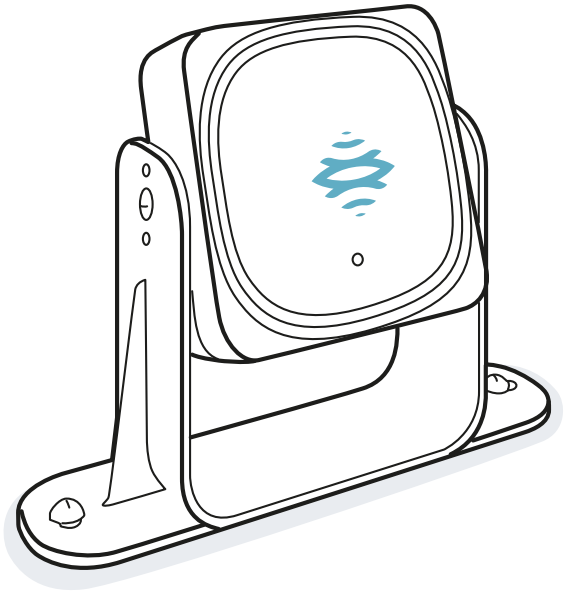
INXPECT

LBK System

Volumetric Safety System



Instruction manual
v1.1 - 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.

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Summary

Information on this manual

Objectives of this instruction manual

This manual explains how to integrate the 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 the LBK system is installed.

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.

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.*

Updates to the instruction manual

Publication date	Code	Updates
MAY 2018	LBK-System_instructions_en v1.1	Updated field of vision dimensions and shape
APR 2018	LBK-System_instructions_en v1.0	First publication

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

Safety

Safety information

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

FORESEEN USE

The 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 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.

The LBK system is suitable for protecting the entire body.

The 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.

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 cause the protective function of the system to be inhibited. 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 includes the possibility of accessing 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.

WARNINGS FOR THE RESTART FUNCTION

- The restart function is not guaranteed near 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

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.

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.

Conformity

Conformity	CE
Directives	2006/42/EC (MD - Machinery)
	2014/53/EC (RED - Radio equipment)
Standards	IEC/EN 62061: 2005
	EN ISO 13849-1: 2015 Category 3 PL d
	EN ISO 13849-2: 2012
	IEC/EN 61496-1: 2013
	IEC/EN 61496-3: 2008
	IEC/EN 61508: 2010 Part 1-7

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

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.

Glossary of terms

D

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.

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

Get to know LBK System

Contents

This section includes the following topics:

LBK System

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 function**: it inhibits the machinery restart if there are people in the dangerous area

Inputs and outputs

Thanks to its digital inputs and outputs, the 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).

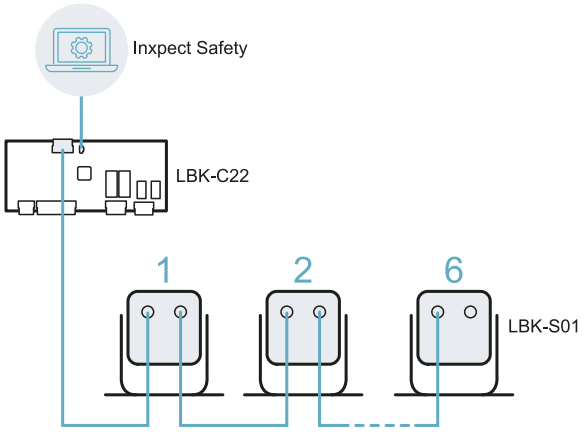
Special features

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

Main components

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



Controller - sensors communication

The sensors communicate with the controller via CAN bus 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.

Applications

LBK integrates with the machinery control system: LBK sends signals to the control system through de-energized safety relays and the control system commands safety conditions in the area or prevents restarting of the machinery.

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

For connection examples, see "Electrical connections" on page 44.

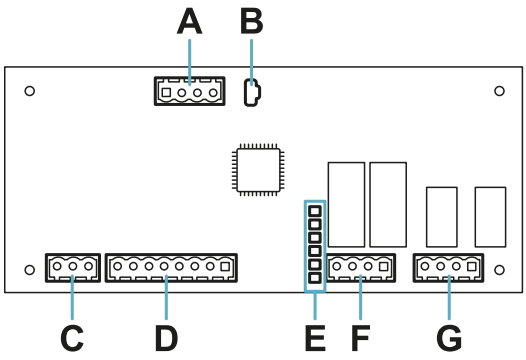
Controller LBK-C22

Functions

The controller performs the following primary 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.
- Energizes the dedicated auxiliary output relay when at least one sensor detects motion in the pre-alarm area.
- Communicates with the Inxpect Safety software for all configuration and diagnostic functions.

Structure



Part	Description
A	Sensors CAN bus terminal block
B	Micro USB port for connecting the computer and communicating with the Inxpect Safety software
C	Power supply terminal block
D	Digital inputs terminal block
E	Status LED
F	Safety outputs terminal block
G	Auxiliary outputs terminal block

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
Red	Error. See "Controller LED" on page 35

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.

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 the stopping area, malfunctions or fault
- energized relay (contact closed) = no motion detected and normal functioning

Auxiliary outputs

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

- pre-alarm
- fault
- muting status

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

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 43).

The function of the inputs can be configured through the software.

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.*

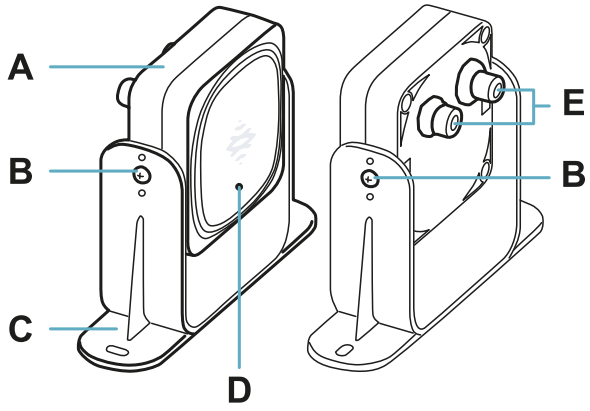
Sensors LBK-S01

Functions

The sensors perform the following primary functions:

- Detect motion in their field of vision.
- Send the motion detection signal to the controller through CAN bus.

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

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 35

Tampering signal

Thanks to an accelerometer, the sensor detects the current inclination. When the system configuration is saved, the sensor memorizes the set inclination and, if inclination variations are subsequently detected, sends a tampering signal to the controller. Upon reception of a tampering signal, the controller de-energizes the safety outputs.

Inxpect Safety application

Functions

The application is used to perform the following main functions:

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

Access

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

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:

Access type	Available functions
without password	• Display the system status (**Dashboard)** • Assign the ID to the sensors (> **Sensors**) • Perform maintenance operations (**Maintenance**) • Download system log (> **Log history**)
with password	• Functions without password • Configure the system (**Configuration** and **Settings**)

Main menu

Page	Function
Dashboard	Display the system status: • LBK system status • controller status • sensors status • status of auxiliary inputs and outputs and relative set function Display the date of the next scheduled diagnostic test Display the sensitivity settings
Configuration	Display or change the configuration parameters in the stopping area and pre-alarm area
Maintenance	Start the wizard for diagnostic test Display the date of the next scheduled diagnostic test Display the performed diagnostic test report
	Configure the sensors Configure the auxiliary inputs and outputs functions Update the firmware Export/import the configuration Download the log Other general functions
Admin login	Enable access to the configuration functions. Password required.

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.

2

Functioning principles

Contents

This section includes the following topics:

Sensor functioning principles

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 recovers information, analyzing the reflection of the objects that it encounters.

Factors that influence the reflected signal

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

- 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

Signaled and missed objects

Many objects inside of an industrial environment reflect the radar signal. The implemented 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.

Sensor field of vision

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 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" above).

The detection area is approximately 110° on the horizontal plane, 30° on the vertical plane and extends for a maximum of 4 m (13,1 ft).

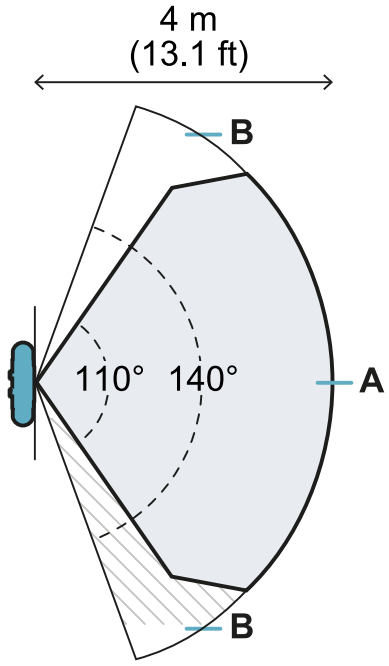


***Figure 1**- Top view.*

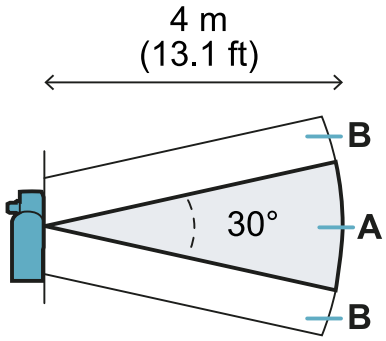


***Figure 2**- Side view.*

Factors that influence the field of vision

The actual field of vision of the sensor depends on:

- sensor installation height
- sensor inclination

When installing the sensor, consider the risk of a blind spot: if the sensor is too high, it must be tilted downwards to reduce the undetected area. However, this also reduces the maximum detected distance. If the sensor is too low, the blind spot is minimum, but the effectiveness of the restart function is reduced.

Calculation of the field of vision

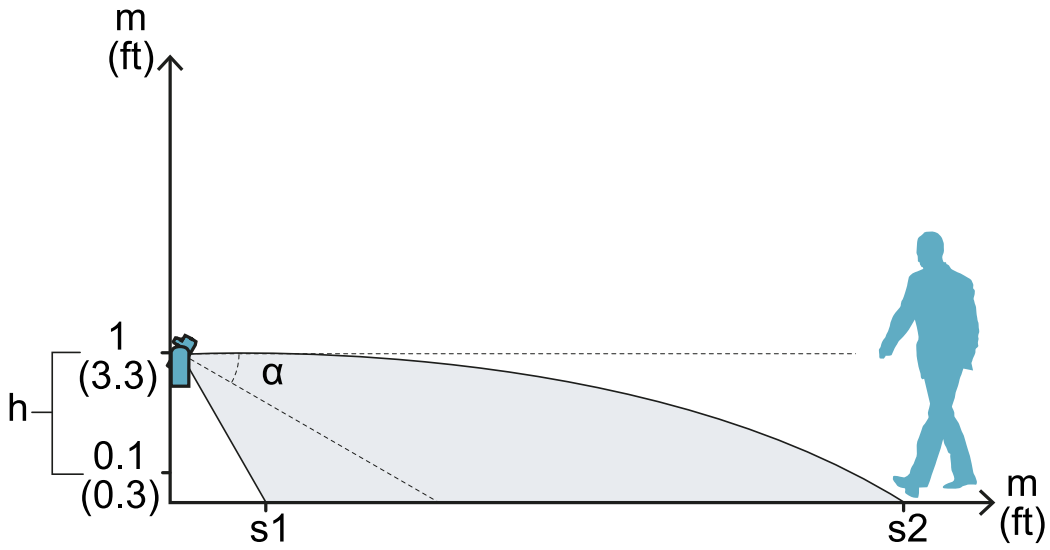


***Figure 3**- Sensor tilted downwards (α negative).*

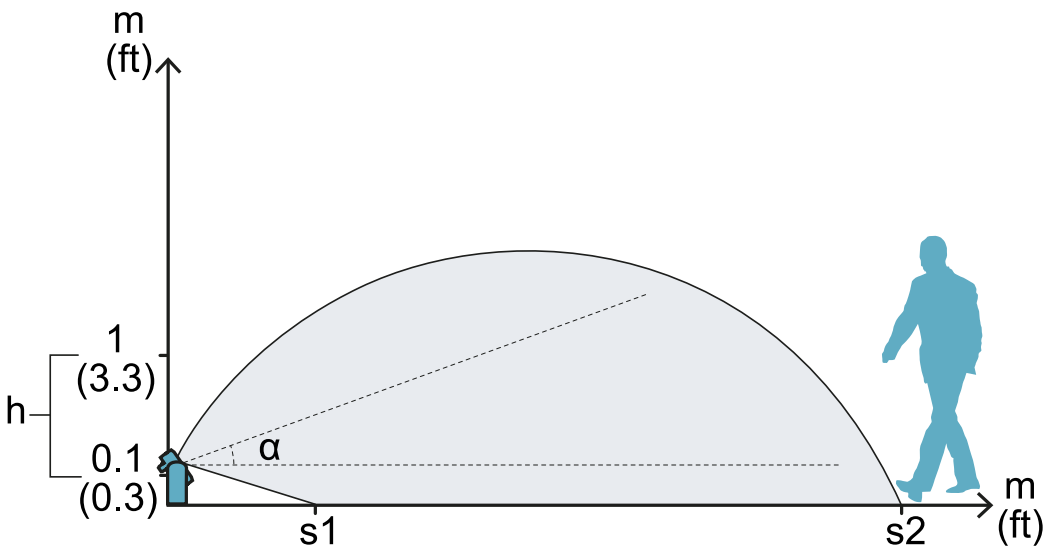


***Figure 4**- Sensor tilted upwards (α positive).*

The dimensions of the field of vision expressed in meters and feet are as follows.

s_1 | s_2 (m)		α (°)				
		-20	**-10**	**0**	**10**	**20**
h (m)	0	n/a	n/a	n/a	0.3 | 4.0	0.0|2.0
	0.1	n/a	n/a	0.2 | 4.0	0 | 4.0	n/a
	0.2	n/a	0 | 4.0	0.0 | 4.0	0 | 4.0	n/a
	0.3	n/a	0.1 | 4.0	0.3 | 4.0	1.3 | 4.0	n/a
	0.4	0.1 | 2.0	0.3 | 4.0	0.7 | 4.0	2.4 | 4.0	n/a
	0.5	0.3 | 3.2	0.5 | 4.0	1.0 | 4.0	3.6 | 4.0	n/a
	0.6	0.4 | 4.3	0.7 | 4.0	1.4 | 4.0	n/a	n/a
	0.7	0.5 | 4.0	1.0 | 4.0	1.8 | 4.0	n/a	n/a
	0.8	0.7 | 4.0	1.2 | 4.0	2.2 | 4.0	n/a	n/a
	0.9	0.8 | 4.0	1.4 | 4.0	2.5 | 4.0	n/a	n/a
	1.0	1.0 | 4.0	1.6 | 4.0	3.0 | 4.0	n/a	n/a

s_1 | s_2 (ft)		α (°)				
		-20	**-10**	**0**	**10**	**20**
h (ft)	0	n/a	n/a	n/a	1.0 | 13.1	0 | 6.6
	0.3	n/a	n/a	0.6 | 13.1	0 | 13.1	n/a
	0.6	n/a	0 | 13.1	0 | 13.1	0 | 13.1	n/a
	1.0	n/a	0.3 | 13.1	1.0 | 13.1	4.3 | 13.1	n/a
	1.3	0.3 | 6.6	1 | 13.1	2.3 | 13.1	7.9 | 13.1	n/a
	1.6	1 | 3.2	1.6 | 13.1	3.3 | 13.1	11.8 | 13.1	n/a
	2	1.3 | 4.3	2.3 | 13.1	1.4 |13.1	n/a	n/a
	2.3	1.6 | 13.1	3.3 | 13.1	4.6 | 13.1	n/a	n/a
	2.6	2.3 |13.1	4.0 | 13.1	7.2 | 13.1	n/a	n/a
	3	2.6 |13.1	4.6 | 13.1	8.2 |13.1	n/a	n/a
	3.3	3.3 | 13.1	5.2 | 13.1	9.8 | 13.1	n/a	n/a

Sensitivity

The sensitivity level for the system can be defined for the detection function as well as the restart 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 the sensitivity level lower if people or objects are in transit at the margins of the dangerous area (e.g. forklifts or trucks).

For the restart function, a delay interval is applied from when there is no motion detected in the area to when the machinery can be restarted.

Detection function

Description

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

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 "Calculation of the field of vision" on page 16) and perform the validation of the function (see "Validate the detection function" on page 31). If necessary, implement additional safety measures.

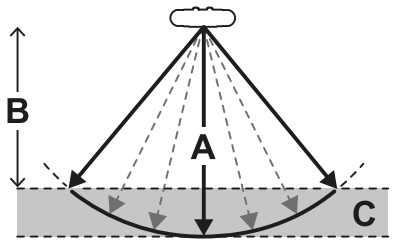
***Note**: for linear barrier application with aligned sensors, the stopping area is calculated automatically by the Inxpect Safety application based on the set dimensions of the dangerous area and the configuration of the sensors.*

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.

Tolerance area

The sensor is based on radial distances, therefore distance **[A]** is the same no matter what angle 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.



It is the responsibility of the machinery designer to enclose the tolerance area to prevent transit and the occurrence of false alarms.

The tolerance area for the linear barrier application with aligned sensors is calculated and provided by the Inxpect Safety application.

Restart function

Description

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

After motion is detected, further motion of only a few millimeters is sufficient (e.g. a person breathing) to prevent 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 "Calculation of the field of vision" on page 16) and perform the validation of the function (see

"Validate the detection function" on page 31). If necessary, implement additional safety measures.

> ***Note**: for linear barrier application with aligned sensors, 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.*

Types of managed restart

The system manages three types of restart:

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

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

Enable the restart function

Type	Procedure
Automatic	In the Inxpect Safety application > ⚙ > **Sensors**, set in **Restart timeout** the desired delay interval.
Semi-manual	1. Connect the machinery restart enable button conveniently, see "Electrical connections" on page 44. 2. 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 44. 2. In the Inxpect Safety application > ⚙ > **Sensors**, set **Restart timeout** = 0.

Muting

Description

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

Muting enabling

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.

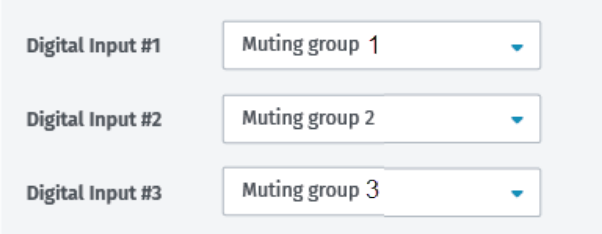
The following are defined through the Inxpect Safety application:

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

See "Configure the auxiliary inputs and outputs" on page 30.

Example of sensors - groups association

Example of digital inputs - groups association



Muting status

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

3

Applications

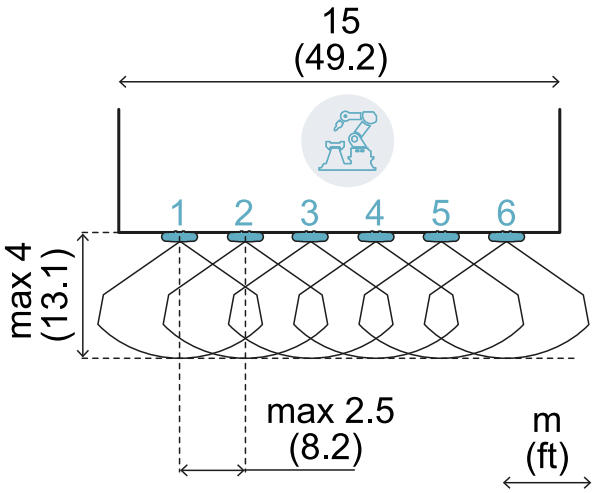
Contents

This section includes the following topics:

Linear barrier (aligned sensors)

Maximum limits of monitored area

The maximum depth of the area that can be set is 4 m (13,1 ft). With six sensors aligned and at a maximum distance of 2.5 m (8,2 ft), an area of 15 m (49,2 ft) total width can be monitored.



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.

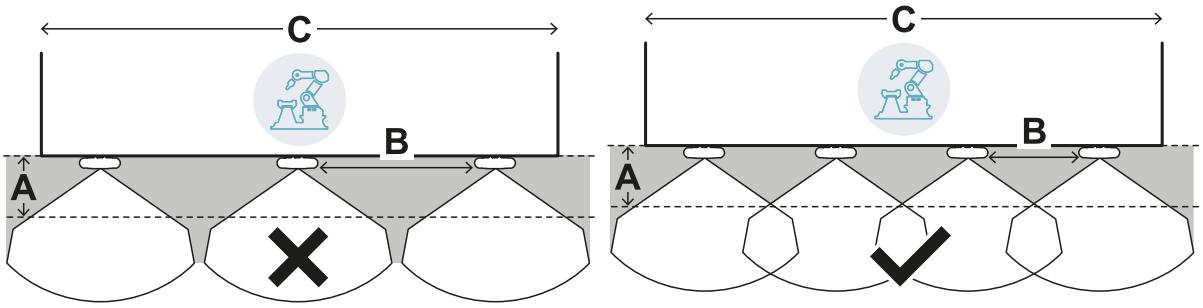


Figure 1- *Example of lower depth.*

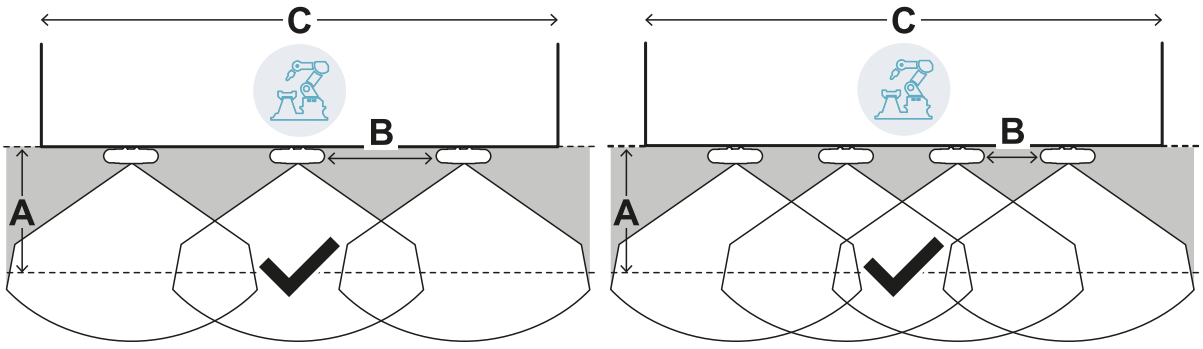
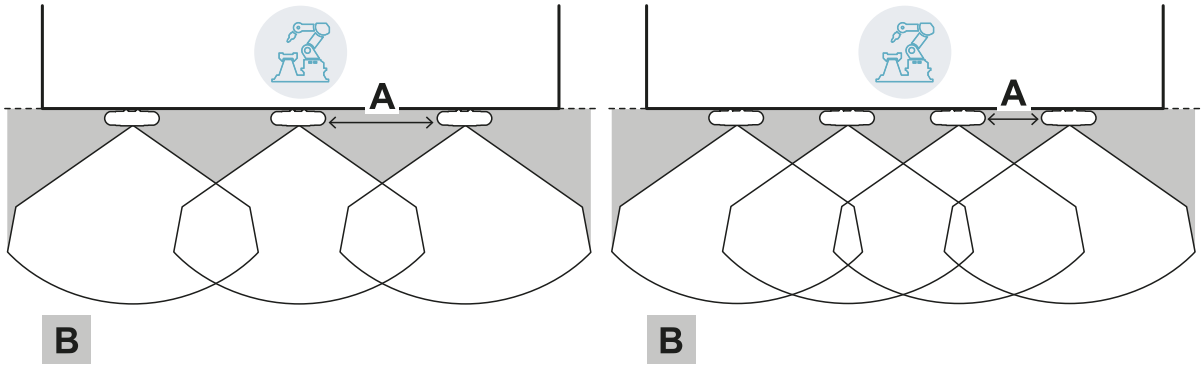


Figure 2. - *Example of greater depth.*

Blind spots

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

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



Restart function limits

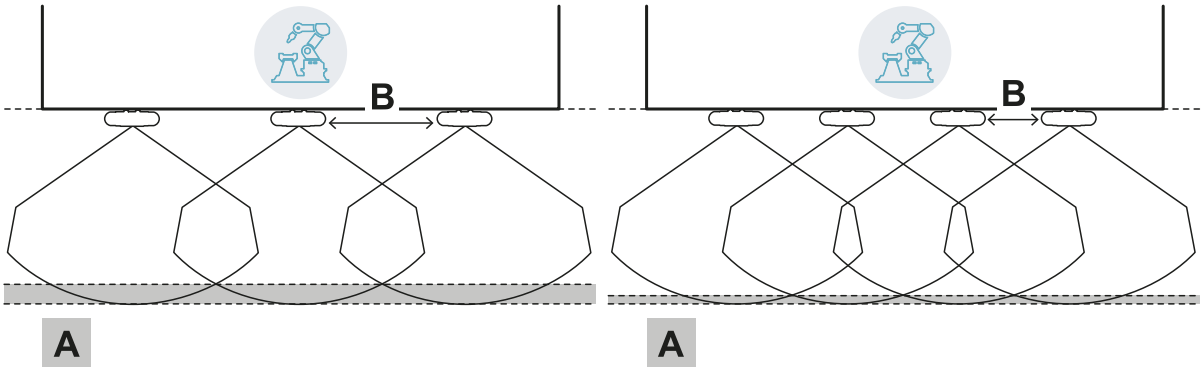
The restart function based on motion detection (automatic and semi-manual type, see "Types of managed restart" on page 19) is not guaranteed in the immediate vicinity of the sensor near the blind spots. The guaranteed minimum distance depends on the distance between the sensors:

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 this system functionality.*

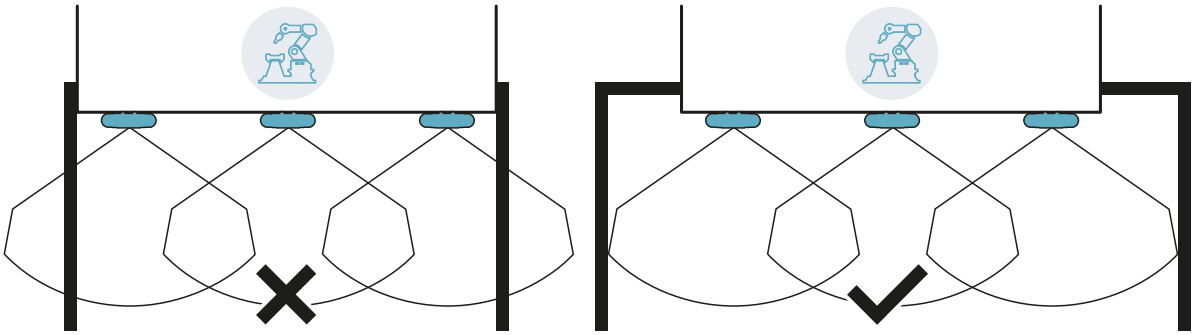
Tolerance area

The tolerance area **[A]** (see "Tolerance area" on page 18) increases with greater distance between the sensors **[B]**, up to a maximum of 20 cm (7,9 in) approximately.



Side areas

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.



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

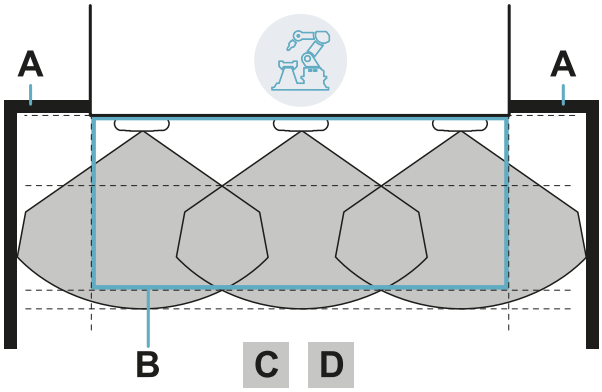
Calculation of the monitored area

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 from the side guards)
- the depth of the tolerance area

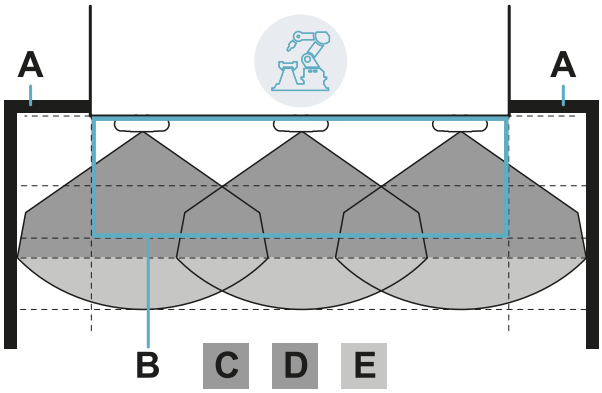
To calculate the depth of the dangerous area, see "Calculate the dangerous area" on page 28.

Example of monitored area without pre-alarm area



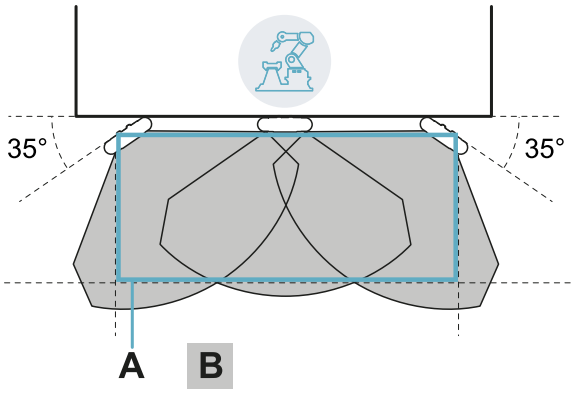
Part	Description
A	Guards to prevent side access
B	Dangerous area
C	Stopping area
D	Tolerance area

Example of monitored area with pre-alarm area



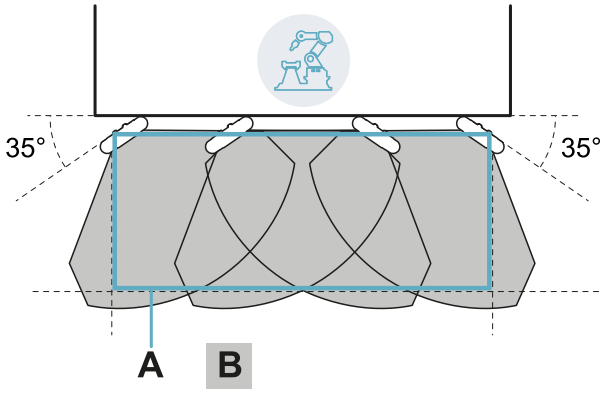
Part	Description
A	Guards to prevent side access
B	Dangerous area
C	Stopping area
D	Tolerance area of the stopping area
E	Pre-alarm area

Example of total coverage (odd number of sensors)



Part	Description
A	Dangerous area
B	Stopping area

Example of total coverage (even number of sensors)



Part	Description
A	Dangerous area
B	Stopping area

4

Installation and use procedures

Contents

This section includes the following topics:

Before installation

Materials required

- Two tamper-proof screws to fasten the sensors to the floor or machinery, see "Specifications of sensor fastening screws" on page 42.
- Cables to connect the controller to the first sensor and the sensors to one another, see "CAN bus cables specifications" on page 42.
- 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. [Trial kits only. Final product will use tamper-resistant screw heads requiring a special accessory to be driven].

Calculate the dangerous area

Use the following formula to calculate the depth of the dangerous area:

$$S = K * T + C$$

Where:

- **T** (s) = 100 ms + Machinery stopping time (calculated in accordance with standard ISO 13855:2010)
- **K** (mm/s) = 1600 mm/s
- **C** (mm) = 1200 mm - 0.4 * Sensor installation height

Example with:

- *Machinery stopping time = 500 ms*
- *Sensor installation height = 100 mm.*

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

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

S** = 1600 * **0.6** + **1160** = **2120 mm

Install the LBK application

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

Initiate the LBK system

1. "Install the controller" below.
2. "Define the area to be monitored" below.
3. "Configure the auxiliary inputs and outputs" on page 30.
4. "Save and print the configuration" on page 30.
5. "Install sensor on the floor" on the facing page or "Install the sensors on the machinery" on the facing page.
6. "Install the side guards" on page 30.
7. "Connect the controller to the sensors and assign the IDs" on page 30.

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

8. "Validate the detection function" on page 31.

Install and configure the LBK system

Install the controller

1. Mount the controller on the DIN guide.
2. Make electrical connections, see "Terminal blocks and connectors pinouts" on page 42 and "Electrical connections" on page 44.

   > ***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 43.*

Define the area to be monitored

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

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 **Admin login**. Leave the password blank for first-time installations.

   > ***Note**: during the first configuration of a given controller, you must set a valid password. Memorize the password and provide it only to people who are authorized to change the configuration.*

5. Select **Configuration**.
6. 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 actual monitored area, see "Linear barrier (aligned sensors)" on page 22.

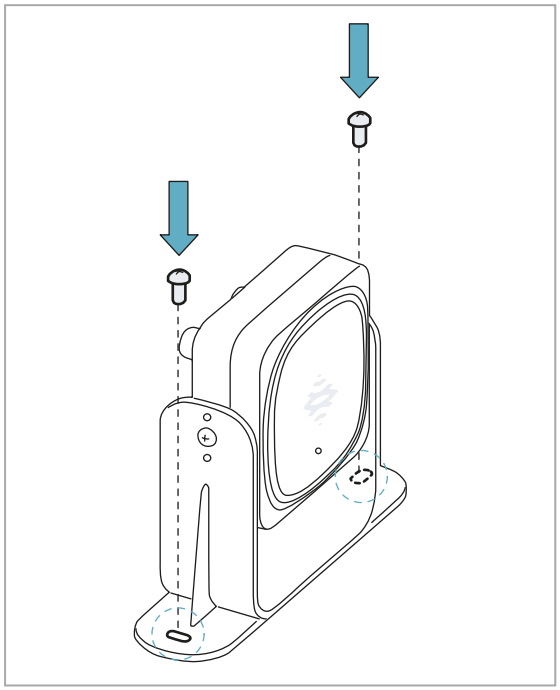
   > ***Note**: when setting a parameter, the system automatically fills in the values or defines an interval of values compatible with the other parameters.*

7. To identify what the parameters refer to, click the name of the parameter: the dimension will be highlighted in the graphic image.
8. Scroll through the two proposed configurations and leave the most suitable on the display.

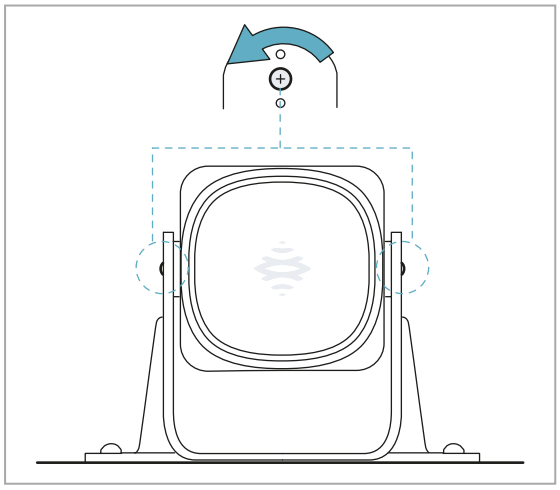
Install sensor on the floor

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.

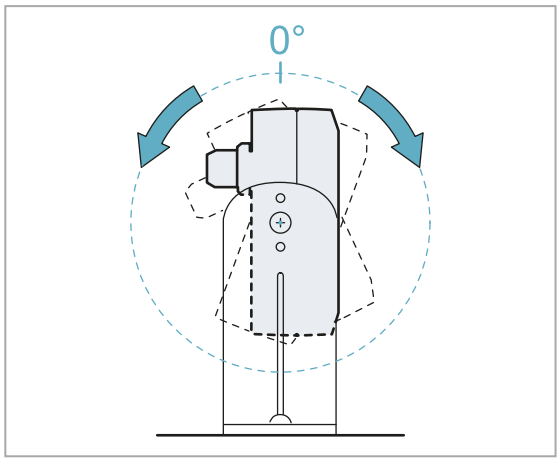
   ***NOTICE**: the support must not interfere with the commands of the machinery.*



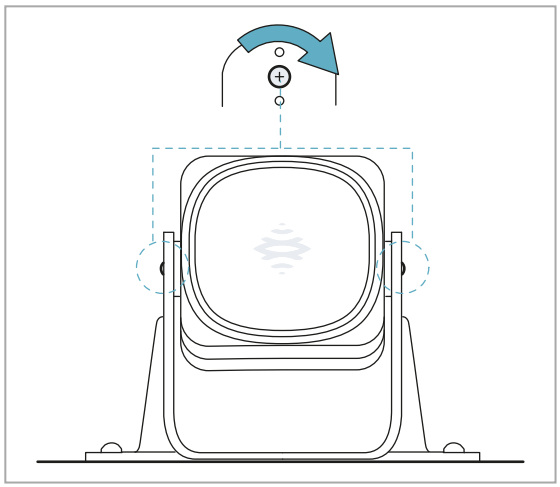
2. To tilt the sensor, loosen the side screws.



3. Direct the sensor up to the desired inclination, see "Calculation of the field of vision" on page 16.

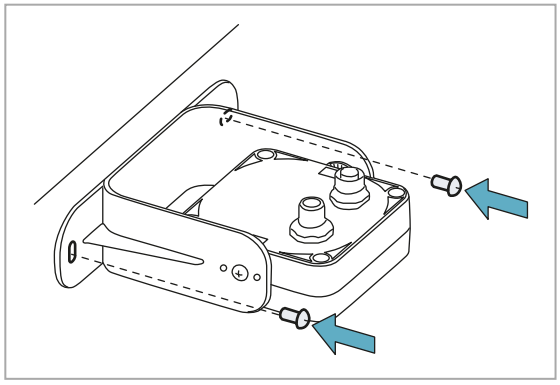


4. Tighten the screws.

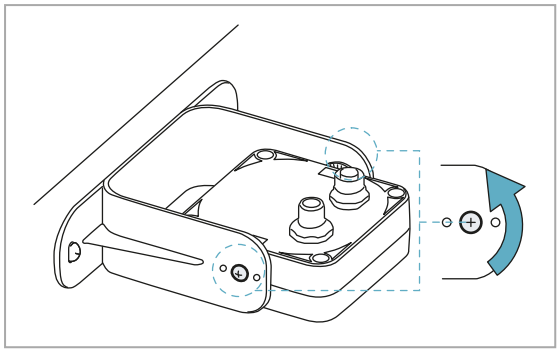


Install the sensors on the machinery

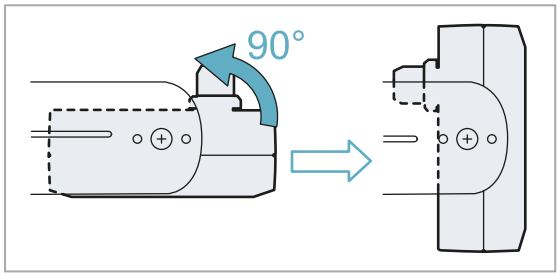
1. Position the sensor as indicated in the configuration report and fasten the bracket with two screws to a machinery support. To select installation height, see "Calculation of the field of vision" on page 16.



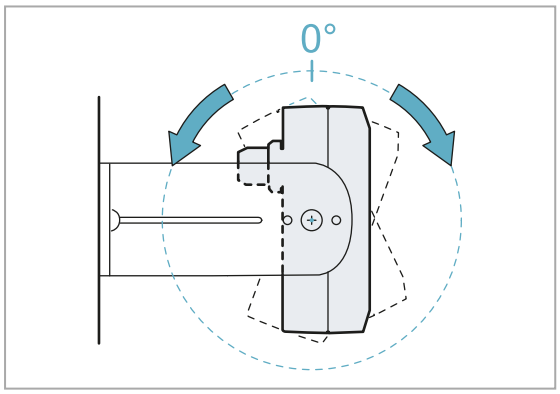
2. Loosen the side screws.



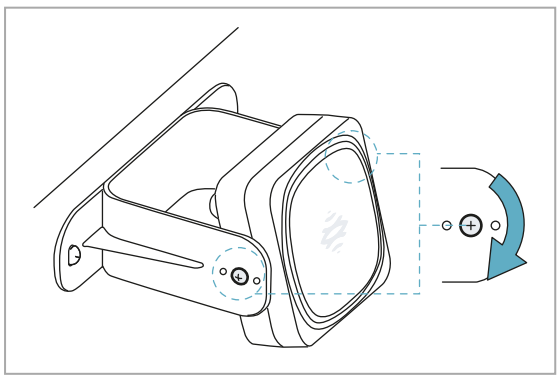
3. Position the sensor parallel to the machinery support.



4. Direct the sensor up to the desired inclination, see "Calculation of the field of vision" on page 16.



5. Tighten the screws.



Install the side guards

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.

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 **Set ID nodes** and follow the instructions on the display.

> ***Note**: to reassign the sensors with the default ID 0, click **Reset ID**.*

5. Proceed by assigning the ID to another sensor or terminate the procedure.
6. Insert the termination connector to the free connector of the last sensor in the chain.

Configure the auxiliary inputs and outputs

1. 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.

Save and print the configuration

1. Click **Apply changes**: the sensors memorize the set inclination. The application transfers the configuration to the controller, and once transfer is complete it generates a configuration report.
2. Click 🖶 to print the report.
3. Complete the report with the inclination and height data of the sensors and request signature by the person assigned to the task.

Validate safety functions

Validation

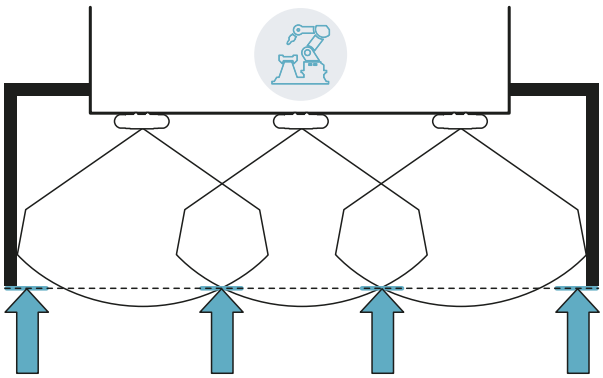
Once the system has been installed and configured, check that the safety functions are activated/deactivated as expected and that the dangerous area, according to the risk assessment, is actually monitored by the system.

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

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). 3. If it does not activate, see "Troubleshooting validation" on the next page.
Specifications	• Access from several different points, with special attention to the border areas (e.g. intersection with side guards), see "Example of access points" below • Access standing as well as kneeling. • Access moving slowly and quickly.

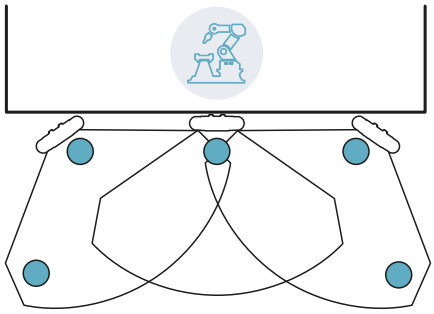
Example of access points



Validate the restart 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). 3. If deactivated, see "Troubleshooting validation" on the next 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 blind spots, see "Examples of stopping points" on the next page. • Stop standing as well as laid down.

Examples of stopping points



Troubleshooting validation

Cause	Remedy
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 (see "Sensor field of vision" on page 15, "Applications" on page 21 and "Calculate the dangerous area" on page 28).
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 field of vision" on page 15 and "Calculate the dangerous area" on page 28. 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)

Manage the configuration

Change the configuration

WARNING! During configuration, the 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 **Admin login** and insert the password.
3. According to the desired change, follow these instructions:

If you want to change...	Then...
Monitored area	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. Once the configuration has been transferred, 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.

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.*

Other functions

Change the access password

In ⚙ > **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.*

Reset the access password

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

Restore factory default settings

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

Identify a sensor

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

5

Maintenance and troubleshooting

Contents

This section includes the following topics:

Troubleshooting

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 30.
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 respect 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.*

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 41).
S2	Steady	Controller temperature value is wrong	Check that the system is operating at the correct operating temperature (see "General specifications" on page 41).
S3	Steady	At least one relay is in error	Reset the system (⚙ > **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 board and connections.
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 (LBK application > ⚙ > **Sensor ID nodes**).
S6	Steady	Configuration saving error or configuration not performed	Reconfigure or configure the system.
Any	Flashing red	Sensor in error	Check what the problem is through the LEDs on the controller and 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.*

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 32. 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 30.
Machinery in safety conditions not caused by motion	No power supply	Check electrical connection. Contact assistance service if necessary.
	Faulty 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.
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.
	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 sensor in error.

System log

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

Download system log

1. Start the **LBK System** application.
2. Select ⚙ and then **Log history**.
3. Click **Download log**.

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

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

Temperature errors (TEMPERATURE ERROR)

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

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

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.*

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 inclinationwith respect to the installation surface (set through fastening screws on the bracket) changed
ACCELEROMETER READ ERROR	Accelerometer reading error

Peripheral error (PERIPHERAL ERROR)

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

System boot (SYSTEM BOOT)

Each time the LBK system starts it records a "SYSTEM BOOT" event with a consecutive number from the last restart. The time stamp is reset to zero.

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

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

Cleaning and spare parts

Cleaning

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

Spare parts

Part	Product code
Sensor	LBK-S01
Controller	LBK-C22

Periodical tests

Test

Frequency	Test	Object of test
At least every six months	Diagnostics	• 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.*

Diagnostic test with Inxpect Safety

The Inxpect Safety application (page **Maintenance**) provides a wizard for performing the diagnostic test. Inxpect Safety also makes it possible to:

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

Perform the test with Inxpect Safety

WARNING! The LBK system is disabled during maintenance. 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**.
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.

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**.

Updates

Download updates

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

Install firmware updates

WARNING! The LBK system is disabled during 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 "Install and configure the LBK system" on page 28.

Install software 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.

6

Appendix

Contents

This section includes the following topics:

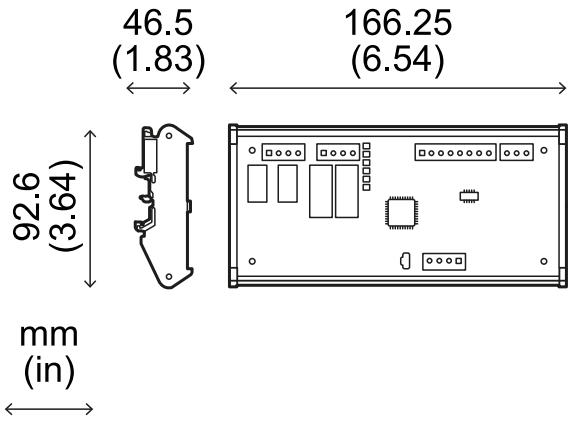
Technical data

General specifications

Detection method	Inxpect motion detection motor based on FMCW radar
Frequency	Working band: 24-24.25 GHz Transmission power: ≤ 13 dBm Modulation: FMCW
Detection interval	From 1 to 4 m (3.3 to 13.1 ft), depending on the installation conditions.
Field of vision	Sensor horizontal plane: 110° Sensor vertical plane: 30° Height: from 0 to 1 m (0 to 3.3 ft) Inclination: from -20° to +20°
Guaranteed response time	< 100 ms
SIL (Safety Integrity Level)	2
PL (Performance Level)	d
Total consumption	11 W (controller and six sensors)
Operating temperature	From -40 to +60 °C (-40 to +140 °F)
Storage temperature	From -40 to +80 °C (-40 to +176 °F)
Communication protocol (sensors-controller)	CAN complies with standard EN 50325-5
Functional duration	20 years
Mean time to recovery (MTTR)	
(PFH)	
Electrical protections	Polarity inversion Overcurrent through integrated fuse (max. 5 s @ 3 A)

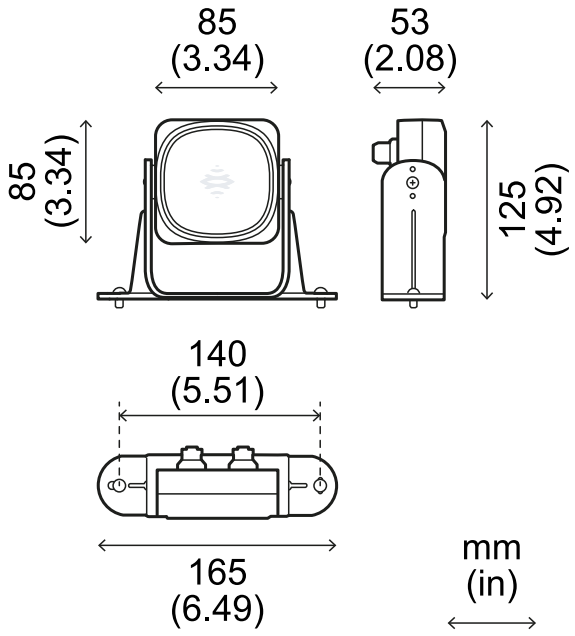
Controller

Outputs	4 relay outputs: • 1 dual channel safety output • 2 auxiliary outputs
Safety output relays	Forced guided relays • Max voltage: 250 V ac • Max current: 8 A ac • Max power: 2000 VA
Auxiliary output relays	Electromechanical relays • Max voltage: 220 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 43.
Power supply	24 V dc (20-28 V dc)
Consumption	Max 3.8 W
Assembly	On DIN guide
Degree of protection	IP20
Terminals	Section: 2.5 mm^2 (13 AWG) max Max current: 12 A with 2.5 mm cables^2



Sensor

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)



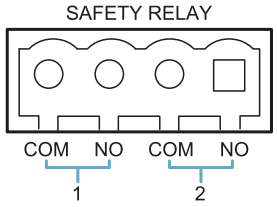
CAN bus cables specifications

Section	2 x 0.34 mm² power supply 2 x 0.34 mm² data lines
Type	Two twisted pairs: power supply and data line
Connectors	5-pole M12, see "Connector M12 CAN bus" on the facing page
Impedance	120 Ω ±12 Ω (f = 1 MHz)
Shield	Shield with twisted wires in tin-plated copper. Requires ground connection.
Length	100 m from controller to sensor (configuration with one sensor)

Specifications of sensor fastening screws

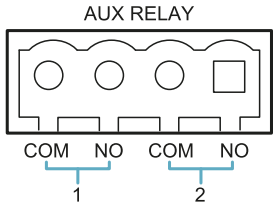
Terminal blocks and connectors pinouts

Safety outputs terminal block



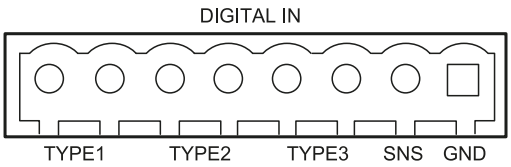
Terminal	Description
COM	Common safety output 1
NO	Relay output normally open
COM	Common safety output 2
NO	Relay output normally open

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

Digital inputs terminal block



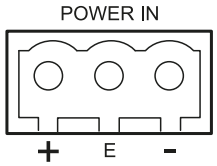
Terminal	Description
Type 1	Input 24 V dc type 1
Type 1	Input 24 V dc type 1
Type 2	Input 24 V dc type 2
Type 2	Input 24 V dc type 2
Type 3	Input 24 V dc type 3
Type 3	Input 24 V dc type 3
SNS	Input 24 V dc for diagnostics
GND	Common reference for all digital inputs

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.

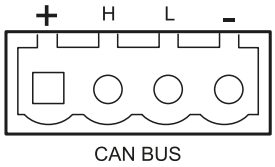
	Type 1	Type 2	Type 3
Voltage limits			
0	from - 3 to 15 V	from - 3 to 11 V	from - 3 to 11 V
1	from 15 to 30 V	from 11 to 30 V	from 11 to 30 V
Current limits			
0	15 mA	30 mA	15 mA
1	from 2 to 15 mA	from 6 to 30 mA	from 2 to 15 mA

Power supply terminal block



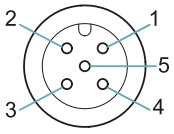
Terminal	Description
+	+ 24 V dc
E	Ground
-	GND

CAN bus terminal block



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

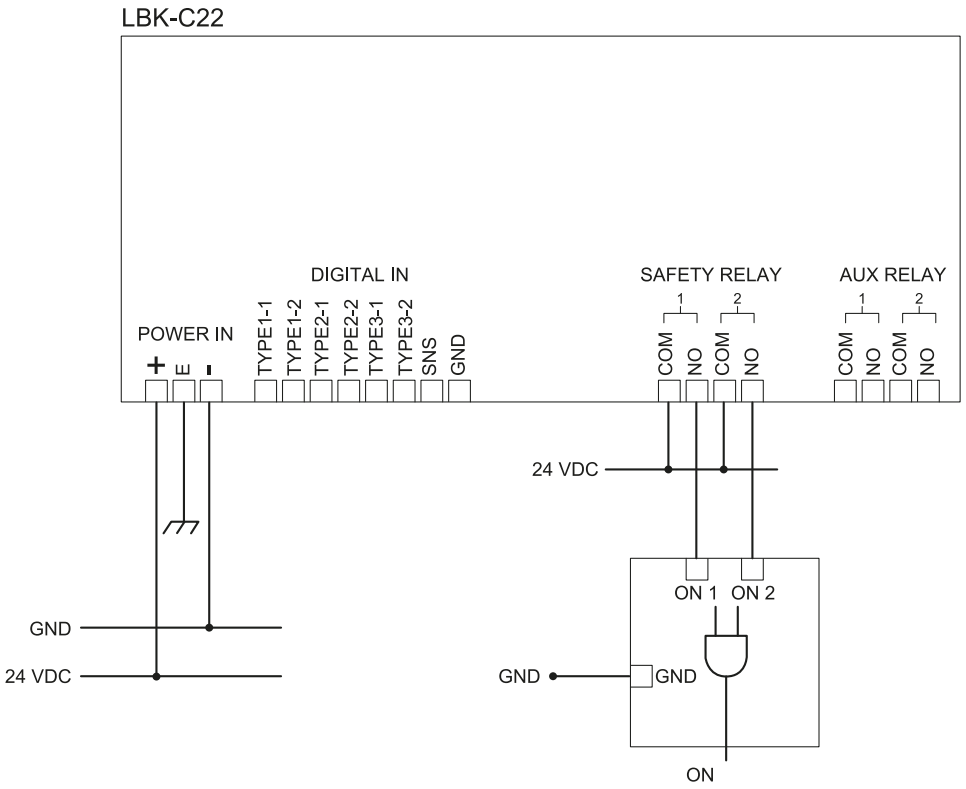
Connector M12 CAN bus



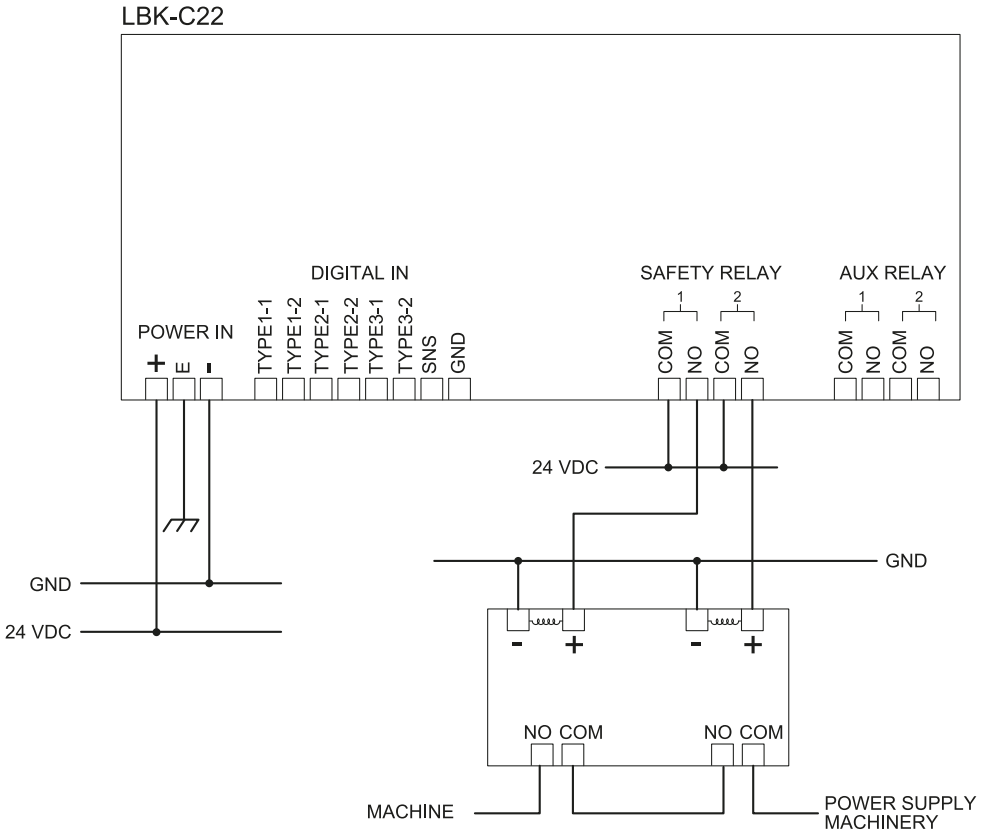
Pin	Function
1	Shield, for ground connection
2	+12 V dc
3	GND
4	CAN H
5	CAN L

Electrical connections

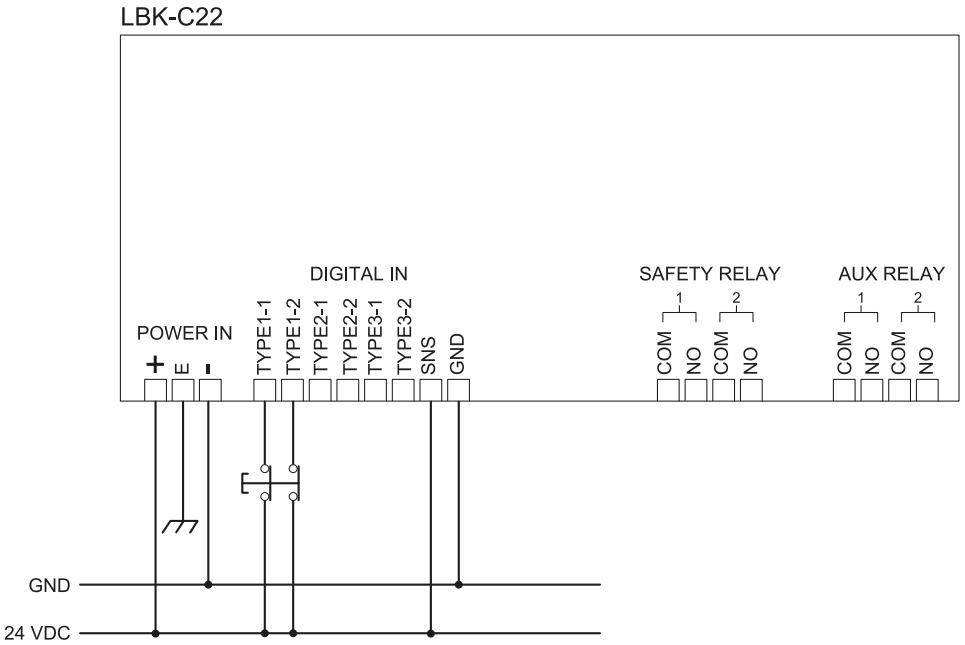
Connection of safety outputs to the machinery control system



Connection of safety outputs to an external safety relay

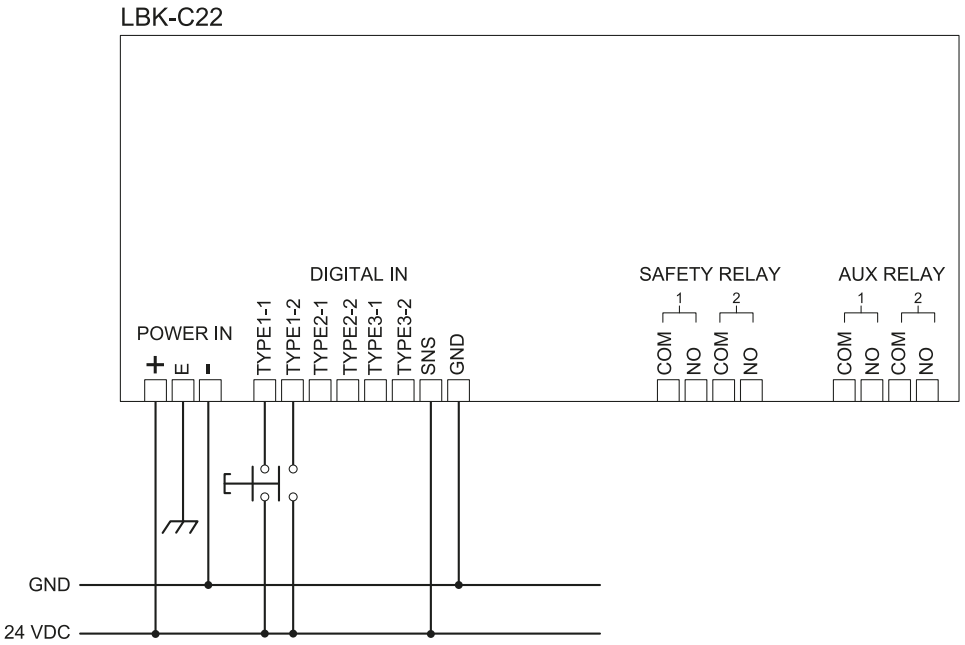


Connection of emergency button



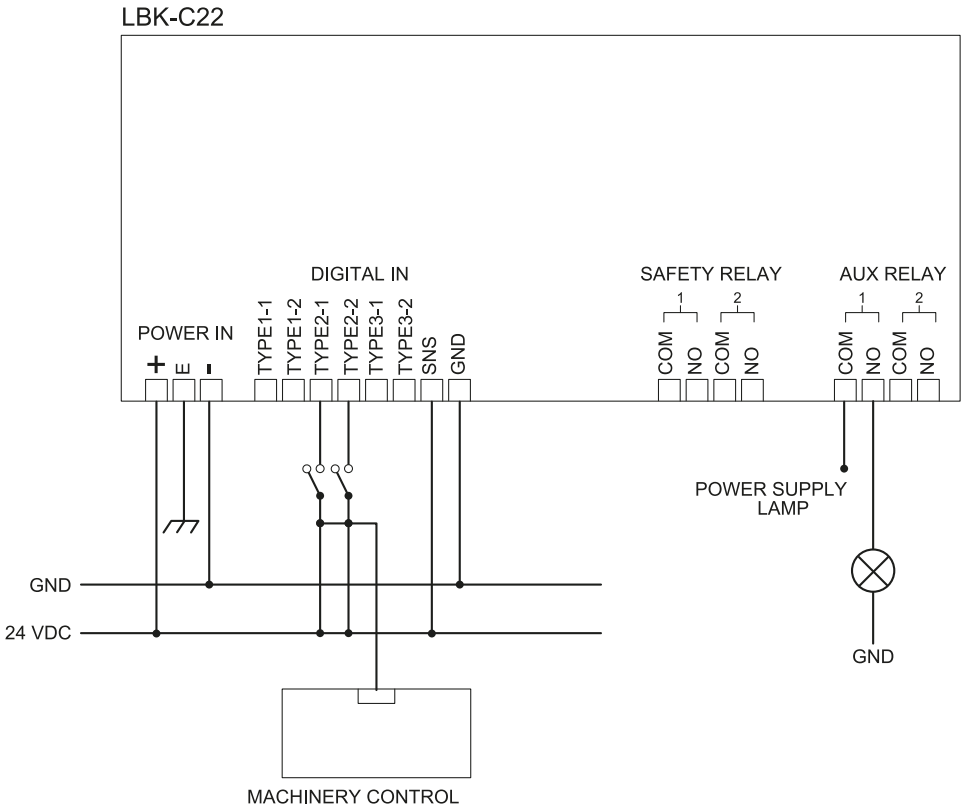
***Note**: the indicated emergency button opens the contact when pressed.*

Connection of restart enable button

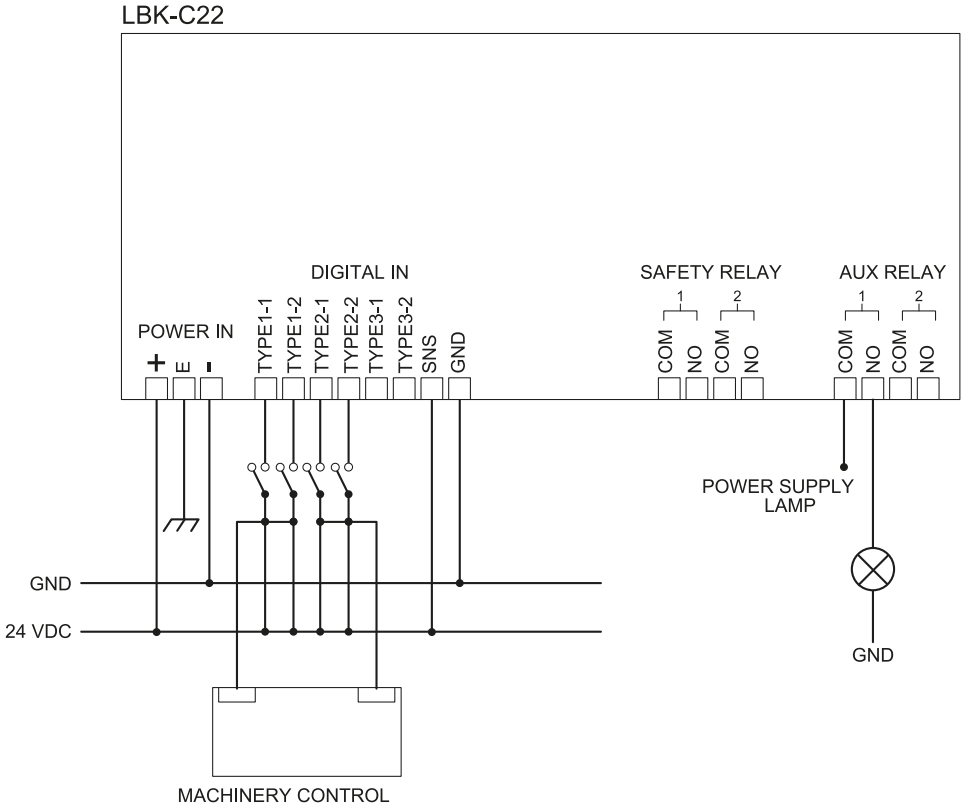


***Note**: the indicated restart enable button closes the contact when pressed.*

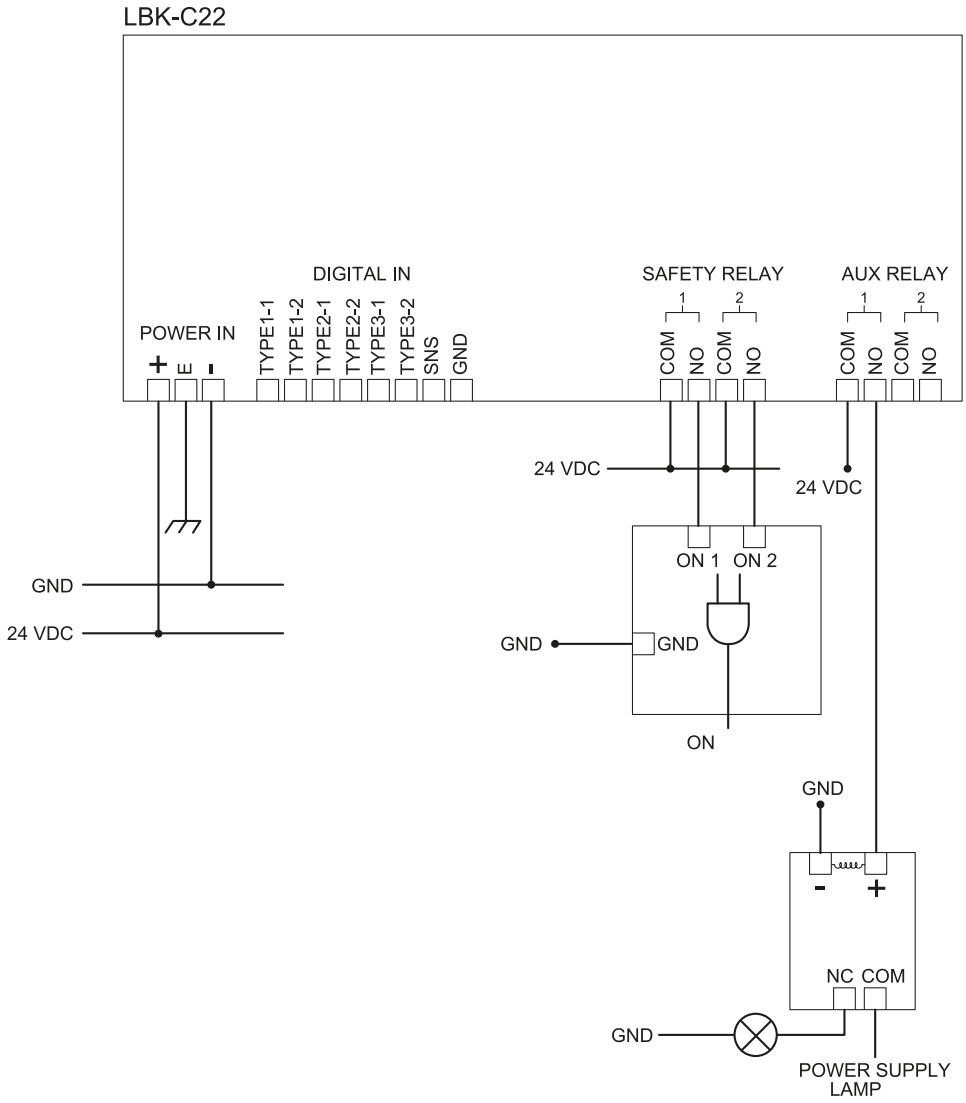
Connection of the muting input and output (one group of sensors)



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

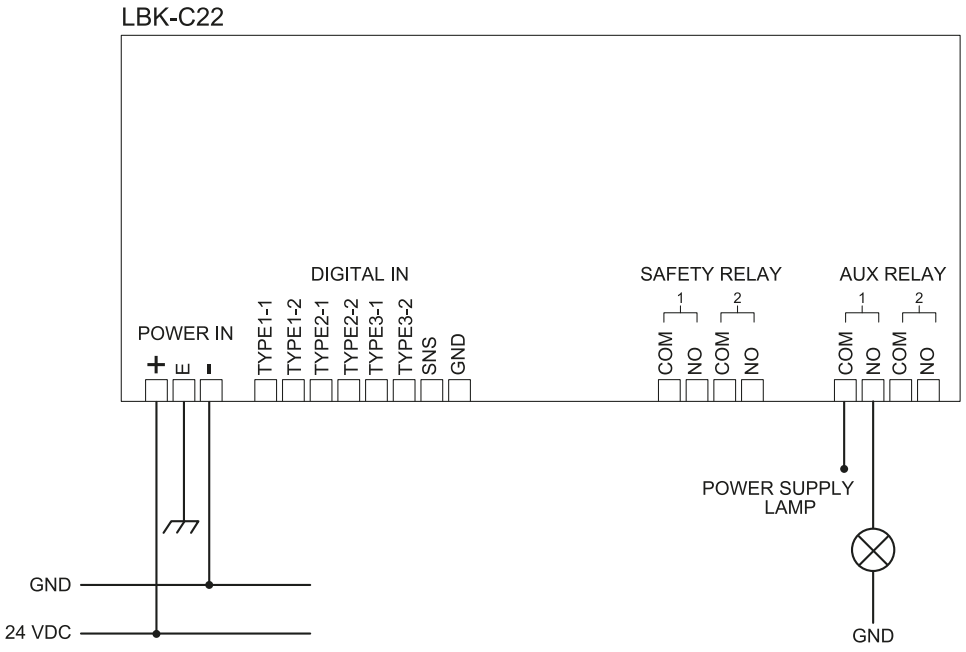


Faulty output connection



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

Pre-alarm output connection



Disposal

The product must be disposed of at the relative recycling centers specified by the government or local public authorities.

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

Service and warranty

Customer service

Inxpect SpA
Via del Serpente, 89
25131 Brescia (BS) - Italy
Tel: +39 030 254 0300
Fax: +39 012 3456789
e-mail: safety@inxpect.com
website: www.inxpect.com

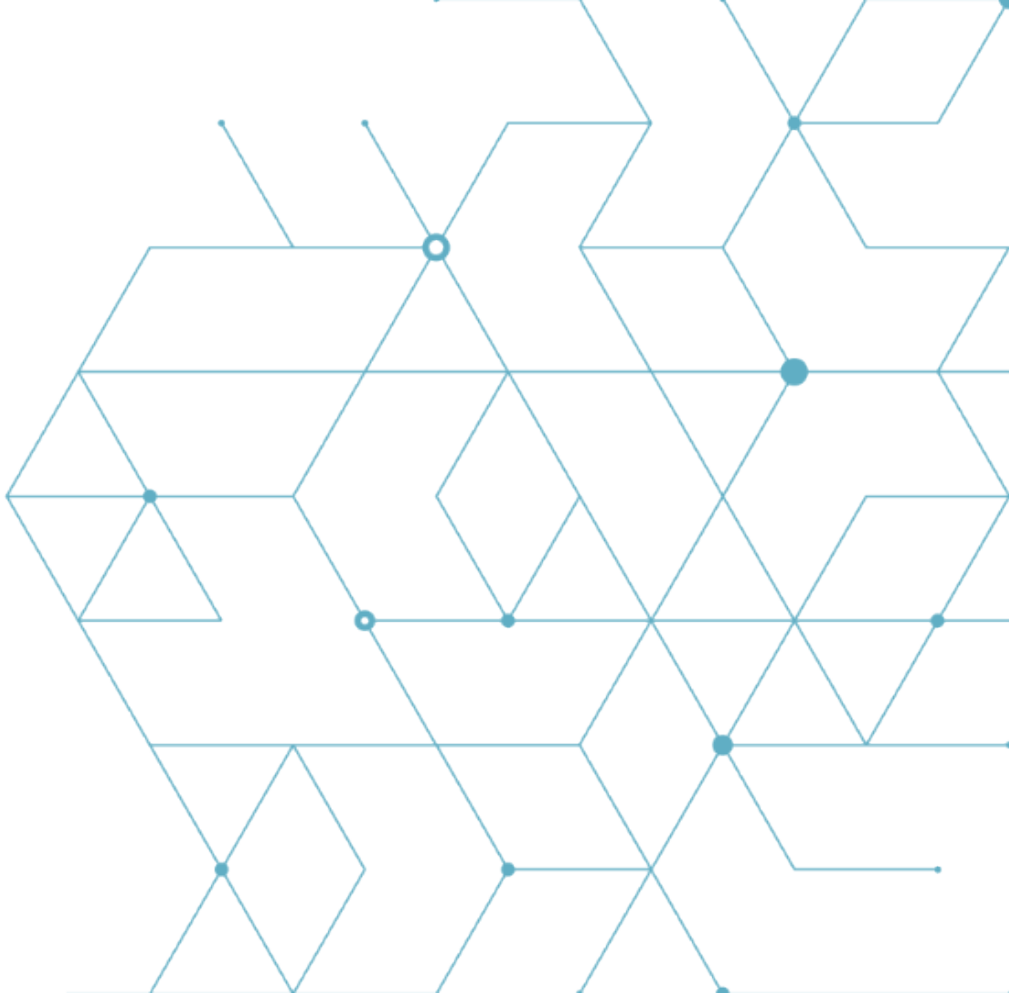
How to return the product

If necessary, **pay to ship the product in its original packaging to the area distributor, or directly to the exclusive distributor.**

Area distributor	Manufacturer
Note distributor information here:	Inxpect SpA Via del Serpente, 89 25131 Brescia (BS) Italy www.inxpect.com

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 v1.1
MAY 2018
LBK-System_instructions_en v1.1

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