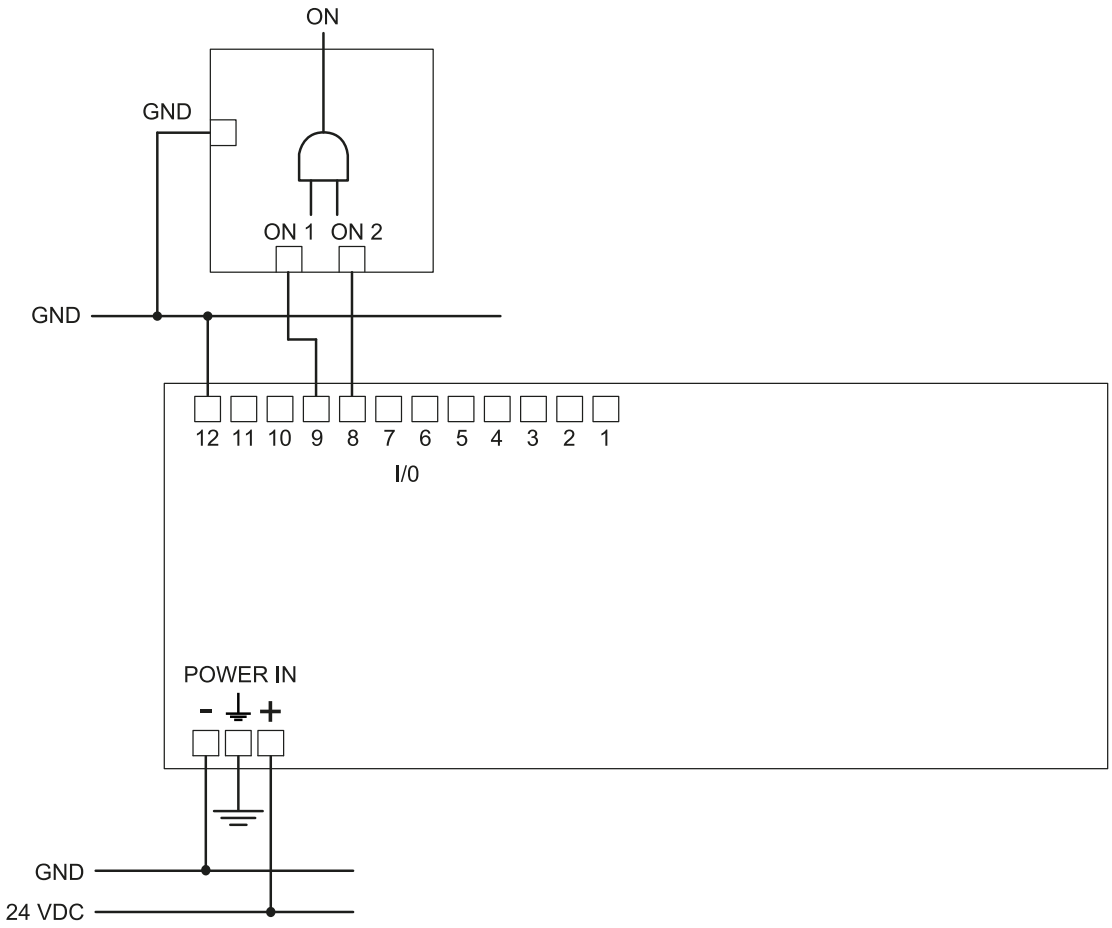
Digital output #1 Not configured

Digital output #2 Not configured

Digital output #3 Not configured

Digital output #4 Muting enable feedback signal

9.3.7 Detection signal 2 connection



Digital I/O settings (through the LBK Designer application)

Digital input #1 Not configured

Digital input #2 Not configured

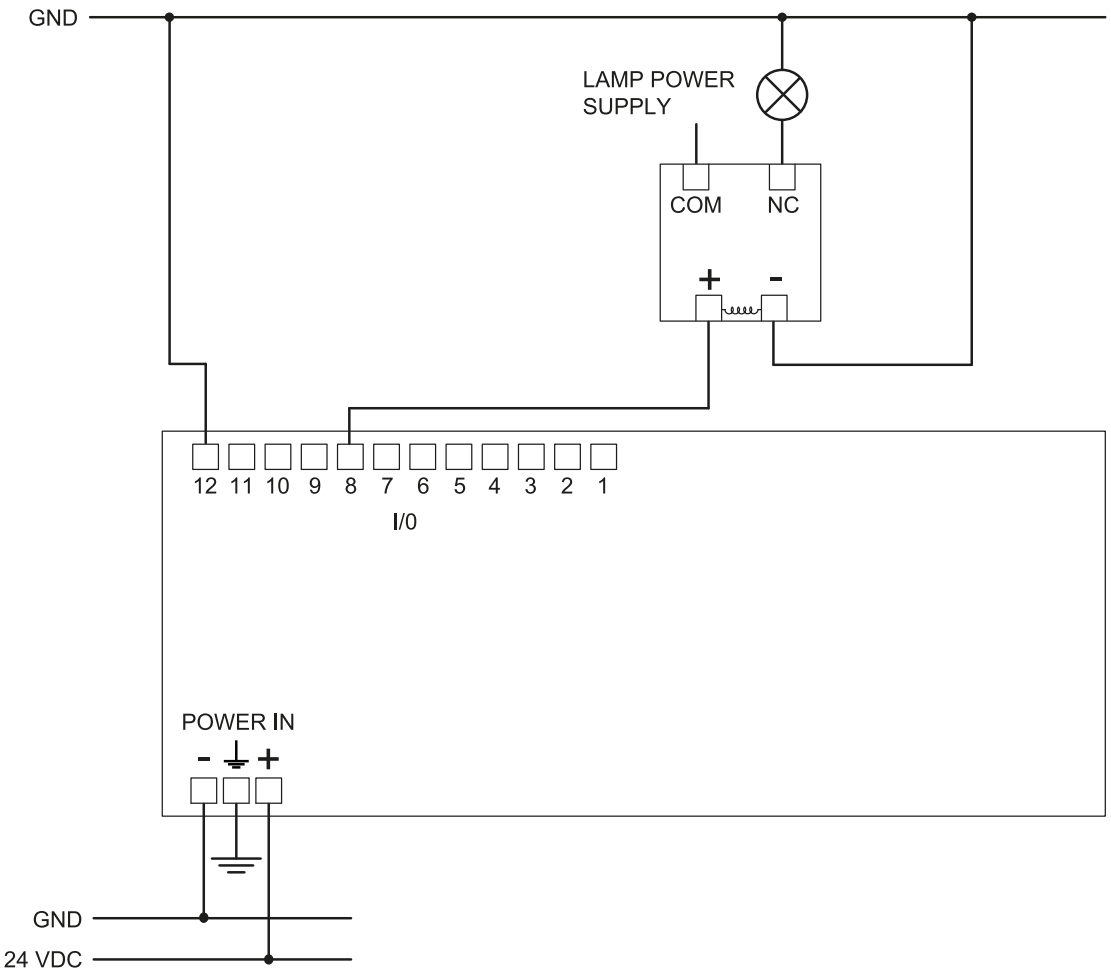
Digital output #1 Not configured

Digital output #2 Not configured

Digital output #3 Detection signal 2

Digital output #4 Detection signal 2

9.3.8 Diagnostic output connection



Note: the indicated light turns on in the presence of a failure.

Digital I/O settings (through the LBK Designer application)

Digital input #1 Not configured

Digital input #2 Not configured

Digital output #1 Not configured

Digital output #2 Not configured

Digital output #3 Not configured

Digital output #4 System diagnostic signal

9.4 Configuration application parameters

9.4.1 Parameter list

Parameter	Min	Max	Default value
Settings > Account			
Password	-	-	Not available
Settings > General			
System	LBK S-01 System, LBK SBV System		LBK S-01 System

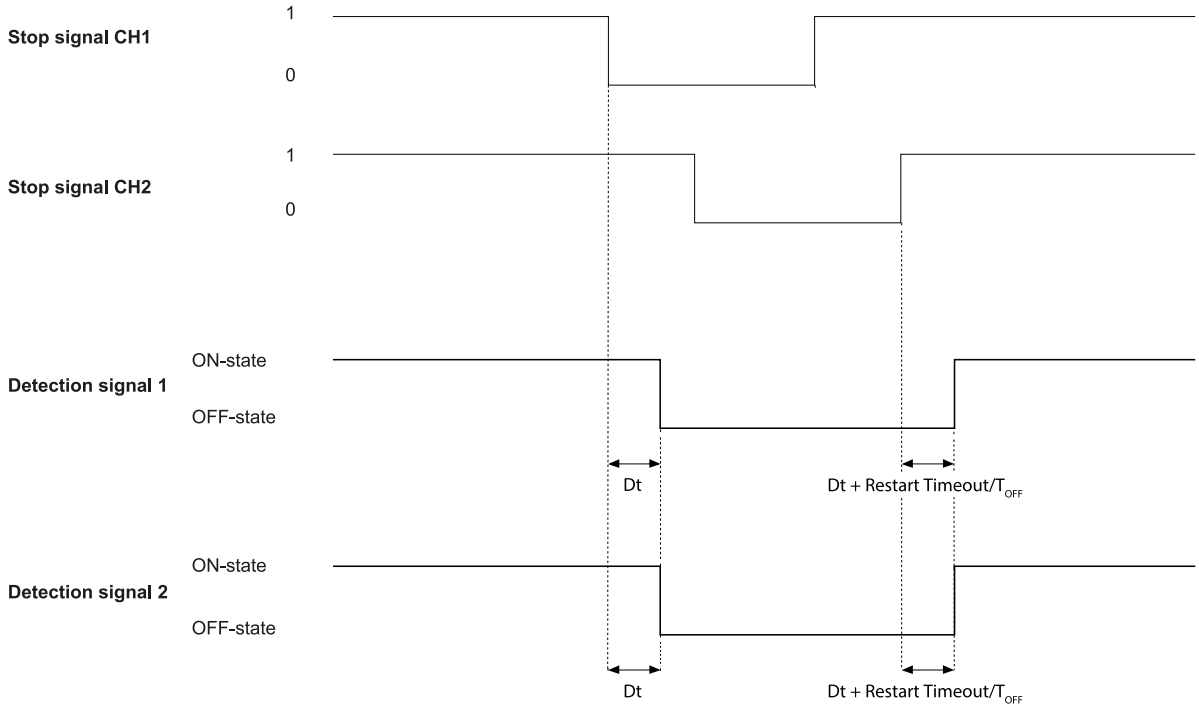
Parameter	Min	Max	Default value
Country	Europe, Rest of the certified countries or list of countries		Europe, Rest of the certified countries
Application type selection	Fixed, Vehicle mount		Fixed
Configuration			
Number of installed sensors	1	6	1
Plane	Dim. X: 1000 mm Dim. Y: 1000 mm	Dim. X: 65000 mm Dim. Y: 65000 mm	Dim. X: 8000 mm Dim. Y: 6000 mm
Position (for each sensor)	X: 0 mm Y: 0 mm	X: 65000 mm Y: 65000 mm	Default position of sensor #1: X: 1000 mm Y: 1000 mm
Rotation 1 (for each sensor)	0°, 90°, 180°, 270°		0°
Rotation 2 (for each sensor)	0°	359°	0°
Rotation 3 (for each sensor)	-90°	90°	0°
Sensor installation height (for each sensor)	0 mm	10000 mm	0 mm
Detection Distance 1(for each sensor)	0 mm	5000 mm	1000 mm
Detection Distance 2, 3 and 4 (for each sensor)	0 mm	5000 mm **Note**: the sum of all the detection distances (for each sensor) must not exceed 5000 mm.	0 mm
Angular coverage	10°	100°	100°
Safety working mode (for each detection field of each sensor)	Both (default), Always-on access detection, Always-on restart prevention		Both (default)
Static object detection (for each detection field of each sensor)	Enabled, Disabled		Disabled
Restart timeout (for each detection field of each sensor)	100 ms	60000 ms	4000 ms
T_{OFF}	100 ms	60000 ms	100 ms
Settings > Advanced			
	Enabled, Disabled		Enabled
Settings > Advanced > Multi-controller synchronization			
Controller channel	0	3	0
Settings > Anti-tampering			
Anti-masking sensitivity (for each sensor)	Disabled, Low, Medium, High		High
Anti-masking distance (for each sensor)	200 mm	1000 mm	1000 mm
Anti-rotation around axes (for each sensor)	Disabled, Enabled		Disabled
Anti-rotation around axes - Enable specific axis - Tilt (for each sensor)	Disabled, Enabled		Disabled

Parameter	Min	Max	Default value
Anti-rotation around axes - Enable specific axis -Roll (for each sensor)	Disabled, Enabled		Disabled
Anti-rotation around axes - Enable specific axis - Pan (for each sensor)	Disabled, Enabled		Disabled
Settings > Digital Input-Output			
Digital input (for each input)	Stop signal, Restart signal, Muting group “N”, Activate dynamic configuration, Fieldbus controlled		Not configured
Digital output (for each output)	System diagnostic signal, Muting enable feedback signal, Fieldbus controlled, Restart feedback signal, Detection signal "N", Static object detection feedback signal		Not configured
OSSD Pulse width	Short (300 µs), Long (2 ms)		Short (300 µs)
Settings > Muting			
Group for muting (for each sensor)	None, Group 1, Group 2, both		Group 1
Pulse width (for each Input TYPE)	0 µs (= Period and Phase shift disabled) 200 µs	2000 µs	0 µs
Period (for each Input TYPE)	200 ms	2000 ms	200 ms
Phase shift (for each Input TYPE)	0.4 ms	1000 ms	0.4 ms
Settings > Restart function			
Detection field 1, 2, 3, 4	Automatic, Manual, Safe manual		Automatic
Settings > Activity History			
Log verbosity level	0	5	0
Settings > Network Parameters			
IP Address	-		192.168.0.20
Netmask	-		255.255.255.0
Gateway	-		192.168.0.1
TCP port	1	65534	80
Settings > Fieldbus Parameters			
System configuration and status PS2v6	1	65535	145
Sensors information PS2v6	1	65535	147
Sensor 1 detection status PS2v6	1	65535	149
Sensor 2 detection status PS2v6	1	65535	151
Sensor 3 detection status PS2v6	1	65535	153
Sensor 4 detection status PS2v6	1	65535	155
Sensor 5 detection status PS2v6	1	65535	157
Sensor 6 detection status PS2v6	1	65535	159
System configuration and status PS2v4	1	65535	146
Sensors information PS2v4	1	65535	148
Sensor 1 detection status PS2v4	1	65535	150
Sensor 2 detection status PS2v4	1	65535	152

Parameter	Min	Max	Default value
Sensor 3 detection status PS2v4	1	65535	154
Sensor 4 detection status PS2v4	1	65535	156
Sensor 5 detection status PS2v4	1	65535	158
Sensor 6 detection status PS2v4	1	65535	160
Fieldbus endianness	Big Endian, Little Endian		Big Endian
Settings > MODBUS Parameters			
MODBUS Enable	Enabled, Disabled		Enabled
Listening port	1	65534	502
Settings > Labels			
Controller	-		-
Sensor 1	-		-
Sensor 2	-		-
Sensor 3	-		-
Sensor 4	-		-
Sensor 5	-		-
Sensor 6	-		-

9.5 Digital input signals

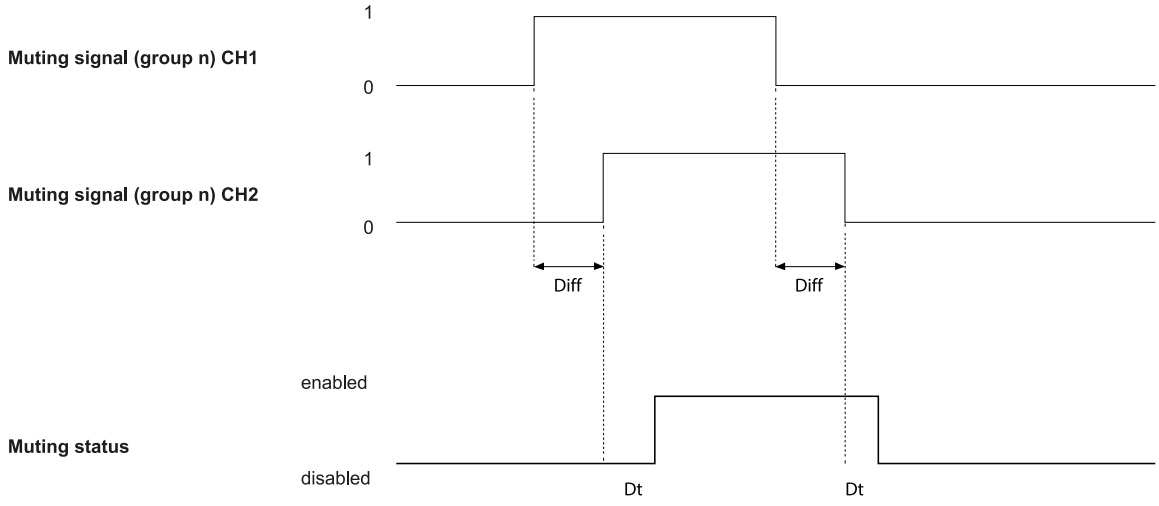
9.5.1 Stop signal



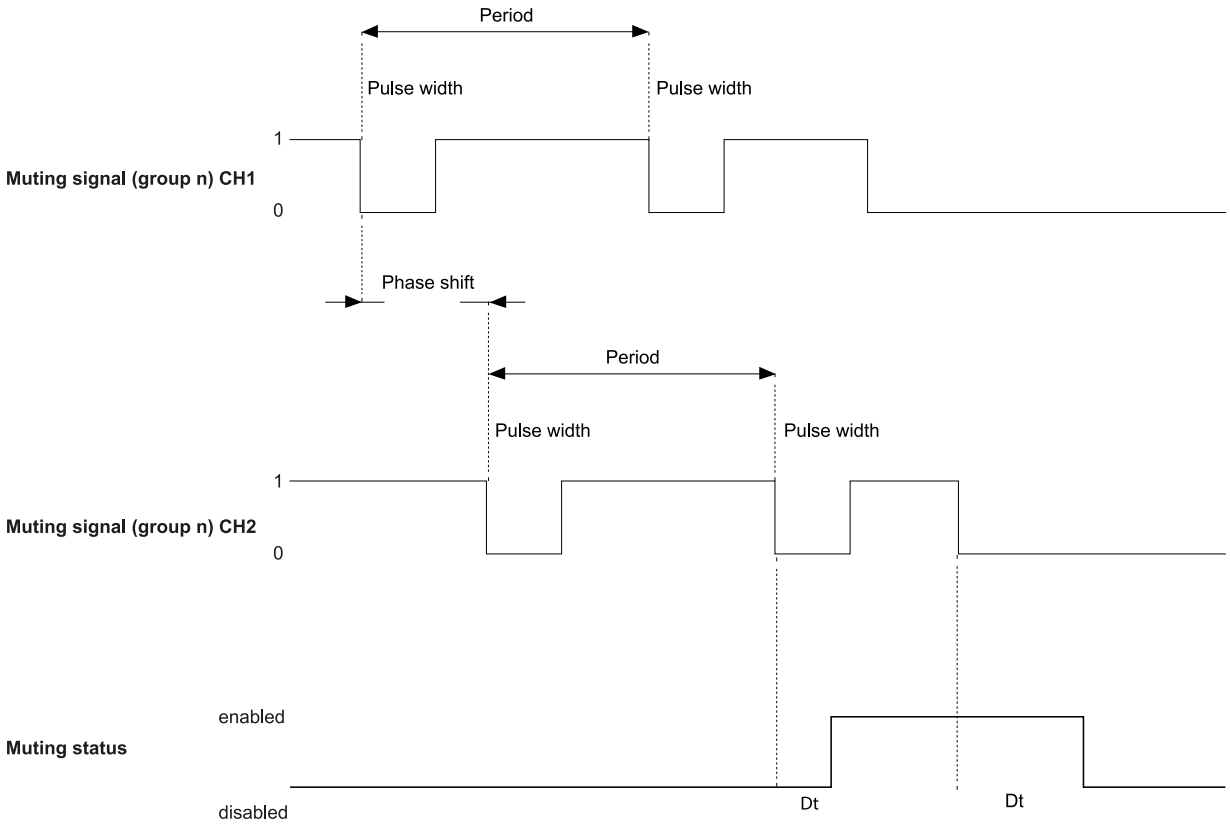
Part	Description
Detection signal 1 **Detection signal 2**	Both deactivate on the falling edge of, at least, one of the two input channels of the input signal. They remain in OFF-state as long as one of the two input channels remains to the low logic status (0).
Stop signal CH1 **Stop signal CH2**	Interchangeable channel. As soon as one channel goes to the low logic level (0), Detection signal 1 and Detection signal 2 are set to OFF-state.
Diff	Less than 50 ms. If the value is greater than 50 ms, the diagnostic alarm starts and the system deactivates the safety outputs.
Dt	Activation delay. Less than 5 ms.

9.5.2 Muting (with/without pulse)

Without pulse

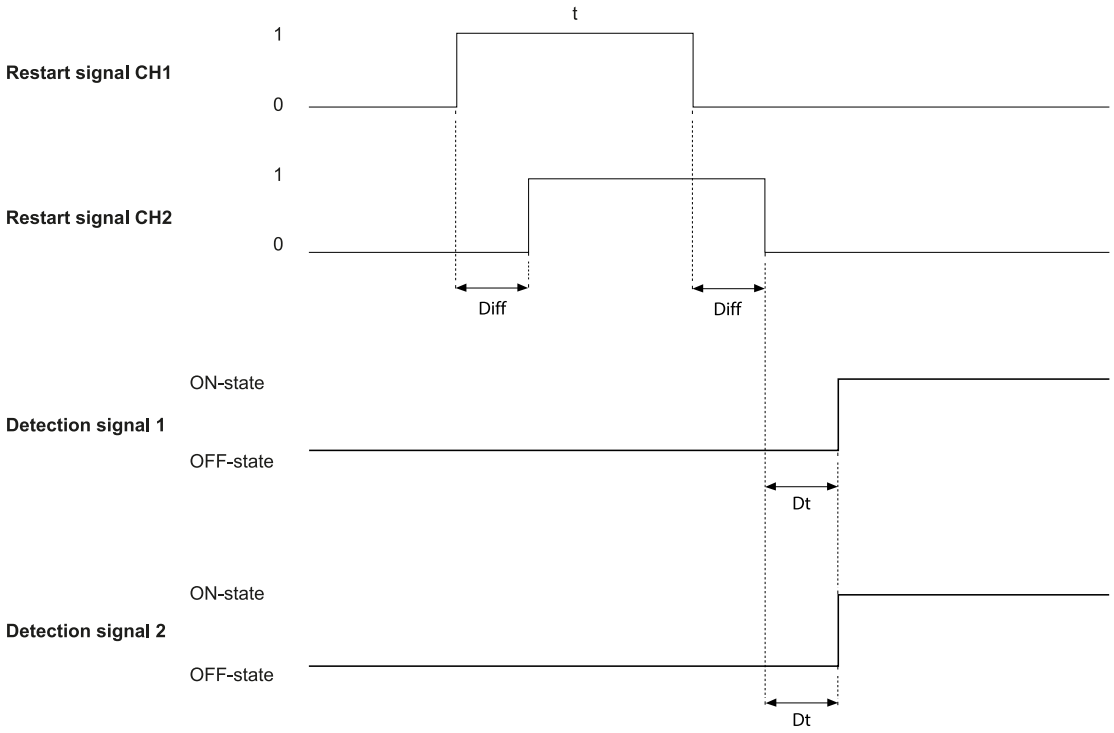


With pulse



Part	Description
Diff	Less than 100 ms. If the value is greater than 100 ms, the diagnostic alarm starts and the system deactivates the safety outputs.
Muting signal (group *n*) CH 1 **Muting signal (group *n*) CH 2**	Interchangeable channel.
Muting status	• Without pulse: enabled as long as both channels are at a high logic level (1), and deactivated when both channels go to low logic level (0). • With pulse: enabled as long as both the input signals follow the configured muting parameters (pulse width, period and phase shift).
Dt	Activation/deactivation delay. Without pulse less than 50 ms, with pulse less than three times the period.

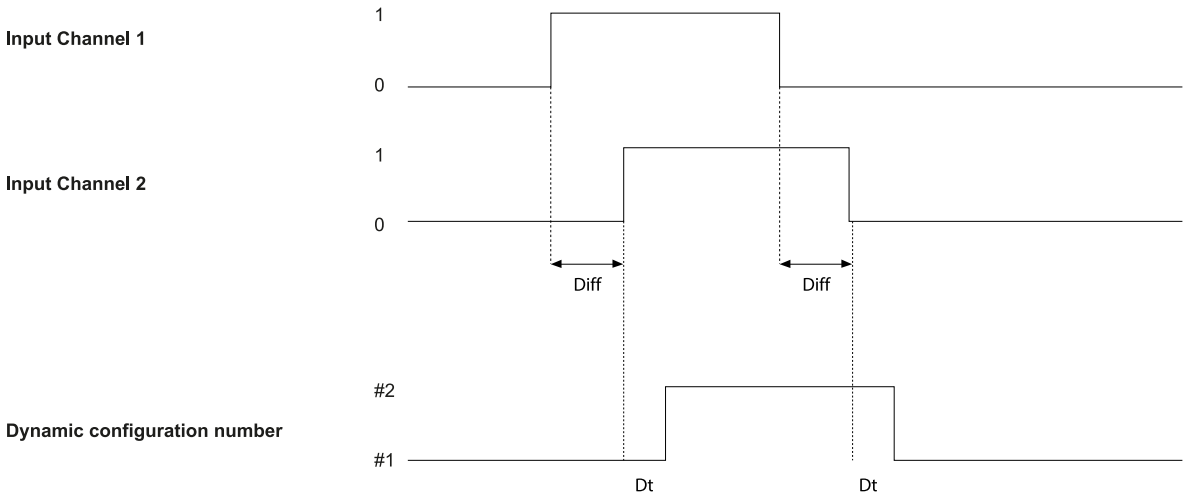
9.5.3 Restart signal



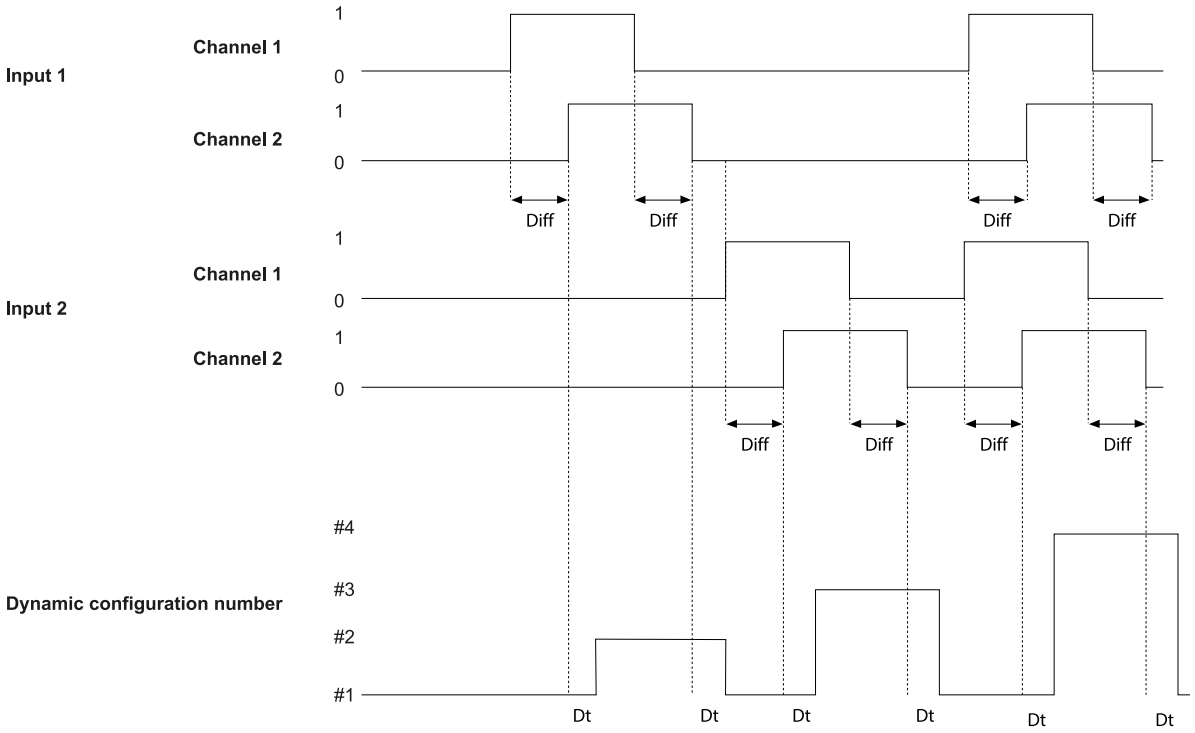
Part	Description
Detection signal 1 **Detection signal 2**	The Detection signal 1 and Detection signal 2 outputs go to ON-state as soon as the last channel has correctly completed the transition 0 -> 1 -> 0.
Restart signal CH1 **Restart signal CH2**	Interchangeable channel. Both channels of Restart signal must have a transition of logical level 0 -> 1 ->0. The time they stay at high logical level (t) must be at least 200 ms.
Dt	Activation delay. Less than 50 ms.
Diff	Less than 100 ms. If the value is greater than 100 ms, the system maintains the outputs deactivated.

9.5.4 Active dynamic configuration

With one input



With two inputs



Part	Description
Diff	Less than 100 ms. If the value is greater than 100 ms, the diagnostic alarm starts and the system deactivates the safety outputs.
Dynamic configuration number	See Dynamic configuration through the digital inputs on page 33.
Dt	Activation/deactivation delay. Less than 50 ms.

10 Appendix

10.1 System software

10.1.1 Introduction

The aim of this appendix is to provide and clarify the information related to the system software. It includes the information necessary for the integrator during the installation and integration in accordance with IEC 61508-3 Annex D.

Considering that LBK SBV System is an embedded system provided with a firmware already deployed on board, no software integration is required by the system installer or by the end user. The following paragraphs analyzes all the information required in IEC 61508-3 Annex D.

10.1.2 Configuration

The system configuration can be performed by means of a PC-based configuration tool, called the LBK Designer application.

The system configuration is described in Installation and use procedures on page 61.

10.1.3 Competence

Although no competence is required for software integration, a skilled person is required for system installation and configuration, as described in Installation and use procedures on page 61.

10.1.4 Installation instructions

The firmware is already deployed on the hardware, the PC-based configuration tool includes a self-explanatory setup installer.

10.1.5 Outstanding anomalies

At the moment of the issue of this document, no software/firmware anomalies or bugs are known.

10.1.6 Backward compatibility

Backward compatibility is guaranteed.

10.1.7 Change control

Any change proposal suggested by the integrator or by the end user should be forwarded to Leuze and evaluated by the Product Owner.

10.1.8 Implemented security measures

Firmware upgrade packages are managed by the Leuze Technical Support and they are signed to prevent the use of unverified binary files.

10.2 Disposal

LBK SBV System contains electrical parts. As set forth in European Directive 2012/19/EU, do not dispose of the product with unsorted urban waste materials.

It is the responsibility of the owner to dispose of these products, as well as other electrical and electronic equipment, through specific waste collection facilities indicated by the government or local public authorities.

Correct disposal and recycling will contribute to the prevention of potentially harmful consequences to the environment and human health.

To receive more detailed information about disposal, contact the relevant public authorities, waste disposal services or the representative from whom you purchased the product.

10.3 Service and support

10.3.1 Service hotline

You can find the contact information for the hotline in your country on our website www.leuze.com under **Contact & Support**.

Repair service and returns

Defective devices are repaired in our service centers competently and quickly. We offer you an extensive service packet to keep any system downtimes to a minimum. Our service center requires the following information:

- Your customer number
- Product description or part description

- Serial number and batch number
- Reason for requesting support together with a description

Please register the merchandise concerned. Simply register return of the merchandise on our website www.leuze.com under **Contact & Support** > **Repair Service & Returns**.

To ensure quick and easy processing of your request, we will send you a returns order with the returns address in digital form.

10.4 Order guide

10.4.1 Sensors

Part no.	Article	Description
50147249	LBK SBV-01	Sensor 60GHz, 5m

10.4.2 Controllers

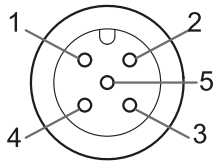
Part no.	Article	Description
50145355	LBK ISC BUS PS	Controller PROFIsafe
50147250	LBK ISC-02	Controller Ethernet, USB
50147251	LBK ISC-03	Controller USB

10.5 Accessories

10.5.1 Connection Technology – Connection Cables

Part no.	Article	Description
50143389	KD DN-M12-5W-P1-150	Connection cable, M12 angled, 5-pin, 15m
50114696	KB DN/CAN-5000 BA	Connection cable, M12 axial, 5-pin, 5m
50114699	KB DN/CAN-10000 BA	Connection cable, M12 axial, 5-pin, 10m

Electrical connection



Pin	Conductor color	Function
1	-	Shield, to be connected to ground circuit power supply terminal block of the controller.
2	Red	+ 12 V DC
3	Black	GND
4	White	CAN H
5	Blue	CAN L

10.5.2 Connection Technology – Interconnection Cables

Part no.	Article	Description
50143385	KDS DN-M12-5W-M12-5W-P3-030	Interconnection cable, M12 angled, 3m
50143386	KDS DN-M12-5W-M12-5W-P3-050	Interconnection cable, M12 angled, 5m
50143387	KDS DN-M12-5W-M12-5W-P3-100	Interconnection cable, M12 angled, 10m
50143388	KDS DN-M12-5W-M12-5W-P3-150	Interconnection cable, M12 angled, 15m

10.5.3 Connection Technology – USB Interconnection Cables

Part no.	Article	Description
50143459	KSS US-USB2-A-mic-B-V0-018	USB cable, USB-A – micro-USB, 1.8m

10.5.4 Connection Technology – Terminating Resistors

Part no.	Article	Description
50040099	TS 01-5-SA	Terminator plug, M12