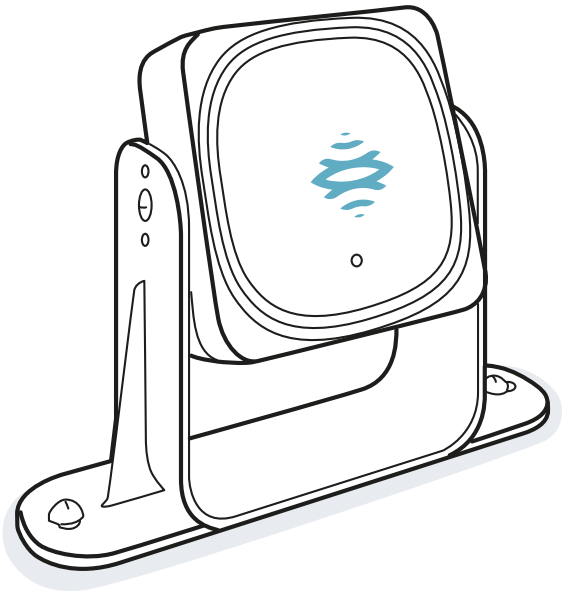
INXPECT

LBK System Series

SRE - Safety Radar Equipment



Instruction manual
v1.2 - EN

Original instructions

WARNING! Anyone who uses this system must read the instruction manual to ensure safety. Read and adhere to the "Safety information" chapter in its entirety before using the system for the first time.

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Contents

Glossary of terms

1

1oo2

(one out of two) Type of multi-channel architecture where one area is monitored by two sensors at the same time.

A

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 of 110° or 50° on the horizontal plane.

D

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 1

Depth of the field of view configured for detection field 1.

Detection distance 2

Depth of the field of view configured for detection field 2.

Detection field 1

Area of the fieldset closer to the sensor. In the absence of detection field 2, it corresponds to the whole fieldset.

Detection field 2

Area of the fieldset that follows detection field 1.

Detection signal 1

Output signal that describes the monitoring status of detection field 1.

Detection signal 2

Output signal that describes the monitoring status of detection field 2.

E

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.

F

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 one or two detection fields.

FMCW

Frequency Modulated Continuous Wave

I

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.

M

Machinery

The system for which the dangerous area is monitored.

Monitored area

Area that is monitored by the system. It is composed of detection field 1 (e.g. used as alarm area) and detection field 2 (e.g. used as warning area) of all the sensors.

O

OSSD

Output Signal Switching Device

R

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.

T

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.

1. This manual

1.1 Information on this manual

1.1.1 Objectives of this instruction manual

This manual explains how to integrate LBK System Series 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 87 and to "System software" on page 106.

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

1.1.2 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 Customer Assistance Service.
Always enclose the manual when the equipment is sold.

1.1.3 Provided documentation

Document	Code	Date	Distribution format
Instruction manual (this manual)	SAF-UM-LBKBus-en-v1.2	SET 2021	online PDF PDF downloadable from the site www.inxpect.com/industrial/tools
PROFIsafe communicationReference guide	SAF-RG-PROFIsafe-en-v16	JUL 2021	online PDF PDF downloadable from the site www.inxpect.com/industrial/tools
Modbus communication Reference guide	SAF-RG-Modbus-en-v1	JUL 2021	online PDF PDF downloadable from the site www.inxpect.com/industrial/tools

1.1.4 Instruction manual updates

Publication date	Code	Hardware version	Firmware version	Updates
SET 2021	SAF-UM-LBKBus-en-v1.2	• ISC-B01, ISC-02 and ISC-03: 2.1 • LBK-S01: 2.1	• ISC-B01, ISC-02 and ISC-03: 1.4.0 e 1.5.0 • LBK-S01: 2.20	Changed system denomination in LBK System Series Changed application denomination in Inxpect Safety Added ISC-02 and ISC-03 control units Added topics: "Modbus communication" on page 27, "System software" on page 106 Added event log (Fieldbus connection, Modbus connection, Session authentication, Validation, Log download) Other minor changes
MAR 2021	SAF-UM-LBKBus-en-v1.1	• ISC-B01: 2.1 • LBK-S01: 1.2	• ISC-B01: 1.3.0 • LBK-S01: 2.10	Updated manual content to firmware version 1.3.0 (main topics: Fieldbus communication, Detection field dependency, Multi-control unit synchronization) Updated application name and UI reference Technical data. Added PFHd values with Fieldbus and control unit and sensor weight. Deleted the "Updates" chapter. Replaced "Dalarm" with "d", "DalarmReal" with "Dalarm", "longitudinal" with "x-axis" and "transverse" with "z-axis" and other minor changes.
SEP 2020	LBK-System-BUS_ instructions_ en v1.0	• ISC-B01: 2.1 • LBK-S01: 1.2	• ISC-B01: 1.1.0 • LBK-S01: 2.10	First publication

1.1.5 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

2. SAFETY

2.1 Safety information

2.1.1 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.*

2.1.2 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 89 and "Electrical connections" on page 91)
- cable operating temperature (see "Terminal blocks and connector pin-outs" on page 89)
- control unit cover, which was subjected to a low energy impact test (see "Technical data" on page 87)

2.1.3 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

2.1.4 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 10. 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.

2.1.5 INTENDED USE

LBK System Series is certified SIL 2 according to IEC/EN 62061 and PL d according to EN ISO 13849-1.

It performs the following safety functions:

- **Access detection function**: access 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 optional safety functions:

- Stop signal: force all the safety outputs to OFF-state.
- Restart signal: enables the control unit to switch to ON-state the safety outputs related to all the detection fields with no motion detected.
- Muting (see "Muting" on page 44).

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

- dangerous area protection
- indoor and outdoor applications

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 87.

2.1.6 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.*

2.1.7 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.

2.1.8 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

2.1.9 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.

2.1.10 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.

2.1.11 DISPOSAL

In safety-related applications, comply with the mission time reported in "General specifications" on page 87.

For decommissioning follow the instructions reported in "Disposal" on page 107.

2.2 Conformity

2.2.1 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 300 440 v2.1.1
	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
	UL/CSA 61010-1
	IEC/EN 61784-3-3 for the PROFIsafe Fieldbus

***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.inxpect.com/en/resources/downloads/.

2.2.2 CE

The manufacturer, Inxpect SpA, states that LBK System Series type of radio 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.inxpect.com/en/resources/downloads/.

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

2.2.3 FCC

LBK System Series complies with FCC CFR title 47, part 15, subpart B. It contains FCC ID: UXS-SMR-3X4.

Operation is subject to the following two conditions:

- this device may not cause harmful interference, and
- this device must accept any interference received, including interference that may cause undesired operation

***NOTICE**: changes or modifications made to this equipment and not explicitly approved by Inxpect SpA may void the FCC authorization to operate this equipment.*

2.2.4 SRRC

en LBK-S01 is a micro-power (short range) radio transmission equipment, type G, and does not require any type approval.

zh-CN LBK-S01是一种微功率(近程)无线电传输设备,G型,不需要任何类型认可。

2.2.5 IMDA

Complies with
IMDA Standards
DA103787

2.2.6 CERTIFICAÇÕES ANATEL

Este produto está homologado pela Anatel, de acordo com os procedimentos regulamentados pela Resolução nº242/2000 e atende aos requisitos técnicos aplicados.

Para maiores informações, consulte o site da ANATEL www.anatel.gov.br.

ANATEL
Agência Nacional de Telecomunicações

07125-19-12500

Este equipamento não tem direito à proteção contra interferências prejudiciaL e não pode causar interferência em sistemas devidamente autorizados.

2.2.7 NCC

en The use of low-power RF devices shall not affect flight safety or interfere with legal communications; if interference is found, the user should stop using the device immediately and improve it until there is no interference.

Legal communication in the preceding paragraph refers to radio communications operating in accordance with the provisions of the Telecommunications Act. Low-power RF devices must withstand interference from legitimate communications or radio electrical equipment for industrial, scientific, and medical use.

zh-TW 低功率射頻電機之使用不得影響飛航安全及干擾合法通信;經發現有干擾現象時,應立即停用,並改善至無干擾時方得繼續使用。

前項合法通信,指依電信法規定作業之無線電通信。低功率射頻電機須忍受合法通信或工業、科學及醫療用電波輻射性電機設備之干擾。

2.2.8 ICASA

TA 2019-5126

APPROVED

2.2.9 ROHS2 CHINA

en According to the SJ/T 11364-2014 Standard of the People's Republic of China for the Electronic Industry.

Model: ISC-B01, ISC-02, ISC-03, LBK-S01

Component name	Hazardous substances					
	Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent Chromium (Cr (VI))	Polybrominated biphenyls (PBB)	Polybrominated diphenyl ethers (PBDE)
Aluminum, steel, copper alloy	X*	O	O	O	O	O
Electrical contacts	O	O	O	O	O	O
Printed board assembly	O	O	O	O	O	O
Plastics	O	O	O	O	O	O

This table was developed according to the provisions of SJ/T 11364.

O: The content of such hazardous substance in all homogeneous materials of such component **is below** the limit required by GB/T 26572.

X: The content of such hazardous substance in all homogeneous materials of such component **is beyond** the limit required by GB/T 26572.

X*: Exemptions applied according to EU RoHS 2011/65 Annex III and IV.

This statement is based on information and data provided by third parties and may not have been verified through destructive testing methods or other chemical analysis.

zh-CN 本表格依据中华人民共和国SJ/T11364的规定编制。

模型: ISC-B01, ISC-02, ISC-03, LBK-S01

部件名称	有害物质					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr (VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
铝、铁、铜合金	X*	O	O	O	O	O
电触头	O	O	O	O	O	O
印制板装置	O	O	O	O	O	O
塑料制品	O	O	O	O	O	O

本表格依据SJ/T11364的规定规制。

O: 表示该有害物质在该部件所有均质材料中的含量均在GB/T 26572规定的限量要求以下。

X: 表示该有害物质至少在该部件的某一均质材料中的含量超出GB/T 26572规定的限量要求。

X*: 根据欧盟RoHS 2011/65的附件III和IV适用豁免。

本声明基于第三方提供的信息和数据, 可能未经破坏性检测方法或其他化学分析进行验证。

2.3 National restrictions

2.3.1 FRANCE AND THE UNITED KINGDOM

LBK System Series is a short-range device in class 2 in accordance with the directive 2014/53/EU (RED - Radio equipment) and is subject to the following restrictions:

	FR	UK

en Restrictions in UK and France. In the United Kingdom and in France, the national allocation of frequencies does not allow the free use of the whole band 24-24.25 GHz. Set the country correctly in the Inxpect Safety application and the authorized band 24.05-24.25 GHz will be automatically selected.

fr Restrictions en FR. En France, la répartition nationale des fréquences ne permet pas l'utilisation libre de la totalité de la bande 24-24,25 GHz. Définissez correctement le pays dans l'application Inxpect Safety et la bande autorisée 24,05-24,25 GHz sera automatiquement sélectionnée.

2.3.2 JAPAN

en Restrictions in Japan. In Japan, the national allocation of frequencies does not allow the free use of the whole band 24-24.25 GHz. Set the country correctly in the Inxpect Safety application and the authorized band 24.05-24.25 GHz will be automatically selected.

ja 日本における制限。日本では、全国的な周波数割り当てでは、24～24.25 GHzの全帯域を自由に使用することはできません。Inxpect Safetyアプリケーションで国を正しく設定すると、許可された帯域24.05-24.25 GHzが自動的に選択されます。

2.3.3 SOUTH KOREA

en Restrictions in South Korea. In South Korea, the national allocation of frequencies does not allow the free use of the whole band 24-24.25 GHz. Set the country correctly in the Inxpect Safety application and the authorized band 24.05-24.25 GHz will be automatically selected.

ko 한국의 제한. 한국에서는 국가의 주파수 할당 규정에 따라 24-24.25 GHz 전체 주파수 대역을 무료로 사용하는 것을 허용하지 않는다. Inxpect Safety 응용프로그램에서 올바른 국가를 설정하면 승인된 대역 24.05-24.25 GHz가 자동으로 선택된다.

2.3.4 ARGENTINA

en Restrictions in Argentina. In Argentina, the national allocation of frequencies does not allow the free use of the whole band 24-24.25 GHz. Set the country correctly in the Inxpect Safety application and the authorized band 24.05-24.25 GHz will be automatically selected.

es-AR Restricciones en Argentina. La atribución de las bandas de frecuencia en la República Argentina no permite el uso libre de toda la banda de 24-24,25 GHz. Configure correctamente el país en la aplicación Inxpect Safety y la banda autorizada 24,05-24,25 GHz se seleccionará automáticamente.

2.3.5 MEXICO

en Restrictions in Mexico. In Mexico, the national allocation of frequencies does not allow the free use of the whole band 24-24.25 GHz. Set the country correctly in the Inxpect Safety application and the authorized band 24.05-24.25 GHz will be automatically selected.

es-MX Restricciones en México. La atribución de las bandas de frecuencia en México no permite el uso libre de toda la banda de 24-24,25 GHz. Configure correctamente el país en la aplicación Inxpect Safety y la banda autorizada 24,05-24,25 GHz se seleccionará automáticamente.

2.3.6 RUSSIAN FEDERATION

en Restrictions in Russian Federation. In Russia Federation, the national allocation of frequencies does not allow the free use of the whole band 24-24.25 GHz. Set the country correctly in the Inxpect Safety application and the authorized band 24.05-24.25 GHz will be automatically selected.

ru Ограничения в Российской Федерации. Порядок использования частот в Российской Федерации не предусматривает свободного использования всего диапазона 24-24,25 ГГц. Необходимо правильным образом выбрать страну в приложении Inxpect Safety, после чего разрешенный диапазон 24,05-24,25 ГГц будет выбран автоматически.

2.3.7 CHINA

en Restrictions in China. Use in China is strictly linked to compliance with the temperature range of operation, which can not fall below 0° C or 32° F.

zh-CN 中国的限制。在中国使用须严格符合操作温度范围，不能低于0°C或32°F。

3. Get to know LBK System Series

Contents

This section includes the following topics:

Product label description

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

Part	Description
DC	"yy/ww" : year and week of the product manufacture
SRE	Safety Radar Equipment
Model	Product model (e.g. LBK-S01, ISC-B01)
Type	Product variant, used for commercial purposes only
S/N	Serial number

3.1 LBK System Series

3.1.1 Definition

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

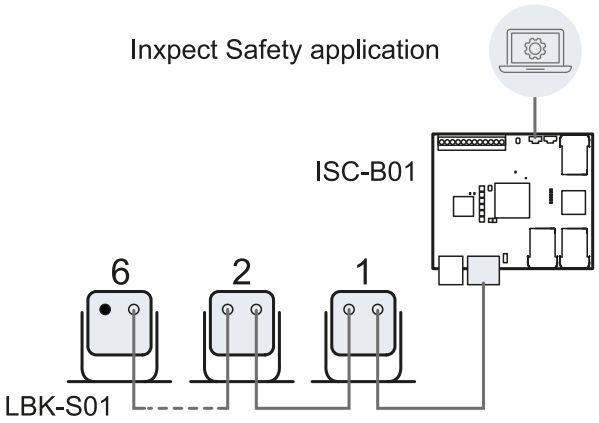
3.1.2 Special features

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

- up to two safe detection fields to signal proximity or prepare the machinery for stopping
- 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
- three configurable sensitivity levels
- 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)

3.1.3 Main components

LBK System Series is composed of a control unit and up to six sensors. The Inxpect Safety application allows system operation configuration and checks.



3.1.4 Control unit - sensor communication

The sensors communicate with the control unit 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 (Node ID).

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

3.1.5 Control unit - machinery communication

The control units communicate with the machinery via I/O ("Inputs" on page 20 and "Outputs" on page 21).

The ISC-B01 control unit is provided with a safety communication on a Fieldbus interface. The Fieldbus interface allows the ISC-B01 control unit 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)

See "Fieldbus communication" on page 26.

The ISC-B01 and ISC-02 are provided with an Ethernet port that allows an unsafe communication on a Modbus interface. See "Modbus communication" on page 27.

3.1.6 Applications

LBK System Series integrates with the machinery control system: when performing safety functions or detecting failures, LBK System Series 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 System Series can be connected to the devices that control the power supply or machinery start-up.

LBK System Series does not perform normal machinery control functions.

For connection examples, see "Electrical connections" on page 91.

3.2 LBK System Series control units

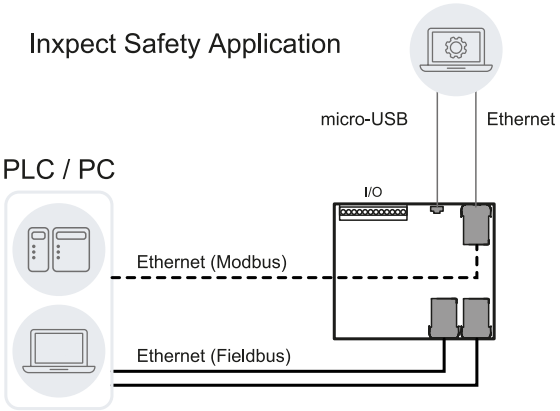
3.2.1 Control units supported

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

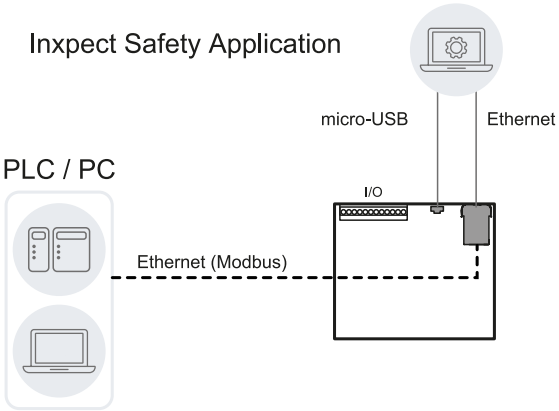
- ISC-B01: two Ethernet ports for Fieldbus, an Ethernet port for system configuration and Modbus communication and a micro-USB port
- ISC-02: an Ethernet port for system configuration and Modbus and a micro-USB port
- ISC-03: a micro-USB port

Safe

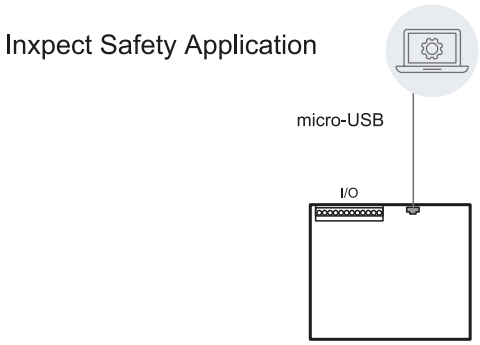
Unsafe



ISC-B01 communication architecture.



ISC-02 communication architecture.



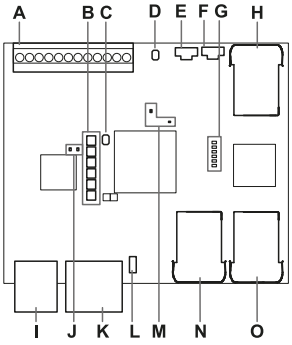
ISC-03 communication architecture.

3.2.2 Functions

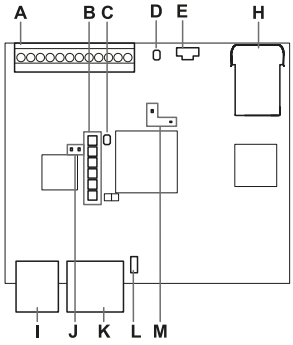
The control unit performs the following functions:

- Collects information from all the sensors via CAN bus.
- Compares the position of detected motion with the set values.
- Deactivates the dedicated 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 control unit.
- Manages the inputs and outputs.
- Communicates with the Inxpect Safety application for all configuration and diagnostic functions.
- Allows dynamically switching between different configurations.
- Communicates with a safety PLC through the Fieldbus connection (if available)
- Communicates and exchanges data through Modbus protocol (if available)

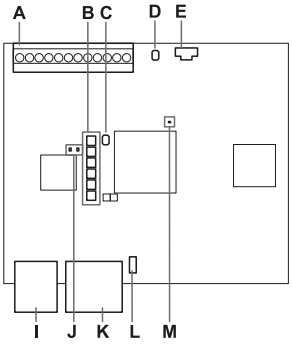
3.2.3 Structures



ISC-B01



ISC-02



ISC-03

Part	Description	Control unit
A	I/O terminal block	ISC-B01, ISC-02, ISC-03
B	System status LEDs	ISC-B01, ISC-02, ISC-03
C	Network parameter reset button	ISC-B01, ISC-02, ISC-03
D	Reserved for internal use. Output reset button	ISC-B01, ISC-02, ISC-03
E	Micro-USB port for connecting the PC and communicating with the Inxpect Safety application	ISC-B01, ISC-02, ISC-03
F	Micro-USB port (reserved)	ISC-B01
G	Fieldbus status LEDs See "Fieldbus status LEDs" on the next page	ISC-B01
H	Ethernet port with LEDs for connecting the PC, communicating with the Inxpect Safety application, and for Modbus communication	ISC-B01, ISC-02
I	Power supply terminal block	ISC-B01, ISC-02, ISC-03
J	Power supply LEDs (steady green)	ISC-B01, ISC-02, ISC-03
K	CAN bus terminal block for connecting the first sensor	ISC-B01, ISC-02, ISC-03
L	DIP switch to turn on/off the bus termination resistance: • On (top position, default) = resistance included • Off (bottom position)= resistance excluded	ISC-B01, ISC-02, ISC-03

Part	Description	Control unit

M	CPU LEDs:
	• on the right: status of hardware functions of the primary micro-controller
	  • off: normal behavior
	  • steady red: contact assistance service
	• only for ISC-B01 and ISC-02, on the left: status of hardware functions of the secondary micro-controller
	  • slow flashing orange: normal behavior
	  • other status: contact assistance service
		ISC-B01, ISC-02, ISC-03

N	Ethernet Fieldbus port n. 1 with LEDs	ISC-B01
O	Ethernet Fieldbus port n. 2 with LEDs	ISC-B01

3.2.4 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 "Control unit LED" on page 73
Steady red	System error. See "Control unit LED" on page 73
Flashing green	Sensor in boot status. See "Control unit LED" on page 73

3.2.5 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 assistance service
F2 (boot)	Off	Normal behavior
	Steady or flashing yellow	Contact assistance service
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)	-	-

3.2.6 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 (for details, see "Technical references" on page 86).

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 Inxpect Safety application. The available functions are the following:

- **Stop signal**: optional safety function, manages a specific signal to force all the safety outputs (detection signal 1 and detection signal 2, if present) to OFF-state.
- **Restart signal**: optional safety function, manages a specific signal which enables the control unit to switch to ON-state the safety outputs related to all the detection fields with no motion detected.
- **Muting group "N"**: optional safety function, manages a specific signal which allows the control unit to ignore the information coming from a selected group of sensors.
- **Activate dynamic configuration**: allows the control unit 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.
- **Acquisition Trigger**: manages a specific signal which allows using Multi-control unit Synchronization (for details, see "Multi-control unit Synchronization" on page 47).

For details about digital input signals, see "Digital input signals" on page 101.

3.2.7 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.

3.2.8 SNS input

The control unit 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.*

3.2.9 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 Inxpect Safety 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**: (e.g. warning signal) 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.*
- **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 parameters**), the dedicated 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 parameters**), the dedicated 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 dedicated input.
- **Acquisition Trigger**: manages a specific signal which allows using Multi-control unit Synchronization (for details, see "Multi-control unit Synchronization" on page 47).

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), or
- 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**), or
- each output as a single output (e.g. **System diagnostic signal**, **Muting enable feedback signal** and a **Restart Feedback signal**).

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

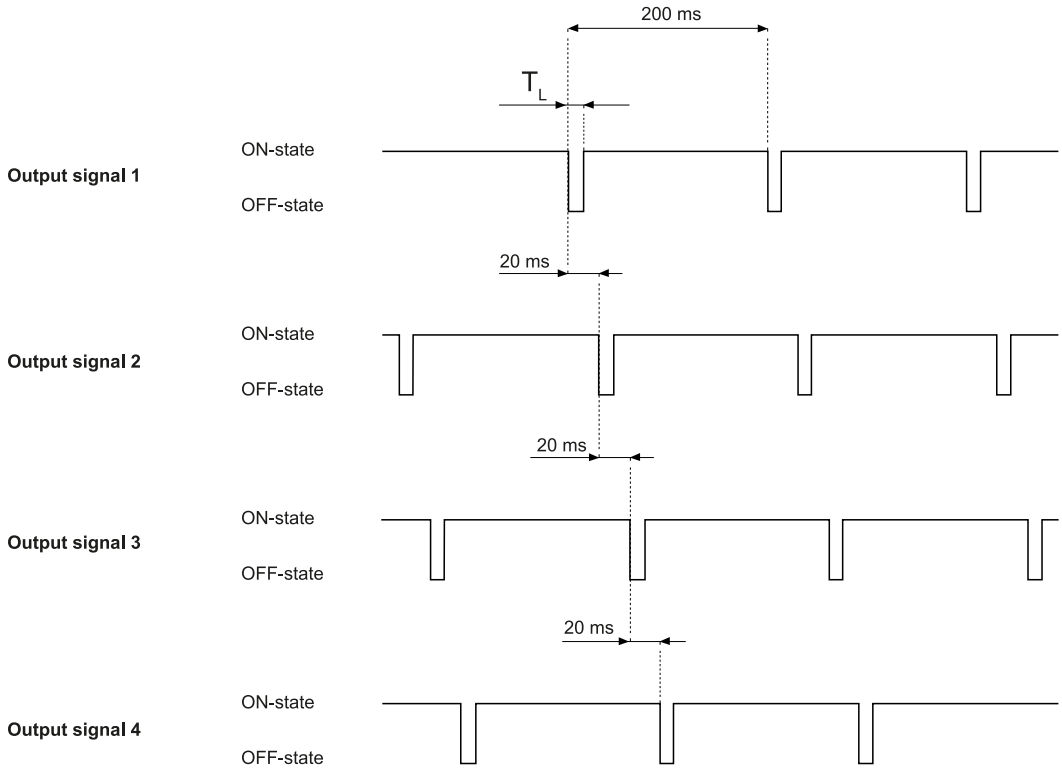
- OSSD 1 with OSSD 2
- OSSD 3 with OSSD 4

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 Inxpect Safety application (**Settings** > **Digital Input-Output** > **OSSD Pulse width**).



For details, see "Technical references" on page 86.

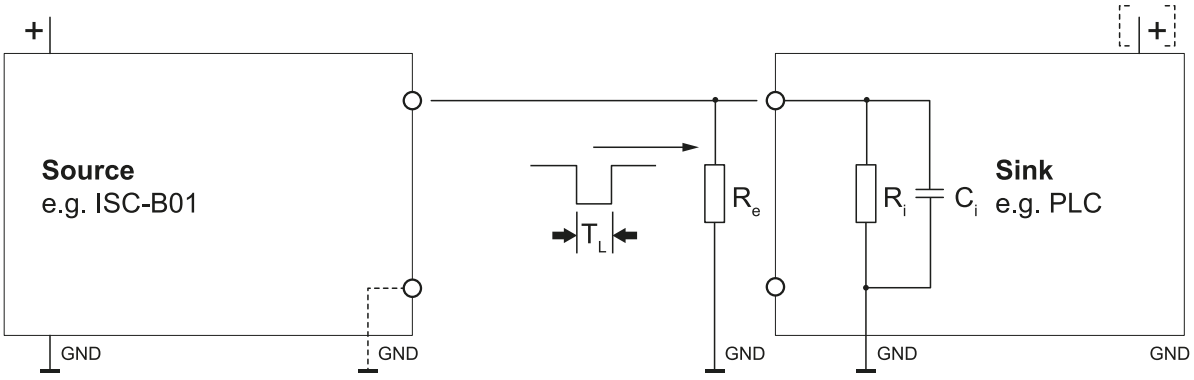
3.2.10 External resistor for OSSD outputs

To guarantee the correct connection between the OSSDs of the control unit 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 87.

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



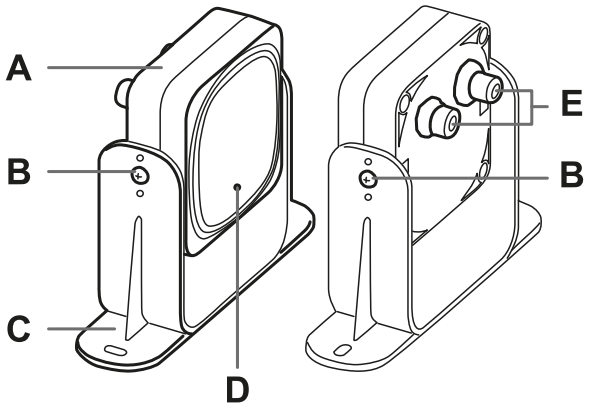
3.3 LBK-S01 sensors

3.3.1 Functions

The sensors perform the following functions:

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

3.3.2 Structure



Part	Description
A	Sensor
B	Screws for fastening the sensor at a specific inclination
C	Perforated bracket for installing the sensor on the ground or on the wall
D	Status LED
E	Connectors for connecting the sensors in a chain and to the control unit

3.3.3 Status LED

Status	Meaning
Steady on	Sensor is working. No motion detected.
Rapid flashing on (100 ms)	Sensor is detecting motion. Not available if the sensor is in muting.
Other conditions	Error. See "Sensor LED" on page 75

3.4 Inxpect Safety application

3.4.1 Functions

The application permits the following main functions to be performed:

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

WARNING! The Inxpect Safety application is designed only for the system configuration and for its first validation. If the application is used for monitoring the system continuously during the regular operation of the machinery, the system response time cannot be guaranteed. Use the application only for the functions for which it has been designed.

3.4.2 Inxpect Safety application usage

To use the application, the control unit must be connected to a computer with a data micro-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 control unit and the Inxpect Safety application is secured by the most advanced security protocols (TLS).

3.4.3 Access

The application can be downloaded free of charge at www.inxpect.com/industrial/tools.

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

Available functions	Access 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**)	without password
• Synchronize more control units (**Settings** > **Multi-control unit synchronization**) • Validate the system (**Validation**) • Restore factory default settings, if using Ethernet connection (**Settings** > **General**) • Download the system log and display reports (**Settings** > **Activity History**) • Check the current checksum for each dynamic configuration (Settings > **Configuration checksum**) • Configure the system (**Configuration**) • Load a configuration (**Settings** > **General**) • Change the admin password (**Settings** > **Account**) • Update the firmware (**Settings** > **General**) • Show and change the network parameters - if available (**Settings** > **Network Parameters**) • Show and change the Modbus parameters - if available (**Settings** > **Modbus Parameters**) • Show and change the Fieldbus parameters - if available (**Settings** > **Fieldbus Parameters**)	with password

3.4.4 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 73.*
Configuration	Define the monitored area. Configure the sensors and the detection fields. Define the dynamic configurations
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 73.*

Page	Function
Settings	Configure the sensors. Configure the auxiliary inputs and outputs function. 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). Update the firmware. Perform the configuration backup and load a configuration. Download the log. Other general functions.
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.

3.5 Fieldbus communication

3.5.1 Fieldbus support

The safety communication on the Fieldbus interface is supported only in the ISC-B01 control unit.

3.5.2 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 Reference guide.

3.5.3 Data exchanged through Fieldbus

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

WARNING! The system is in alarm if the "control unit 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 ISC-B01 control unit: • internal status • status of each of the four outputs • status of each of the two inputs LBK-S01 sensor: • status of each detection field (target detected or not) or error status • muting status	from the control unit
Safe	SYSTEM SETTING COMMAND ISC-B01 control unit: • set the ID of the dynamic configuration that shall be activated • set the status of each of the four outputs • fix the current accelerometer information • enable the restart signal LBK-S01 sensor: • set the muting status	to the control unit
Safe	DYNAMIC CONFIGURATION STATUS • ID of the dynamic configuration currently active • signature (CRC32) of the dynamic configuration ID currently active	from the control unit
Safe	TARGET DATA • Current distance of the target detected by each sensor connected to the control unit. For each sensor, only the closest target to the sensor is considered.	from the control unit
Unsafe	DIAGNOSTIC DATA ISC-B01 control unit: • internal status with an extended description of the error condition LBK-S01 sensor: • internal status with an extended description of the error condition	from the control unit
Unsafe	SYSTEM STATUS AND TARGET DATA	from the control unit

3.6 Modbus communication

3.6.1 Modbus support

The Modbus communication uses the Ethernet port (Modbus TCP) and consequently is only available for ISC-B01 and ISC-02 control units.

3.6.2 Modbus communication enabling

In the Inxpect Safety application, click on **Settings** > **Modbus Parameters** > **ON** to enable the feature.

Within the Ethernet network, the control unit 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**.

3.6.3 Data exchanged through Modbus

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

Data type	Description	Communication direction
Unsafe	SYSTEM STATUS DATA ISC-B01 or ISC-02 control unit: • internal status • status of each of the four outputs • status of each of the two inputs LBK-S01 sensor: • status of each detection field (target detected or not) or error status • muting status	from the control unit
Unsafe	DYNAMIC CONFIGURATION STATUS • ID of the dynamic configuration currently active • signature (CRC32) of the dynamic configuration ID currently active	from the control unit
Unsafe	TARGET DATA • Current distance of the target detected by each sensor connected to the control unit. For each sensor, only the closest target to the sensor is considered.	from the control unit
Unsafe	DIAGNOSTIC DATA ISC-B01 or ISC-02 control unit: • internal status with an extended description of the error condition LBK-S01 sensor: • internal status with an extended description of the error condition	from the control unit

3.7 System configuration

3.7.1 System configuration

The control unit parameters have their own default values that can be modified via the Inxpect Safety application (see "Parameters" on page 99).

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.*

3.7.2 Dynamic system configuration

LBK System Series allows a real-time adjustment of the most important system parameters, providing the means to switch dynamically among different preset configurations. Via the Inxpect Safety 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 (1 or 2)
- angular coverage (50° or 110° on the horizontal plane)

These are the programmable parameters for each detection field:

- detection distance
- safety working mode (**Both (default)**, **Always access detection** or **Always restart prevention**) (see

"Safety working modes and safety functions" on page 35)
- restart timeout

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

3.7.3 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.

3.7.4 Dynamic configuration through the digital inputs

To activate the dynamic system configuration, one or both the digital inputs of the control unit 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" below and "Example 2" below)
both digital inputs are used for the dynamic configuration	**four** preset configurations (see "Example 3" below)

***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

3.7.5 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 control unit. 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 System Series uses the digital input data and ignores the dynamic changes made through the safety Fieldbus.

WARNING! The firmware version 1.1.0 of the control unit does not support safety communication on the Fieldbus interface.

3.7.6 Safe configuration switch

WARNING! The new dynamic configuration is activated every time the command is received (via digital input or Fieldbus command) regardless of the system status. Verify that the safety of the area is still guaranteed before switching to another configuration.

The usage of the feature can be split in the following two main categories, resulting in different consequences on the safety of the area.

Sensor mounted on movable machinery

While the machinery with the mounted sensor is moving, in the dynamic switch between different preset configurations the safety is always guaranteed. The sensor itself is moving and any kind of configuration will trip an alarm as soon as a relative movement is detected, even in case of a still person.

When the machinery with the mounted sensor stops, see "Sensor mounted on fixed machinery" below.

Sensor mounted on fixed machinery

If the machinery with the mounted sensor is fixed, the dynamic switch between different preset configurations is safe only if no one is in the monitored area. In fact, for example, if the new configuration has a longer detection field and a person stands still in the new monitored area, it won't be detected until the person moves.

4. Functioning principles

Contents

This section includes the following topics:

4.1 Sensor functioning principles

4.1.1 Introduction

LBK-S01 is an FMCW (Frequency Modulated Continuous Wave) radar device based on a proprietary detection algorithm. LBK-S01 is also a single target sensor that sends pulses and receives information, analyzing the reflection of the nearest moving target that it encounters.

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" on the next page.

4.1.2 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 System Series and cannot lead to a dangerous situation. These factors may occasionally influence the behavior of the system causing spurious activation of the safety function.

This behavior can be minimized with an ad hoc installation and a metal protector kit.

4.1.3 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.

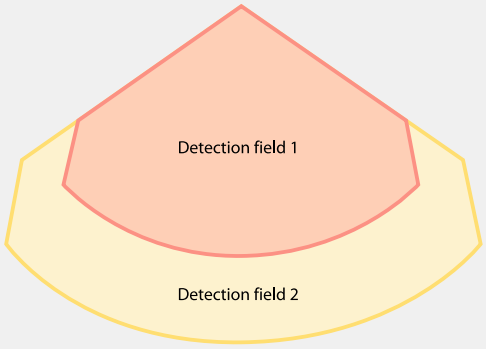
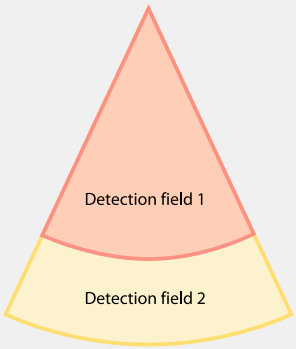
4.2 Detection fields

4.2.1 Introduction

The field of view of each sensor can be composed of up to two detection fields. Each of the two 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.

Detection field examples

Angular coverage	Detection fields
110°	
50°	

4.2.2 Detection field parameters

These are the programmable parameters for each sensor:

- angular coverage (50° or 110°)

These are the programmable parameters for each detection field:

- detection distance
- safety working mode (**Both (default)**, **Always access detection** or **Always restart prevention**) (see "Safety working modes and safety functions" on page 35)

4.2.3 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 detection field 1, the output related to detection field 2 is deactivated, too. Example Detection field configured: 1, 2 Detection field with target detected: 1 Detection field in alarm status: 1, 2 • if a sensor detects motion within detection field 2, only the output related to detection field 2 is deactivated. Example Detection field configured: 1, 2 Detection field with target detected: 2 Detection field in alarm status: 2
the **Independent mode** is set and thus detection fields are independent from each other	• if a sensor detects motion within detection field 1, only the output related to detection field 1 is deactivated. Example Detection field configured: 1, 2 Detection field with target detected: 1 Detection field in alarm status: 1 • if a sensor detects motion within detection field 2, only the output related to detection field 2 is deactivated. Example Detection field configured: 1, 2 Detection field with target detected: 2 Detection field in alarm status: 2

WARNING! If detection fields are independent, an evaluation of the safety of the monitored area must be performed during the risk assessment. LBK-S01 is a single target sensor. This means that when a target is detected in detection field 1 of a sensor, detection field 2 becomes temporarily blind.

In the **Inxpect Safety** application, click on **Settings** > **Sensors** > **Detection field dependency** to set the dependency mode of the detection fields.

4.3 System category (according to EN ISO 13849)

4.3.1 System safety degree

Both control unit (ISC-B01, ISC-02 and ISC-03) and LBK-S01 are classified PL d according to EN ISO 13849-1, and SIL 2 according to IEC/EN 62061.

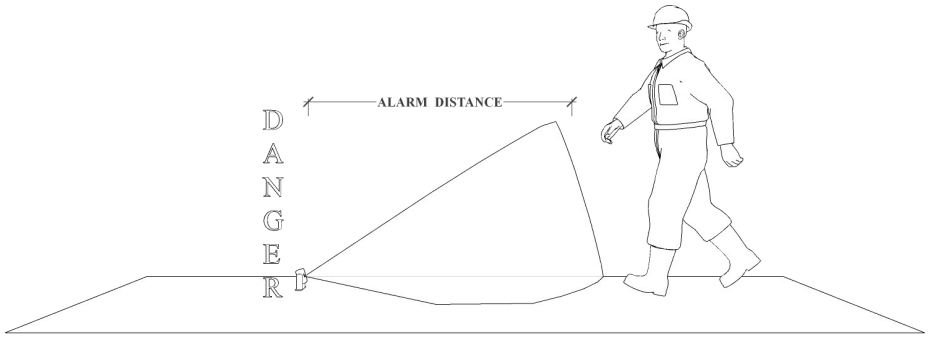
According to EN ISO 13849-1, the architectures of the control unit and LBK-S01 sensor are classified respectively as category 3 equivalent and category 2. Since LBK System Series is composed of the control unit and sensors together, it can be classified category 2 or category 3 equivalent based on the installation configuration and layout.

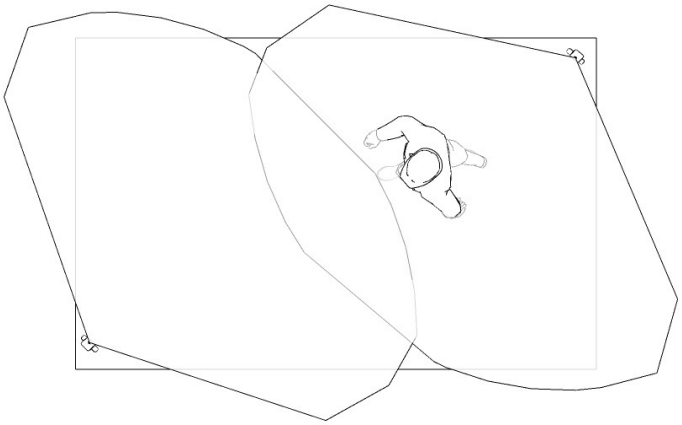
LBK System Series compliance with PL d, category 2 architecture is always guaranteed, and does not require the installer to perform any additional operation. There is no parameter combination that can lead to a configuration which has a risk reduction lower than PL d, category 2.

On the contrary, compliance with PL d, category 3 equivalent architecture requires a specific configuration of the system sensors.

4.3.2 PL d, category 2 configuration

Sensors connected to the same control unit operate independently. They can have different positions, configurations and safety working modes (see "Safety working modes and safety functions" on the next page). Some architecture examples are as follows:





4.3.3 PL d, category 3 configuration

Requirements

Sensors must be installed with a redundant configuration to cover the same dangerous area, thus creating a 1oo2 multi-channel architecture.

To reach a category 3 equivalent architecture, the following requirements must be met:

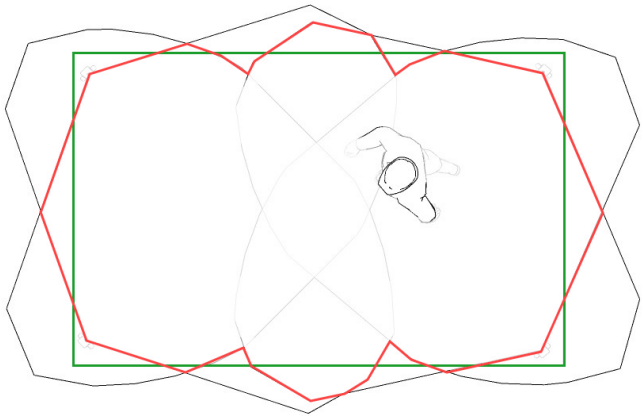
- At least two sensors must monitor the same dangerous area at the same time.
- Sensors that monitor the same area must have the same safety working mode. Assuming that an area is monitored by two sensors, the valid safety working mode combinations are the following:
  - Sensor 1: access detection, Sensor 2: access detection
  - Sensor 1: both access detection and restart prevention, Sensor 2: both access detection and restart prevention
  - Sensor 1: restart prevention, Sensor 2: restart prevention
- Sensors that monitor the same area must have the same restart timeout.
- The muting of sensors that monitor the same area must be enabled or disabled at the same time.

If multiple configurations were stored on the control unit, each individual configuration should comply with the requirements listed above in order to classify the system as category 3 equivalent.

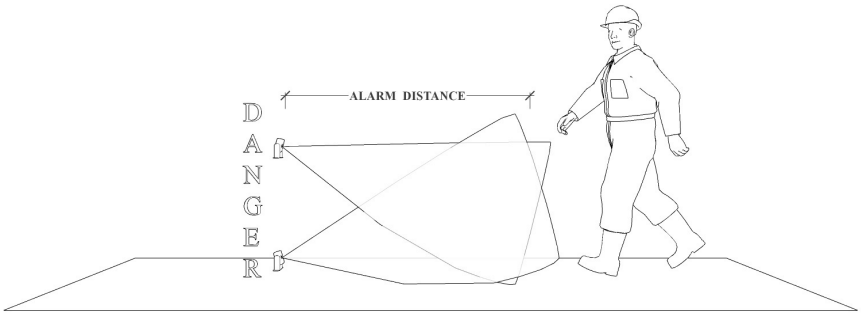
Position

Two sensors covering the same area should not necessarily be installed in the same position. The system monitored area is defined as the area covered by two or more sensor detection fields. Following are some examples:

- Actual monitored area in category 3 (red) and dangerous area (green) covered by the detection fields of two or more sensors that comply with a category 3 equivalent architecture:



- Sensors belonging to each pair that are installed on two different heights and have the same detection fields:



***NOTICE**: For the safety parameters of the category 3 architecture that apply, see "Technical references" on page 86.*

4.4 Safety working modes and safety functions

4.4.1 Introduction

Each sensor can perform the following safety working modes:

- **Both (default)**
- **Always access detection**
- **Always 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 a person enters the dangerous area.
Restart prevention	The machinery is prevented from restarting if people are in the dangerous area.

4.4.2 Safety working modes

Via the Inxpect Safety 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 access detection**:
  - the sensor always performs the access detection function (**No alarm** status + **Alarm** status)
- **Always restart prevention**:
  - the sensor always performs the restart prevention function (**No alarm** status + **Alarm** status)

Inside the field of view of each sensor you can set up to two detection fields:

- Detection field 1, e.g. used as alarm area
- Detection field 2, e.g. used as warning area

4.4.3 Safety working modes examples

The following examples show the four possible combinations of the safety working modes of LBK System Series and what changes if the motion is detected in detection field 1 or detection field 2.

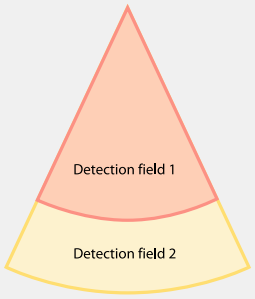
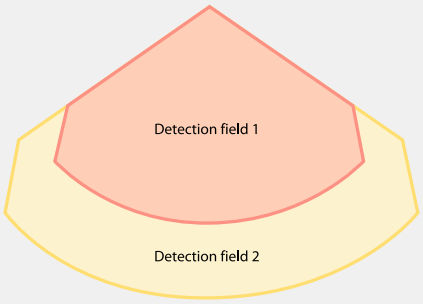
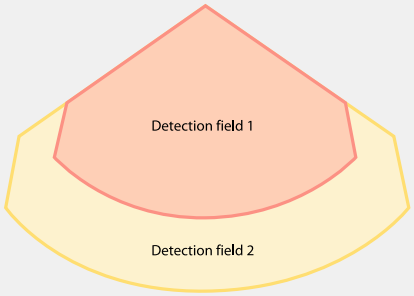
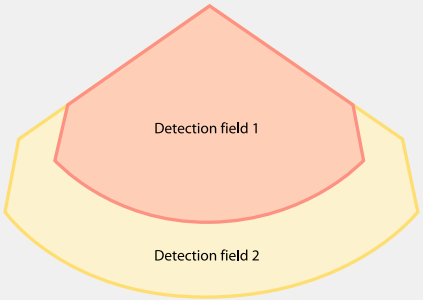
Example 1

The combination is the following:

- Detection field 1: **Both (default)**
- Detection field 2: **Both (default)**

Once an alarm is notified, a sensor set with a 50° angular coverage changes its angular coverage to 110°.

***NOTICE**: during the configuration phase, take this aspect into consideration to avoid generating undesired alarms.*

Angular coverage	No alarm status	Alarm status
50°	 • Detection field 1: access detection function • Detection field 2: access detection function	 • Detection field 1: restart prevention function • Detection field 2: restart prevention function
110°	 • Detection field 1: access detection function • Detection field 2: access detection function	 • Detection field 1: restart prevention function • Detection field 2: restart prevention function

If the motion is detected in the...	Then the output of detection field 1...	And the output of detection field 2...
detection field 1	is deactivated and switches to the restart prevention function	is deactivated and switches to the restart prevention function
detection field 2	remains active and switches to the restart prevention function	is deactivated and switches to the restart prevention function

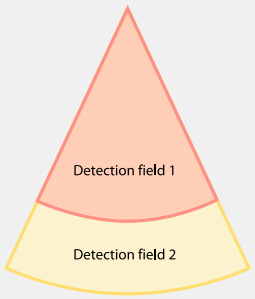
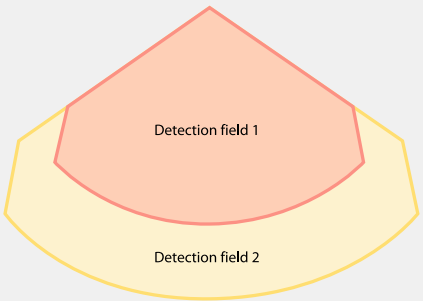
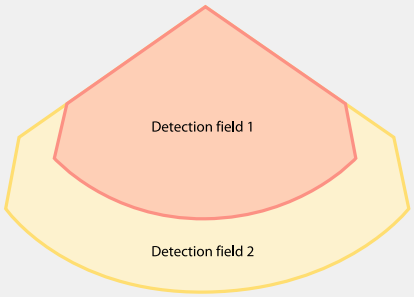
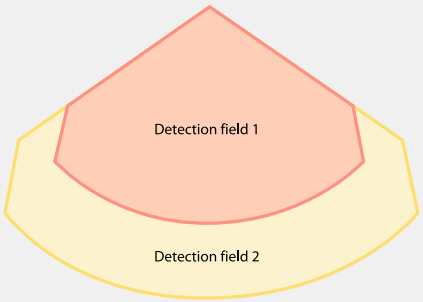
Example 2

The combination is the following:

- Detection field 1: **Both (default)**
- Detection field 2: **Always access detection**

Once an alarm is notified, a sensor set with a 50° angular coverage changes its angular coverage to 110°.

***NOTICE**: during the configuration phase, take this aspect into consideration to avoid generating undesired alarms.*

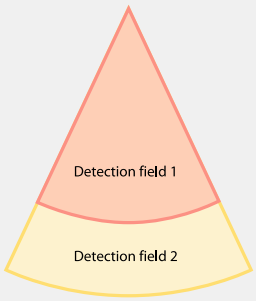
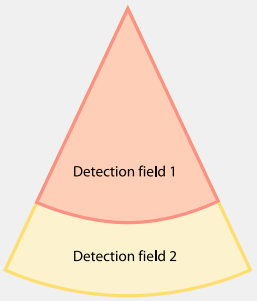
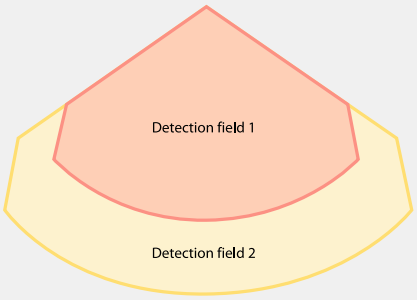
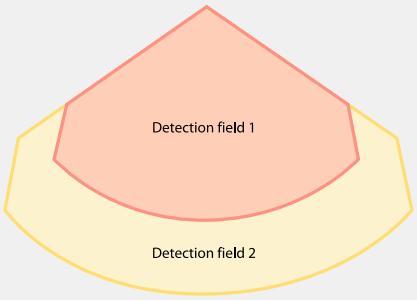
Angular coverage	No alarm status	Alarm status
50°	 • Detection field 1: access detection function • Detection field 2: access detection function	 • Detection field 1: restart prevention function • Detection field 2: access detection function
110°	 • Detection field 1: access detection function • Detection field 2: access detection function	 • Detection field 1: restart prevention function • Detection field 2: access detection function

If the motion is detected in the...	Then the output of detection field 1...	And the output of detection field 2...
detection field 1	is deactivated and switches to the restart prevention function	is deactivated
detection field 2	remains active and switches to the access detection function	is deactivated and remains in the access detection function

Example 3

The combination is the following:

- Detection field 1: **Always access detection**
- Detection field 2: **Always access detection**

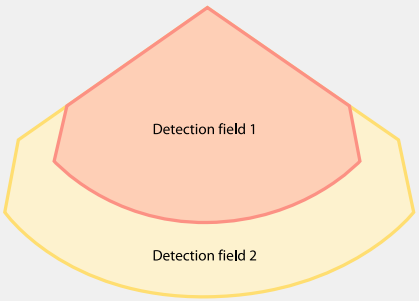
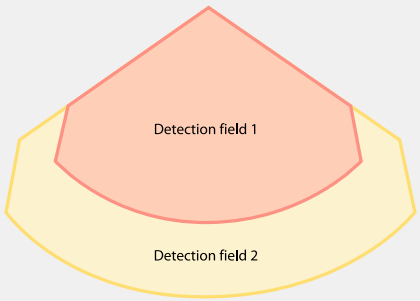
Angular coverage	No alarm status	Alarm status
50°	 • Detection field 1: access detection function • Detection field 2: access detection function	 • Detection field 1: access detection function • Detection field 2: access detection function
110°	 • Detection field 1: access detection function • Detection field 2: access detection function	 • Detection field 1: access detection function • Detection field 2: access detection function

If the motion is detected in the...	Then the output of detection field 1...	And the output of detection field 2...
detection field 1	is deactivated and remains in the access detection function	is deactivated and remains in the access detection function
detection field 2	remains active and in the access detection function	is deactivated and remains in the access detection function

Example 4

The combination is the following:

- Detection field 1: **Always restart prevention**
- Detection field 2: **Always restart prevention**

Angular coverage	No alarm status	Alarm status
110°	 • Detection field 1: restart prevention function • Detection field 2: restart prevention function	 • Detection field 1: restart prevention function • Detection field 2: restart prevention function

If the motion is detected in the...	Then the output of detection field 1...	And the output of detection field 2...
detection field 1	is deactivated and remains in the restart prevention function	is deactivated and remains in the restart prevention function
detection field 2	remains active and in the restart prevention function	is deactivated and remains in the restart prevention function

4.5 Safety working mode: Both (default)

4.5.1 Introduction

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

- access detection
- restart prevention

4.5.2 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

4.5.3 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.

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 all the sensors have a 110° angular coverage.

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).

4.6 Safety working mode: Always access detection

4.6.1 Safety function: access detection

This is the only safety function available for the **Always 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 angular coverage and sensitivity remain as they were before the motion detection

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

4.6.2 T_{OFF} parameter

If the safety working mode is **Always 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.

4.7 Safety working mode: Always restart prevention

4.7.1 Safety function: restart prevention

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

The restart prevention 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 remains active • the angular coverage and sensitivity remain as they were before motion 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 all the sensors have a 110° angular coverage.

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).

4.8 Features of the restart prevention function

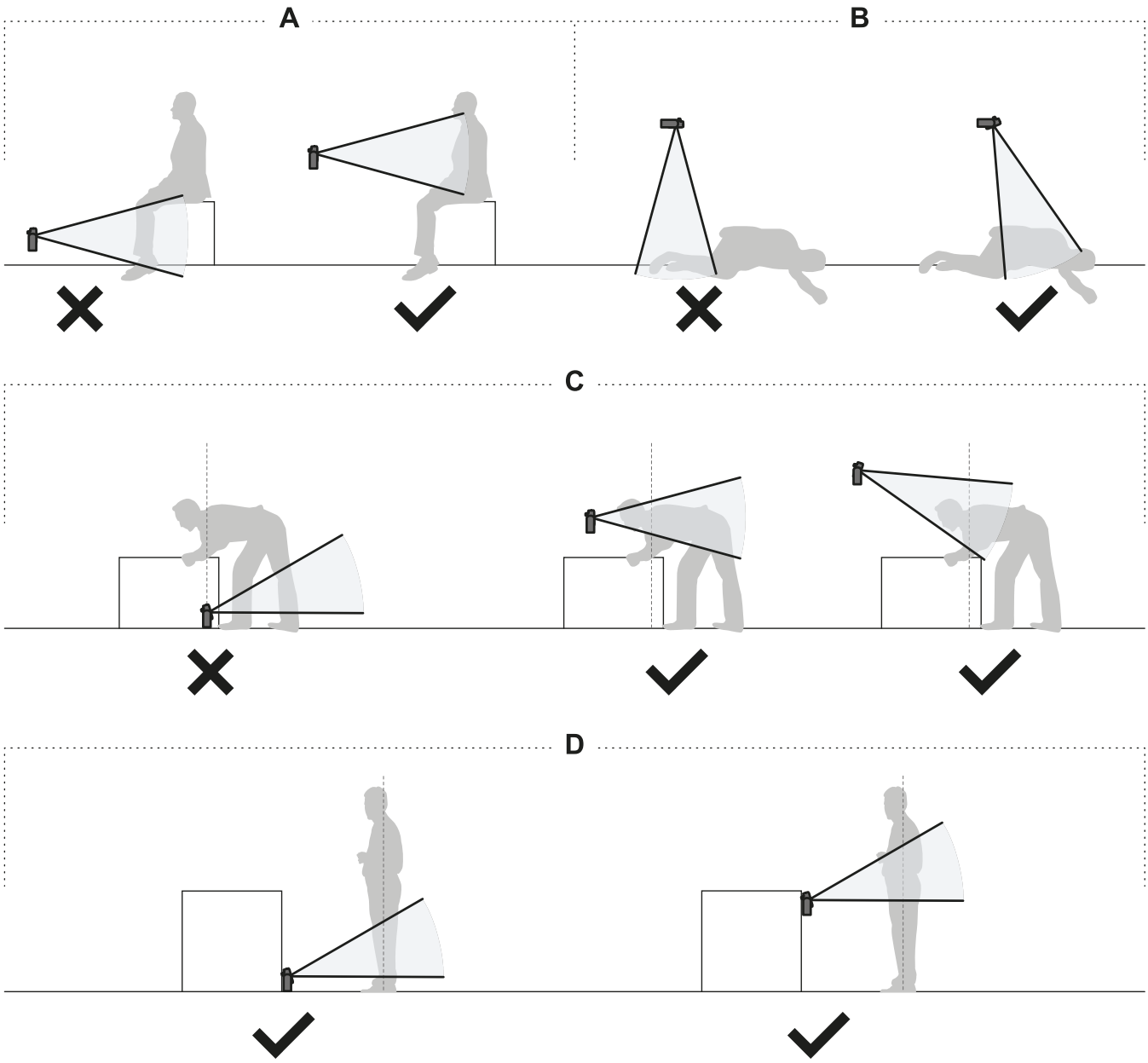
4.8.1 Cases of non-guaranteed function

The function is not guaranteed in the following cases:

- there are objects that limit or prevent the sensor from detecting motion.
- the 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]**.



4.8.2 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 Inxpect Safety application (**Restart timeout**) has passed since the last motion detection*.	All
Manual	The **Restart signal** was received correctly** (see "Restart signal" on page 104).	**Always access detection**
Safe manual	1. The time interval set through the Inxpect Safety 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 104).	**Both (default)** and **Always restart prevention**

***Note ***: machinery restart is enabled if no motion is detected up to 30 cm (11.8 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.)*

4.8.3 Precautions for preventing unexpected restarting

To prevent unexpected restarting the following rules must be followed:

- the set restart timeout must be greater than or equal to 10 s.
- if the sensor is installed at a height of less than 30 cm (11.8 in) from the ground, a minimum distance of 30 cm (11.8 in) from the sensor must be guaranteed.

4.8.4 Configure the restart prevention function

Type	Procedure
Automatic	1. In the Inxpect Safety application in **Settings** > **Restart parameters**, select **Automatic**. 2. In the Inxpect Safety 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 $\mathbf{T_{OFF}}$ parameter, if present).
Manual	1. In the Inxpect Safety application in **Settings** > **Restart parameters**, 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 91. 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 Inxpect Safety application, in **Configuration** for each detection field in use with manual restart, set the $\mathbf{T_{OFF}}$ parameter value. ***Note**: the **Safety working mode** is automatically set to **Always access detection** for all the detection fields in use with manual restart.*
Safe manual	1. In the Inxpect Safety application in **Settings** > **Restart parameters**, 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 91. 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 Inxpect Safety 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.

4.9 Muting

4.9.1 Description

Muting temporarily suspends the safety functions. Motion detection is disabled and therefore the control unit maintains the safety outputs activated even when the sensors detect motion in detection field 1 or detection field 2 (if present).

4.9.2 Muting enabling

The muting function can be enabled through digital input (see "Enable muting signal characteristics" below) or safety Fieldbus (if available).

Through digital input 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 to a digital input.

Through the Inxpect Safety 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 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 64.

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

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

***Note**: the muting function remains deactivated until the system detects motion in the area.*

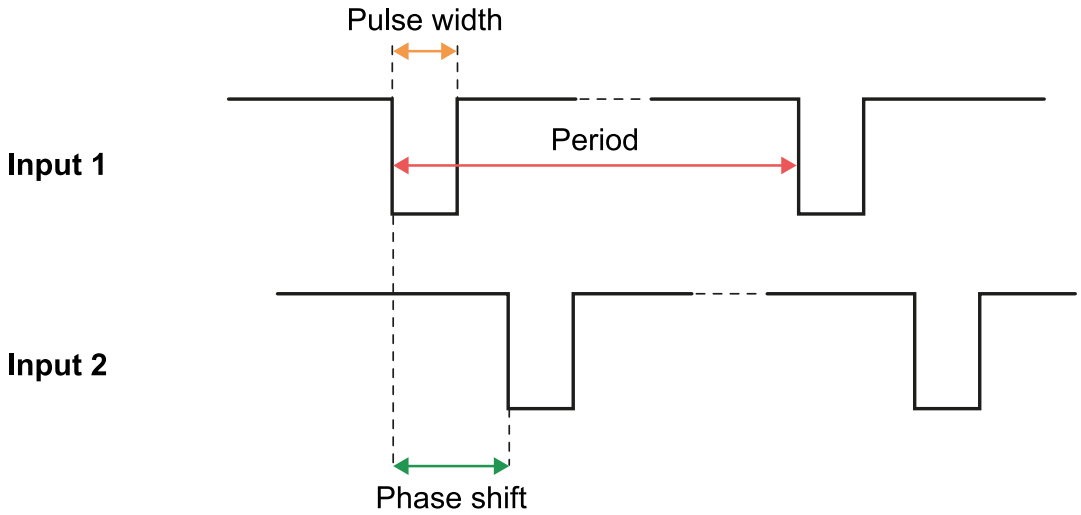
4.9.3 Muting activation

The muting function is activated only if all the detection fields are free from motion and the restart timeout has expired for all the detection fields.

4.9.4 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 **Inxpect Safety** 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.*

4.9.5 Muting status

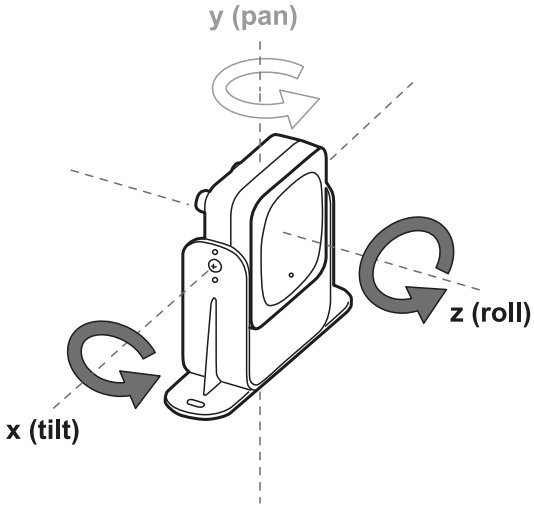
Any output dedicated to the muting status (Muting enable feedback signal) is activated if at least one of the groups of sensors is in muting.

***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).*

4.10 Anti-tampering functions: anti-rotation around axes

4.10.1 Anti-rotation around axes

The sensor detects rotation around its x-axis and z-axis.



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 control unit. Upon reception of a tampering signal, the control unit deactivates the safety outputs.

4.10.2 Disable the anti-rotation around axes function

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

In the Inxpect Safety application, in **Settings** click **Sensors** to disable the anti-rotation around axes function.

4.10.3 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 position is that defined by the configuration. Check that the monitored area is the same as defined by the configuration. See "Validate the safety functions" on page 68.
Restart prevention function	Each time the safety outputs are deactivated	

4.10.4 When to disable

It may be necessary to disable the anti-rotation around axes function if the sensor is installed on a moving object (e.g. carriage, vehicle) whose motion would change the sensor inclination (e.g. motion on a slope or in a curve).

4.11 Anti-tampering functions: anti-masking

4.11.1 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 control unit. Upon receiving a masking signal, the control unit 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.*

4.11.2 Environment memorization process

The sensor starts the surrounding environment memorization process when the Inxpect Safety 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.

4.11.3 Causes of masking

Possible causes of masking signals are presented as follows:

- 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.
- temperature fluctuations.

4.11.4 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.

4.11.5 Sensitivity level

The anti-masking function has four levels of sensitivity:

Level	Description	Example application
High	The system 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 system 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.

Level	Description	Example application
Low	The system 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 system 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 Inxpect Safety application click **Settings** and then **Sensors**.

4.11.6 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	

4.11.7 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).

4.12 Multi-control unit Synchronization

4.12.1 Introduction

The multi-control unit synchronization function is necessary when multiple LBK System Series are sharing the same area and it allows the interferences between their sensors to be removed using a time synchronization signal.

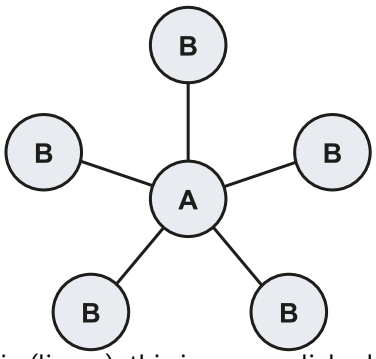
***Note**: the function can be used only if all the sensors have the safety working mode set to **Always restart prevention**.*

4.12.2 Network topology

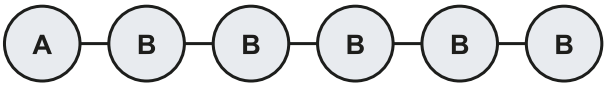
The control units must be connected in a master/slave cabling topology. The following topologies are allowed:

***Note**: the maximum number of slaves that can be connected is 8.*

- Star: every peripheral node (slave **B**, i.e. control unit) is connected to a central node (master **A**, i.e. control unit, PLC, or square wave generator).



Daisy chain (linear): this is accomplished by connecting each slave **B** (control unit) in series after the master **A** (control unit, PLC, or square wave generator).



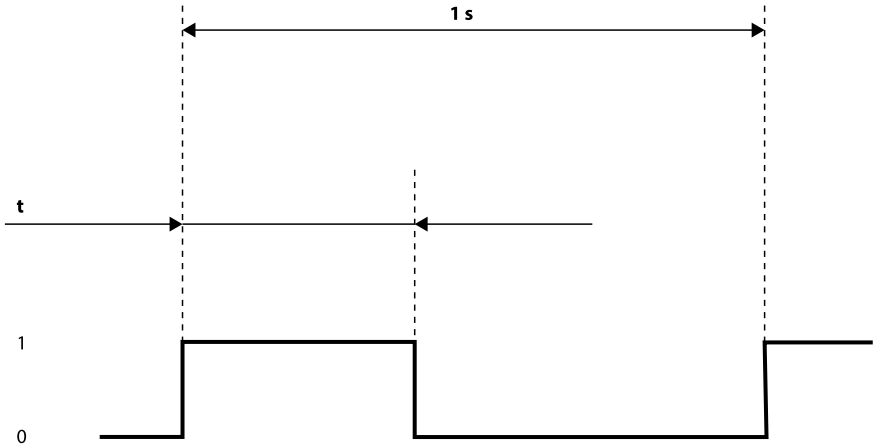
4.12.3 Trigger source

The following synchronization sources are allowed:

- Internal source: the source is the control unit, which acts as the network master.
- External source: the source is a PLC or a square wave generator, which acts as the network master.

4.12.4 Required signal

The control units need a 1 Hz synchronization signal frequency. The digital signal required from the trigger (master) to all the control units (slaves) is described in the image below.



With *t* in the range [6 ms, 500 ms].

Synchronization takes place on the rising edge of the signal.

***Note**: if the trigger source is internal, the signal is automatically generated by the control unit (master).*

***Note**: if the topology is daisy chain (linear), the signal is automatically propagated between the slaves without any relevant delay.*

4.12.5 Enable the multi-control unit synchronization function

1. For each control unit, in the Inxpect Safety application click **Settings** > **Multi-control unit synchronization** and assign a different **Control unit channel**.

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

2. Click Configuration and set the **Safety working mode** parameter to **Always restart prevention** for all the sensors.
3. Click **Settings** > **Digital Input-Output** and set the digital input-output as follows:

If the network topology is...	And the control unit is...	Then...
star	master*	Configure two of the digital outputs as **Acquisition Trigger**.
	slave	Configure one of the digital inputs as **Acquisition Trigger**.
daisy chain (linear)	master*	Configure two of the digital outputs as **Acquisition Trigger**.
	slave (except the last in the chain)	1. Configure one of the digital inputs as **Acquisition Trigger** 2. Configure two of the digital outputs as **Acquisition Trigger**.
	slave (last of the chain)	Configure one of the digital inputs as **Acquisition Trigger**.

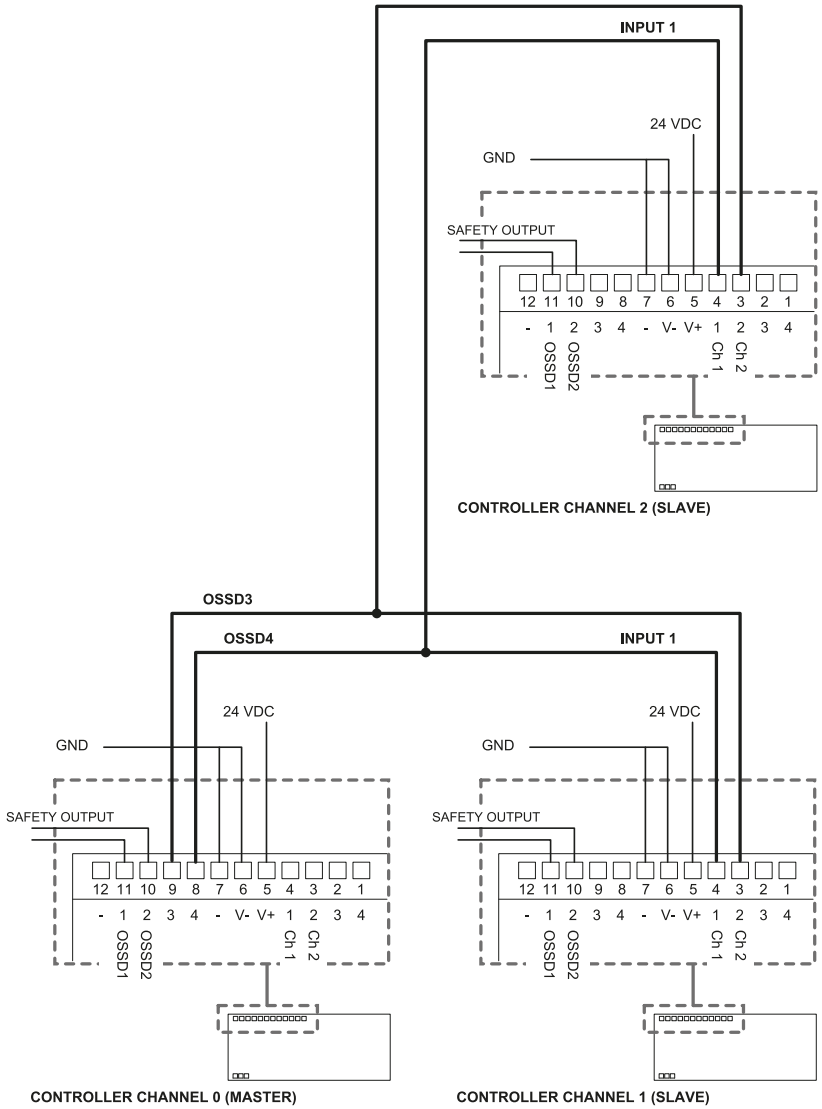
Note*: *present only if the trigger source is internal.*

4. Connect the cables on the I/O terminal blocks of the control unit. See "Electrical connections" on the next page for more details.

4.12.6 Electrical connections

Star example

Internal trigger source (control unit Master) + 2 control units (Slaves)

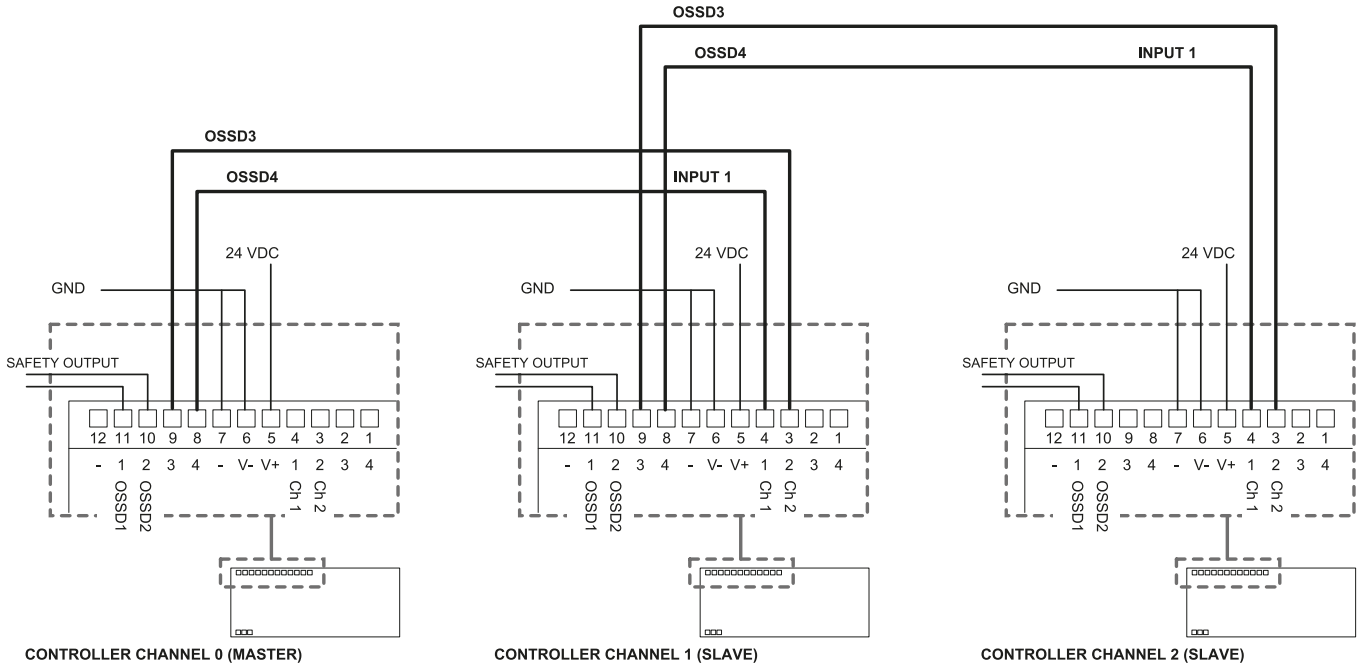


In this example:

- Control unit channel 0 (Master) has OSSD3 and OSSD4 configured as **Acquisition Trigger**.
- Control unit channel 1 (Slave) has Digital Input 1 configured as **Acquisition Trigger**.
- Control unit channel 2 (Slave) has Digital Input 1 configured as **Acquisition Trigger**.

Daisy chain (linear) example

Internal trigger source (control unit Master) + 2 control units (Slaves)



In this example:

- Control unit channel 0 (Master) has OSSD3 and OSSD4 configured as **Acquisition Trigger**.
- Control unit channel 1 (Slave) has OSSD3 and OSSD4 configured as **Acquisition Trigger**, and Digital Input 1 configured as **Acquisition Trigger**.
- Control unit channel 2 (Slave) has Digital Input 1 configured as **Acquisition Trigger**.

5. Sensor position

Contents

This section includes the following topics:

5.1 Basic concepts

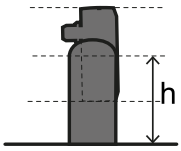
5.1.1 Determining factors

The sensor installation height and inclination depend on the optimum position of the sensor. The optimum position of the sensor depends on what follows:

- sensor field of view
- depth of the dangerous area (and therefore the detection field)
- the presence of other sensors

5.1.2 Sensor installation height

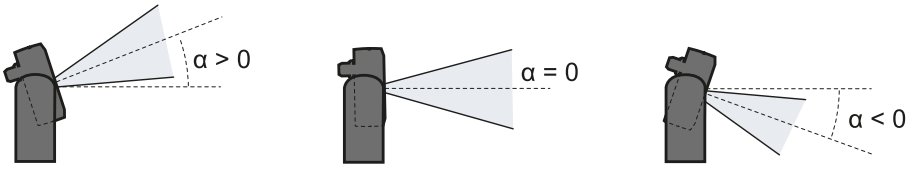
The installation height (h) is the distance between the center of the sensor and the ground or reference plane of the sensor.



5.1.3 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



5.2 Sensor field of view

5.2.1 Types of field of view

During the configuration phase, for each sensor it is possible to select the angular coverage of the field of view:

- 110°
- 50°

The actual detection field of the sensor also depends on the sensor installation height and inclination. See "Calculation of position for sensor height ≤ 1 m" on page 56 and "Calculation of position for sensor height > 1 m" on page 60.

5.2.2 Features of the 50° field of view

For the access detection function, the 50° field of view makes the sensor more resistant to interference from materials such as iron and water, which reflect the radar signal (e.g. iron shavings, water splatters, rain). It is therefore also suitable for outdoor installations.

WARNING! When the restart prevention function is active all the sensors have a 110° angular coverage, regardless of the set angular coverage.

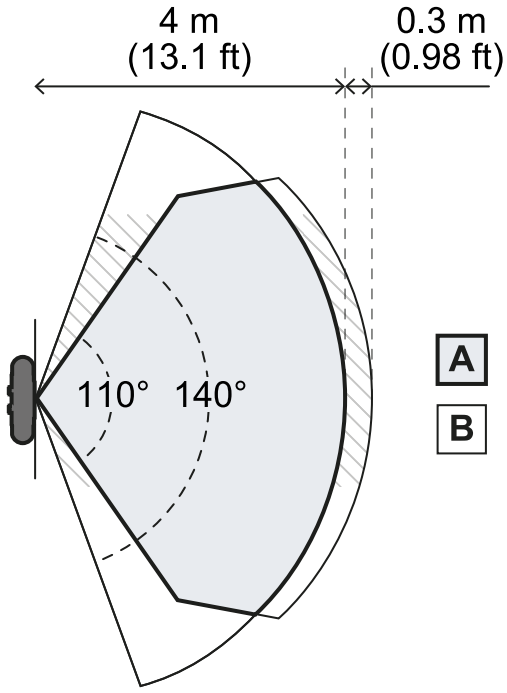
***NOTICE**: during the configuration phase, take this aspect into consideration to avoid generating undesired alarms.*

5.2.3 Areas and dimensions of the field of view

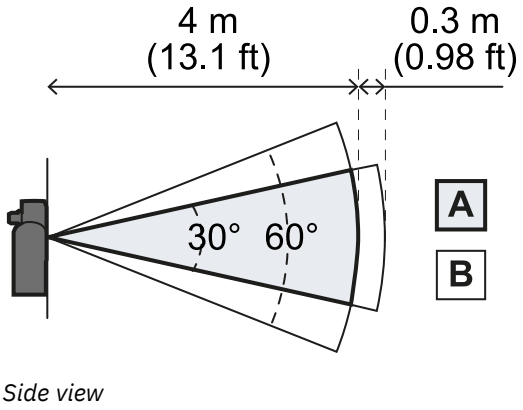
The sensor field of view is composed of two areas:

- 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 31).

Dimensions of the 110° field of view

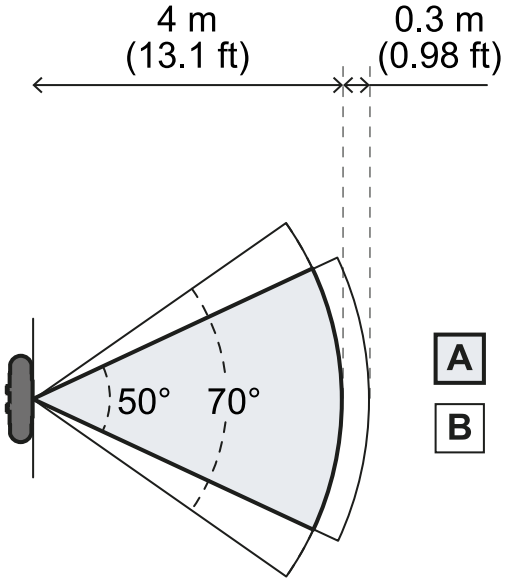


Top view

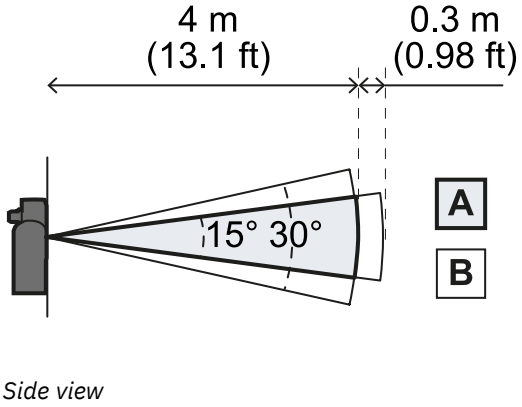


Side view

Dimensions of the 50° field of view



Top view



Side view

5.2.4 Sensitivity

The system sensitivity level can be defined for the access detection function as well as the restart prevention function. The sensitivity defines the ability of the system to prevent undesired alarms. Only for the access detection function, it also defines the reaction times to motion detection: with high sensitivity the system is more prone to undesired alarms, but detection is faster.

For example, it is recommended to set a lower level of sensitivity for the access detection function if people or objects are in transit at the perimeters of the dangerous area (e.g. forklifts or trucks).

5.3 Dangerous area calculation

5.3.1 Introduction

The dangerous area of the machinery to which LBK System Series is applied must be calculated as indicated in standards ISO 13855:2010. For LBK System Series the fundamental factors for calculation are height (h) and inclination (α) of the sensor, see "Sensor position" on page 52.

5.3.2 Sensor height ≤ 1 m

To calculate the depth of the dangerous area (S) for sensors with installation heights less than or equal to 1 m, use the following formula:

$$S = K * T + C_h + C_\alpha$$

Where:

Variable	Description	Value	Measurement unit
K	Maximum dangerous area access speed	1600	mm/s
T	Total system stopping time (LBK System Series + machinery)	0.1 + Machinery stopping time (calculated in accordance with ISO 13855:2010 standard)	s

Variable	Description	Value	Measurement unit
C_h	Variable that takes into account the sensor installation height (h) according to standard ISO 13855:2010	1200 - 0.4 * H ***Note**: minimum value = 850 mm. If the result of the calculation is a value less than the minimum, use 850 mm.*	mm
C_α	Variable that takes into account the sensor inclination (α) according to the indications of Inxpect SpA	If H < 500 = (20 - α) * 16 If H ≥ 500 = (-α) * 16 ***Note**: minimum value = 0 mm. If the result of the calculation is a value less than the minimum, use 0 mm.*	mm

Example 1

- Machinery stopping time = 0.5 s
- Sensor installation height (H) = 100 mm
- Sensor inclination (α) = 10°

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

C_h = 1200 - 0.4 * 100 = **1160 mm**

C_α = (20 - 10) * 16 = **160 mm**

S = 1600 * **0.6** + **1160** + **160** = **2280 mm**

Example 2

- Machinery stopping time = 0.2 s
- Sensor installation height (H) = 800 mm
- Sensor inclination (α) = -20°

T = 0.1 s + 0.2 s = **0.3 s**

C_h = 1200 - 0.4 * 800 = **880 mm**

C_α = (-(-20))* 16 = **320 mm**

S = 1600 * **0.3** + **880** + **320** = **1680 mm**

5.3.3 Sensor height > 1 m

To calculate the depth of the dangerous area (S) for sensors with installation heights greater than 1 m, use the following formula:

$$S = K * T + C_h$$

Where:

Variable	Description	Value	Measurement unit
K	Maximum dangerous area access speed	1600	mm/s
T	Total system stopping time (LBK System Series + machinery)	0.1 + Machinery stopping time (calculated in accordance with ISO 13855:2010 standard)	s
C_h	Constant that takes into account the sensor installation height (h) according to standard ISO 13855:2010	850	mm

Example 1

- Machinery stopping time = 0.5 s

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

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

5.4 Calculation of position for sensor height ≤ 1 m

5.4.1 Introduction

The formulas for calculating the optimum position of the sensor for sensors with installation heights less than or equal to 1 m (3.3 ft) are reported as follows.

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

5.4.2 Overview of possible installation configurations

The configurations with possible heights (**h**) and inclinations (**α**) are presented as follows:

- **1** = Configuration 1: the field of view of the sensor never intersects the ground
- **2** = Configuration 2: the upper portion of the field of view of the sensor never intersects the ground
- **3** = Configuration 3: the upper portion and the bottom portion of the field of view always intersect the ground
- **X** = Configuration not possible

WARNING! With configurations not listed in these tables or marked with an “x”, safety functions are not guaranteed.

110° field of view

Installation configuration		α (°)				
		-20	**-10**	**0**	**10**	**20**
h (cm | in)	0 | 0	x	x	x	2	1
	10 | 3.9	x	x	x	2	1
	20 | 7.9	x	x	2	2	1
	30 | 11.8	x	x	2	2	x
	40 | 15.7	x	x	2	2	x
	50 | 19.7	x	2	2	2	x
	60 | 23.6	3	2	2	x	x
	70 | 27.5	3	2	2	x	x
	80 | 31.5	3	2	2	x	x
	90 | 35.4	3	2	2	x	x
	100 | 39.4	3	2	2	x	x

50° field of view

Installation configuration		α (°)				
		-20	**-10**	**0**	**10**	**20**
h (cm | in)	0 | 0	x	x	x	1	1
	10 | 3.9	x	x	x	1	1
	20 | 7.9	x	x	2	1	x
	30 | 11.8	x	x	2	x	x
	40 | 15.7	x	x	2	x	x
	50 | 19.7	x	3	2	x	x
	60 | 23.6	x	3	2	x	x
	70 | 27.5	x	3	2	x	x
	80 | 31.5	3	3	2	x	x
	90 | 35.4	3	3	2	x	x
	100 | 39.4	3	3	2	x	x

5.4.3 Legend

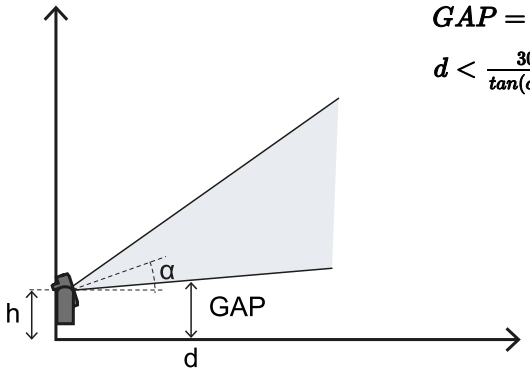
Element	Description	Measurement unit
GAP	Distance between the ground and the field of view of the sensor	cm
α	Sensor inclination	degrees
h	Sensor installation height	cm
d	Detection distance (linear)	cm
Dalarm	Detection distance (real)	cm
S_1	Start detection distance	cm
S_2	End detection distance	cm

5.4.4 Configuration 1

In this configuration, the field of view of the sensor never intersects the ground.
To guarantee that the sensor also detects access by people crawling, respect the following condition:

$$GAP < 30\text{cm}$$

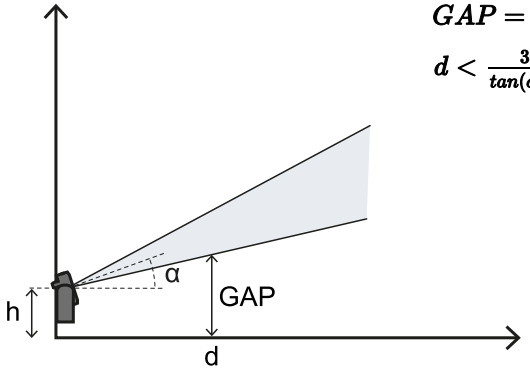
110° field of view



$$GAP = h + d * tan(\alpha - 15^\circ)$$

$$d < \frac{30-h}{tan(\alpha-15^\circ)}$$

50° field of view



$$GAP = h + d * tan(\alpha - 7.5^\circ)$$

$$d < \frac{30-h}{tan(\alpha-7.5^\circ)}$$

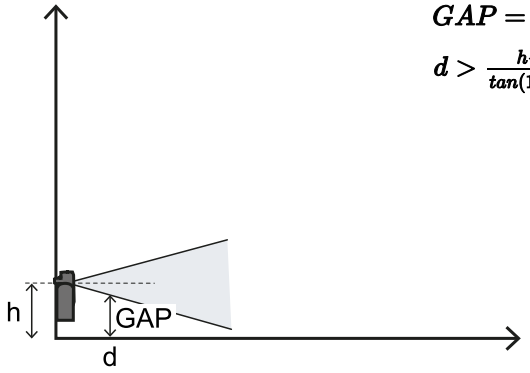
5.4.5 Configuration 2

In this configuration, the upper portion of the field of view of the sensor never intersects the ground.

To guarantee that the sensor also detects the presence of people crawling near the sensor, respect the following condition:

$$GAP < 30\text{cm}$$

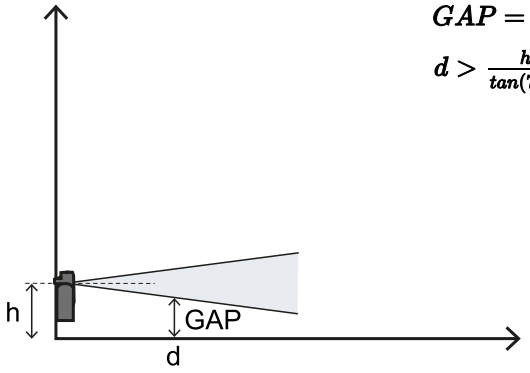
110° field of view



$$GAP = h - d * tan(15^\circ - \alpha)$$

$$d > \frac{h-30}{tan(15^\circ-\alpha)}$$

50° field of view



$$GAP = h - d * tan(7.5^\circ - \alpha)$$

$$d > \frac{h-30}{tan(7.5^\circ-\alpha)}$$

5.4.6 Configuration 3

In this configuration, the upper and the bottom portions of the field of view of the sensor always intersect the ground.

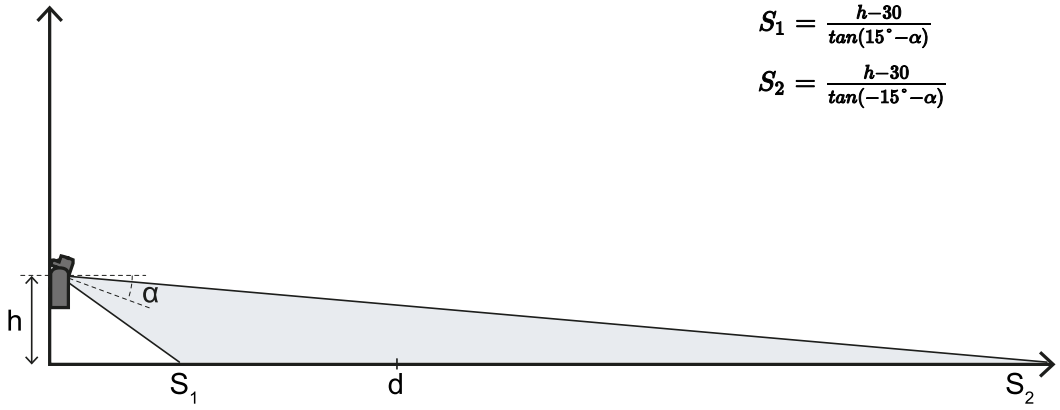
To guarantee optimum performance, respect the following conditions:

$$S_1 < d < S_2$$

110° field of view

$$S_1 = \frac{h-30}{tan(15^\circ-\alpha)}$$

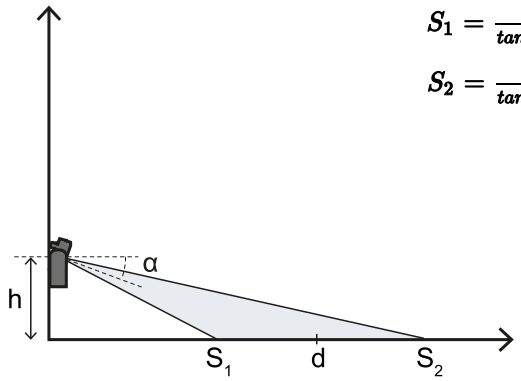
$$S_2 = \frac{h-30}{tan(-15^\circ-\alpha)}$$



50° field of view

$$S_1 = \frac{h-30}{tan(7.5^\circ-\alpha)}$$

$$S_2 = \frac{h-30}{tan(-7.5^\circ-\alpha)}$$

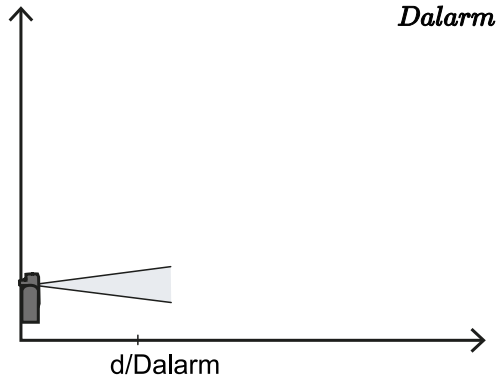


5.4.7 Calculate the real detection distance

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

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

$$Dalarm = d$$



5.5 Calculation of position for sensor height > 1 m

5.5.1 Introduction

The formulas for calculating the optimum position of the sensor for sensors with installation heights greater than 1 m (3.3 ft) are reported as follows.

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

***Note**: the sensor inclination can only be downwards (α negative).*

5.5.2 Legend

Element	Description	Measurement unit
α	Sensor inclination	degrees
h	Sensor installation height	cm
d	Detection distance (linear)	cm
Dalarm	Detection distance (real)	cm
S_1	Start detection distance	cm
S_2	End detection distance	cm

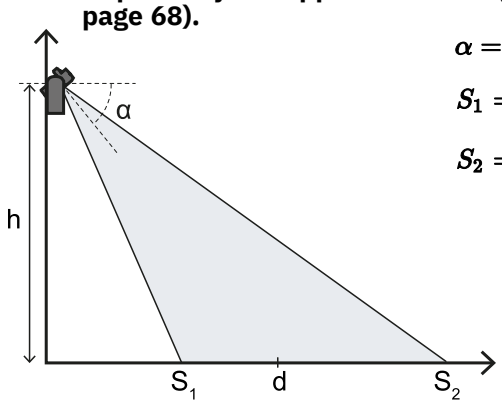
5.5.3 110° field of view

WARNING! It is only possible to check if the other configurations respect the performance levels required by the application through the validation procedure (see "Validate the safety functions" on page 68).

$$\alpha = -(15^\circ + tan^{-1}(\tfrac{h-60}{d}))$$

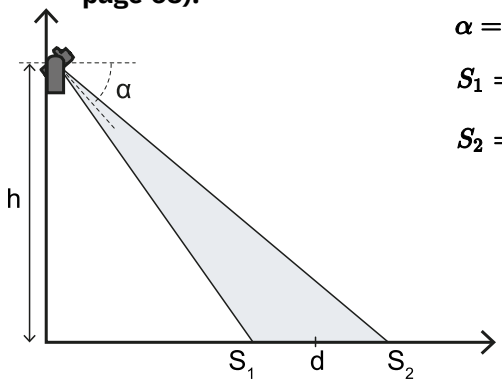
$$S_1 = \frac{h}{tan((-\alpha)+15^\circ)}$$

$$S_2 = \frac{h}{tan((-\alpha)-15^\circ)}$$



5.5.4 50° field of view

WARNING! It is only possible to check if the other configurations respect the performance levels required by the application through the validation procedure (see "Validate the safety functions" on page 68).



$$\alpha = -(7.5^\circ + tan^{-1}(\frac{h-60}{d}))$$

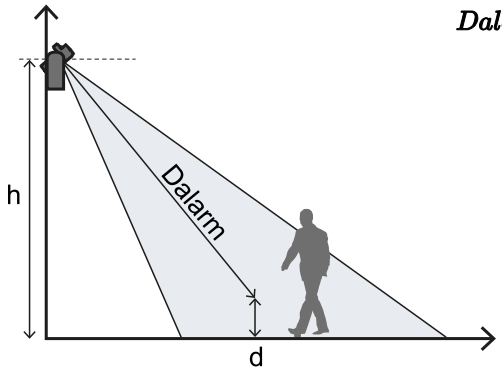
$$S_1 = \frac{h}{tan((-\alpha)+7.5^\circ)}$$

$$S_2 = \frac{h}{tan((-\alpha)-7.5^\circ)}$$

5.5.5 Calculate the real detection distance

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

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



$$Dalarm = \sqrt{d^2 + (h-30)^2}$$

5.6 Outdoor installations

5.6.1 Position exposed to precipitation

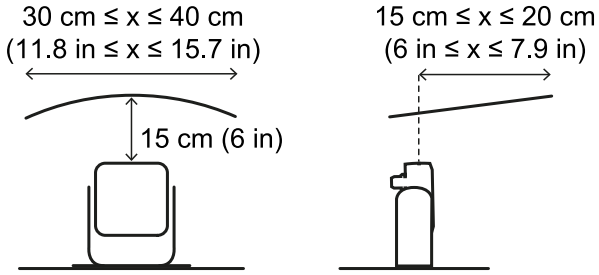
If the sensor installation position might be exposed to precipitation that can cause undesired alarms, it is recommended to take the following precautions:

- 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

5.6.2 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)

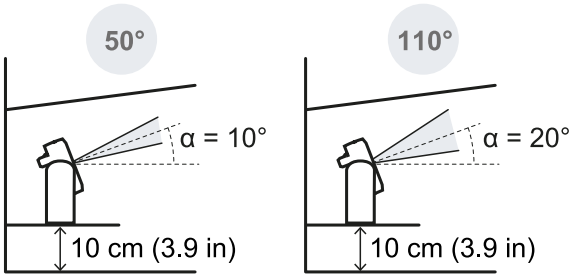


5.6.3 Recommendations for positioning the sensor

Below are some recommendations for defining the sensor position:

- height above the ground: minimum 10 cm (3.9 in)
- suggested inclination: 10° for 50° field of view and 20° for 110° field of view

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



***Note**: during the restart prevention function or if the sensor has a 110° field of view, undesired alarms may occur due to the higher sensitivity of the system.*

5.6.4 Position not exposed to precipitation

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

6. Installation and use procedures

Contents

This section includes the following topics:

6.1 Before installation

6.1.1 Materials required

- Two tamper-proof screws (see "Side screw specifications" on page 89) to fasten the sensors to the floor or machinery.
- Cables to connect the control unit to the first sensor and the sensors to one another, see "CAN bus cables recommended specifications" on page 88.
- A data micro-USB cable or, only if the Ethernet port is available, an Ethernet cable to connect the control unit to the computer.
- A bus terminator (product code: 07000003) with resistance of 120 Ω for the last sensor of the CAN bus.
- A screwdriver for tamper-proof screws ("Side screw specifications" on page 89) to be used with the Hex pin security bit supplied in the control unit package.
- If necessary, to protect the sensor and to prevent reflections from generating undesired alarms, one Metal protector kit (product code: 90202ZAA) per sensor. See the instructions supplied with the kit for installation instructions.
  ***Note**: the Metal protector kit is particularly recommended if the sensor is installed on parts that are moving, vibrating or that are near vibrating parts.*

6.1.2 Operating system required

- Microsoft Windows 7 or later
- Apple OS X 10.10 or later

6.1.3 Install the Inxpect Safety application

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

1. Download the application from the www.inxpect.com/industrial/tools website 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 (data micro-USB or Ethernet). If desired, select the update command to upgrade the firmware version.
   ***Note**: the default IP address for the Ethernet connection is 192.168.0.20. The computer and the control unit 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 device (LBK System Series).
7. Set the working frequency. If the system is installed in one of the countries with national restrictions, select the restricted band, otherwise select the full band.
   ***Note**: this setting does not have any effect on system performance or safety.*
8. Set the number of sensors connected.

6.1.4 Initiate LBK System Series

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 control unit" below.
3. Open the Inxpect Safety application.
4. Optional. "Synchronize the control units" below.
5. "Define the area to be monitored" below.
6. "Configure the inputs and outputs" below.
7. "Install sensors on the floor" on the next page or "Install the sensors on the machinery" on page 66.
8. "Connect the control unit to the sensors" on page 67.
   ***Note**: connect the sensors to the control unit off-site if access to the connectors becomes difficult once they are installed.*
9. "Save and print the configuration" on page 68.
10. If available, "Set the control unit Ethernet parameters" on page 68
11. "Validate the safety functions" on page 68.

6.2 Install and configure LBK System Series

6.2.1 Install the control unit

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

1. Mount the control unit on the DIN rail.
2. Make electrical connections, see "Terminal blocks and connector pin-outs" on page 89 and "Electrical connections" on page 91.
   ***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 2 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 90.*

6.2.2 Synchronize the control units

If there are more than one ISC-B01 control unit in the area, to configure the system and to perform the electrical connections, see "Enable the multi-control unit synchronization function" on page 48.

6.2.3 Define the area to be monitored

WARNING! LBK System Series is disabled during configuration. Prepare opportune safety measures in the dangerous area protected by the system before configuring the system.

1. In the Inxpect Safety 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 angular coverage of the field of view for each sensor.
5. Define the selected safety working modes, the detection distance and the restart timeout for each detection field of each sensor.

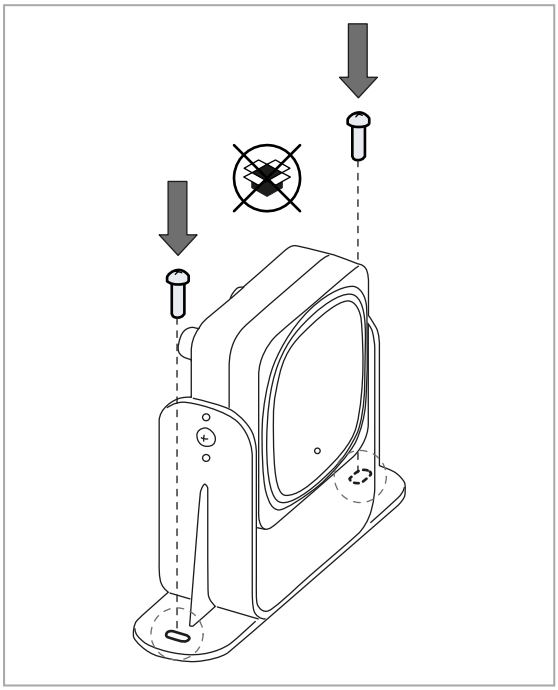
6.2.4 Configure the inputs and outputs

1. In the Inxpect Safety 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.

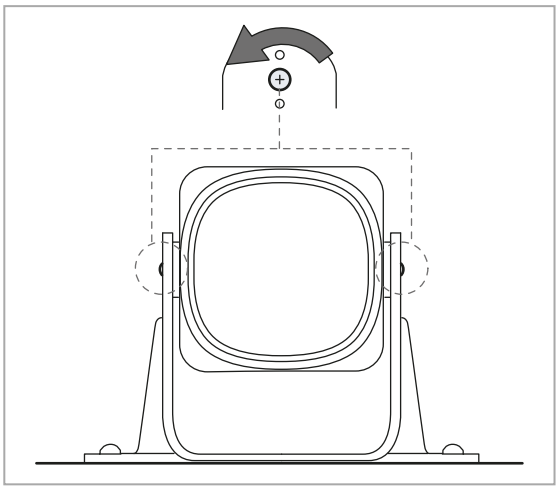
6.2.5 Install sensors on the floor

***Note**: for installation with Metal protector kit (product code 90202ZAA), see the instructions supplied with the kit.*

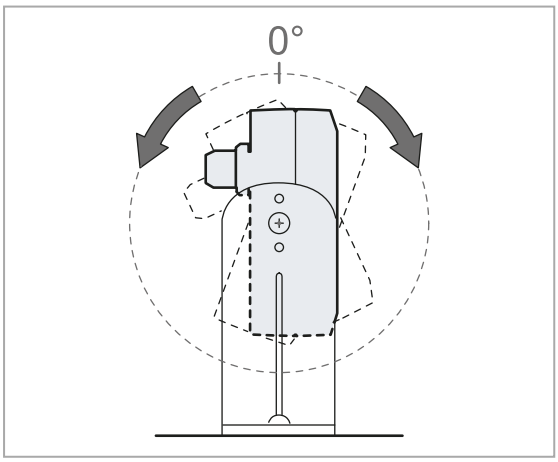
1. Position the sensor as indicated in the configuration report and fasten the bracket with two tamper-proof screws directly onto the floor or another support.
   ***NOTICE**: make sure the support does not inhibit machinery commands.*



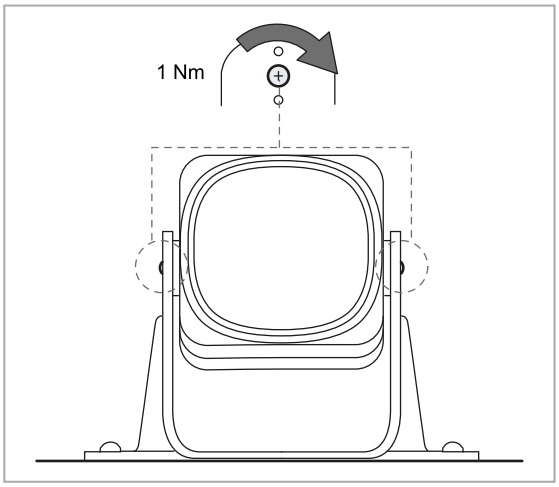
2. Loosen the side screws to tilt the sensor.



3. Direct the sensor up to the desired inclination, see "Sensor position" on page 52.
   ***Note**: a notch is equal to 10° of inclination.*



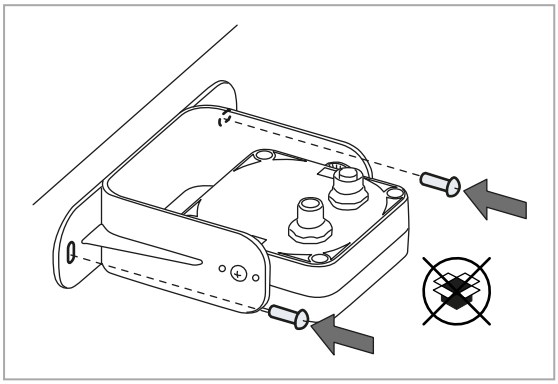
4. Tighten the screws.



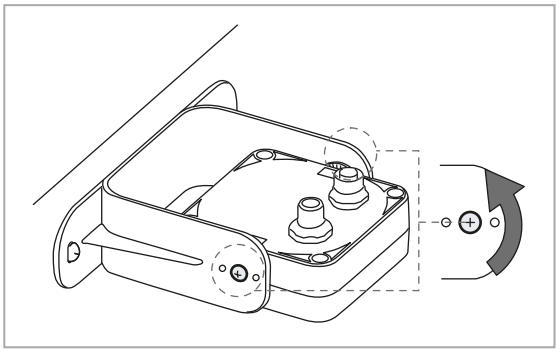
6.2.6 Install the sensors on the machinery

***Note**: if the sensor is installed on parts that vibrate and objects are present in the field of view, the sensor could generate undesired alarms.*

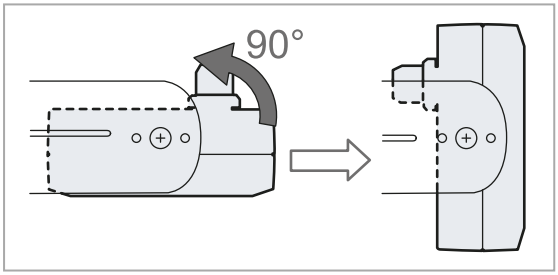
1. Position the sensor as indicated in the configuration report and fasten the bracket with two screws to a machinery support. To select installation height, see "Sensor position" on page 52.



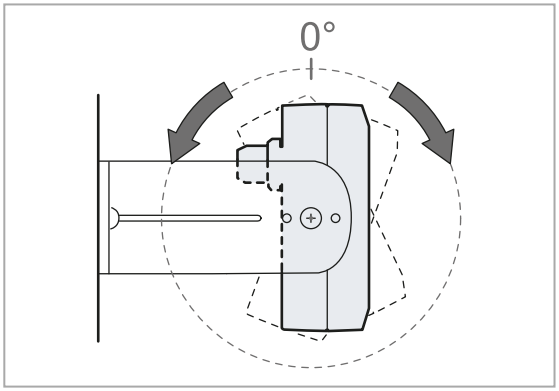
2. Loosen the side screws.



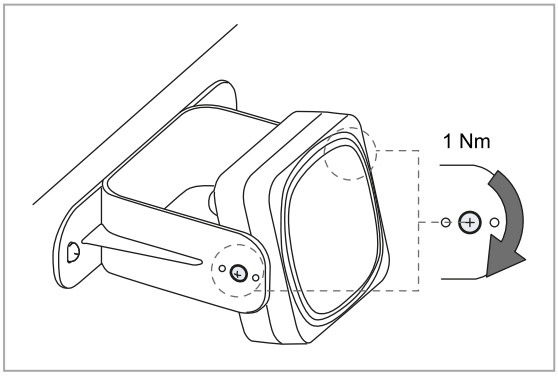
3. Position the sensor parallel to the machinery support.



4. Direct the sensor up to the desired inclination, see "Sensor position" on page 52.
***Note**: a notch is equal to 10° of inclination.*



5. Tighten the screws.



6.2.7 Connect the control unit to the sensors

***Note**: the maximum length of the CAN bus line from the control unit to the last sensor in the chain is 30 m (98.4 ft).*

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

1. Decide if the control unit 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 control unit based on its position in the chain.
3. Connect the desired sensor directly to the control unit.
4. To connect another sensor, connect it to the last sensor in the chain or directly to the control unit to start a second chain.
5. Repeat step 4 for all the sensors to be installed.
6. Insert the bus terminator (product code: 07000003), into the free connector of the last sensor of the chain (s).

6.2.8 Assign the Node IDs

Type of assignment

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.

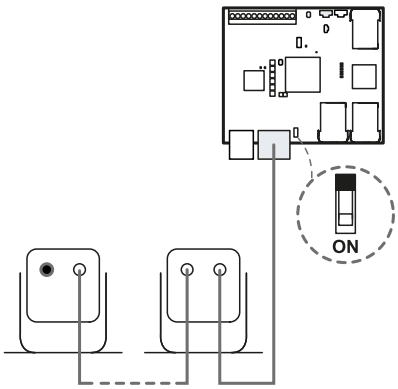
Procedure

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:

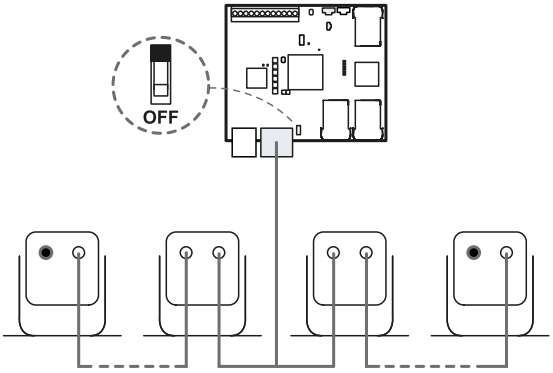
If the assignment is...	Then...
manual	1. Click **DISCOVER CONNECTED SENSORS** to display the connected sensors. 2. To assign a Node ID, click **Assign** for the unassigned Node ID in the **Configured sensors** list. 3. To change a Node ID, click **Change** for the already assigned Node ID in the **Configured 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.

5. Click **Settings** > **General** > **SENSOR FW UPGRADE** to update the sensors to the firmware version compatible with LBK System Series.

6.2.9 Chain examples



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



Chain with control unit inside the chain and two sensors with bus terminator

6.2.10 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 control unit, and once transfer is complete it will generate a configuration report.
2. Click to save and print the report.
3. Ask the authorized person for a signature.

6.2.11 Set the control unit Ethernet parameters

1. Ensure the control unit 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 control unit turns steady green: the Ethernet parameters are set to their default values (see "Ethernet connection (if available)" on page 87).
5. Configure the control unit again.

6.3 Validate the safety functions

6.3.1 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 Inxpect Safety application facilitates installation and configuration of the system, but the validation process described below is still required.

6.3.2 Validate the access detection function

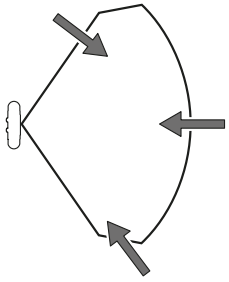
Example 1

Starting conditions	• **Detection field dependency**: **Dependent mode** • All the safety outputs activated
Validation procedure	1. Access detection field 2 (if present). 2. Check that the system deactivates only the safety output related to the second detection field. See "Validate the system with Inxpect Safety" on the next page. 3. Exit the monitored area so that all the safety outputs are activated again. 4. Access detection field 1, without entering detection field 2 (if possible). 5. Check that the system deactivates the safety outputs related to the first detection field and to the second detection field, too. See "Validate the system with Inxpect Safety" on the next page. 6. If the safety outputs are not deactivated, see "Troubleshooting validation" on page 71.
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" below. • Access standing as well as crawling. • Access moving slowly and quickly.

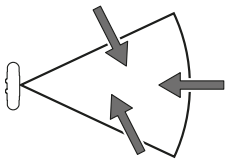
Example 2

Starting conditions	• **Detection field dependency**: **Independent mode** • All the safety outputs activated
Validation procedure	1. Access detection field 2 (if present). 2. Check that the system deactivates only the safety output related to the second detection field. See "Validate the system with Inxpect Safety" on the next page. 3. Exit the monitored area so that all the safety outputs are activated again. 4. Access detection field 1, without entering detection field 2 (if possible). 5. Check that the system deactivates only the first safety output related to the first detection field. See "Validate the system with Inxpect Safety" on the next page. 6. If the safety outputs are not deactivated, see "Troubleshooting validation" on page 71.
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" below. • Access standing as well as crawling. • Access moving slowly and quickly.

6.3.3 Example of access points



Access points for 110° field of view



Access points for 50° field of view

6.3.4 Validate the restart prevention function

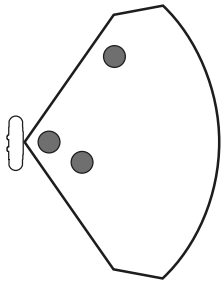
Example 1

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 Inxpect Safety" below. 3. Stand still in detection field 2. 4. Check that the system maintains only the second safety output deactivated. See "Validate the system with Inxpect Safety" below. 5. If the safety outputs do not remain deactivated, see "Troubleshooting validation" on the next page.
Specifications	• Stop longer than the restart timeout (Inxpect Safety > **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" below. • Stop standing as well as laid down.

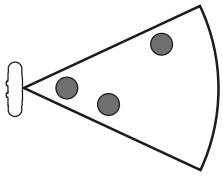
Example 2

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 Inxpect Safety" below. 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.

6.3.5 Example of stopping points



Stopping points for 110° field of view



Stopping points for 50° field of view

6.3.6 Validate the system with Inxpect Safety

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

The Inxpect Safety application is helpful during the safety functions validation phase and allows the sensors' actual field of view 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 the previous page and "Validate the restart prevention function" above.

3. Check that the sensor behaves as expected .
4. Check that the distance where the motion is detected is the expected value.

6.3.7 Troubleshooting validation

If the sensor does not perform as expected, see the following table:

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 ("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.
Inadequate restart timeout	Change the restart timeout through the Inxpect Safety application (**Configuration** > select the affected sensor and detection field)

6.4 Manage the configuration

6.4.1 Configuration reports

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

- configuration data
- unique checksum
- 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.

6.4.2 Change the configuration

WARNING! LBK System Series is disabled during configuration. Prepare opportune safety measures in the dangerous area protected by the system before configuring the system.

1. Start the Inxpect Safety application.
2. Click **User** and enter the admin password.
3. Depending on what you want to change, follow the instructions below:

To change...	Then...
Monitored area and sensors configuration	Click **Configuration**
System sensitivity	Click **Settings** > **Sensors**
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 control unit, click to print the report.

6.4.3 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 System Series.

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

6.4.4 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 control unit and approval according to the safety plan.*

6.4.5 Display previous configurations

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

In **Configuration** click .

6.5 Other functions

6.5.1 Change language

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

6.5.2 Locate the area with detected motion

Click **Validation**: the area with detected motion in detection field 1 turns red and the area with detected motion in detection field 2 turns yellow. The detection position appears on the left.

6.5.3 Change the admin password

In **Settings** > **Account**, click **CHANGE PASSWORD**.

6.5.4 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 Inxpect Safety application by clicking APPLY CHANGES.

For the default values of the parameters, see "Parameters" on page 99.

6.5.5 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.

6.5.6 Change network parameters

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

6.5.7 Change Modbus parameters

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

6.5.8 Change Fieldbus parameters

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

7. 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 System Series through the software and to perform maintenance.

Contents

This section includes the following topics:

7.1 Troubleshooting

7.1.1 Control unit LED

LED	Status	Inxpect Safety application messages	Problem	Remedy
S1*	Steady red	CONTROL UNIT POWER ERROR	At least one voltage value on the control unit 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 87).
S2	Steady red	CONTROL UNIT TEMPERATURE ERROR	Control unit temperature value is wrong	Check that the system is operating at the correct operating temperature (see "General specifications" on page 87).
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, contact assistance for output replacement.
S4	Steady red	PERIPHERAL ERROR	At least one of the control unit peripherals is in error	Check the status of the terminal block and connections.
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 Inxpect Safety **Settings** > **Node ID Assignment**). Check that the firmware of the control unit and sensors are updated to the compatible versions.

LED	Status	Inxpect Safety application messages	Problem	Remedy
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 71. If the error persists, please contact assistance service.
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 and the exchanged data are maintained passivated by the host itself.
S1–S5 together	Steady red	DYNAMIC CONFIGURATION ERROR	Error in the selection of the dynamic configuration: invalid ID	Check the preset configurations within the Inxpect Safety 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 Inxpect Safety application.
At least one LED	Flashing red	"Sensor LED" on the next page	Sensor corresponding to the flashing LED in error ** ("Sensor LED" on the next page)	Check the problem through the LED on the sensor.
At least one LED	Flashing green	"Sensor LED" on the next page	Sensor corresponding to the flashing LED in error ** ("Sensor LED" on the next page)	If the issue persists longer than one minute, please contact assistance service.
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 control unit is in boot state.	Please contact assistance service.

***Note**: fault signal on the control unit (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.*

7.1.2 Sensor LED

Status	Inxpect Safety application messages	Problem	Remedy
2 flashes *	CAN ERROR	ID not assigned	Assign a Node ID to the sensor, see "Connect the control unit to the sensors" on page 67.
3 flashes *	CAN ERROR	Error in communication with the control unit	Check connections of all sensors in the chain starting from the last sensor in error.
4 flashes *	SENSOR TEMPERATURE ERROR or SENSOR POWER ERROR	Wrong power supply voltage or temperature value	• Check the sensor connection and that the length of the cables respects maximum limits. • Check that the ambient temperature where the system is functioning complies with the operating temperatures indicated in the technical data in this manual

Status	Inxpect Safety application messages	Problem	Remedy
5 flashes *	MASKING, Signal error	Masking, micro-controller, micro-controller peripherals, radar or radar control in error	Check that the sensor is correctly installed and that the area is free of any objects that obstruct the field of view of the sensors.
	PERIPHERAL ERROR	Error detected by diagnostics relative to the internal micro-controller, its internal peripherals or memories	If the issue persists, please contact assistance service.
6 flashes *	ACCELEROMETER ERROR	Inclination of the sensor different from the installation inclination	Check if the sensor has been tampered with or if the side screws or fastening screws are loose.

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

7.1.3 Other problems

Problem	Cause	Remedy
Undesired alarms	Transit of people or objects in close proximity to the detection field	Change the sensors sensitivity, "Change the configuration" on page 71.
Machinery in safe status without motion in the detection field	No power supply	Check electrical connection. Contact assistance service if necessary.
	Failure of the control unit or one or more sensors	Check the status of the LEDs on the control unit, see "Control unit LED" on page 73. Access the application Inxpect Safety, on the **Dashboard** page, mouse-over on ⊗ in correspondence with the control unit or the sensor.
The voltage value detected on the SNS input is zero	The chip that detects inputs is faulty	Contact assistance service.
The system does not function correctly	Control unit error	Check the status of the LEDs on the control unit, see "Control unit LED" on page 73. Access the application Inxpect Safety, on the **Dashboard** page, mouse-over on ⊗ in correspondence with the control unit or the sensor.
	Sensor error	Check the status of the LEDs on the sensor, see "Sensor LED" above. Access the application Inxpect Safety, on the **Dashboard** page, mouse-over on ⊗ in correspondence with the control unit or the sensor.

7.2 Event log management

7.2.1 Introduction

The event log recorded by the system can be downloaded from the Inxpect Safety 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.

7.2.2 Download the system log

1. Start the Inxpect Safety application.
2. Click **Settings** and then **Activity History**.

3. Click **DOWNLOAD LOG**.

7.2.3 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 Inxpect Safety application
2	Diagnostic event log	Error events	1000	Not possible

7.2.4 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
  - CONTROL UNIT = if the event is generated by the control unit
  - SENSOR ID = if the event is generated by a sensor. In this case is provided also the node ID of the sensor.
- Event description

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

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 control unit is receiving the local time of the machine where the software is running.*

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)

7.2.5 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] CONTROL UNIT 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] CONTROL UNIT Dynamic configuration #1

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

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

90 Rel. 0 d 00:01:30 [INFO] CONTROL UNIT 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] CONTROL UNIT Dynamic configuration #1

0 0 d 00:00:00 [INFO] CONTROL UNIT 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] CONTROL UNIT 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

7.2.6 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
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 (control unit)" on page 82.

7.2.7 Verbosity level

There are six verbosity levels for the log. The verbosity can be set during the configuration of the system via the Inxpect Safety 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

7.2.8 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 control unit level and the additional information is the detection distance (in mm) in detection access.

  Format:

  CONTROL UNIT Detection access (distance mm)

  CONTROL UNIT Detection exit

- LEVEL 1: the events are logged in a single field at control unit level and the additional information are: detection field, detection distance (in mm) in access, and detection field at exit.

  Format:

  CONTROL UNIT Detection access (field #n, distance mm)

  CONTROL UNIT Detection exit (field #n)

- LEVEL 2 / LEVEL 3 / LEVEL 4 The events are logged:
  - in a single field at control unit level and the additional information are: detection field, detection distance (in mm) in access, and detection field at exit
  - at sensor level and the additional information read by the sensor are: detection distance (in mm) in access, and detection field at exit.

  Format:

  CONTROL UNIT #k Detection access (field #n, distance mm)

  SENSOR #k Detection access (distance mm)

  CONTROL UNIT Detection exit (field #n)

  SENSOR #k Detection exit

7.3 INFO events

7.3.1 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] CONTROL UNIT SYSTEM BOOT #60

7.3.2 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] CONTROL UNIT System configuration #3

7.3.3 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] CONTROL UNIT Factory reset

7.3.4 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] CONTROL UNIT Stop signal ACTIVATION

7.3.5 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] CONTROL UNIT Restart signal RECEIVED

7.3.6 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). See "Verbosity level for detection access and exit events" on page 79

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°)

7.3.7 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] CONTROL UNIT Detection exit (field #1)

7.3.8 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] CONTROL UNIT Dynamic configuration #1

7.3.9 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

7.3.10 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] CONTROL UNIT Fieldbus connection CONNECTED

7.3.11 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] CONTROL UNIT Modbus connection CONNECTED

7.3.12 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] CONTROL UNIT Session OPEN via USB

7.3.13 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] CONTROL UNIT Validation STARTED via USB

7.3.14 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] CONTROL UNIT Log download via USB

7.4 ERROR events (control unit)

7.4.1 Introduction

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

7.4.2 Temperature errors (TEMPERATURE ERROR)

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

7.4.3 Control unit voltage errors (POWER ERROR)

Error	Meaning
Control unit voltage **UNDERVOLTAGE**	Undervoltage error for the indicated voltage
Control unit voltage **OVERVOLTAGE**	Overvoltage error for the indicated voltage
ADC CONVERSION ERROR	(only for the ADC) ADC conversion error in the micro-controller

The following table describes the control unit 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

7.4.4 Peripheral error (PERIPHERAL ERROR)

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

7.4.5 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).

7.4.6 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
OSSD 1 NO LOAD	No load detected on MOS output 1
OSSD 2 NO LOAD	No load detected on MOS output 2
OSSD 3 NO LOAD	No load detected on MOS output 3
OSSD 4 NO LOAD	No load detected on MOS output 4
OSSD 1-2 CROSS CHECK	Short-circuit error between MOS output 1 and 2
OSSD 1-3 CROSS CHECK	Short-circuit error between MOS output 1 and 3
OSSD 1-4 CROSS CHECK	Short-circuit error between MOS output 1 and 4

Error	Meaning
OSSD 2-3 CROSS CHECK	Short-circuit error between MOS output 2 and 3
OSSD 2-4 CROSS CHECK	Short-circuit error between MOS output 2 and 4
OSSD 3-4 CROSS CHECK	Short-circuit error between MOS output 3 and 4

7.4.7 Flash errors (FLASH ERROR)

A flash error represents an error on the external flash.

7.4.8 Dynamic configuration error (DYNAMIC CONFIGURATION ERROR)

A dynamic configuration error indicates an invalid dynamic configuration ID.

7.4.9 Internal communication error (INTERNAL COMMUNICATION ERROR)

Indicates that there is an internal communication error.

7.4.10 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

7.4.11 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

7.4.12 RAM error (RAM ERROR)

Error	Meaning
INTEGRITY ERROR	Wrong integrity check on the RAM

7.4.13 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.

7.5 ERROR events (sensor)

7.5.1 Introduction

A diagnostic error is logged every time the periodic diagnostic functions detect a coming or going fault on the LBK-S01 sensor.

7.5.2 Radar signal errors (Signal error)

Error	Meaning
HEAD FAULT	Radar not functioning
HEAD POWER OFF	Radar off
MASKING	Presence of object obstructing the field of view of the radar

Error	Meaning
SIGNAL DYNAMIC	Wrong signal dynamic
SIGNAL MIN	Signal with dynamic below minimum
SIGNAL MIN MAX	Signal with out of range dynamic
SIGNAL MAX	Signal with dynamic over maximum
SIGNAL AVG	Flat signal

7.5.3 Temperature errors (TEMPERATURE ERROR)

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

7.5.4 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
ADC CONVERSION ERROR	(only for the ADC) ADC conversion error in the micro-controller

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
V+	Radar reference voltage
VDCDC	Main chip power supply internal voltage
VOPAMP	Operational amplifier voltage
VADC REF	Analog-digital converter (ADC) reference voltage
ADC	Analog-digital converter

7.5.5 Anti-tampering sensor (ACCELEROMETER ERROR)

Error	Meaning
TILT ANGLE ERROR	Sensor inclination around the x-axes
ROLL ANGLE ERROR	Sensor inclination around the z-axes
ACCELEROMETER READ ERROR	Accelerometer reading error

7.5.6 Peripheral error (PERIPHERAL ERROR)

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

7.6 ERROR events (CAN bus)

7.6.1 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 control unit or a single sensor.

7.6.2 CAN errors (CAN ERROR)

Error	Meaning
TIMEOUT	Timeout on message to sensor/control unit
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	Control unit and sensors have different and incompatible firmware versions
POLLING TIMEOUT	Timeout on data polling

7.7 Cleaning and spare parts

7.7.1 Cleaning

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

7.7.2 Spare parts

Part	Product code
Sensor	LBK-S01
Control unit	ISC-B01, ISC-02, ISC-03

8. Technical references

Contents

This section includes the following topics:

8.1 Technical data

8.1.1 General specifications

Detection method	Inxpect motion detection algorithm based on FMCW radar
Frequency	Working band: 24–24.25 GHz Transmission power: ≤ 13 dBm Modulation: FMCW
Detection interval	From 0 to 4 m (from 0 to 13.1 ft), depending on the installation conditions.
Detectable target RCS	0.17 sqm
Field of view	• 110° (sensor horizontal plane: 110°, sensor vertical plane: 30°) • 50° (sensor horizontal plane: 50°, sensor vertical plane: 15°)
Guaranteed response time	< 100 ms
Total consumption	12.2 W (control unit and six sensors)
Electrical protections	Polarity inversion Overcurrent through resettable integrated fuse (max. 5 s @ 8 A)
Overvoltage category	II
Altitude	Max 2000 m ASL
Air humidity	Max 95%
Noise emission	Negligible

8.1.2 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 for ISC-B01 2 for ISC-B01, ISC-02 and ISC-03
Communication protocol (sensors-control unit)	CAN complies with standard EN 50325-5
Mission time	20 years
MTTFd	44 years
PFHd - category 2	With PROFINET/PROFIsafe communication: • Access detection: 4.60E-08 [1/h] • Restart prevention: 4.60E-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: 4.50E-08 [1/h] • Restart prevention: 4.50E-08 [1/h] • Muting: 5.13E-09 [1/h] • Stop signal: 5.14E-09 [1/h] • Restart signal: 5.14E-09 [1/h]
PFHd - category 3	With PROFINET/PROFIsafe communication: • Access detection: 7.81E-09 [1/h] • Restart prevention: 7.81E-09 [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: 7.72E-08 [1/h] • Restart prevention: 7.72E-08 [1/h] • Muting: 5.13E-09 [1/h] • Stop signal: 5.14E-09 [1/h] • Restart signal: 5.14E-09 [1/h]
SFF	99.21%
DCavg	98.24%
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.*

8.1.3 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

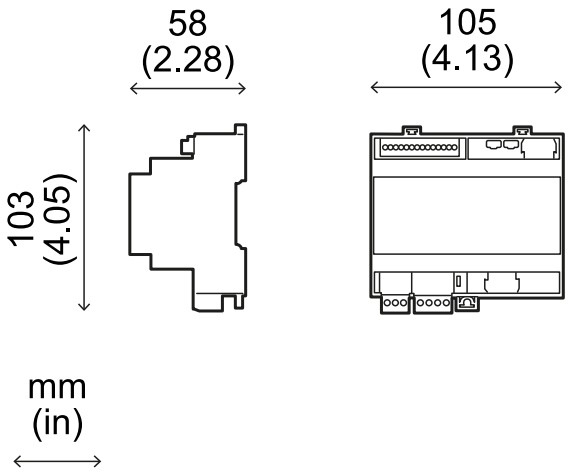
8.1.4 Control unit features

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) • Max current: 0.4 A • Max 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 90.

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 mm² (16 AWG) max Max current: 4 A with 1 mm² cables (16 AWG)
Impact test	0.5 J, 0.25 kg ball from a 20 cm height
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)

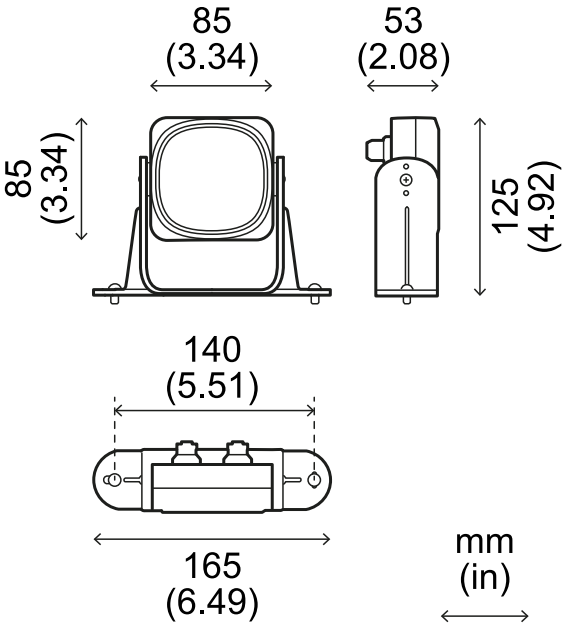
Note*: the unit shall be supplied by an isolated power source which fulfils the requirements of:*

- *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).*



8.1.5 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 control unit
Consumption	Max 1.2 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)
Weight	With bracket: 220 g (7.8 oz)
Impact test	5 J, 0.5 kg ball from a 100 cm height
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)

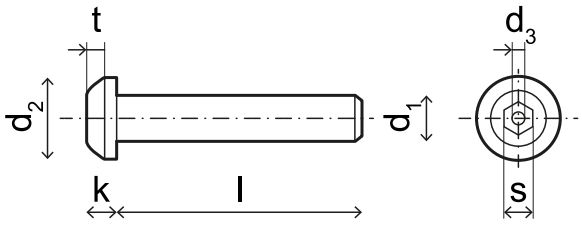


8.1.6 CAN bus cables recommended specifications

Section	2 x 0.34 mm² (22 AWG) power supply 2 x 0.25 mm² (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 90 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 control unit.
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.

8.1.7 Side screw specifications

Pin Hex button head security screw



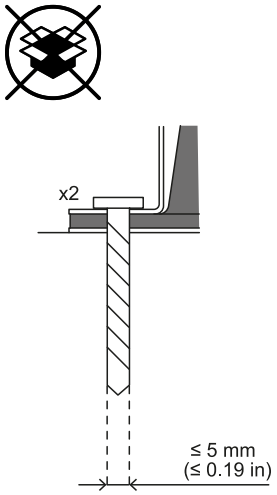
d_1	M4
l	10 mm (0.39 in)
d_2	7.6 mm (0.30 in)
k	2.2 mm (0.09 in)
t	min 1.3 mm (0.05 in)
s	2.5 mm (0.10 in)
d_3	max 1.1 mm (0.04 in)

8.1.8 Bottom screws specifications

The bottom screws can be:

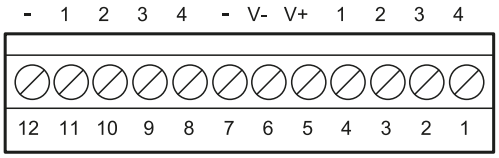
- cheese head
- button head

***Note**: Avoid using countersunk head screws.*



8.2 Terminal blocks and connector pin-outs

8.2.1 Digital inputs and outputs terminal block



***Note**: facing the control unit so that the terminal block is on the top left, number 12 is the closest to the control unit 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.*

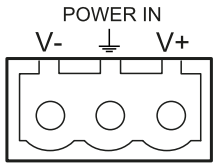
***Note**: use only copper wires with a minimum gauge of 18 AWG and a torque of 0.62 Nm (5,5 lbs in).*

8.2.2 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

8.2.3 Power supply terminal block



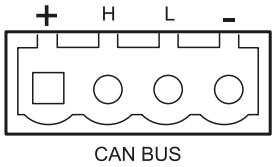
***Note**: connector front view.*

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).*

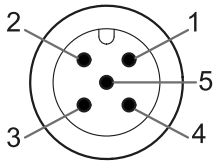
8.2.4 CAN bus terminal block



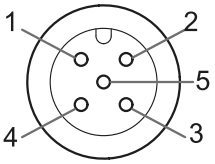
Symbol	Description
+	+ 12 V dc output
H	CAN H
L	CAN L
-	GND

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

8.2.5 Connectors M12 CAN bus



Male connector

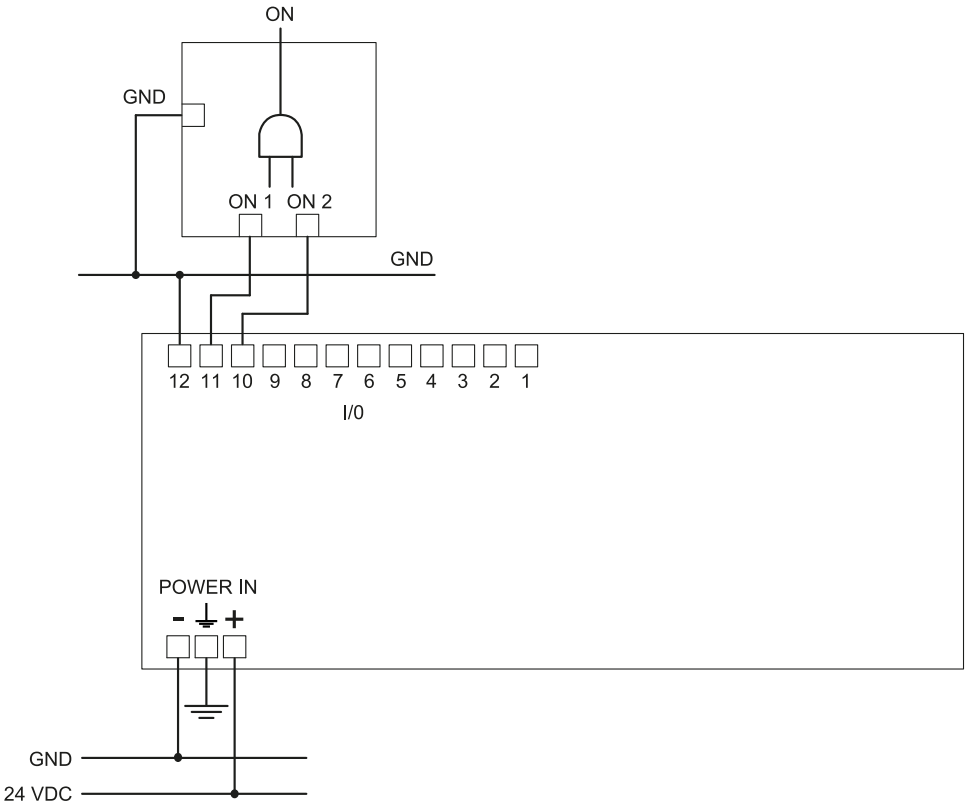


Female connector

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

8.3 Electrical connections

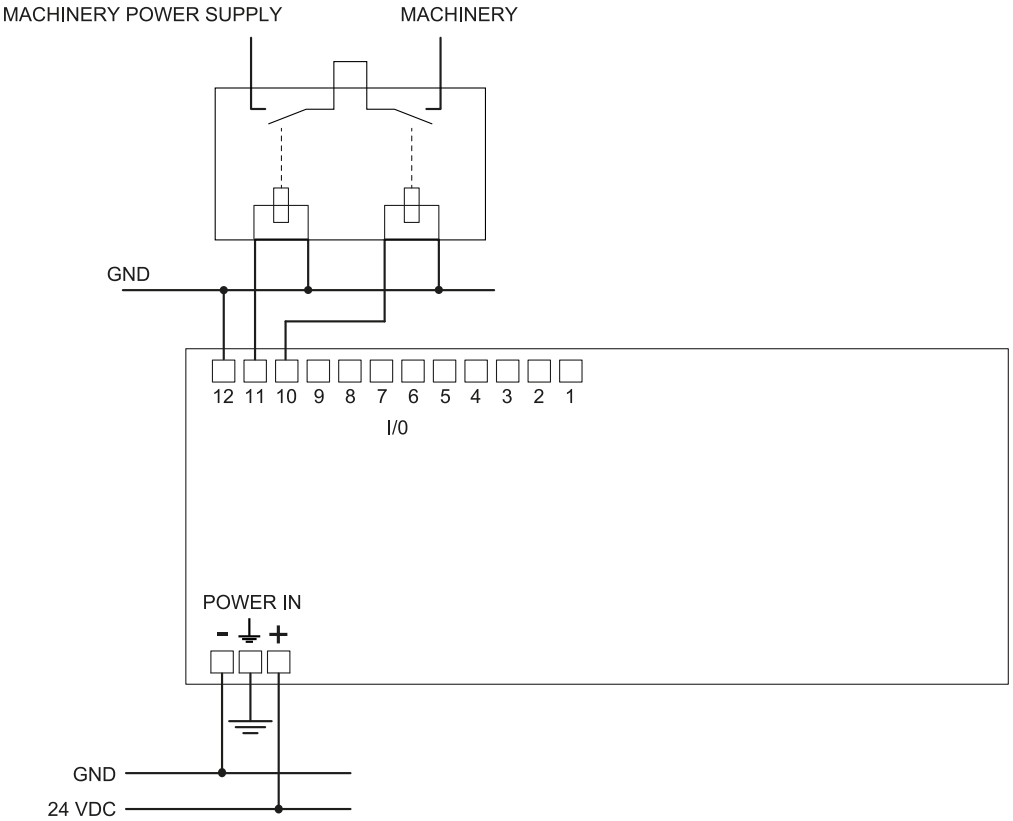
8.3.1 Connection of safety outputs to the machinery control system



Digital I/O settings (through the Inxpect Safety 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

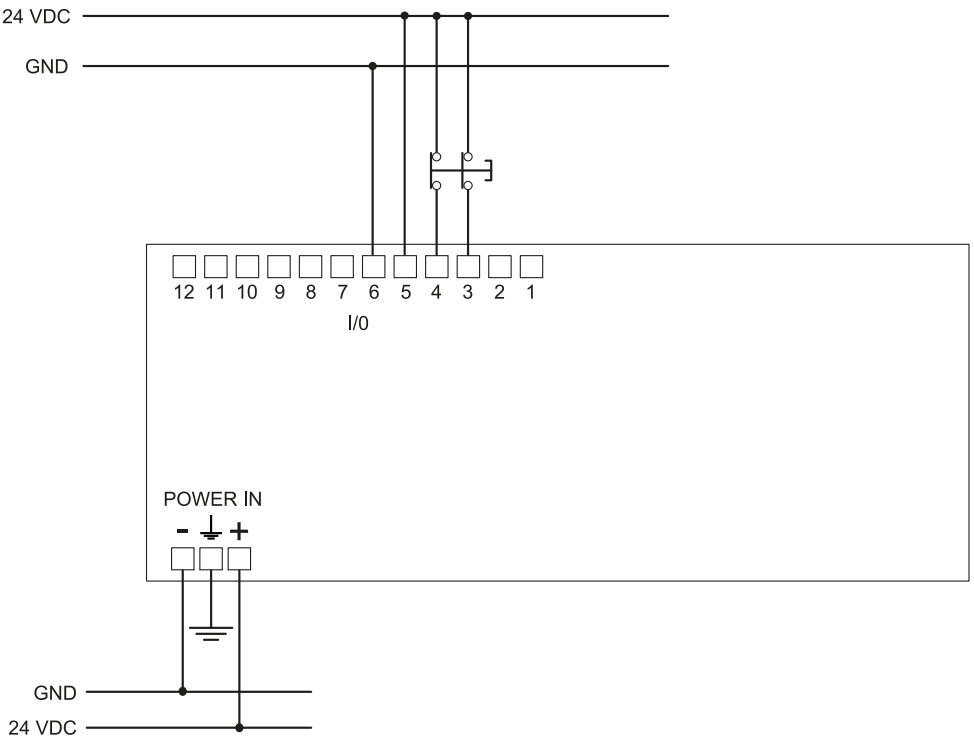
8.3.2 Connection of safety outputs to an external safety relay



Digital I/O settings (through the Inxpect Safety 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

8.3.3 Connection of stop signal (emergency button)



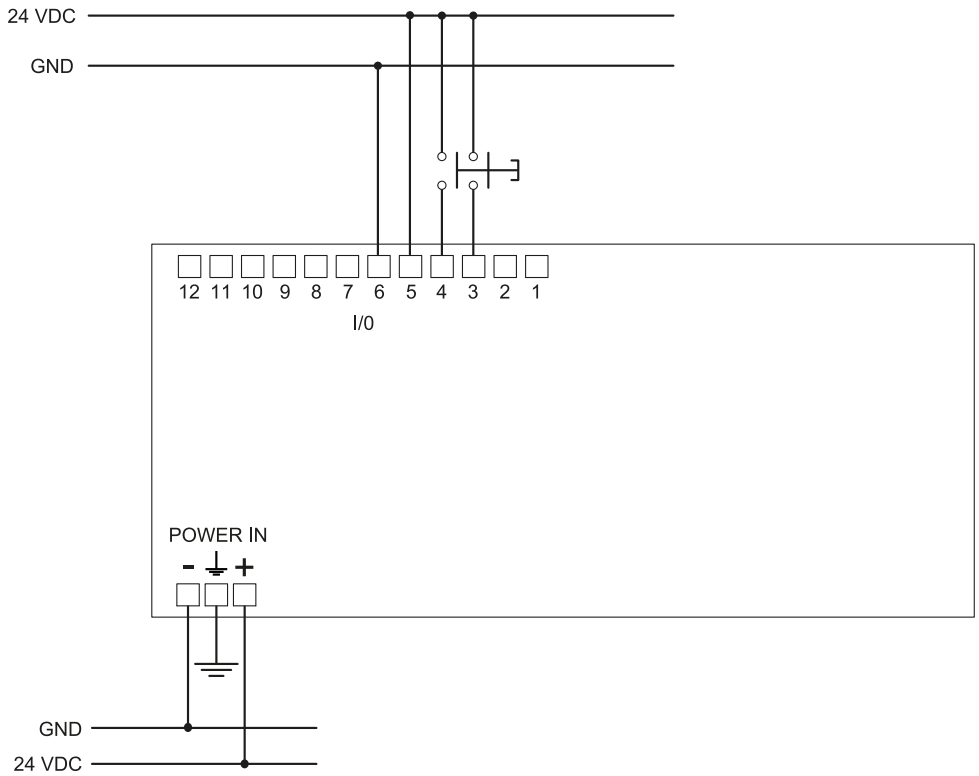
***Note**: the indicated emergency button opens the contact when pressed.*

***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 Inxpect Safety 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

8.3.4 Connection of restart signal



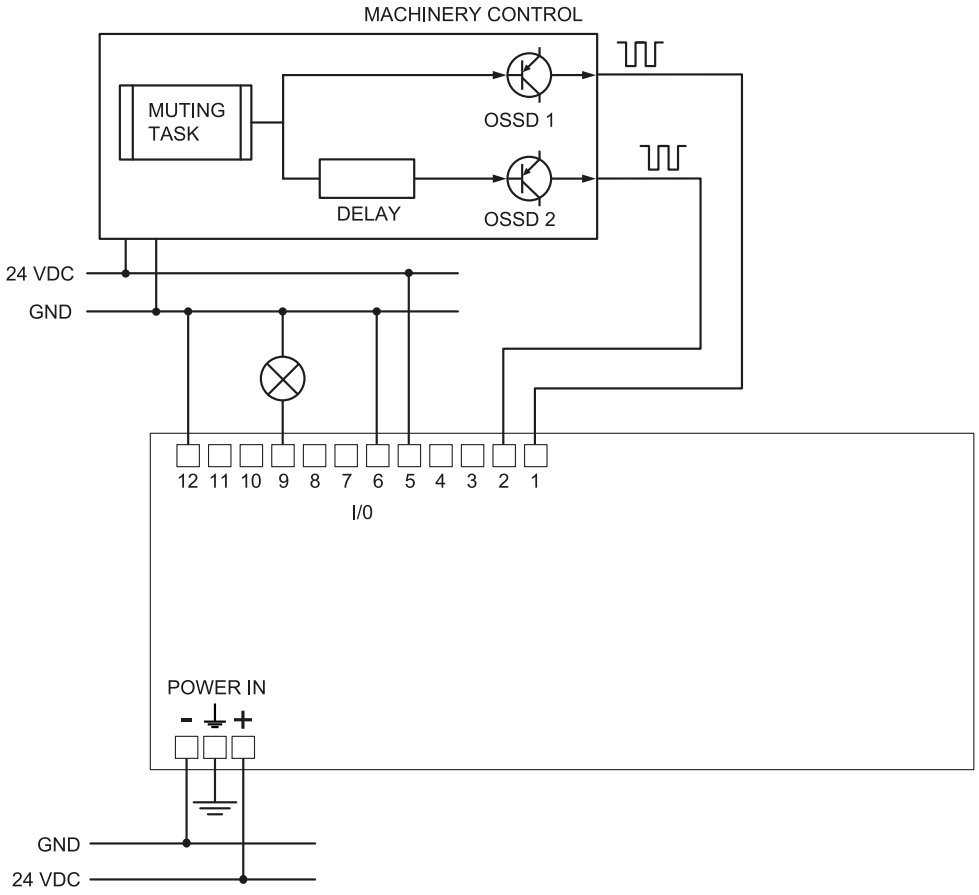
***Note**: the button indicated for the restart signal closes the contact when pressed.*

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

Digital I/O settings (through the Inxpect Safety application)

Digital input #1 Restart 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

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

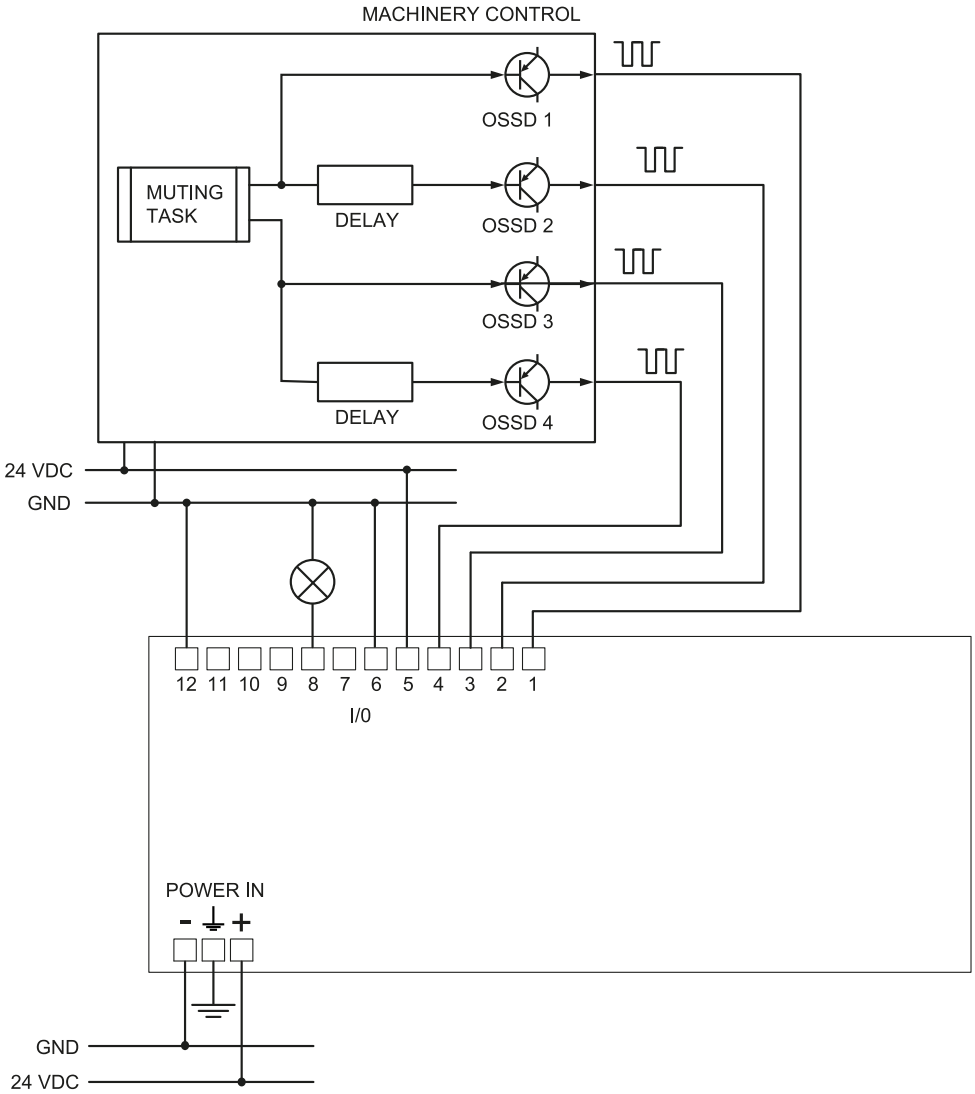


***Note**: the cables used for wiring the digital inputs must have a maximum length of 30 m (98.4 ft).*

Digital I/O settings (through the Inxpect Safety 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

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

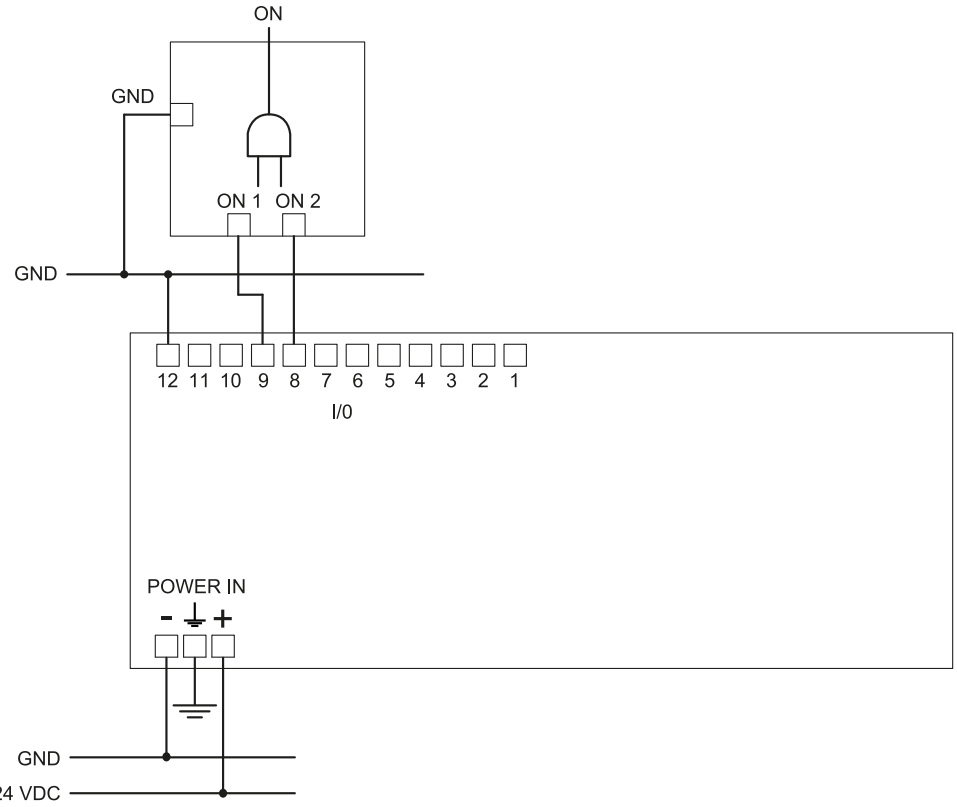


***Note**: the cables used for wiring the digital inputs must have a maximum length of 30 m (98.4 ft).*

Digital I/O settings (through the Inxpect Safety 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

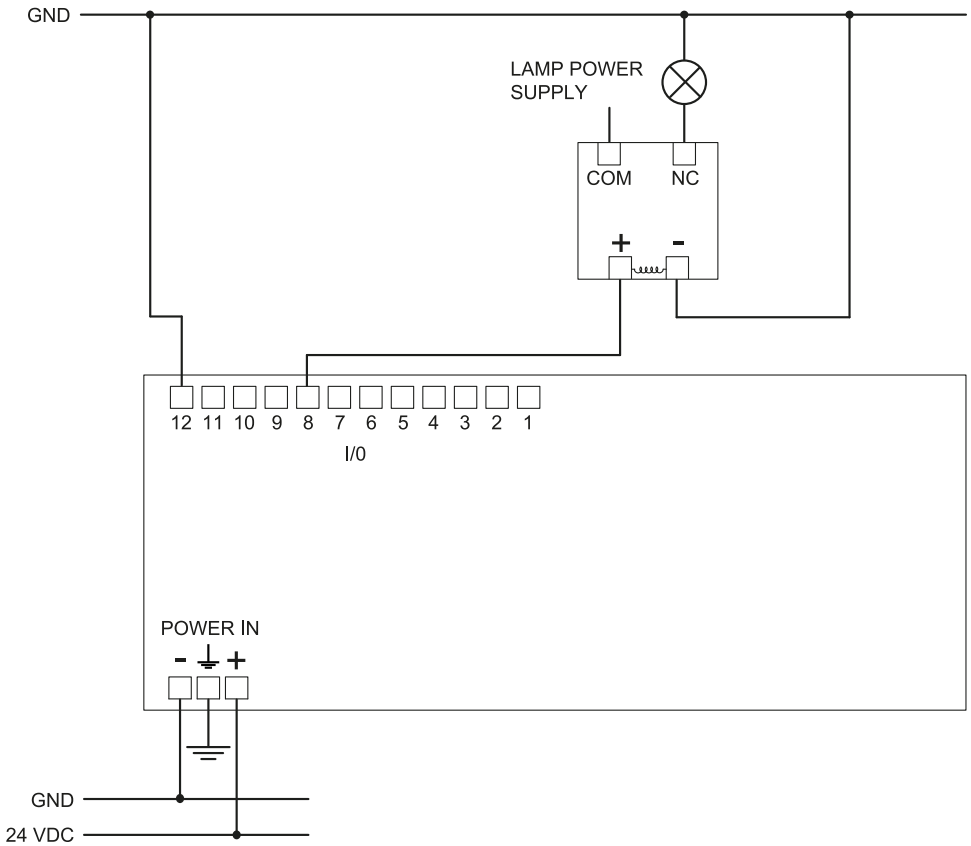
8.3.7 Detection signal 2 connection



Digital I/O settings (through the Inxpect Safety 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

8.3.8 Diagnostic output connection



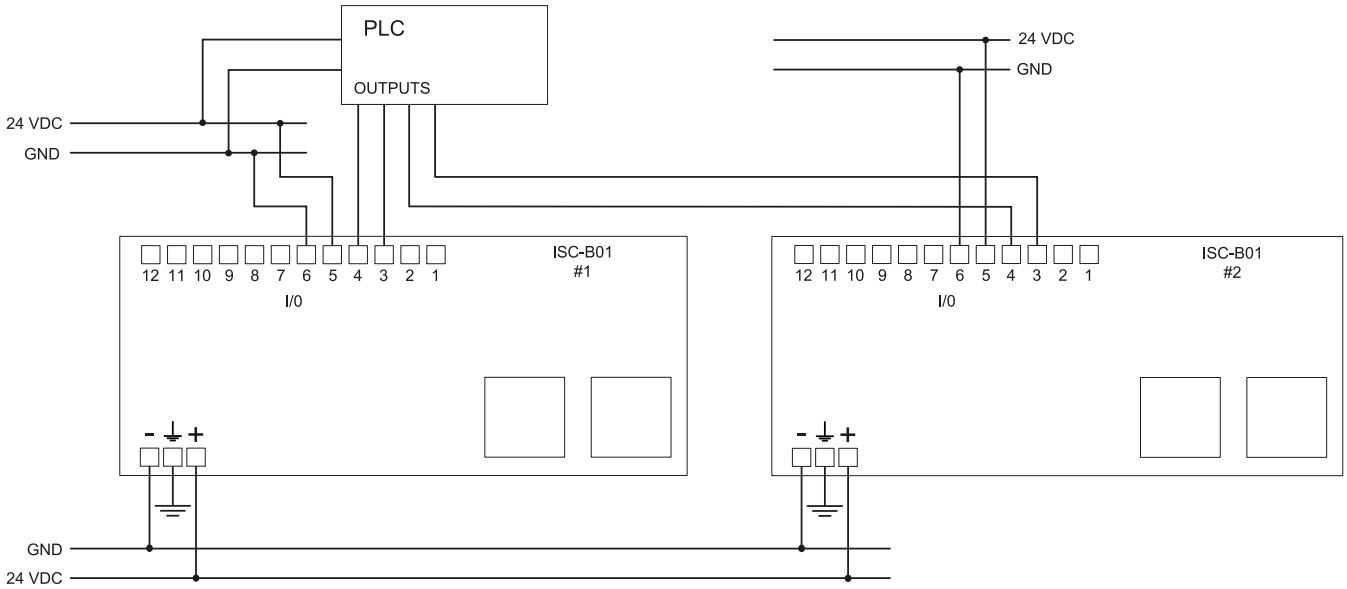
***Note**: the indicated light turns on in the presence of a failure.*

Digital I/O settings (through the Inxpect Safety 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

8.3.9 Multi-control unit Synchronization

Example with two ISC-B01 control units.



***Nota**: only if the Inxpect Safety application supports the function.*

Digital I/O settings (through the Inxpect Safetyapplication)

Control unit #1

- Control unit channel 0
- Digital input #1 Acquisition Trigger

Control unit #2

- Control unit channel 1
- Digital input #1 Acquisition Trigger

8.4 Parameters

8.4.1 Parameter list

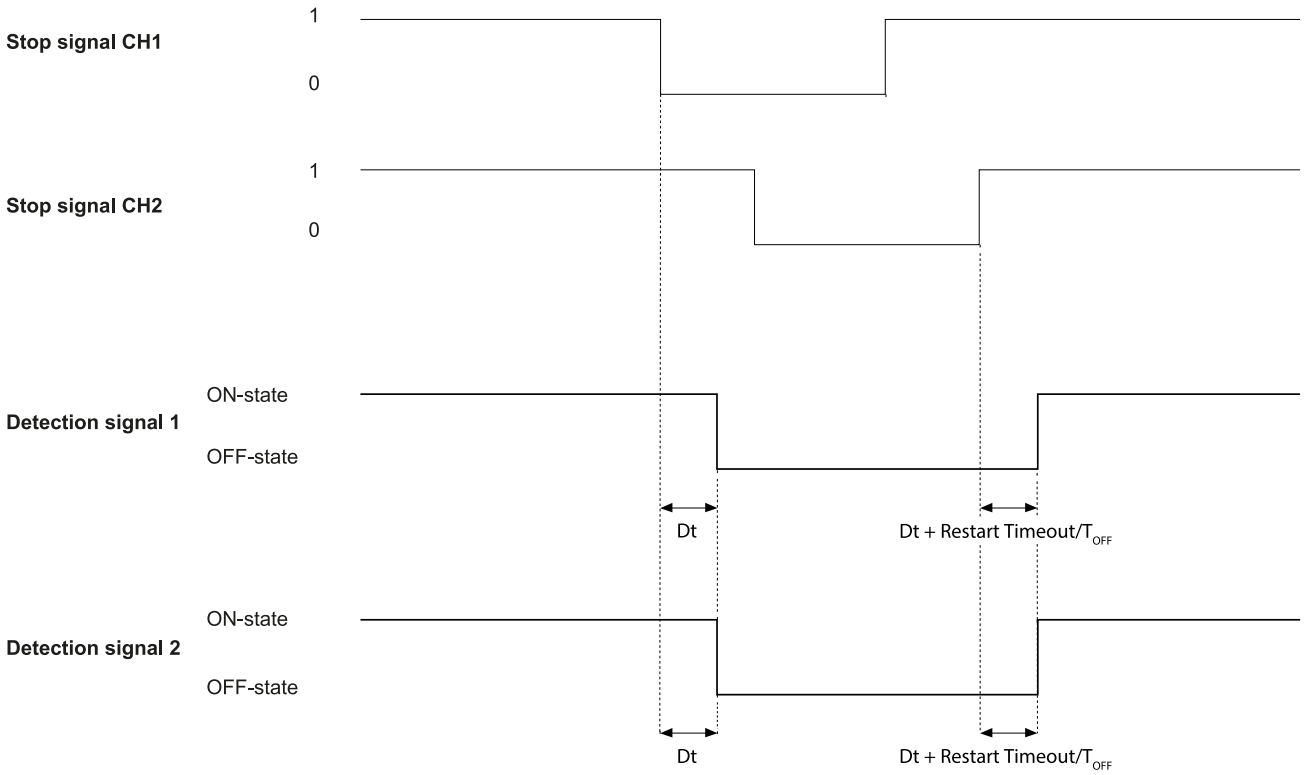
Parameter	Min	Max	Default value
Settings > Account			
Password	-	-	Not available
Settings > General			
Operational frequency	Full BW, Restricted BW		Full BW
Configuration			
Number of installed sensors	1	6	1
Plane	Dim. X: 1000 mm Dim. Y: 1000 mm	Dim. X: 20000 mm Dim. Y: 65000 mm	Dim. X: 8000 mm Dim. Y: 4000 mm
Position (for each sensor)	X: 0 mm Y: 0 mm	X: 65000 mm Y: 65000 mm	X: 1000 mm Y: 1000 mm
Rotation (for each sensor)	0°	359°	0°
Inclination (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	4000 mm	1000 mm
Detection Distance 2 (for each sensor)	0 mm	3000 mm	0 mm

Parameter	Min	Max	Default value
Angular coverage (for each sensor)	110°. 50°		110°
Safety working mode (for each detection field of each sensor)	Both (default), Always access detection, Always restart prevention		Both (default)
Restart timeout for each detection field	0 ms	60000 ms	10000 ms
T_{OFF}	100 ms	60000 ms	100 ms
Settings > Sensors			
Detection field dependency	Enabled, Disabled		Enabled
Access sensitivity	Normal, High, Very High		Normal
Restart sensitivity	Normal, High, Very High		Normal
Anti-masking	Disabled, Low, Medium, High		High
Anti-rotation around axes	Disabled, Enabled		Enabled
Settings > Digital Input-Output			
Digital input (for each input)	Stop signal, Restart signal, Muting group “N”, Activate dynamic configuration, Fieldbus controlled, Acquisition Trigger		Not configured
Digital output (for each output)	System diagnostic signal, Muting enable feedback signal, Fieldbus controlled, Restart Feedback signal, Detection signal 1, Detection signal 2, Acquisition Trigger		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 parameters			
Detection field 1, 2, 3, 4	Automatic, Manual, Safe manual		Automatic
Settings > Multi-control unit synchronization			
Control unit channel	0	3	0
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 for configuration	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

Parameter	Min	Max	Default value
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
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

8.5 Digital input signals

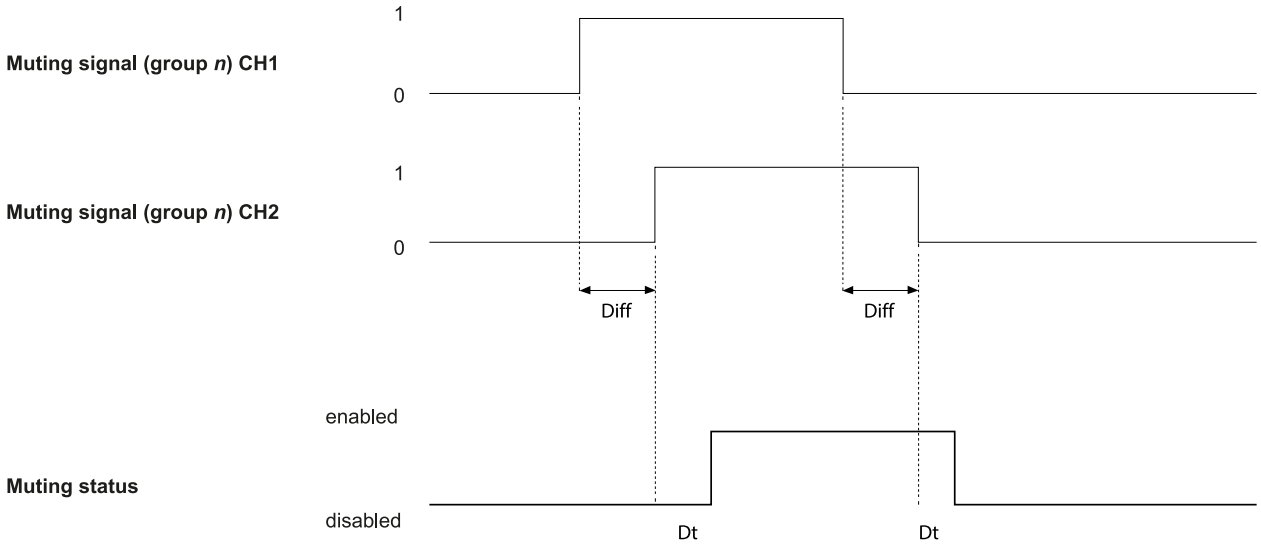
8.5.1 Stop signal



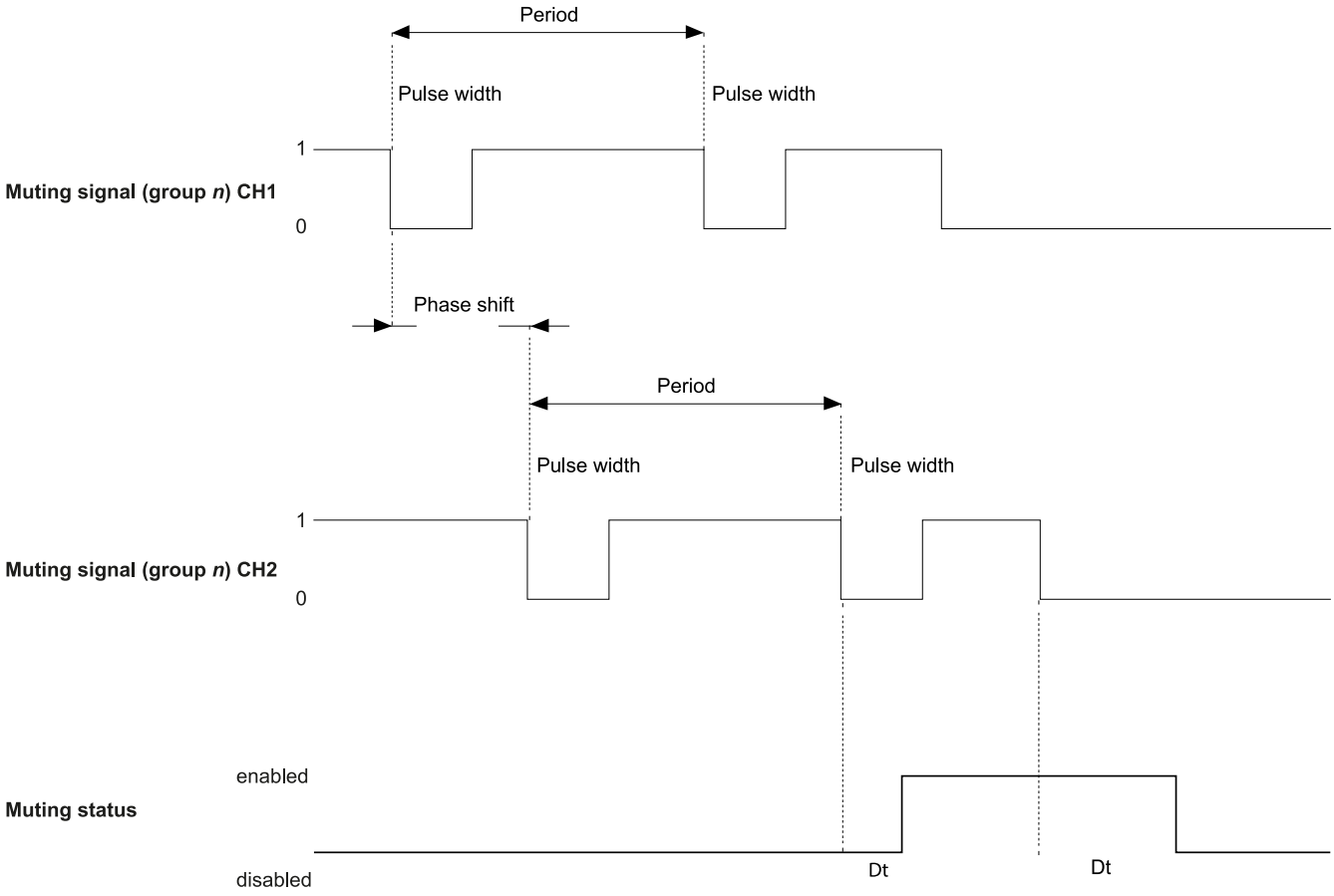
Part	Description
Detection signal 1 **Detection signal 2**	Both deactivate on the falling edge of, at least, one of the two input channels of the input signal. They remain in OFF-state as long as one of the two input channels remains to the low logic status (0).
Stop signal CH1 **Stop signal CH2**	Interchangeable channel. Both channels must go to low logic level (0) to set Detection signal 1 and Detection signal 2 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.

8.5.2 Muting (with/without pulse)

Without pulse

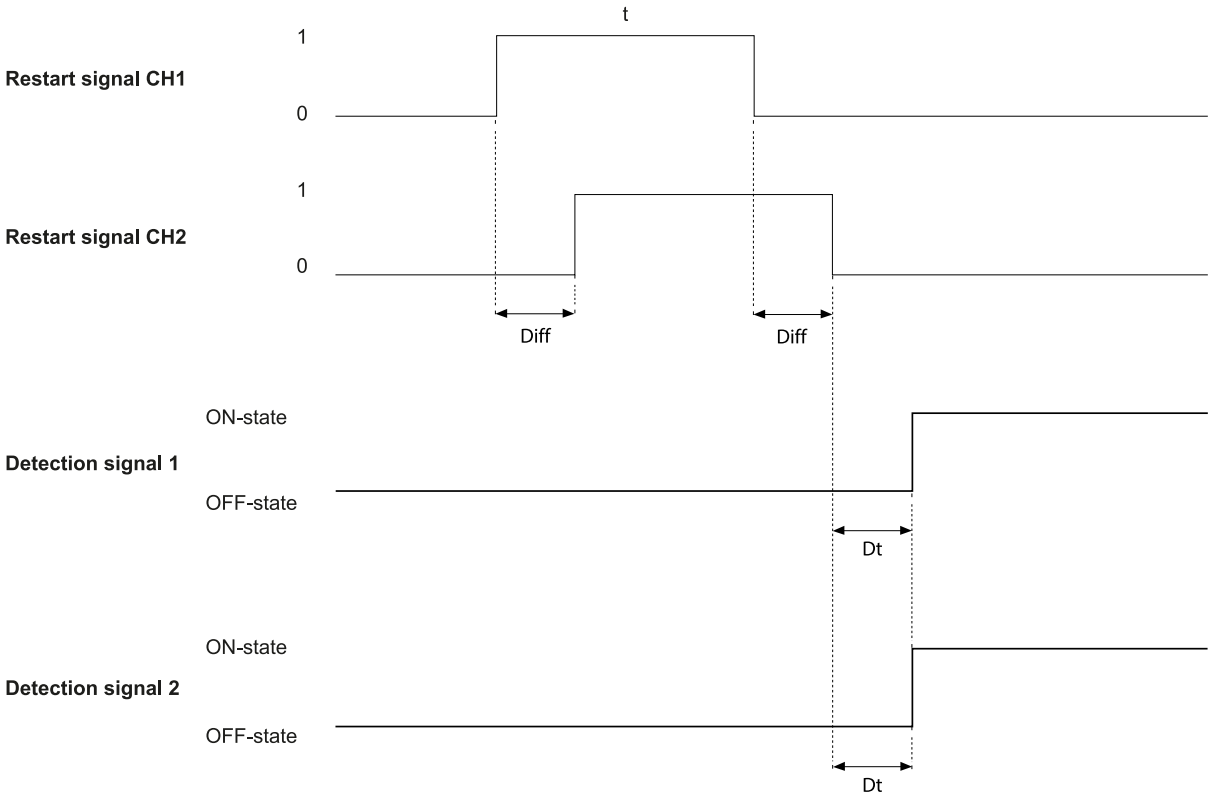


With pulse



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.

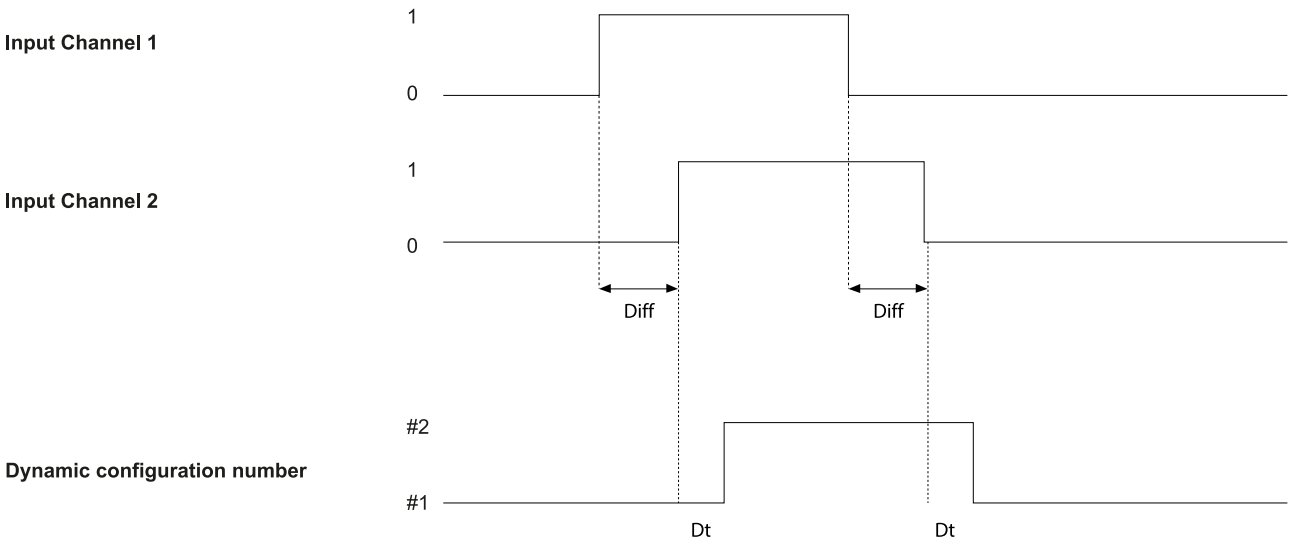
8.5.3 Restart signal



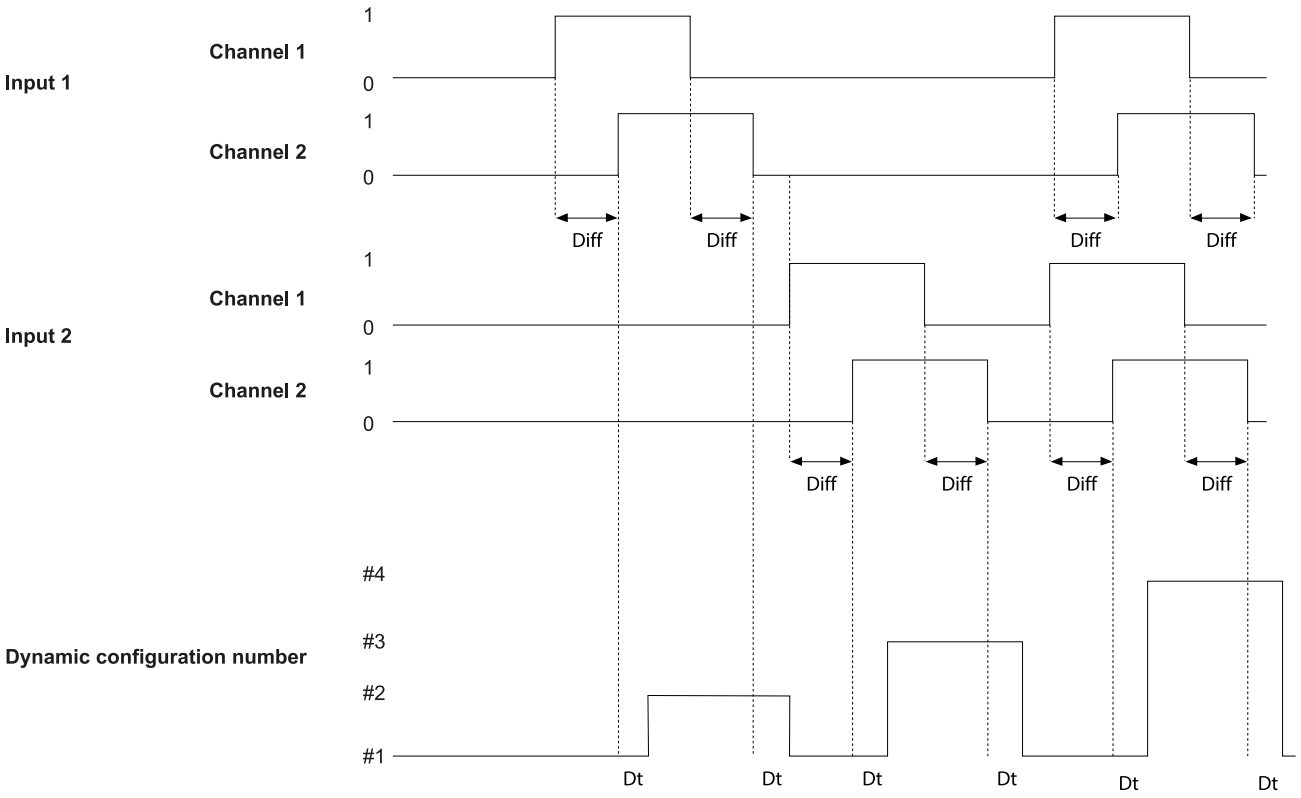
Part	Description
Detection signal 1 **Detection signal 2**	The Detection signal 1 and Detection signal 2 outputs go to ON-state as soon as the last channel has correctly completed the transition 0 -> 1 -> 0.
Restart signal CH1 **Restart signal CH2**	Interchangeable channel. Both channels of Restart signal 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.

8.5.4 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 29 for details.
Dt	Activation/deactivation delay. Less than 50 ms.

9. Appendix

Contents

This section includes the following topics:

9.1 System software

9.1.1 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 System Series 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.

9.1.2 Configuration

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

The system configuration is described in "Installation and use procedures" on page 63.

9.1.3 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 63.

9.1.4 Installation instructions

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

9.1.5 Outstanding anomalies

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

9.1.6 Backward compatibility

Backward compatibility is guaranteed.

9.1.7 Change control

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

9.1.8 Implemented security measures

Firmware upgrade packages are managed by the Inxpect technical support team and they are signed to prevent the use of unverified binary files.

9.2 Disposal

LBK System Series 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.

9.3 Service and warranty

9.3.1 Customer service

Inxpect SpA
Via Serpente, 91
25131 Brescia (BS) - Italy
Tel: +39 030 5785105
Fax: +39 012 3456789
email: safety-support@inxpect.com
website: www.inxpect.com

9.3.2 How to return the product

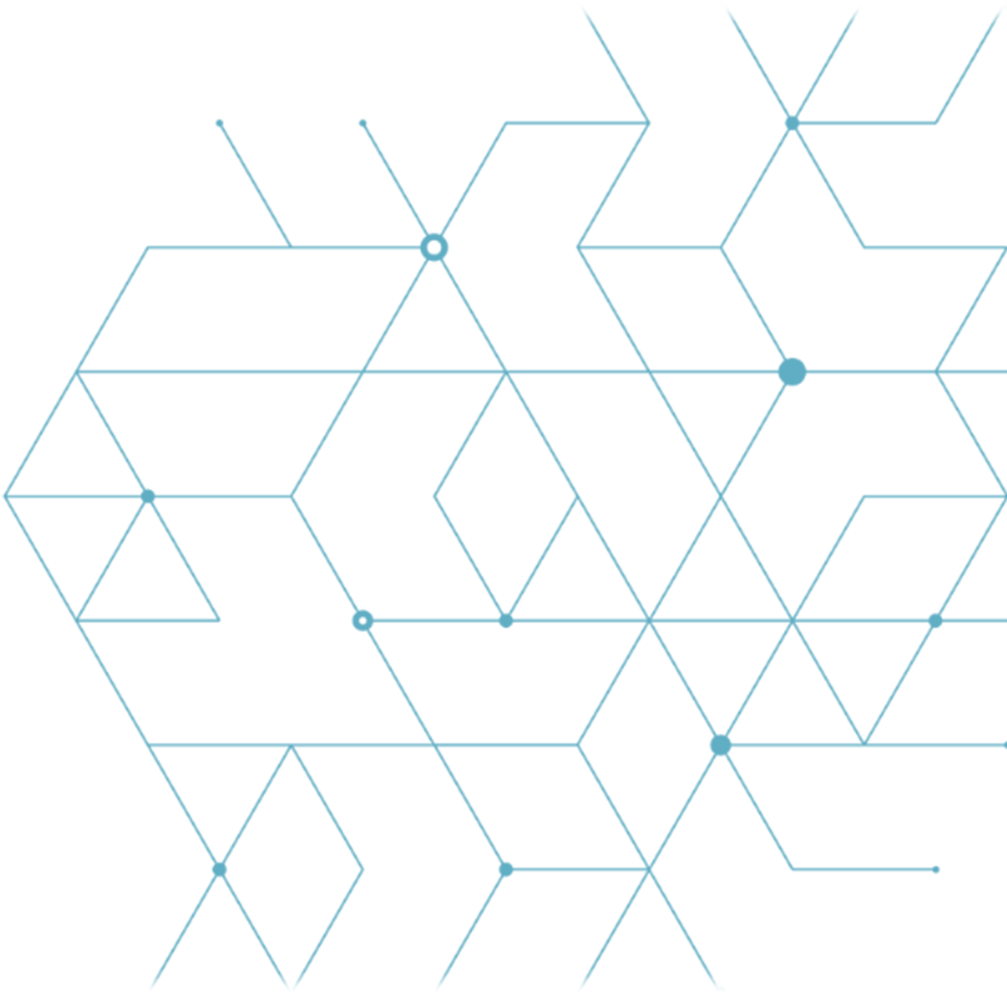
If necessary, complete the request with information about the return on the website www.inxpect.com/industrial/rma. Then, return the product to the local distributor or exclusive distributor. **Use original packaging. Shipping costs are at the customer's expense**.

Area distributor	Manufacturer
Note distributor information here:	Inxpect SpA Via Serpente, 91 25131 Brescia (BS) Italy www.inxpect.com

9.3.3 Service and warranty

Refer to www.inxpect.com for the following information:

- terms, exclusions and cancellation of the warranty
- general conditions of the Return Merchandise Authorization (RMA)



LBK System Series
Instruction manual v1.2
SET 2021
SAF-UM-LBKBus-en-v1.2

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