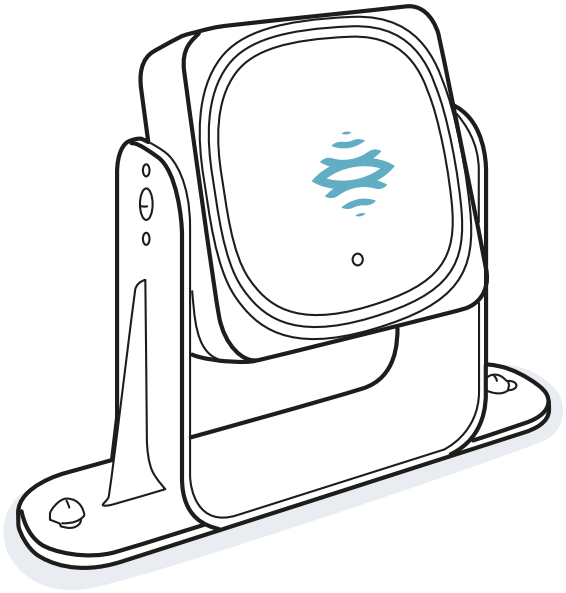
INXPECT

LBK System

Volumetric Safety System



Instruction manual
v1.2 - EN

Instructions translated from the original

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

Contents

Glossary of terms

D

Dangerous area

Area to be monitored because it is dangerous for people.

Detection area

Portion of the field of vision where detection is guaranteed.

F

Field of vision

Sensor area of vision. It is composed of two areas: detection area and uncertainty area. It can have two ranges: 110° and 50°

FMCW

Frequency Modulated Continuous Wave.

M

Machinery

The system for which the dangerous area is monitored.

Monitored area

Area actually monitored by the system. Includes the stopping area, and only for detection function, any pre-alarm area.

P

Pre-alarm area

Only for the detection function. Area where motion detection triggers the closure of the dedicated auxiliary relay.

S

Stopping area

Portion of the area monitored by the sensor where, if motion is detected, the system safety relays are de-energized. If it does not correspond to the dangerous area defined in the risk assessment, the residual risk must be calculated and additional safety measures must be introduced.

T

Tolerance area

Portion of the monitored area where detection is not guaranteed.

U

Uncertainty area

Area of the field of vision where detection or not of an object depends on the characteristics of the same object.

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 to protect machinery operators and how to install it, use it and maintain it safely.

These instructions do not pertain to the functioning of the machinery where LBK System is installed.

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 through to decommissioning.
It must be conserved 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 Updates to the instruction manual

Publication date	Code	Updates
FEB 2019	LBK-System_ instructions_en v1.2	Added 50° field of vision ("Sensor field of vision" on page 21) Added application validation procedure Inxpect Safety ("Validate safety functions" on page 41) Updated contents for installation of sensors at heights over 1 m (3.3 ft) Integration for masking signals ("Masking conditions" on page 18) Added formulas for calculation of sensor position ("Calculation of position for sensor height > 1 m" on page 25 Reorganization of topics
SEP 2018	LBK-System_ instructions_en v1.1	"Tamper-proof functions" on page 17 Changed and integrated the section "Applications" on page 29 Added working frequency setting Changed voltage and current values for safety relays
JUN 2018	LBK-System_ instructions_en v1.0	First publication

1.1.4 Intended users of this instruction manual

The recipients of the instruction manual are:

- The designer of the machinery 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 safety of the user and 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 damage to the equipment.*

2.1.2 PERSONNEL SKILLS

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

Recipient	Assignments	Skills
Machinery designer	• Defines which protection devices should be installed and installation specifications	• Knowledge of significant dangers of the machinery that must be mitigated 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 report	• 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 designer
Machinery maintenance technician	• Performs maintenance on the system	• Advanced technical knowledge in the electrical and industrial safety fields

2.1.3 FORESEEN USE

LBK System is certified as SIL 2 according to IEC/EN 62061 and PL d in accordance with EN ISO 13849-1. Performs the following safety functions:

- **detection function**: prevents access to a dangerous area. Access to the area de-energizes the safety relays to stop the machinery's moving parts.
- **restart prevention function**: prevents unexpected starting or restarting of the machinery. Detection of motion within the dangerous area maintains the safety relays de-energized to prevent machinery starting.

LBK System is suitable for protecting the entire body.

LBK System has been designed to monitor dangerous areas in industrial environments. Thanks to IP67 protection grade, the sensors are suitable for indoor and outdoor installations.

2.1.4 GENERAL WARNINGS

- Wrong 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 vision may limit the efficiency of sensor detection. Keep the sensor field of vision 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.

2.1.5 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 restart enable button must be installed:
  - outside of the dangerous area
  - not accessible from the dangerous area
  - in a point where the dangerous area is fully visible

2.1.6 RESPONSIBILITY

The machinery designer and system installer are responsible for:

- Providing adequate integration of the system's outgoing signals (both safety and auxiliary).
- 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.

2.1.7 LIMITS

- The system does not detect the presence of inert people 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.

2.2 Conformity

2.2.1 DIRECTIVES AND STANDARDS

Conformity	CE
Directives	2006/42/EC (MD - Machinery)
	2014/53/EU (RED - Radio equipment)
Standards	IEC/EN 62061: 2005 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
	ETSI EN 300 440 v2.1.1
	ETSI EN 301 489-1 v2.2.0 (only emissions)
	ETSI EN 301 489-3 v2.1.1 (only emissions)
	IEC/EN 61326-3-1:2017
	IEC/EN 61010-1: 2010

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

2.2.2 DECLARATION OF CONFORMITY AND CERTIFICATIONS

The manufacturer, Inxpect SpA, declares that the type of radio equipment LBK System complies with the directive 2014/53/EU. The full EU declaration of conformity text is available on the company's website at the address www.inxpect.com.

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

2.2.3 FCC CERTIFICATION

LBK System 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 NATIONAL RESTRICTIONS

LBK System 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:

	UK	FR

In Regno Unito e in Francia, l'allocazione nazionale delle frequenze non permette il libero uso dell'intera banda 24-24,25 GHz. Impostare correttamente il paese nell'applicativo Inxpect Safety e la banda autorizzata verrà automaticamente selezionata.

Restrictions in UK. In the United Kingdom, 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 will be automatically selected.

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

3. Get to know LBK System

Contents

This section includes the following topics:

3.1 LBK System

3.1.1 Description

LBK is an active protection radar system that monitors the dangerous areas of a machinery. It performs two safety functions:

- **detection function**: it places the machinery in safe conditions when someone enters the dangerous area
- **restart prevention function**: it inhibits the machinery restart if there are people in the dangerous area

3.1.2 Inputs and outputs

Thanks to its digital inputs and outputs, LBK System provides an automatic control system that manages the primary safety functions of the machinery.

In addition to safety outputs, the system is also fitted with two configurable auxiliary outputs (fault, pre-alarm and muting status) and three digital inputs (emergency button, restart enable button and muting).

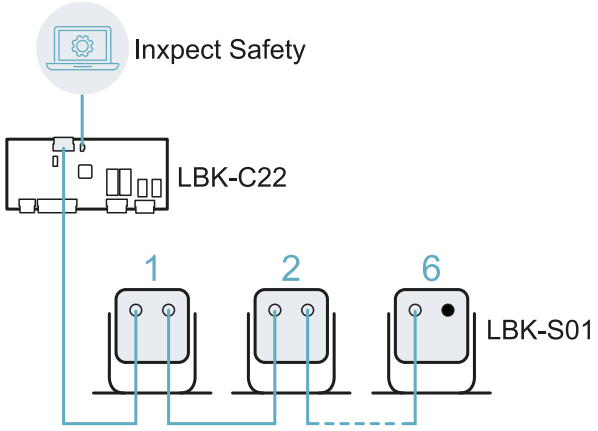
3.1.3 Special features

Some of the special features of this protection system are presented as follows:

- resistant to dust, water, smoke and work waste
- pre-alarm area to signal proximity or prepare the machinery for stopping
- three configurable sensitivity levels
- muting on the entire system or only on some sensors

3.1.4 Main components

LBK System is composed of a controller and up to six sensors. The Inxpect Safety software application allows configuration and inspection of system functioning.



3.1.5 Controller - sensors communication

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

For correct functioning, each sensor must be assigned with an identification (ID). Two sensors on the same bus must have different IDs.

The default settings for the sensors is ID = 0, or no assigned ID.

3.1.6 Applications

LBK System integrates with the machinery control system: when performing safety functions or detecting faults, LBK System de-energizes the safety relays and keeps them de-energized, so the control system can command safety conditions of the area and/or prevent restarting of the machinery.

In the absence of other control systems, LBK System can be connected to the devices that control the power supply or machinery start-up (e.g. external relays on the power supply line).

LBK System does not perform normal machinery control functions.

For connection examples, see "Electrical connections" on page 54.

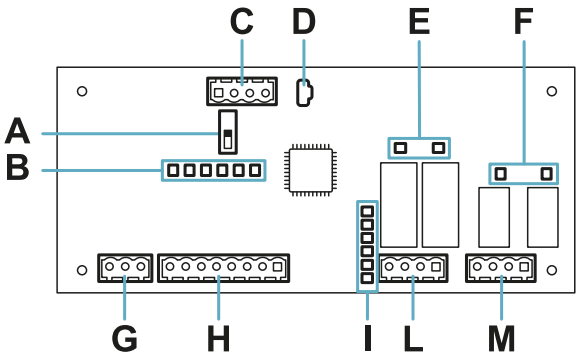
3.2 Controller LBK-C22

3.2.1 Functions

The controller performs the following functions:

- Collects information from all the sensors via CAN bus.
- Compares the position of detected motion with the set stopping and pre-alarm thresholds.
- De-energizes the safety output relays when at least one sensor detects motion in the stopping area.
- De-energizes the safety output relays if a fault is detected in the sensor or the controller.
- Manages the auxiliary inputs and outputs (to learn about the functions see "Auxiliary outputs" on the next page and "Digital inputs" on the next page).
- Communicates with the Inxpect Safety software for all configuration and diagnostic functions.

3.2.2 Structure



Part	Description
A	DIP switch to include/exclude the termination resistance: • On (default) = resistance included • Off = resistance excluded
B	Digital inputs status LED
C	Sensors CAN bus terminal block
D	Micro USB port for connecting the computer and communicating with the Inxpect Safety software
E	Safety outputs status LED
F	Auxiliary outputs status LED
G	Power supply terminal block
H	Digital inputs terminal block

Part	Description
I	Sensors status LED
L	Safety outputs terminal block
M	Auxiliary outputs terminal block

3.2.3 Sensors status LED

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

Status	Meaning
Green	Normal functioning and no detected motion
Orange	Normal functioning and motion detected
Flashing red	Error. See "Controller LED" on page 45

3.2.4 Inputs and outputs status LED

The meaning of the LEDs when they are on is as follows:

LED	Meaning
Safety output	Energized relay (closed contact)
Auxiliary output	Energized relay (closed contact)
Digital input	High logic level (1)

3.2.5 Safety outputs

The controller has one dual channel safety output realized with forced guided safety relays for alarms and, direct or indirect, safety of the machinery.

3.2.6 Safety outputs status

The relay contacts are normally open. The statuses of the safety outputs are as follows:

- de-energized relay (open contact):
  - motion detected in stopping area or
  - fault detected in system
- energized relay (contact closed): no motion detected and normal functioning

3.2.7 Auxiliary outputs

The controller has two relay outputs, which can be configured via the Inxpect Safety application, for:

- pre-alarm
- fault
- muting status

3.2.8 Auxiliary outputs status

The statuses of the auxiliary outputs are as follows:

Output	De-energized relay (open contact)	Energized relay (closed contact)
Pre-alarm	No motion detected in the pre-alarm area	Motion detected in the pre-alarm area
Fault	Fault	Normal functioning
Muting status	Muting disabled	Muting enabled

3.2.9 Digital inputs

The controller has three dual channel digital inputs and common reference potential for:

- muting (high logic level (1) = muting enabled)
- machinery emergency button (low logic level (0) = stopping enabled)
- machinery restart button enabled (high logic level (1) = restart enabled)

The inputs are type1, type 2 and type 3 (see "Voltage and current limits for digital inputs" on page 53).

The function of the inputs can be configured through the Inxpect Safety application.

3.2.10 SNS input

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

***NOTICE**: if at least one input is connected, the SNS input must also be connected.*

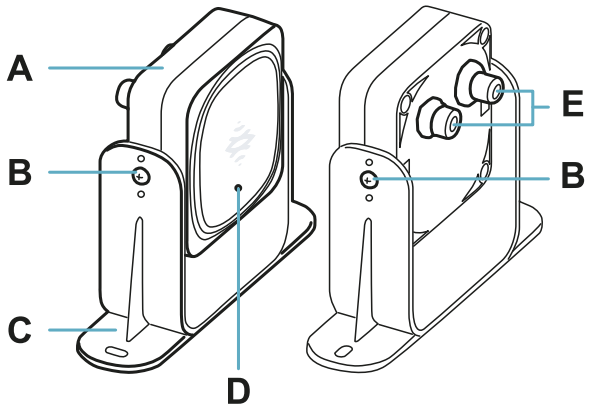
3.3 Sensors LBK-S01

3.3.1 Functions

The sensors perform the following functions:

- Detect motion in their field of vision.
- Send the motion detection signal to the controller through CAN bus.
- Signal faults detected in diagnostics on the controller through CAN bus.

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 machinery
D	Status LED
E	Connectors for connecting the sensors in a chain and to the controller

3.3.3 Status LED

Status	Meaning
Steady on	Normal functioning and no detected motion
Rapid flashing on (100 ms)	Normal functioning and motion detected
Other conditions	Error. See "Sensor LED" on page 45

3.4 Inxpect Safety application

3.4.1 Functions

The application is used to perform the following main functions:

- Configure the system.
- Print configuration report.

- Check system functioning.
- Download system log.

3.4.2 Access

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

Some functions are password protected. The password must be set through the application and is saved on the controller. 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**) • Perform maintenance operations (**Maintenance**) • Download the system log and display the reports (> **Activity history**) • Restore factory default settings (> **General**) • Export the configuration (> **General**) • Validate the system (**Validation**)	without password
• All the available functions without password • Configure the system (**Configuration** and) • Import the configuration (> **General**) • Change the access password (> **User account**) • Update the firmware (> **General**)	with password

3.4.3 Main menu

Page	Function
Dashboard	Display the system status: • controller status, • sensors status, • status of auxiliary inputs and outputs and relative set function. Display the date of the next scheduled periodical test. Display the sensitivity settings.
Configuration	Define the configuration of the sensors and monitored area.
Validation	Start the validation procedure.
Maintenance	Start the wizard for periodical test. Display the date of the next scheduled periodical test. Display the performed periodical tests report.
	Configure the sensors. Configure the auxiliary inputs and outputs function. Update the firmware. Export/import the configuration. Download the log. Other general functions.
	Enable access to the configuration functions. Password required.

3.4.4 Configuration report

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

- configuration data
- date and time of configuration change
- name of computer where the change was inserted

The reports are documents that cannot be changed, and can only be printed and signed by the person assigned to the task.

4. Functioning principles

Contents

This section includes the following topics:

4.1 Sensor functioning principles

4.1.1 Introduction

The LBK-S01 sensor is an FMCW (Frequency Modulated Continuous Wave) radar device based on a proprietary detection algorithm. The sensor sends impulses and obtains information, analyzing the reflection of the objects that it encounters.

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: objects positioned perfectly in front of the radar generate a greater signal with respect to side objects.
- motion speed: the faster the motion of the object, the greater the reflected signal

4.1.3 Signaled and missed objects

Many objects inside of an industrial environment reflect the radar signal. The signal analysis algorithm takes into consideration only those objects that move within the field of vision, ignoring completely static objects.

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

4.2 Detection function

4.2.1 Description

The function de-energizes the safety relays and prevents the machinery from restarting if motion is detected in the system stopping area.

For the detection function the sensor can be set with 50° or 110° field of vision. For details, see "Sensor field of vision" on page 21.

WARNING! The stopping area may not correspond to the defined dangerous area according to the risk assessment. Calculate the actual dimensions based on the field of vision of the single sensor (see "Sensor position" on page 20) and perform the validation of the function (see "Validate safety functions" on page 41). If necessary, implement additional safety measures.

***Note**: for linear barrier application, the stopping area is calculated automatically by the Inxpect Safety application based on the set dimensions of the dangerous area and the configuration of the sensors.*

4.2.2 Pre-alarm area

A pre-alarm area can be configured, where if the machinery is functioning and the system detects motion,

the dedicated auxiliary output relay closes. For example, this is useful for connecting a light or acoustic signal. The pre-alarm area is defined through the Inxpect Safety application.

4.3 Restart prevention function

4.3.1 Description

The function maintains safety relays de-energized and prevents the machinery from restarting if motion is detected in the system stopping area.

After motion is detected, even a motion of only a few millimeters (e.g. a person breathing) prevents the machinery from restarting.

WARNING! The stopping area may not correspond to the defined dangerous area according to the risk assessment. Calculate the actual dimensions based on the field of vision of the single sensor (see "Sensor position" on page 20) and perform the validation of the function (see "Validate safety functions" on page 41). If necessary, implement additional safety measures.

***Note**: for linear barrier application, the stopping area is calculated automatically by the Inxpect Safety application based on the set dimensions of the dangerous area and the configuration of the sensors.*

4.3.2 Function limits

The coverage of the restart prevention function is defined by the geometry of the field of vision. The field of vision of the sensor depends on the inclination and height of the sensor installation, see "Sensor position" on page 20.

For the restart prevention function, a sensor set with 50° field of vision has the same coverage as the 110° field of vision.

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

4.3.3 Types of managed restart

***NOTICE**: it is the responsibility of the machinery designer to assess if automatic restart prevention can guarantee the same level of safety as manual restart (as defined in standard EN ISO 13849-1:2006, section 5.2.2).*

The system manages three types of restart prevention:

Type	Conditions for enabling machinery restart
Automatic	The time interval set through the Inxpect Safety application has passed since the last motion detection*.
Manual	The status of the restart enable button indicates that the restart is enabled (digital input status = 1).
Safe manual	• The time interval set through the Inxpect Safety application has passed since the last motion detection* and • the status of the restart enable button indicates that the restart is enabled (digital input status = 1).

***Note** *: machinery restart is enabled if no motion is detected up to 50 cm (19.7 in) beyond the stopping area.*

4.3.4 Precautions for preventing automatic restarting

To prevent automatic restarting the following rules must be followed:

- the set time interval must be more than or equal to 10 s.
- if the sensor is installed less than 30 cm from the ground a minimum distance of 30 cm from the sensor must be guaranteed.

4.3.5 Enable the restart prevention function

Type	Procedure
Automatic	In the Inxpect Safety application > ⚙ > **Sensors**, set in **Restart timeout** the desired delay interval.
Manual	1. Connect the machinery restart enable button conveniently, see "Electrical connections" on page 54. 2. In the Inxpect Safety application > ⚙ > **Sensors**, set **Restart timeout** = 0.

Type	Procedure
Safe manual	1. Connect the machinery restart enable button conveniently, see "Electrical connections" on page 54. 2. In the Inxpect Safety application > ⚙ > **Sensors**, set in **Restart timeout** the desired delay interval.

4.4 Muting

4.4.1 Description

Muting temporarily suspends the safety functions. Motion detection is disabled and therefore the controller maintains the safety outputs in an energized state even when the sensors detect motion in the stopping area.

4.4.2 Muting enabling

The muting can be enabled through digital input for all the sensors simultaneously or only for a group of sensors. Up to three groups can be configured, each associated to a digital input.

Through the Inxpect Safety application, it is necessary to define:

- for each input, the group of managed sensors
- for each group, the sensors that belong to it

See "Configure the auxiliary inputs and outputs" on page 38.

4.4.3 Example of sensors - groups association

4.4.4 Example of digital inputs - groups association

4.4.5 Muting status

Any auxiliary output dedicated to the muting status is closed if at least one of the groups of sensors is in muting.

***NOTICE**: it is the responsibility of the machinery designer to assess if the status indicator of the muting is necessary (as set forth in standard EN ISO 13849-1:2006, section 5.2.5).*

4.5 Tamper-proof functions

4.5.1 Tampering signal

The sensor is fitted with an accelerometer that detects inclination. When the system configuration is saved, the sensor memorizes the set inclination. If the sensor subsequently detects variations in inclination, it

sends a tampering signal to the controller. Upon reception of a tampering signal, the controller de-energizes the safety outputs.

4.5.2 Masking signal

The sensor detects the presence of objects that could obstruct the field of vision. When the system configuration is saved, the sensor memorizes the surrounding environment in a one meter radius. If the sensor subsequently detects variations in the environment that could influence the field of vision, it sends a masking signal to the controller. Upon reception of a masking signal, the controller de-energizes the safety outputs. For details, see "Masking conditions" below.

4.6 Masking conditions

4.6.1 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 then scans and memorizes the environment for 15 seconds.

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 working temperature.

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

4.6.2 Causes of masking

Possible causes of masking signals are presented as follows:

- an object has been placed inside of the stopping area that obstructs the field of vision of the sensor.
- the environment in the stopping area changes significantly, for example, if the sensor is installed on moving parts or if there are moving parts inside of the stopping area.
- the configuration has been saved with sensors installed in an environment that is different from the working environment.

4.6.3 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 signal deactivates automatically within 3 minutes when the sensor reaches its working temperature.

4.6.4 Disable masking signals

WARNING! If the function is disabled the system cannot signal the presence of possible objects that obstruct normal detection. See "Inspections with masking signals disabled" below.

In the Inxpect Safety application > ⚙ > **Sensors**, disable the **Masking** function.

4.6.5 Inspections with masking signals disabled

If masking signals are disabled, it is the responsibility of the operator to perform the following inspections:

- sensor position unchanged with respect to the initial installation
- field of vision of the sensor free of objects

When the masking function is disabled, perform the following controls.

Safety function	Schedule	Action
Detection function	Before each machinery restart	Remove any objects that obstruct the field of vision of the sensor.
Restart prevention function	Each time the safety relays are de-energized	Reposition the sensor according to the initial installation.

4.6.6 When to disable

Some conditions in which it is necessary to disable the masking signals are presented as follows:

- (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).

5. Sensor position

Contents

This section includes the following topics:

5.1 Basic concepts

5.1.1 Determining factors

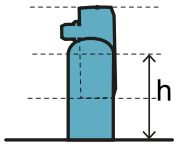
The optimum position of the sensor depends on:

- sensor field of vision
- depth of the dangerous area (and therefore the stopping area)
- sensor installation height
- sensor inclination
- the presence of other sensors (see "Applications" on page 29)

The actual field of vision of the sensor depends on the height of installation and inclination of the sensor.

5.1.2 Sensor installation height

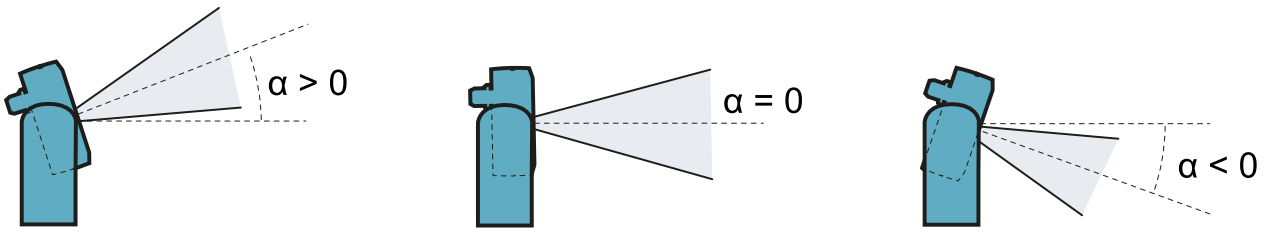
The installation height (h) is the distance between the center of the sensor and the ground or installation base of the sensor.



5.1.3 Sensor inclination

The sensor inclination is the angle between the center of the field of vision of the sensor and the parallel line with 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 vision

5.2.1 Types of field of vision

During the configuration phase it is possible to select the type of field of vision for each sensor:

- 110°
- 50°

The actual field of vision of the sensor also depends on the sensor installation height and inclination. See "Calculation of position for sensor height < 1 m" on the next page and "Calculation of position for sensor height > 1 m" on page 25.

5.2.2 Features of the 50° field of vision

For the detection function, the 50° field of vision makes the sensor stronger to interferences from materials that reflect the radar signal, like iron and water (e.g. iron shavings, water splatters, rain). It is therefore also suitable for outdoor installations.

For the restart prevention function, a sensor set with 50° field of vision has the same coverage as the 110° field of vision.

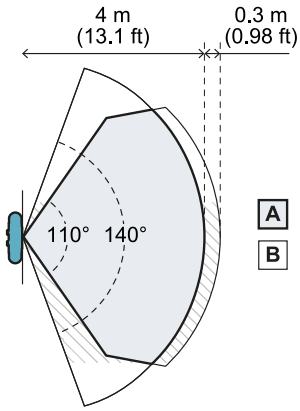
***NOTICE**: during the configuration phase, take this aspect into consideration to avoid generating false alarms.*

5.2.3 Areas and dimensions of the field of vision

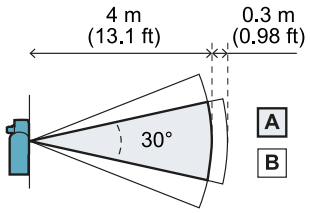
The sensor field of vision is composed of two areas:

- detection area **[A]**: where detection of objects similar to humans in any position is guaranteed.
- uncertainty area **[B]**: where the actual detection of motion depends on the characteristics of the object (see "Factors that influence the reflected signal" on page 15).

5.2.4 Dimensions of the 110° field of vision

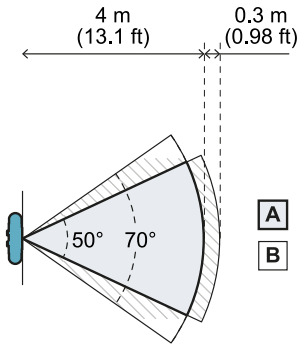


Top view

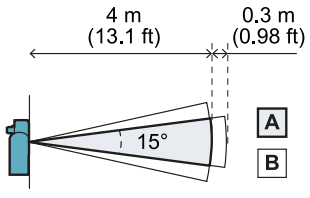


Side view

5.2.5 Dimensions of the 50° field of vision



Top view



Side view

5.2.6 Sensitivity

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

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

To adjust the sensitivity of the restart prevention function, a delay interval is defined from when there is no motion detected in the area to when machinery restart is allowed.

5.3 Calculation of position for sensor height < 1 m

5.3.1 Introduction

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

WARNING! Define the optimum sensor position based on the risk assessment requirements.

5.3.2 Overview of possible installation-inclination configurations

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

- **1** = Configuration 1 with sensor tilted upwards (α positive)
- **2** = Configuration 2 with straight sensor
- **3** = Configuration 3 with sensor tilted downwards (α negative)
- **X** = Configuration not possible

5.3.3 110° field of vision

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	x
	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

5.3.4 50° field of vision

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	1	x
	40 | 15.7	x	x	2	1	x
	50 | 19.7	x	3	2	1	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

5.3.5 Legend

Element	Description
α	Sensor inclination
h	Sensor installation height
Dalarm	Alarm area distance
S_1	Start detection distance
S_2	End detection distance

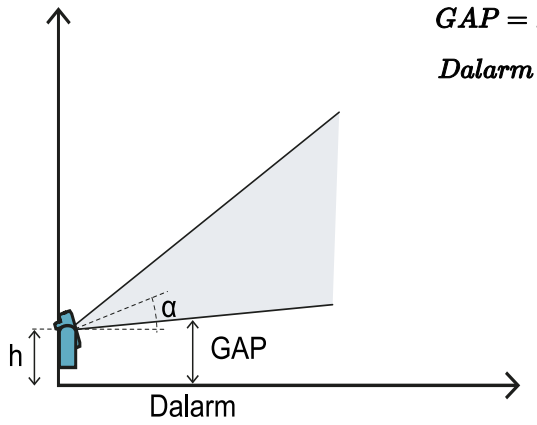
5.3.6 Configuration 1 (sensor upwards)

To guarantee that the sensor also detects access by people crawling, respect the following condition:

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

***Note**: the values **h**, **Dalarm**, **GAP** are expressed in cm, while **α** is in degrees.*

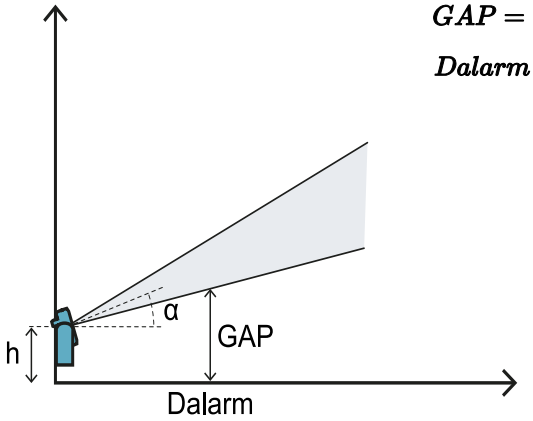
5.3.7 110° field of vision



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

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

5.3.8 50° field of vision



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

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

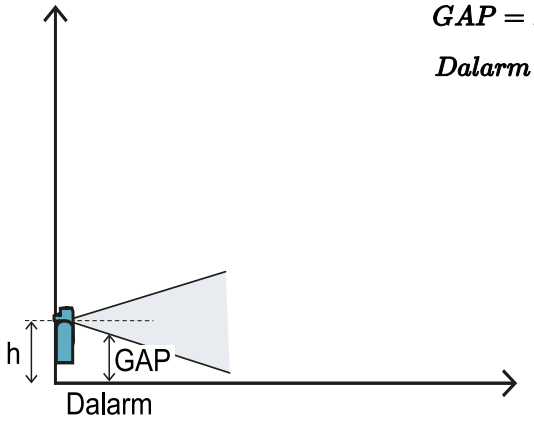
5.3.9 Configuration 2 (straight sensor)

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

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

***Note**: the values **h**, **Dalarm**, **GAP** are expressed in cm, while **α** is in degrees.*

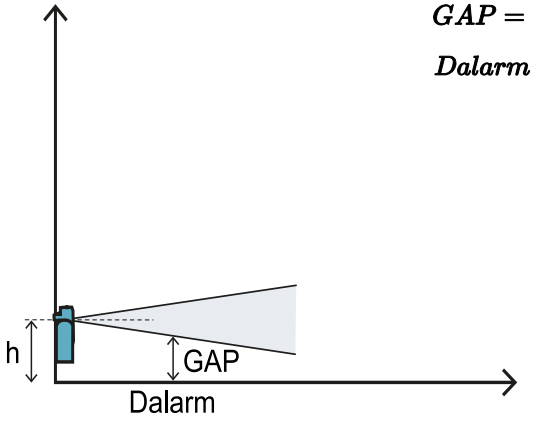
5.3.10 110° field of vision



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

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

5.3.11 50° field of vision



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

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

5.3.12 Configuration 3 (sensor downwards)

To guarantee optimum performance, respect the following conditions:

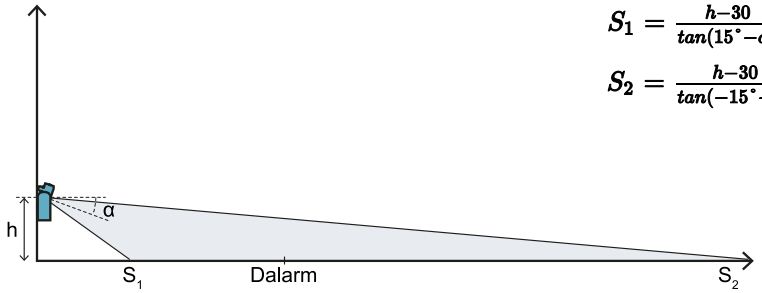
$$S_1 < Dalarm < S_2$$

***Note**: the values **h**, **Dalarm**, **S_1** and **S_2** are expressed in cm, while **α** is in degrees.*

5.3.13 110° field of vision

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

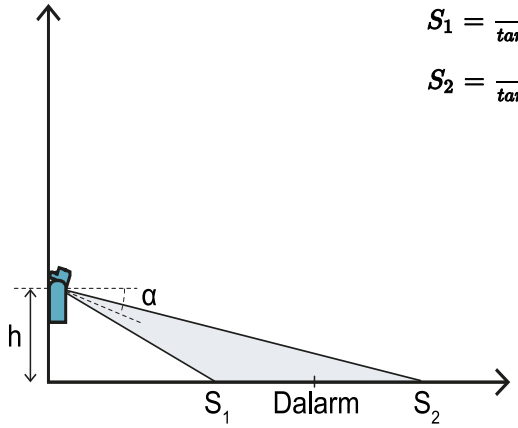
$$S_2 = \frac{h-30}{tan(-15^\circ-\alpha)}$$



5.3.14 50° field of vision

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

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



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 greater than 1 m (3.3 ft) are reported as follows.

WARNING! Define the optimum sensor position based on the risk assessment requirements.

***Note**: the maximum allowed height is 3 m (9.8 ft) and the sensor inclination can only be downwards (α negative).*

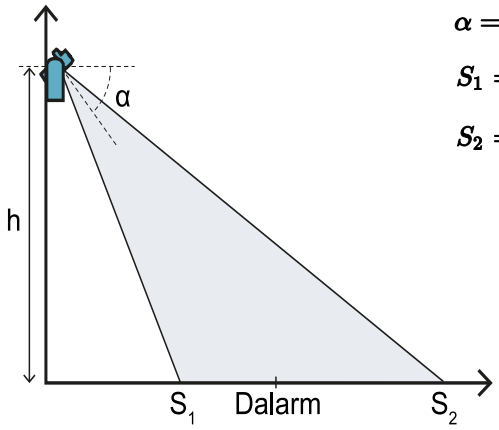
5.4.2 Legend

Element	Description
α	Sensor inclination
h	Sensor installation height
Dalarm	Alarm area distance
S_1	Start detection distance
S_2	End detection distance

5.4.3 110° field of vision

WARNING! It is only possible through the validation procedure (see "Validate safety functions" on page 41) to check if the other configurations respect the performance levels required by the application.

***Note**: the values **h**, **Dalarm**, **S_1** and **S_2** are expressed in cm, while **α** is in degrees.*



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

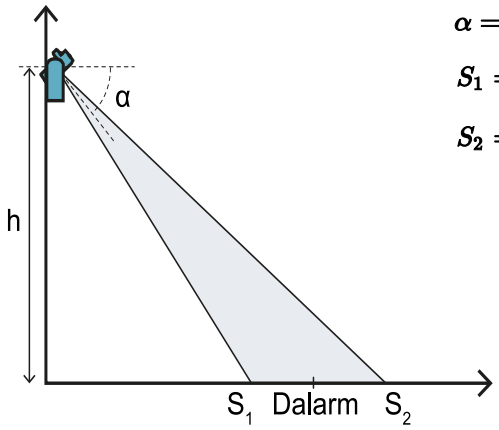
$$S_1 = \frac{h}{tan((-\alpha)+15^\circ)}$$

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

5.4.4 50° field of vision

WARNING! It is only possible through the validation procedure (see "Validate safety functions" on page 41) to check if the other configurations respect the performance levels required by the application.

***Note**: the values **h**, **Dalarm**, **S_1** and **S_2** are expressed in cm, while **α** is in degrees.*



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

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

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

5.5 Dangerous area calculation

5.5.1 Introduction

The dangerous area of the machinery to which LBK System is applied must be calculated as indicated in standards ISO 13855:2010 and ISO 13857:2008. For LBK System the fundamental factors for calculation are height (h) and inclination (α) of the sensor, see "Sensor position" on page 20.

5.5.2 Sensor height < 1 m

To calculate the depth of the dangerous area (S) for sensors with installation heights less than 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 + machinery)	100 + Machinery stopping time (calculated in accordance with standard ISO 13855:2010)	ms
C_h	Constant 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	Constant that takes into account the sensor installation inclination (α) according to the indications of Inxpect SpA	If H < 500 = (20 - I) * 16 If H ≥ 500 = (-I) * 16 ***Note**: minimum value = 0mm. If the result of the calculation is a value less than the minimum, use 0 mm.*	mm

Example 1

- *Machinery stopping time = 500 ms*
- *Sensor installation height (H) = 100 mm*
- *Sensor installation inclination (I) = 10°*

T** = 100 ms + 500 ms = 600 ms = **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 = 200 ms*
- *Sensor installation height (H) = 800 mm.*
- *Sensor installation inclination (I) = -20°*

T** = 100 ms + 200 ms = 300 ms = **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

5.5.3 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 + machinery)	100 + Machinery stopping time (calculated in accordance with standard ISO 13855:2010)	ms
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 = 500 ms*

T** = 100 ms + 500 ms = 600 ms = **0.6 s

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

6. Applications

Contents

This section includes the following topics:

6.1 Applications overview

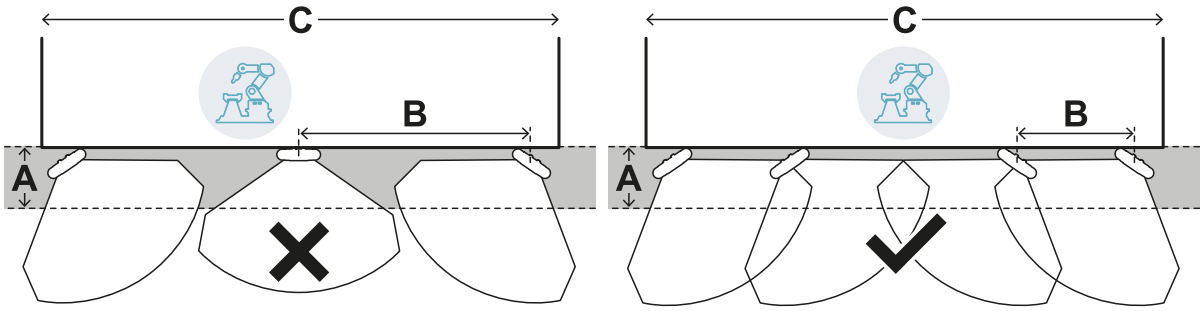
6.1.1 Comparison of the managed applications

Application	Pro	Against	Configuration type in Inxpect Safety
Linear barrier (complete restart prevention)	Blind spots absent and therefore complete coverage of restart prevention function. Monitoring of side access points to the dangerous area without the need for side guards. Configuration of sensors and area actually monitored provided by the Inxpect Safety application.	Need for more sensors in respect to the linear barrier with limited restart prevention for monitoring the same area.	Configuration: **linear**, option **Full coverage** enabled (default)
Linear barrier (limited restart prevention)	Monitoring of an extended area with few sensors. Configuration of sensors and area actually monitored provided by the Inxpect Safety application.	Need for side guards to prevent access to unmonitored side areas. Presence of blind spots and therefore limited restart prevention function.	Configuration: **linear**, option **Full coverage** disabled
Other applications	Flexibility in sensors configuration to obtain maximum coverage in dangerous areas.	Sensors configuration and area actually monitored defined by the designer.	Configuration: **manual**

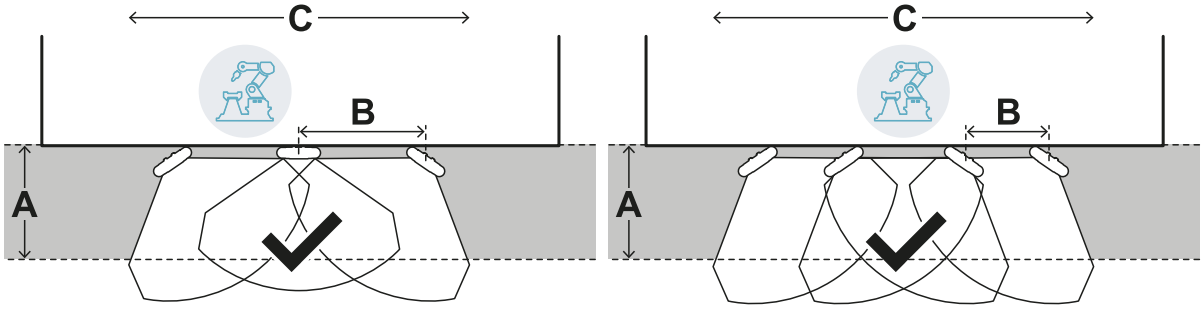
6.2 Linear barrier (complete restart prevention)

6.2.1 Distance between sensors and number of sensors

The depth of the area to be monitored **[A]** determines the maximum distance between the sensors **[B]** and therefore the number of sensors necessary to cover the width of the dangerous area **[C]**. The deeper the area, the greater the possible distance between the sensors, and therefore a lower number of sensors is necessary.



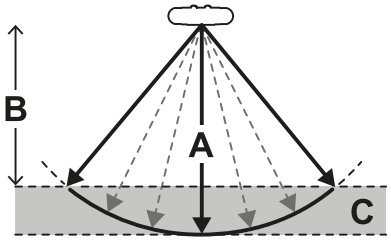
Example of lower depth



Example of greater depth

6.2.2 Tolerance area

The sensor works in the radial direction, therefore detection distance **[A]** is the same no matter what angle the motion is detected from. Defining the dangerous area (and pre-alarm area) with a linear distance **[B]**, a tolerance area **[C]** is generated at the periphery of the stopping area (and pre-alarm area) subject to false alarms because it exceeds the area of interest.

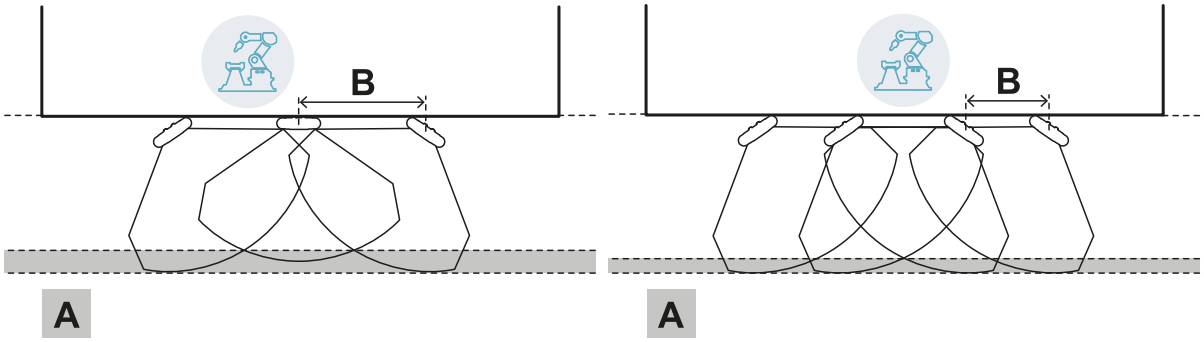


The machinery designer must enclose the tolerance area to prevent transit in the area and thus avoid false alarms.

The tolerance area is calculated and provided by the Inxpect Safety application.

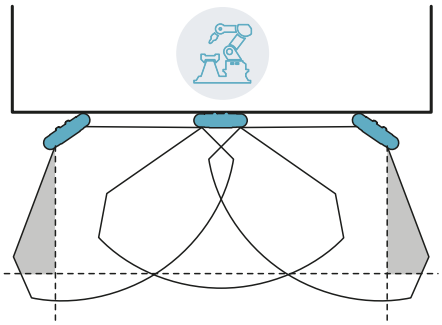
6.2.3 Distance of sensors and tolerance area

The tolerance area **[A]** increases as the distance between the sensors **[B]** increases, up to a maximum of 20 cm (7.9 in) approximately.



6.2.4 Side areas and false alarms

Given the geometry of the field of vision, areas subject to false alarms are generated in the side areas of the dangerous area.



The machinery designer must enclose these areas to prevent transit in the area and thus avoid false alarms.

The distance for installation of the delimiting barriers can be calculated based on the parameters provided by the Inxpect Safety application during the configuration phase.

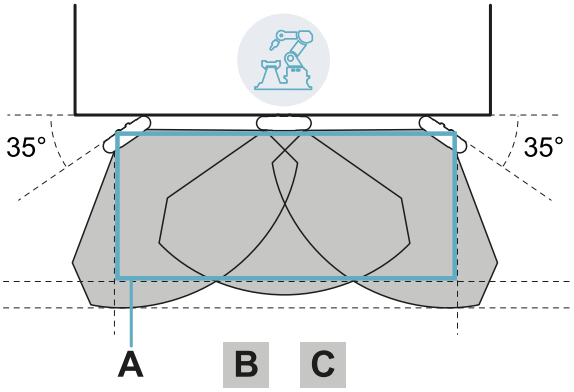
6.2.5 Calculation of the monitored area

The monitored area is calculated automatically by the Inxpect Safety application. Given the dimensions of the dangerous area and any pre-alarm areas, the system calculates:

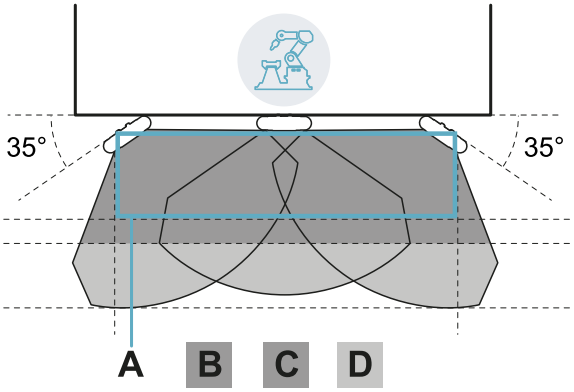
- the number of necessary sensors
- the sensors installation distance
- the inclination of each sensor
- the total depth of the monitored area (dangerous area + pre-alarm area + tolerance area)
- the total width of the monitored area (dangerous area + possible distance of side delimiting barriers)
- the depth of the tolerance area

To calculate the depth of the dangerous area, "Dangerous area calculation" on page 26.

6.2.6 Example of a monitored area with an odd number of sensors



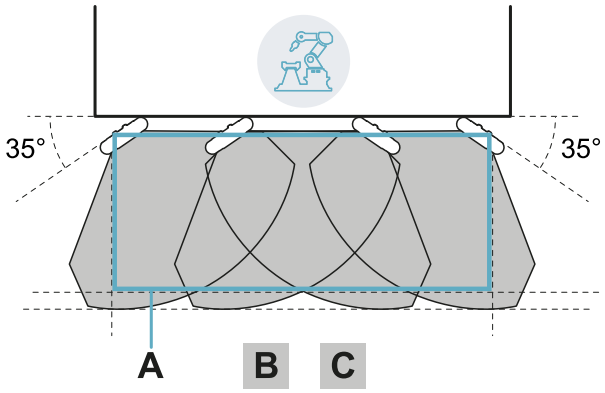
Without pre-alarm area.



With pre-alarm area.

Part	Description
A	Dangerous area
B	Stopping area
C	Tolerance area
D	Pre-alarm area

6.2.7 Example of a monitored area with an even number of sensors



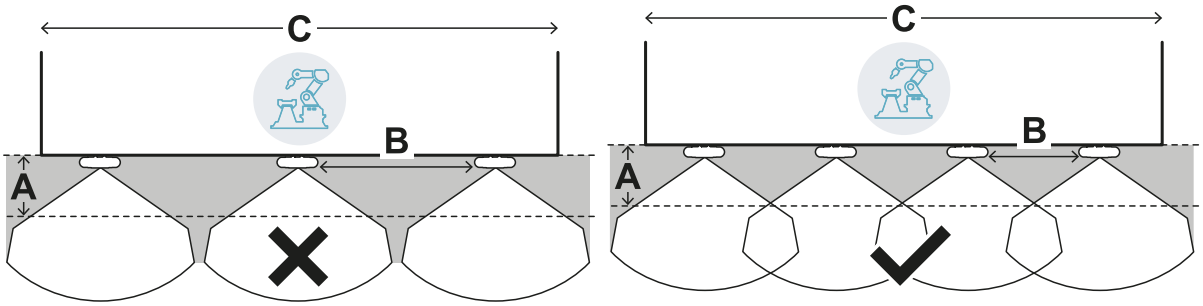
Part	Description
A	Dangerous area
B	Stopping area
C	Tolerance area

6.3 Linear barrier (limited restart prevention)

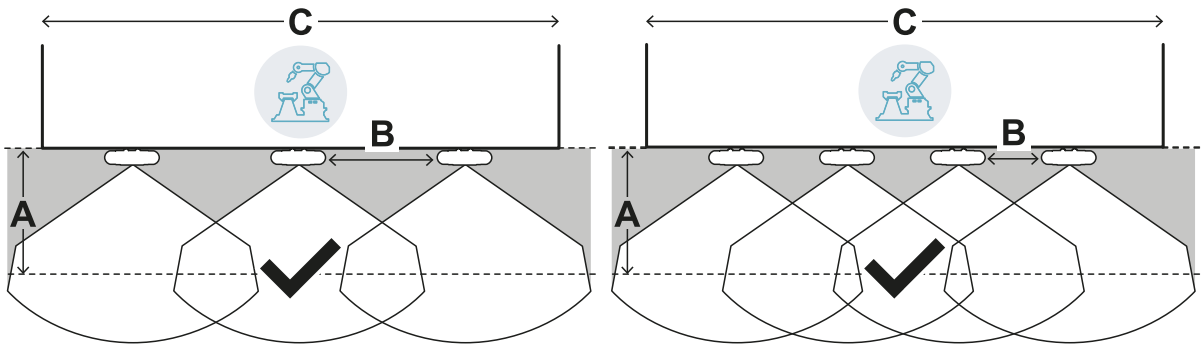
***Note**: the following illustrations show, as an example, sensor configurations all with 110° field of vision. Sensor configurations with all 50° field of vision or mixed configurations are also possible.*

6.3.1 Distance between sensors and number of sensors

The depth of the area to be monitored **[A]** determines the maximum distance between the sensors **[B]** and therefore the number of sensors necessary to cover the width of the dangerous area **[C]**. The deeper the area, the greater the possible distance between the sensors, and therefore a lower number of sensors is necessary.



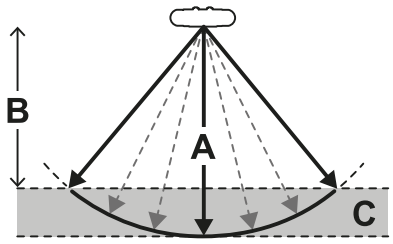
Example of lower depth



Example of greater depth

6.3.2 Tolerance area

The sensor works in the radial direction, therefore detection distance **[A]** is the same no matter what angle the motion is detected from. Defining the dangerous area (and pre-alarm area) with a linear distance **[B]**, a tolerance area **[C]** is generated at the periphery of the stopping area (and pre-alarm area) subject to false alarms because it exceeds the area of interest.

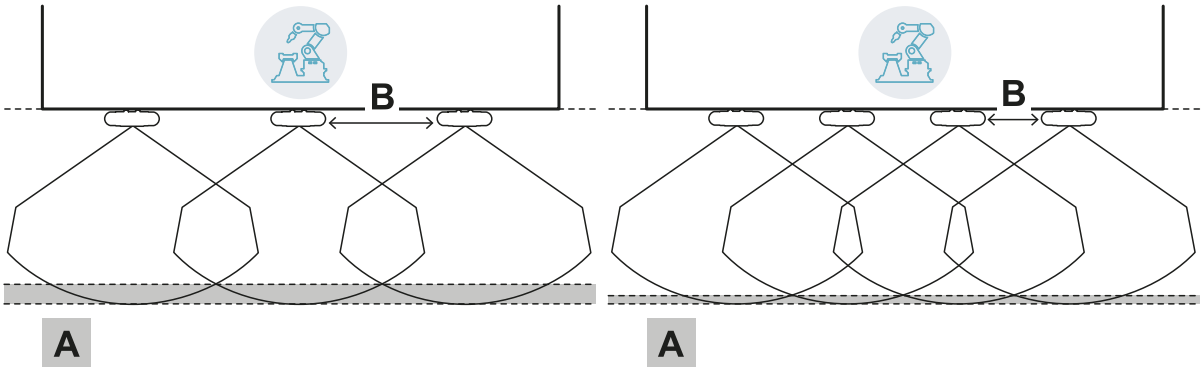


The machinery designer must enclose the tolerance area to prevent transit in the area and thus avoid false alarms.

The tolerance area is calculated and provided by the Inxpect Safety application.

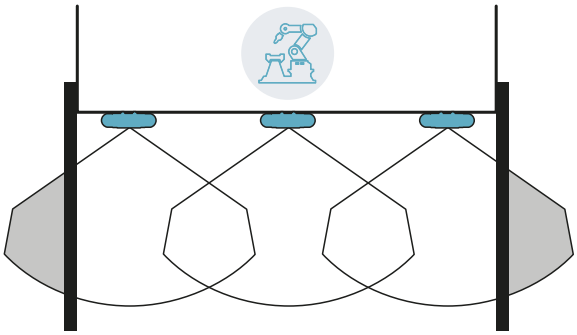
6.3.3 Distance of sensors and tolerance area

The tolerance area **[A]** increases as the distance between the sensors **[B]** increases, up to a maximum of 20 cm approximately.

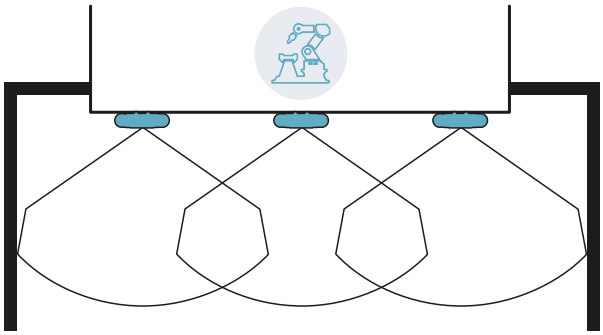


6.3.4 Side guards and false alarms

Given the geometry of the sensor field of vision, guards must be installed to prevent side access to the machinery. To prevent false alarms, the guards must be positioned on the exterior of the dangerous area.



Guards and possible false alarms



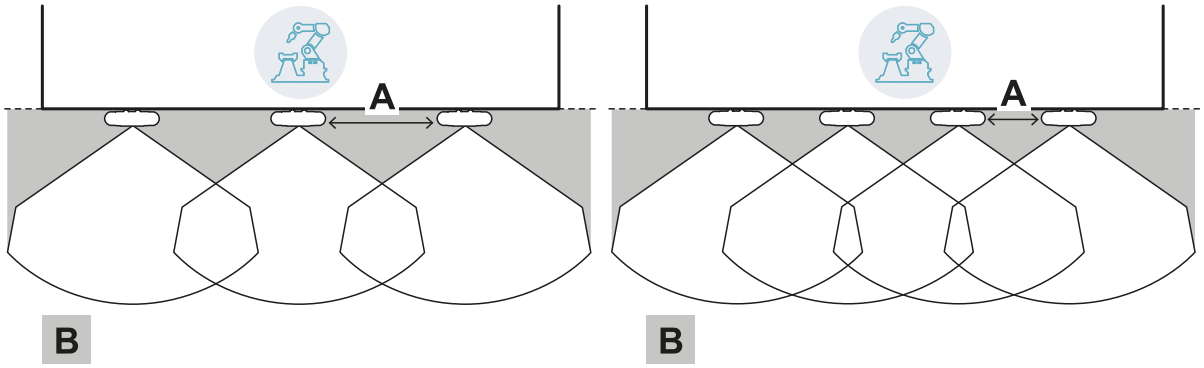
Guards without false alarms

The distance for installation of the guards can be calculated based on the parameters provided by the Inxpect Safety application during the configuration phase.

6.3.5 Blind spots

Given the geometry of the sensor field of vision, blind spots are generated within the monitored area. In blind spots sensitivity to motion is greatly reduced.

The greater the distance between sensors **[A]** the wider the blind spot areas become **[B]**.



6.3.6 Restart prevention function limits

The restart prevention function based on motion detection (automatic and safe manual type, see "Types of managed restart" on page 16) is not guaranteed in the immediate vicinity of the sensor blind spots. The guaranteed minimum detection distance depends on the distance between the sensors:

Distance between sensors (cm) | (in)	Guaranteed minimum distance (cm) | (in)
50 | 19.7	30 | 11.8
100 | 39.4	60 | 23.6
150 | 59.1	90 | 35.4

***NOTICE**: auxiliary functions are necessary in the immediate vicinity of the sensor to guarantee the system restart prevention function.*

6.3.7 Calculation of the monitored area

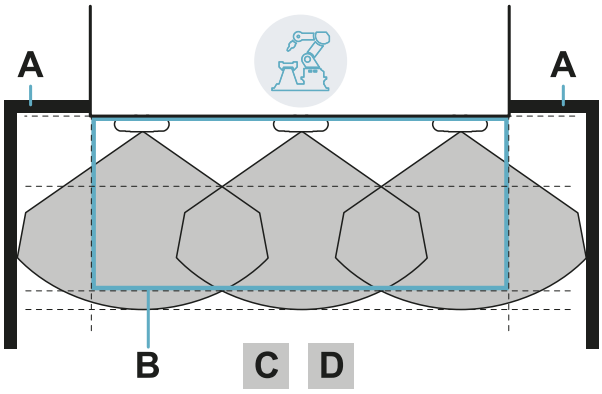
The monitored area is calculated automatically by the Inxpect Safety application. Given the dimensions of the dangerous area and any pre-alarm areas, the system calculates:

- the number of necessary sensors
- the sensors installation distance

- the total depth of the monitored area (dangerous area + pre-alarm area + tolerance area)
- the total width of the monitored area (dangerous area + distance of side guards)
- the depth of the tolerance area

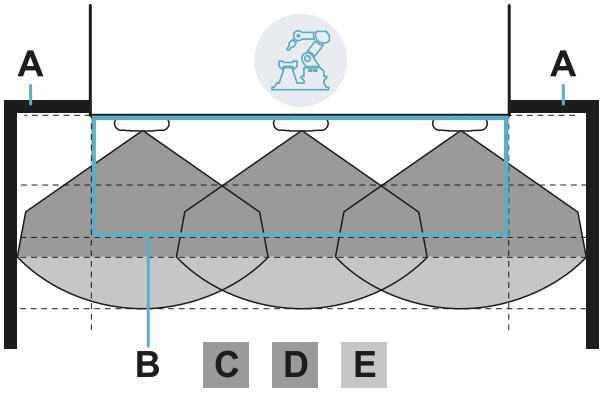
To calculate the depth of the dangerous area, "Dangerous area calculation" on page 26.

6.3.8 Example of monitored area without pre-alarm area



Part	Description
A	Guards to prevent side access
B	Dangerous area
C	Stopping area
D	Tolerance area

6.3.9 Example of monitored area with pre-alarm area



Part	Description
A	Guards to prevent side access
B	Dangerous area
C	Stopping area
D	Tolerance area of the stopping area
E	Pre-alarm area

6.4 Other applications

6.4.1 Types of applications

Thanks to manual configuration it is possible to monitor different shaped areas. Flexibility in sensors configuration allows obtaining maximum coverage in dangerous areas.

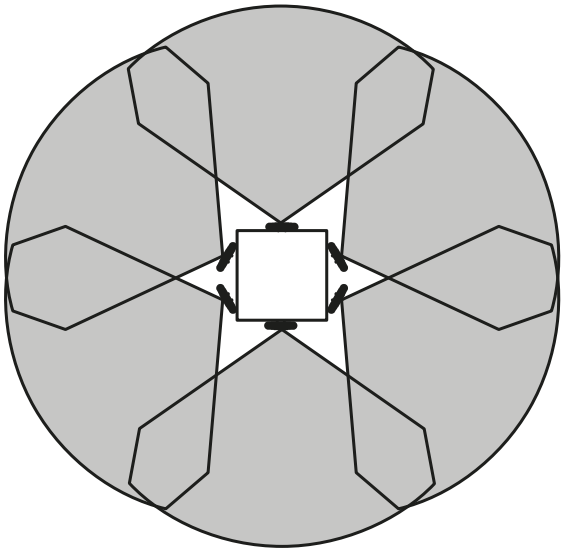
6.4.2 Calculation of the monitored area

In the configuration phase, based on the area to be monitored (see "Dangerous area calculation" on page 26), the designer must define:

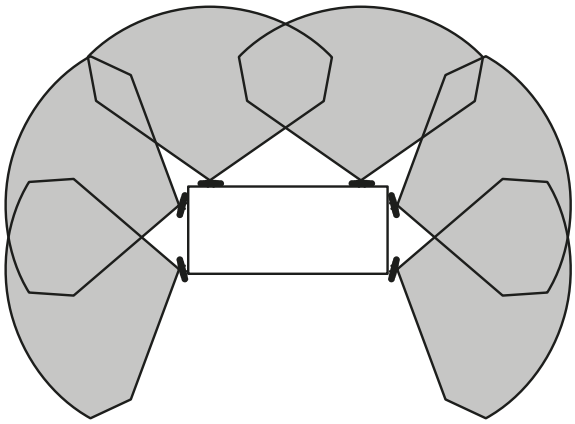
- the number of sensors
- the distance between sensors
- sensors inclination
- the depth of the stopping area
- the depth of the possible pre-alarm area

WARNING! It is the responsibility of the designer to calculate the actual monitored area (total depth = dangerous area + pre-alarm area; total width = dangerous area + distance of possible side delimiting barriers) and to install guards and/or delimiting barriers to prevent access and/or false alarms.

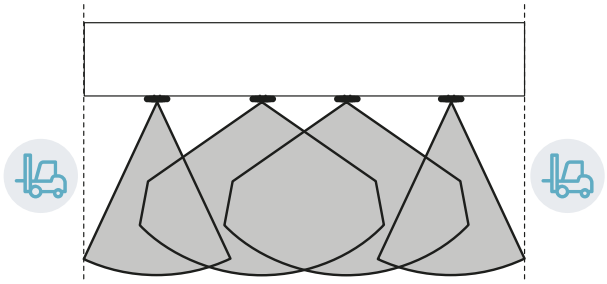
6.4.3 Examples



Circular dangerous area around a robot



Dangerous area on three sides out of four of a machinery



Dangerous area laterally delimited by transit areas

7. Installation and use procedures

Contents

This section includes the following topics:

7.1 Before installation

7.1.1 Materials required

- Two tamper-proof screws to fasten the sensors to the floor or machinery, see "Side screws specifications" on page 52.
- Cables to connect the controller to the first sensor and the sensors to one another, see "CAN bus cables specifications" on page 52.
- A micro USB cable to connect the controller to the computer.
- A termination resistor with resistance of 120 Ω for the last sensor of the CAN bus.
- A six-pointed Phillips head screwdriver or an accessory for tamper-proof screws with button head ("Side screws specifications" on page 52).

7.1.2 Install the Inxpect Safety application

1. Download the application from the website www.inxpect.com/industrial/tools and install it on the computer.
2. Start the application.
3. Select and set the password.
4. Memorize the password and provide it only to people who are authorized to change the configuration.

7.1.3 Initiate LBK System

1. Calculate the position of the sensor (see "Sensor position" on page 20) and the depth of the dangerous area (see "Dangerous area calculation" on page 26).
2. "Install the controller" below.
3. "Define the working frequency of the sensors" on the next page.
4. "Define the area to be monitored" on the next page.
5. "Configure the auxiliary inputs and outputs" on the next page.
6. "Save and print the configuration" on the next page.
7. "Install sensors on the floor" on page 39 or "Install the sensors on the machinery" on page 40.
8. If necessary, "Install the side guards" on page 41.
9. "Connect the controller to the sensors and assign the IDs" on page 41.
   ***Note**: connect the sensors to the controller off-site if access to the connectors becomes difficult once they are installed.*
10. "Validate safety functions" on page 41.

7.2 Install and configure LBK System

7.2.1 Install the controller

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

1. Mount the controller on the DIN rail.
2. Make electrical connections, see "Terminal blocks and connectors pin-outs" on page 52 and "Electrical connections" on page 54.

***NOTICE**: if at least one input is connected, the SNS input must also be connected.*
***Note**: to correctly connect the digital inputs, see "Voltage and current limits for digital inputs" on page 53.*

7.2.2 Define the working frequency of the sensors

1. Connect the controller to the computer via micro-USB cable.
2. Supply power to the controller.
3. Start the Inxpect Safety application.
4. Select ⚙ and then **General**.
5. In **Operational frequency** if the system is installed in the United Kingdom or in France, select **UK/France**, otherwise leave the default value **Other countries**.
   ***Note**: this setting does not have any effect on system performance.*

7.2.3 Define the area to be monitored

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

1. In the Inxpect Safety application, select ➔ and insert password.
   ***Note**: if not yet set, set a valid password. Memorize the password and provide it only to people who are authorized to change the configuration.*
2. Select **Configuration**.
3. Define the area to be monitored and configuration of the sensors as follows:

For...	Then...
linear barrier applications	1. Select **Linear configuration**. 2. Only for applications with limited restart prevention function, deselect **Full coverage**. 3. Define the dimensions of the dangerous area and any pre-alarm areas: the system calculates the number of necessary sensors, the distance for installation of the sensors, and the dimensions of the actually monitored area ***Note**: when setting a parameter, the system automatically compiles the values or defines an interval of compatible values for the other parameters.* 4. Scroll through the proposed configurations and leave the most suitable on the display.
other applications	1. Select **Manual configuration**. 2. Define the number of sensors, their position and inclination, the depth of the stopping area and possible pre-alarm area. ***Note**: it is possible to upload an image to facilitate definition of the area to be monitored.*

7.2.4 Configure the auxiliary inputs and outputs

1. In the Inxpect Safety application, select ⚙.
2. If the muting is managed, select **Sensors** and assign the sensors to the groups:

If...	Then...
only one digital input is connected for the muting	assign all the sensors to group 1
several digital inputs are connected for the muting	assign the sensors according to the logic of the digital inputs

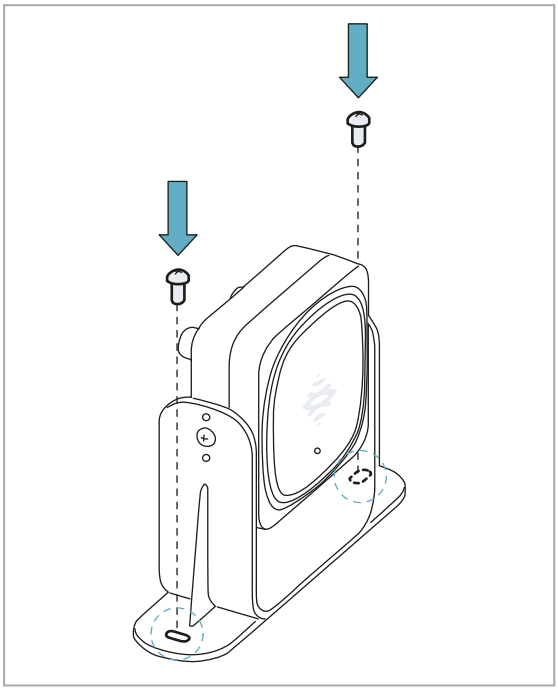
3. Select **Digital Input/Output** and define the function of the auxiliary inputs and outputs.

7.2.5 Save and print the configuration

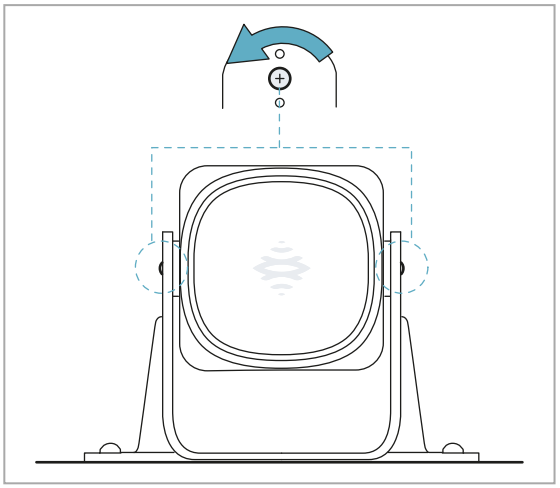
1. In the Inxpect Safety application, click **Apply changes**: the sensors memorize the set inclination and the surrounding environment. The application transfers the configuration to the controller, and once transfer is complete it generates a configuration report.
2. Click ⭳ to save and print the report.
3. If necessary, complete the report with the inclination and height data of the sensors.
4. Require a signature by the authorized person.

7.2.6 Install sensors on the floor

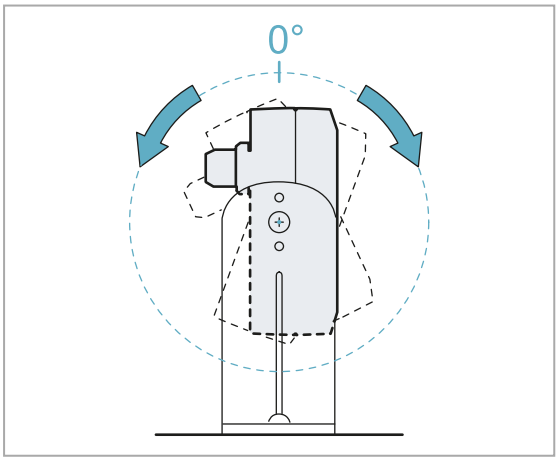
1. Position the sensor as indicated in the configuration report and fasten the bracket with two tamper-proof screws directly onto the floor or another support.
   ***NOTICE**: make sure the support does not inhibit machinery commands.*



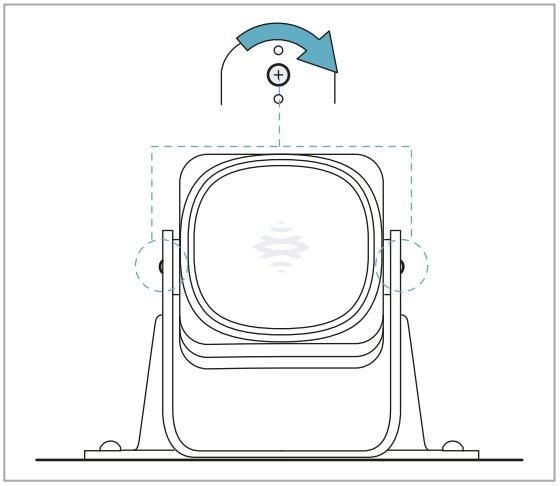
2. To tilt the sensor, loosen the side screws.



3. Direct the sensor up to the desired inclination, see "Sensor position" on page 20.
   ***Note**: a notch is equal to 10° of inclination.*



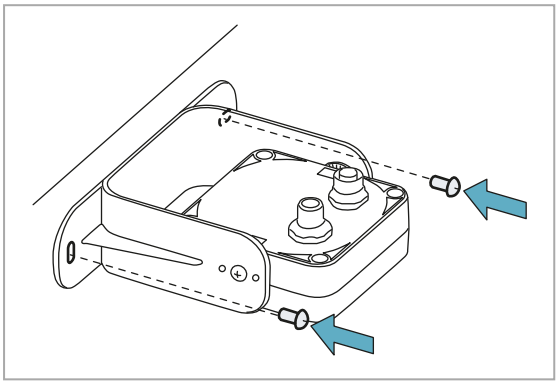
4. Tighten the screws.



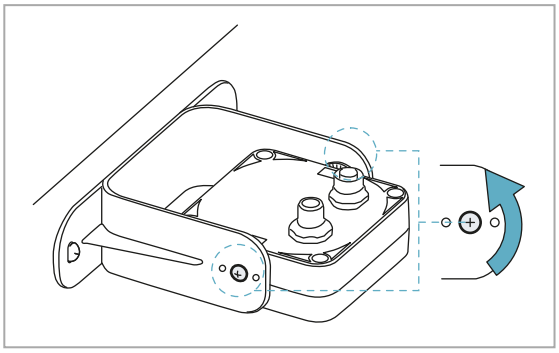
7.2.7 Install the sensors on the machinery

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

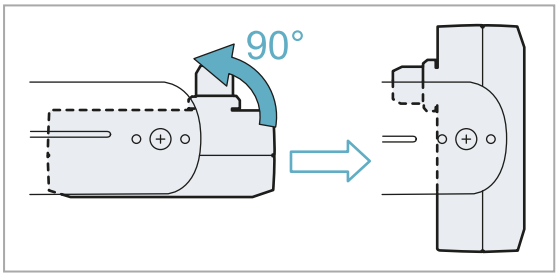
1. Position the sensor as indicated in the configuration report and fasten the bracket with two screws to a machinery support. To select installation height, see "Sensor position" on page 20.



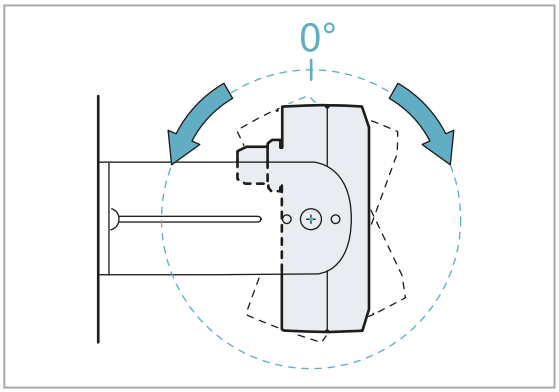
2. Loosen the side screws.



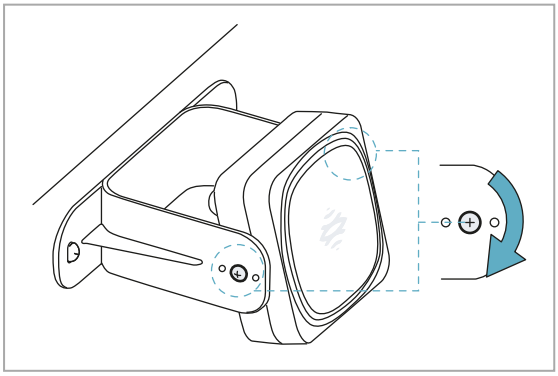
3. Position the sensor parallel to the machinery support.



4. Direct the sensor up to the desired inclination, see "Sensor position" on page 20.
***Note**: a notch is equal to 10° of inclination.*



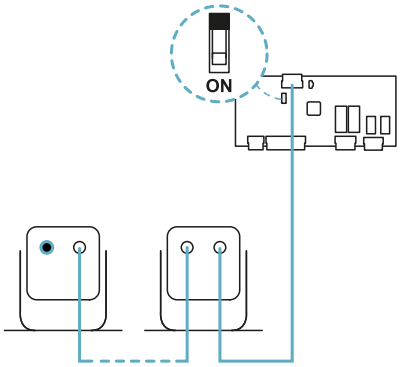
5. Tighten the screws.



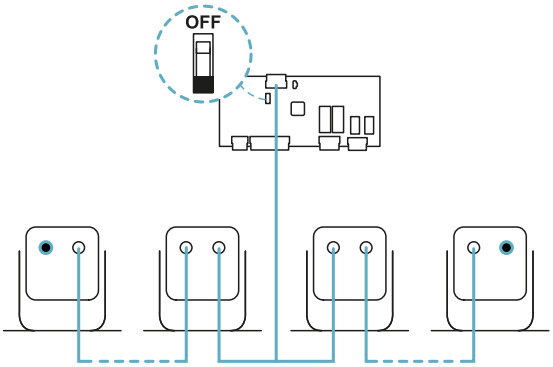
7.2.8 Connect the controller to the sensors and assign the IDs

1. Start the Inxpect Safety application.
2. Select ⚙ and then **Sensor ID nodes**.
3. Connect the desired sensor directly to the controller or to the last sensor on the chain.
   ***Note**: connect a sensor without an assigned ID (ID = 0) to the controller one at a time.*
4. Click **Assign ID nodes** and follow the instructions on the display.
   ***Note**: to reassign the sensors with the default ID 0, click **Reset ID**.*
5. Repeat step 4 for all the sensors, then conclude the procedure.
6. Insert the termination connector into the free connector of the sensor/sensors at the end of the chain. Set the DIP switch of the controller based on its position in the chain. See "Chain examples" below.

7.2.9 Chain examples



Chain with controller at the end of the chain and a sensor with termination connector



Chain with controller inside of the chain and two sensors with termination connector

7.2.10 Install the side guards

***Note**: valid procedure for linear barrier applications with limited restart prevention function.*

1. Calculate the installation distance of the guards, referring to the values in the configuration report: (**Actual lenght** - **Barrier lenght**) / 2.
2. Position the guards at the distance calculated in step 1.

7.3 Validate safety functions

7.3.1 Validation

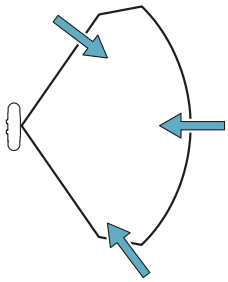
Once the system has been installed and configured, check that the safety functions are activated/deactivated as expected and that the dangerous area is actually monitored by the system.

WARNING! The Inxpect Safety application facilitates installation and configuration of the system, but the validation process described as follows is still required.

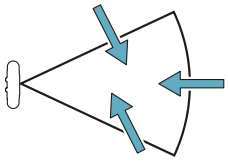
7.3.2 Validate the detection function

Starting conditions	Machinery in safe conditions.
Validation procedure	1. Access the stopping area. 2. Check that the system activates the safety function (de-energizing safety outputs). See "Validate the system with Inxpect Safety" on the facing page. 3. If it does not activate, see "Troubleshooting validation" on the facing page.
Specifications	• Access from several points with particular attention to the side areas of the field of vision 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.

7.3.3 Example of access points



Access points for 110° field of vision

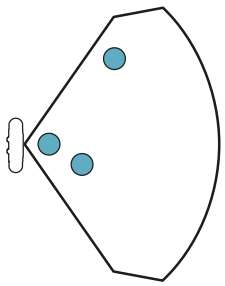


Access points for 50° field of vision

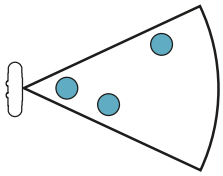
7.3.4 Validate the restart prevention function

Starting conditions	• Machinery in safe conditions • Safety function activated (safety outputs de-energized)
Validation procedure	1. Stand still in the stopping area. 2. Check that the system maintains the safety function activated (safety outputs de-energized). See "Validate the system with Inxpect Safety" on the facing page. 3. If deactivated, see "Troubleshooting validation" on the facing page.
Specifications	• Stop for at least one time interval set as the restart delay (Inxpect Safety > ⚙ > **Sensors**). • Stop in several different points, with special attention to the areas in close proximity to the sensor and any blind spots, see "Examples of stopping points" below. • Stop standing as well as laid down.

7.3.5 Examples of stopping points



Stopping points for 110° field of vision

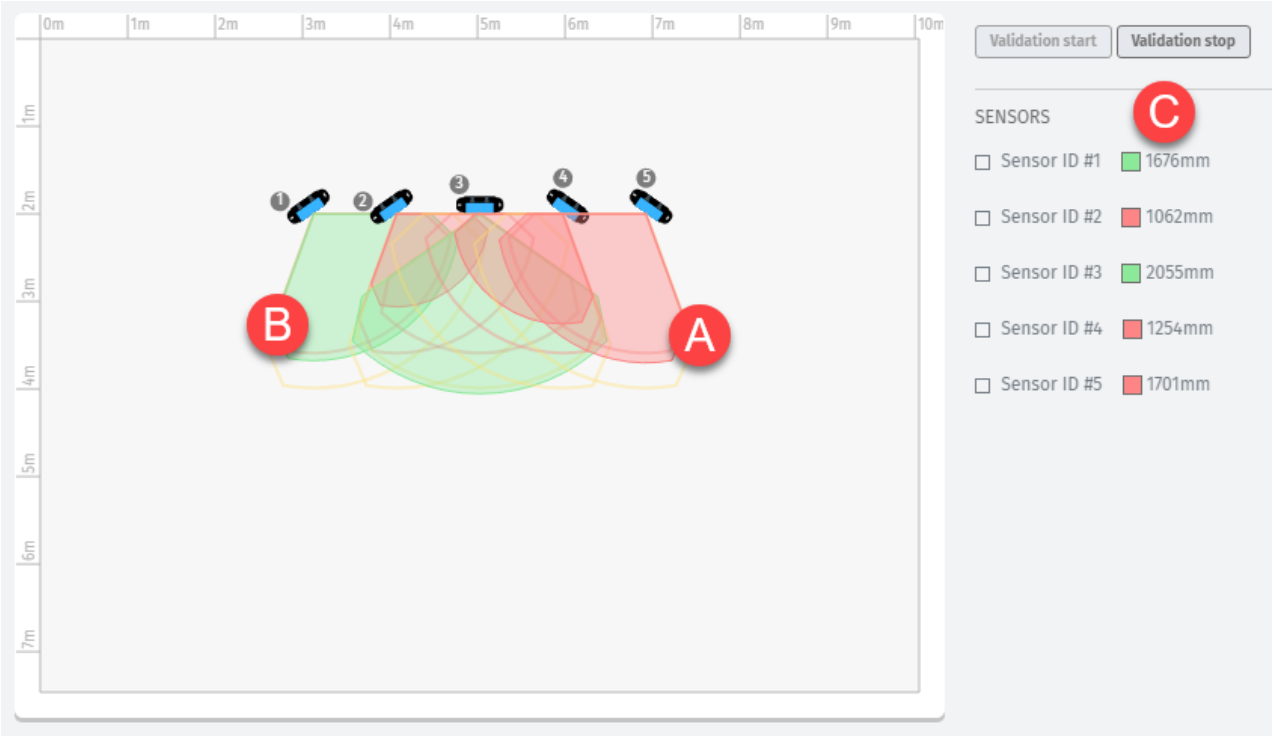


Stopping points for 50° field of vision

7.3.6 Validate the system with Inxpect Safety

The Inxpect Safety application supports safety functions during the validation phase and allows checking the actual field of vision of the sensors based on their installation position.

1. Click **Validation** and then **Validation start**.
2. Move in the stopping area as indicated in "Validate the detection function" on the previous page and "Validate the restart prevention function" on the previous page.
3. Check that the sensor behaves as expected (**A**: field of vision red for motion detected in the stopping area, **B**: field of vision green for motion detected outside of the stopping area).
4. Check that the distance where the motion is detected (**C**) is the expected one.



7.3.7 Troubleshooting validation

Problem	Solution
Presence of objects obstructing the field of vision	If possible, remove the object. Otherwise, implement additional safety measures in the area impacted by the object.
Position of sensors	Position the sensors to ensure that the monitored area is adequate to the dangerous area to be monitored ("Sensor position" on page 20 and "Applications" on page 29).
Inclination and height of one or more sensors	1. Change the inclination and height of the sensors to ensure that the monitored area is adequate to the dangerous area to be monitored, see "Sensor position" on page 20. 2. Note or update the inclination and height of the sensors in the printed configuration report.
Inadequate restart delay	Change the restart delay through the Inxpect Safety application (> **Sensors**)

7.4 Manage the configuration

7.4.1 Change the configuration

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

1. Start the Inxpect Safety application.
2. Select and enter the password.

3. According to the desired change, follow these instructions:

To change...	Then...
Monitored are and sensors configuration	Select **Configuration**
System sensitivity	Select ⚙ > **Sensors**
Sensor ID	Select ⚙ > **Sensor ID nodes**
Function of auxiliary inputs and outputs	Select ⚙ > **Digital Input/Output**
Muting: composition of groups of sensors	Select ⚙ > **Sensors** ***Note**: if only one digital input is connected for the muting, assign all the sensors to group 1.*
Sensors inclination	Loosen the side screws on the sensors using a six-pointed Phillips head screwdriver and direct the sensors to the desired inclination.

4. Click **Apply changes**.
5. Upon conclusion of transfer of the configuration to the controller, click ⬇ to print the report.
6. Complete the report with the inclination and height data of the sensors and request signature by the person assigned to the task.

7.4.2 Export/import the configuration

In ⚙ > **General** export the current configuration and re-import it subsequently.

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

7.5 Other functions

7.5.1 Change the access password

In ⚙ > **User account**, click **Change password**.

***NOTICE**: changing the password resets system configuration. It will be necessary to reconfigure the system, download the configuration on the controller and request signature by the person in assigned to the task.*

7.5.2 Reset the access password

In ⚙ > **General** click **Factory reset**.

7.5.3 Restore factory default settings

In ⚙ > **General** click **Factory reset**: the configuration parameters are restored to default settings and the access password is reset.

7.5.4 Identify a sensor

In ⚙ > **Sensor ID nodes**, click **Blink LED** near the desired sensor ID: the LED on the sensor flashes for 5 seconds.

8. Maintenance and troubleshooting

Contents

This section includes the following topics:

8.1 Troubleshooting

8.1.1 Sensor LED

Status	Problem	Remedy
2 flashes *	ID not assigned	Assign an ID to the sensor, see "Connect the controller to the sensors and assign the IDs" on page 41.
3 flashes *	Error in communication with the controller	Check connections of all sensors in the chain starting from the last sensor in error.
4 flashes *	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
5 flashes *	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 vision of the sensors.
6 flashes *	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 2 s pause.*

8.1.2 Controller LED

LED	Status	Problem	Remedy
S1	Steady	At least one voltage value on the controller is wrong	If at least one digital input is connected, check that the SNS input is connected. Check that the input power supply is the specified type (see "General specifications" on page 51).
S2	Steady	Controller temperature value is wrong	Check that the system is operating at the correct operating temperature (see "General specifications" on page 51).
S3	Steady	At least one relay is in error	Reset the system (in Inxpect Safety > ⚙ > **General** > **Factory reset**). If the problem persists, contact assistance for relay replacement.
S4	Steady	At least one of the controller peripherals is in error	Check the status of the terminal block and connections.

LED	Status	Problem	Remedy
S5	Steady	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 a valid assigned ID (in Inxpect Safety > ⚙ > **Sensor ID nodes**).
S6	Steady	Configuration saving error or configuration not performed	Reconfigure or configure the system, see "Manage the configuration" on page 43.
S1 –S6	Flashing red	Sensor corresponding to the flashing LED in error	Check what the problem is through the LED on the sensor.

***Note**: anomaly signal on the controller (steady LED) takes priority over an anomaly sensor signal. For the status of the single sensors, check the sensor LED.*

8.1.3 Other problems

Problem	Cause	Remedy
False alarms	Transit of people or objects in close proximity to the stopping area	Change the sensors sensitivity, "Change the configuration" on page 43. Check that the guards are positioned as indicated in the configuration report.
	Incorrect installation of side guards	Position the guards as indicated in the configuration report, see "Install the side guards" on page 41.
Machinery in safe status without motions in the stopping area	No power supply	Check electrical connection. Contact assistance service if necessary.
	Fault in the controller or one or more sensors	Check the status of the LEDs on the controller, see "Controller LED" on the previous page. Access the Inxpect Safety application, on page **Dashboard** click **?** next to the controller or 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	Error in controller	Check the status of the LEDs on the controller, see "Controller LED" on the previous page. Access the Inxpect Safety application, on page **Dashboard** click **?** next to the controller or sensor.
	Sensor error	Check the status of the LEDs on the sensor, see "Sensor LED" on the previous page. Access the Inxpect Safety application, on page **Dashboard** click **?** next to the controller or sensor.

8.2 System log

8.2.1 Introduction

The event log recorded by the system can be downloaded. Once downloaded the events are no longer stored in the system memory.

The log file reports the following information separated by ";":

- time stamp (in ms) from system start
- who generated the event
- type of error
- details of error

8.2.2 Download system log

1. Start the Inxpect Safety application.
2. Select ⚙ and then **Activity history**.
3. Click **Download log**.

8.2.3 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 vision of the radar
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

8.2.4 CAN errors (CAN ERROR)

Error	Meaning
TIMEOUT	Timeout on message to sensor/controller
CROSS CHECK	Two redundant messages do not coincide
SEQUENCE NUMBER	Message with sequence number different from the expected number
CRC CHECK	Packet control code does not match
COMMUNICATION LOST	Impossible to communicate with the sensor

8.2.5 Temperature errors (TEMPERATURE ERROR)

Error	Meaning
TEMPERATURE TOO LOW	Temperature below minimum
TEMPERATURE TOO HIGH	Temperature above maximum

8.2.6 Relay errors (RELAY ERROR)

Error	Meaning
RELAY1 BAD MOSFET STATUS	Error on diagnostics signal of MOS relay 1
RELAY2 BAD MOSFET STATUS	Error on diagnostics signal of MOS relay 2
RELAY1 INCONSISTENT FEEDBACK	Error on feedback signal of relay 1
RELAY2 INCONSISTENT FEEDBACK	Error on feedback signal of relay 2

8.2.7 Sensor/controller voltage errors (POWER ERROR)

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

***Note** *: see "Sensor voltage" on the next page and "Controller voltage" on the next page.*

8.2.8 Sensor inclination errors (ACCELEROMETER ERROR)

Error	Meaning
PITCH ANGLE ERROR	Sensor inclination with respect to the bracket (set through the side screws) changed
ROLL ANGLE ERROR	Sensor inclination with respect to the installation surface (set through fastening screws on the bracket) changed
ACCELEROMETER READ ERROR	Accelerometer reading error

8.2.9 Peripheral error (PERIPHERAL ERROR)

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

8.2.10 System boot (SYSTEM BOOT)

Each time LBK System starts, a "SYSTEM BOOT" event is recorded with the incremental progressive number of the restart. The time stamp is reset to zero.

8.2.11 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

8.2.12 Controller voltage

Screen printing	Description
VIN	Power supply voltage (+24 V dc)
V12	Relay power supply voltage
V12 sensors	Sensors power supply voltage
VUSB	USB port voltage
VSNS	Inputs reference voltage

8.3 Cleaning and spare parts

8.3.1 Cleaning

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

8.3.2 Spare parts

Part	Product code
Sensor	LBK-S01
Controller	LBK-C22

8.4 Periodical tests

8.4.1 Test

Frequency	Test	Object of test
At least every six months	Periodical	• Sensors (detection capacity) • Digital inputs • Safety outputs • Auxiliary outputs
Daily	Visual inspection	Sensors (integrity, position, inclination)

***Note**: keep a record of the date and result of the tests performed.*

8.4.2 Periodical test with Inxpect Safety

The Inxpect Safety application (**Maintenance** page) provides a wizard for performing the periodical test. The periodical test checks:

- correct detection of motion by the installed sensors
- correct functioning of the inputs in use
- correct functioning of the auxiliary outputs in use

Inxpect Safety also makes it possible to:

- save and print the test report
- calculate the data for performing the next test

8.4.3 Perform the test with Inxpect Safety

WARNING! During maintenance, LBK System is disabled. Prepare opportune safety measures in the dangerous area monitored by the system before performing maintenance on the system.

***NOTICE**: the maintenance procedure is complete and valid only if all the steps indicated in the software have been completed and if the maintenance manager has read and signed the maintenance report.*

1. Start the Inxpect Safety application.
2. Select **Maintenance** and then click **Start maintenance**.
3. Follow the wizard for inspecting the sensors, inputs and outputs.
   ***Note**: to select the sensor to be inspected, click the corresponding **Identify sensor**. To interrupt the procedure, click **Terminate**.*
4. Once the procedure is completed, print the report.

8.4.4 Display the performed test reports

To display the performed test reports and download the PDF version, select **Maintenance** or **Dashboard** and then click **Maintenance reports**.

8.5 Updates

8.5.1 Download updates

To download any available updates for the sensor control firmware and application software, visit www.inxpect.com.

8.5.2 Install firmware updates

WARNING! LBK System is not disabled during the firmware update. Make sure that the machinery is in safe conditions before installing updates.

1. Start the Inxpect Safety application.
2. Select ⚙ and then **General**.
3. Click the button for the desired action and select the previously downloaded update file.
4. Validate the correct functioning of the system, see "Validate safety functions" on page 41.

9. Technical references

Contents

This section includes the following topics:

9.1 Technical data

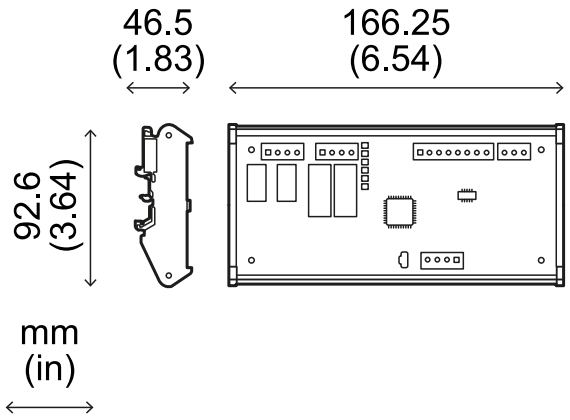
9.1.1 General specifications

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.
Field of vision	• 110° (sensor horizontal plane: 110°, sensor vertical plane: 30°) • 50° (sensor horizontal plane: 50°, sensor vertical plane: 15°)
Installation height	From 0 to 3 m (from 0 to 9.8 ft)
Guaranteed response time	< 100 ms
SIL (Safety Integrity Level)	2
PL (Performance Level)	d
Category	2 (3 for the outputs)
Total consumption	11 W (controller and six sensors)
Operating temperature	From -40 to +60 °C (from -40 to +140 °F)
Storage temperature	From -40 to +80 °C (from -40 to +176 °F)
Communication protocol (sensors-controller)	CAN complies with standard EN 50325-5
Functional duration	20 years
MTTFd	40 years
PFH	4.34E-08 [1/h]
SFF	99.03%
DCavg	98.33%
Electrical protections	Polarity inversion Overcurrent through resettable integrated fuse (max. 5 s @ 8 A)

9.1.2 Controller features

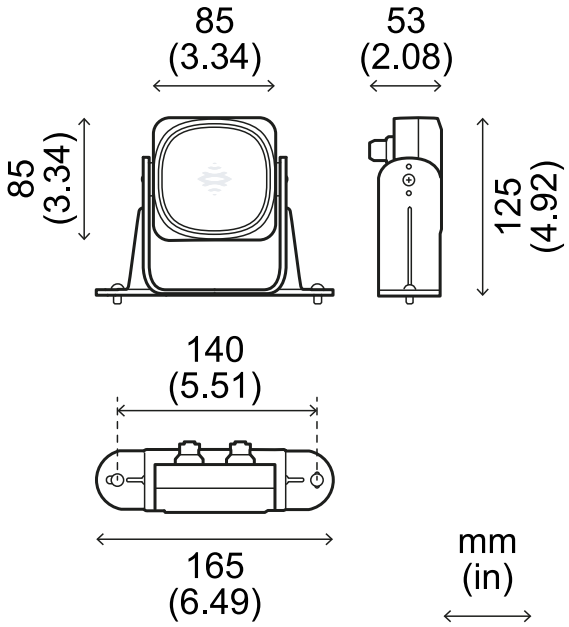
Outputs	4 relay outputs: • 1 dual channel safety output • 2 auxiliary outputs
Safety output relays	Forced guided relays • Max voltage: 30 V dc • Max current: 8 A dc • Max power: 240 W • Minimum switching load mW (V/mA): 500 (10/10)
Auxiliary output relays	Electromechanical relays • Max voltage: 30 V dc • Max current: 2 A dc • Max power: 60 W
Inputs	3 dual channel digital inputs with common GND: • 1 type 1 • 1 type 2 • 1 type 3 See "Voltage and current limits for digital inputs" on page 53.
Power supply	24 V dc (20–28 V dc) * Maximum current: 0.6 A
Consumption	Max 3.8 W
Assembly	On DIN rail
Degree of protection	IP20
Terminals	Section: 2.5 mm2 (13 AWG) max Max current: 12 A with 2.5 mm cables2 (13 AWG)

***Note** *: the device has been designed to be supplied by an external power supply unit, internally protected by a short-circuit.*



9.1.3 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 termination connector)
Power supply	12 V dc ± 20%, through controller
Consumption	Max 1.2 W
Degree of protection	IP67
Material	Sensor: PA66 Bracket: PA66 and glass fiber (GF)



9.1.4 CAN bus cables specifications

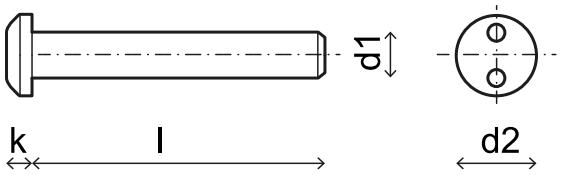
Section	2 x 0.34 mm2 (22 AWG) power supply 2 x 0.34 mm2 (22 AWG) data lines
Type	Two twisted pairs: power supply and data line
Connectors	5-pole M12, see "Connectors M12 CAN bus" on the facing page
Impedance	120 Ω ±12 Ω (f = 1 MHz)
Shield	Shield with twisted wires in tin-plated copper. To be connected to earth circuit on the power supply terminal block of the controller.
Length	30 m (98.4 ft) from controller to sensor (configuration with one sensor)

9.1.5 Side screws specifications

The side screws can be:

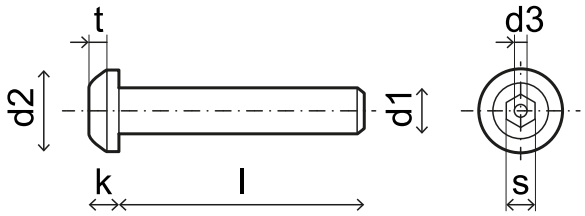
- cheese head and two hole drive
- button head

Cheese head and two hole drive screws



d_1	M4
l	10 mm (0.39 in)
d_2	7.6 mm (0.30 in)
k	2.2 mm (0.09 in)

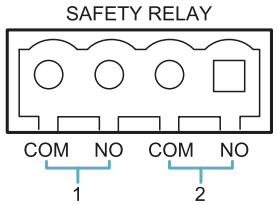
Button head screws



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

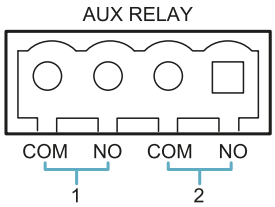
9.2 Terminal blocks and connectors pin-outs

9.2.1 Safety outputs terminal block



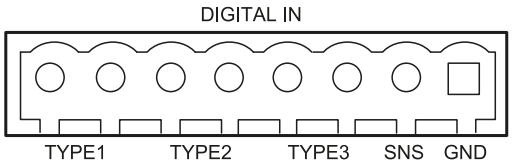
Terminal	Description
COM	Common safety output 1
NO	Relay output normally open
COM	Common safety output 2
NO	Relay output normally open

9.2.2 Auxiliary outputs terminal block



Terminal	Description
COM	Common auxiliary output 1
NO	Relay output normally open
COM	Common auxiliary output 2
NO	Relay output normally open

9.2.3 Digital inputs terminal block



Terminal	Description
Type 1	Input 24 V dc type 1
Type 1	Input 24 V dc type 1
Type 2	Input 24 V dc type 2
Type 2	Input 24 V dc type 2
Type 3	Input 24 V dc type 3
Type 3	Input 24 V dc type 3
SNS	Input 24 V dc for diagnostics
GND	Common reference for all digital inputs

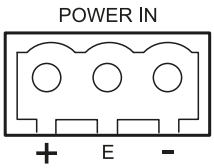
***Note**: the cables used must have a maximum length of 30 m (98.4 ft).*

9.2.4 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 EN 61131-2:2003.

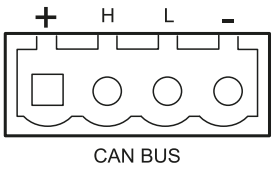
	Type 1	Type 2	Type 3
Voltage limits			
0	from - 3 to 15 V	from - 3 to 11 V	from - 3 to 11 V
1	from 15 to 30 V	from 11 to 30 V	from 11 to 30 V
Current limits			
0	15 mA	30 mA	15 mA
1	from 2 to 15 mA	from 6 to 30 mA	from 2 to 15 mA

9.2.5 Power supply terminal block



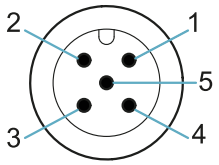
Terminal	Description
+	+ 24 V dc
E	Earth
-	GND

9.2.6 CAN bus terminal block

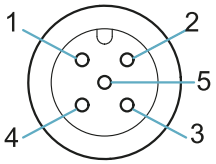


Terminal	Description
+	+ 12 V dc
H	CAN H
L	CAN L
-	GND

9.2.7 Connectors M12 CAN bus



Male connector

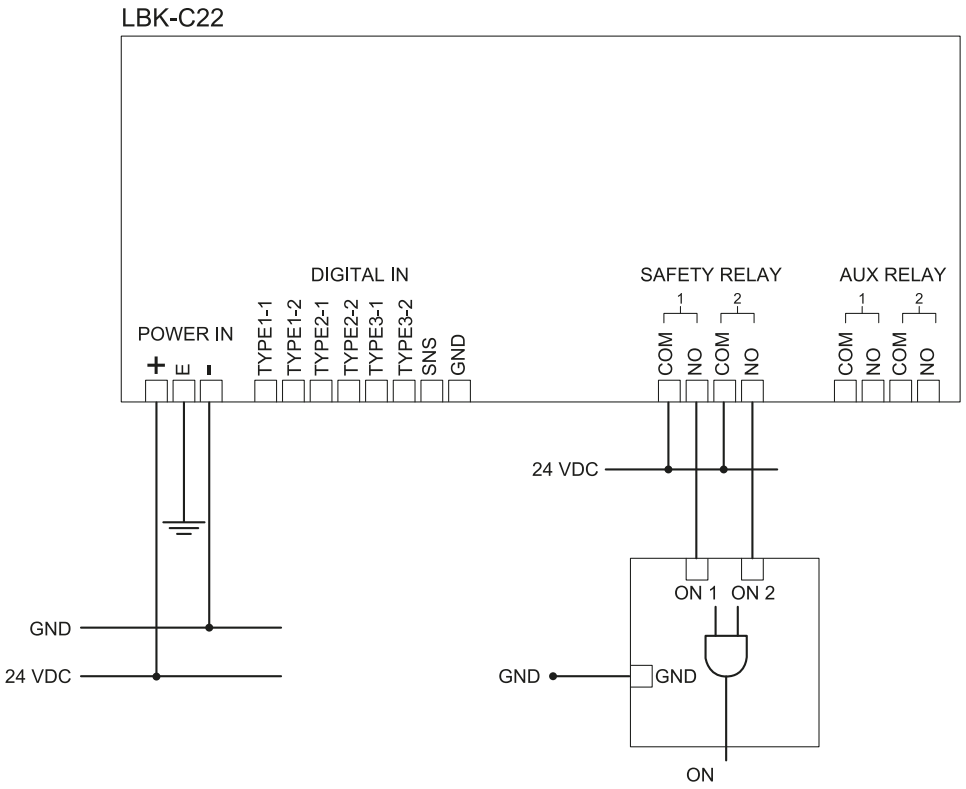


Female connector

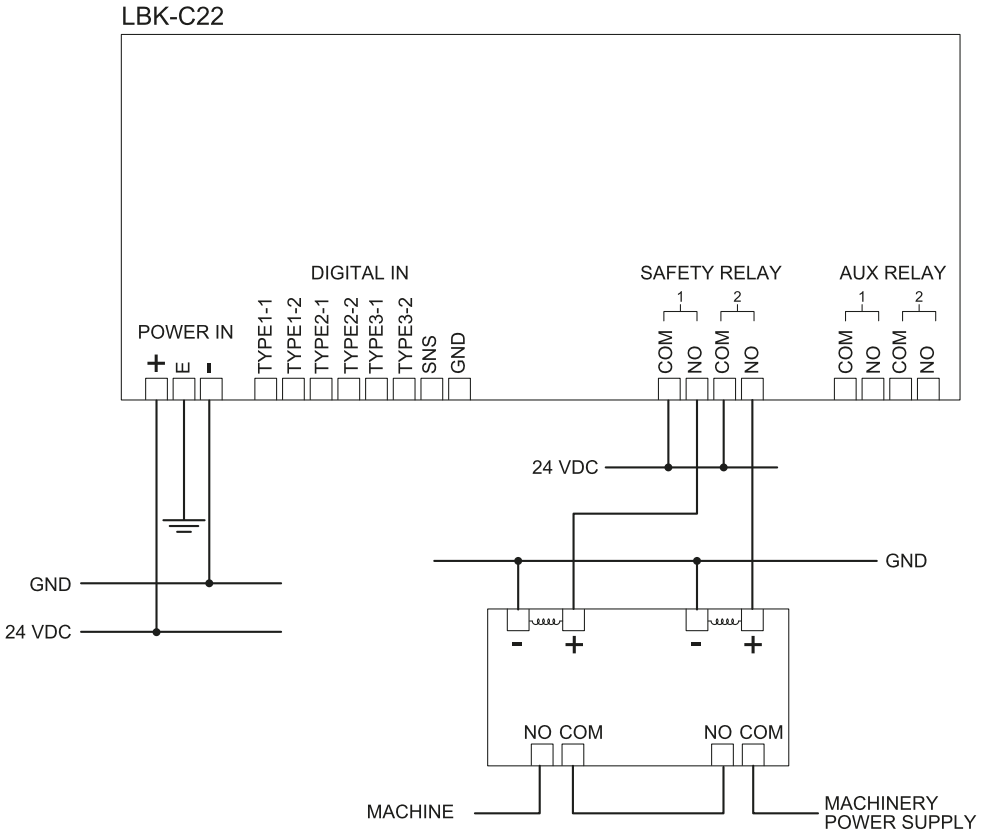
Pin	Function
1	Shield, to be connected to earth circuit power supply terminal block of the controller.
2	+12 V dc
3	GND
4	CAN H
5	CAN L

9.3 Electrical connections

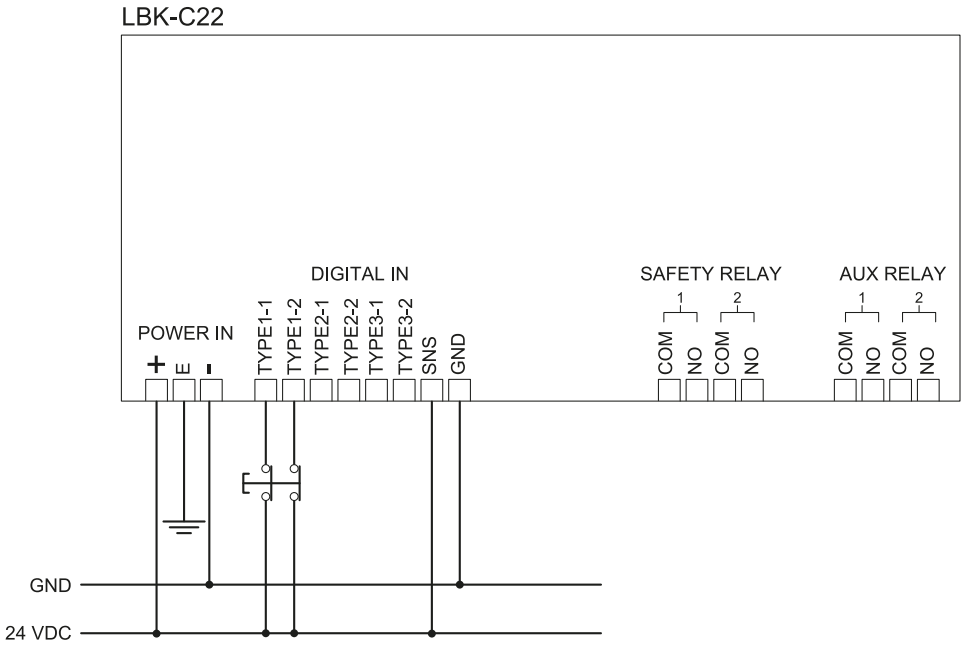
9.3.1 Connection of safety outputs to the machinery control system



9.3.2 Connection of safety outputs to an external safety relay



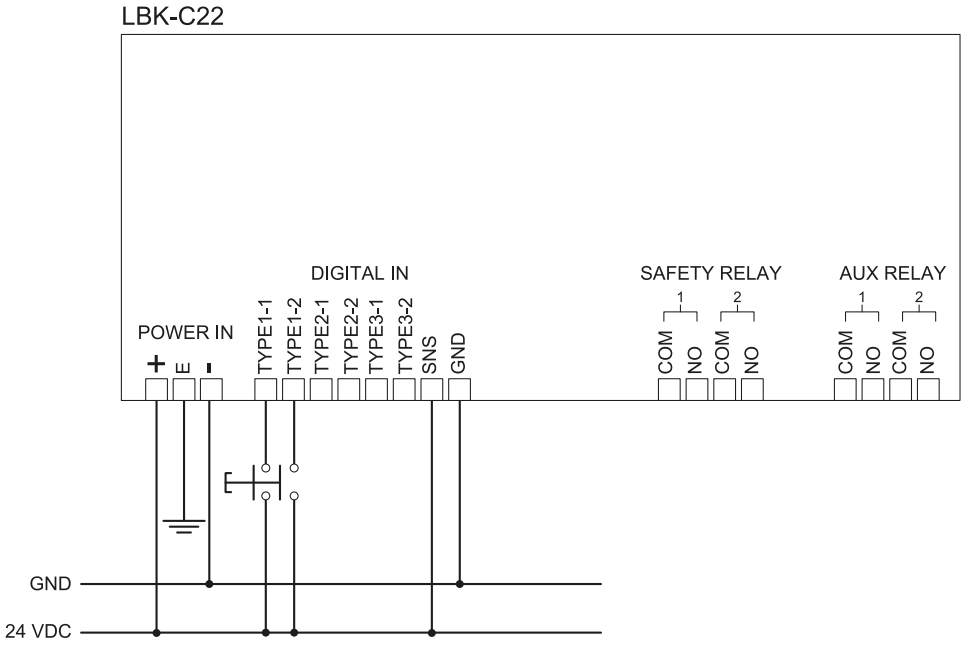
9.3.3 Connection of emergency button



***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).*

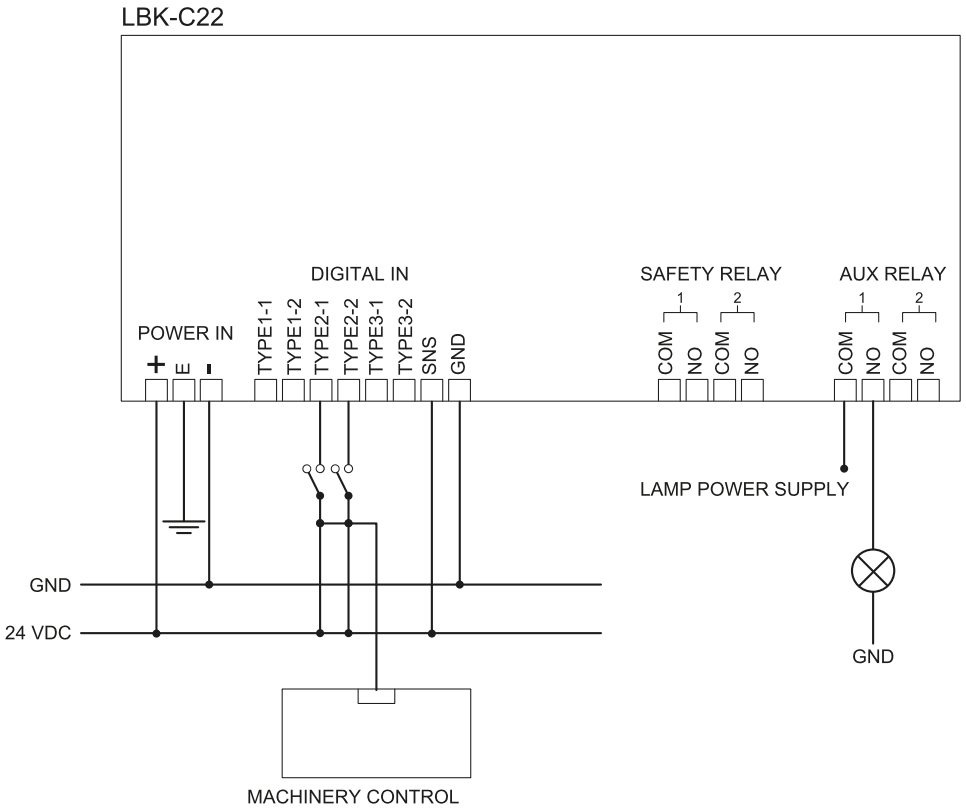
9.3.4 Connection of restart enable button



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

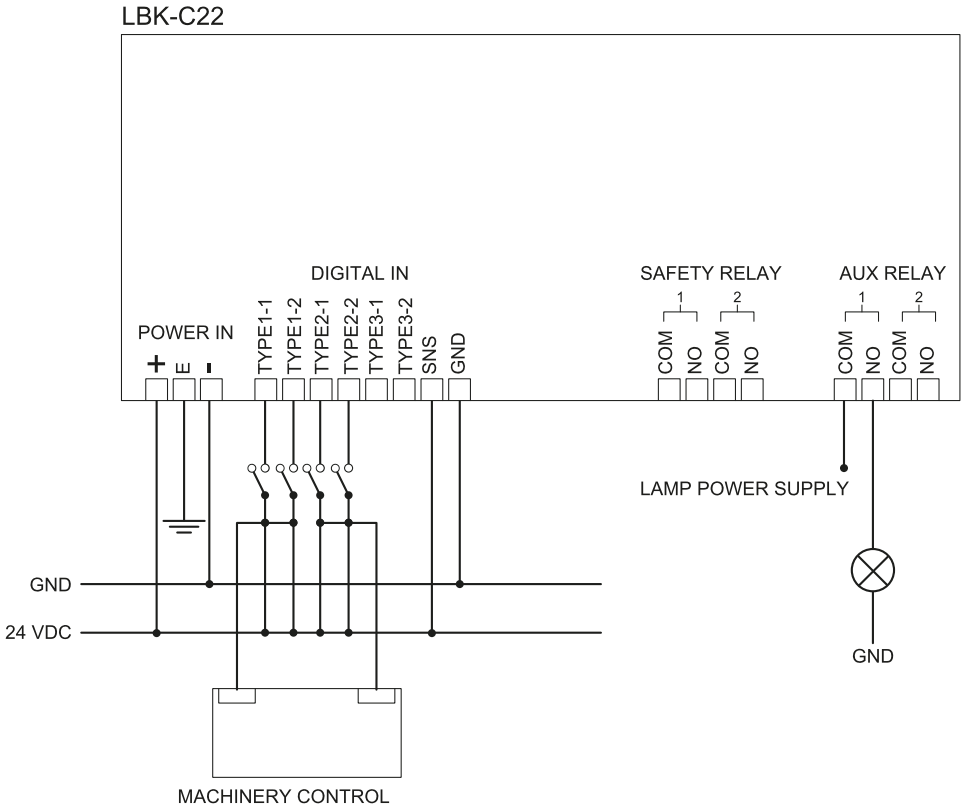
***Note**: the cables used for wiring the digital inputs must have a maximum length of 30 m (98.4 ft).*

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



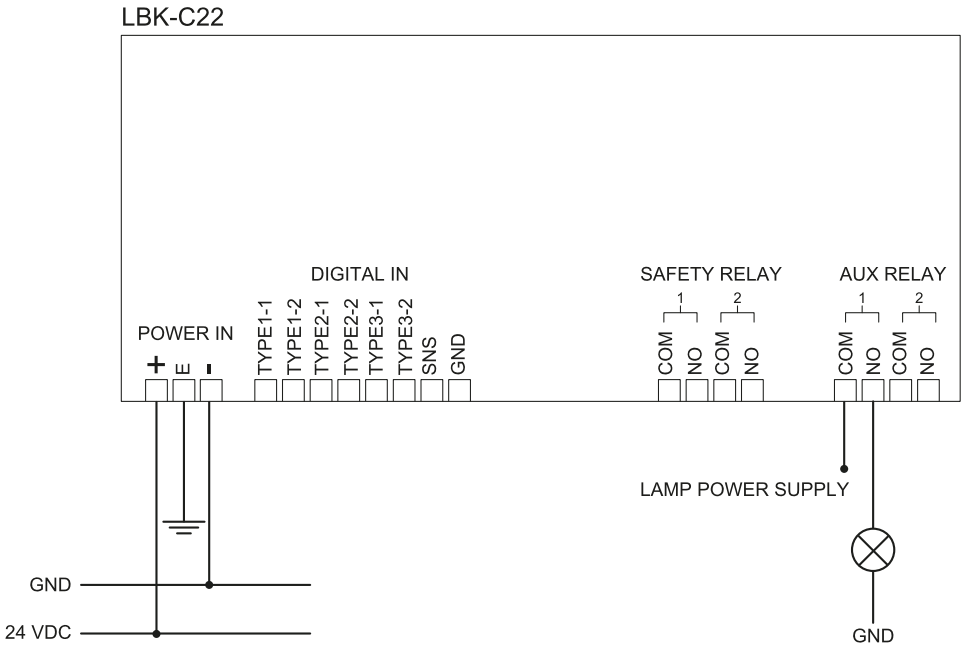
***Note**: the cables used for wiring the digital inputs must have a maximum length of 30 m (98.4 ft).*

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

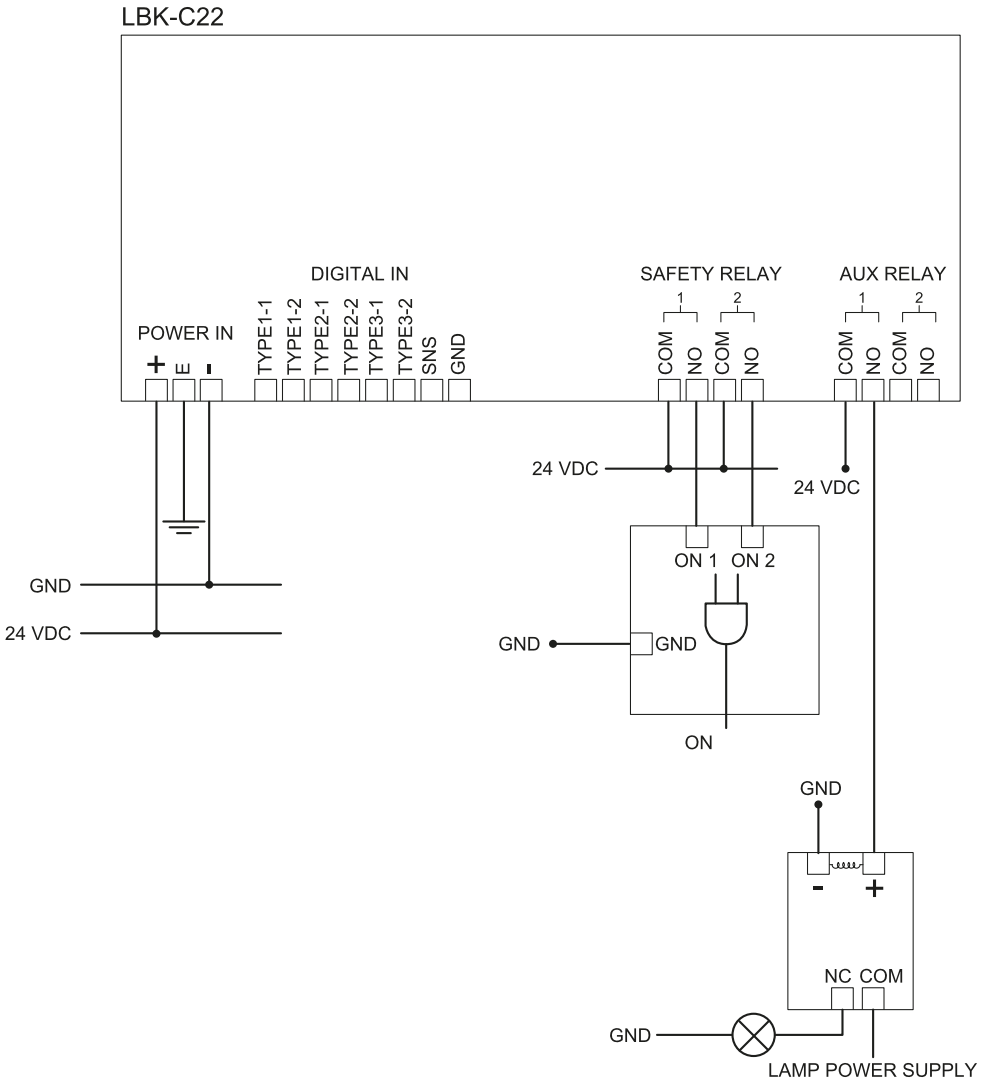


***Note**: the cables used for wiring the digital inputs must have a maximum length of 30 m (98.4 ft).*

9.3.7 Pre-alarm output connection



9.3.8 Faulty output connection



***Note**: the indicated lamp turns on in the presence of a fault.*

10. Appendix

Contenuti

Questa sezione include i seguenti argomenti:

10.1 Disposal

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

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

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

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

10.2 Service and warranty

10.2.1 Customer service

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

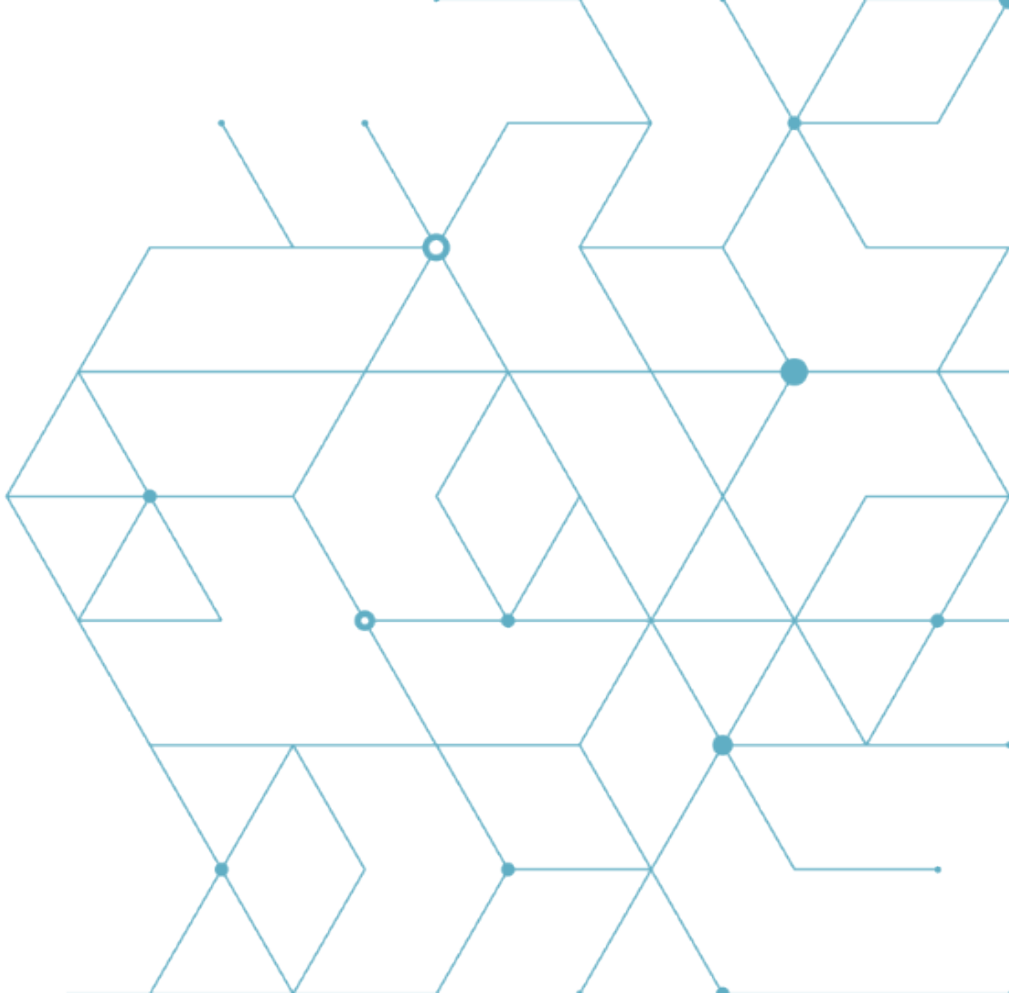
10.2.2 How to return the product

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

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

10.2.3 Service and warranty

To find out about the terms of the warranty, exclusions and cancellation of the warranty, refer to the website www.inxpect.com.



LBK System
Instruction manual v1.2
FEB 2019
LBK-System_instructions_en v1.2