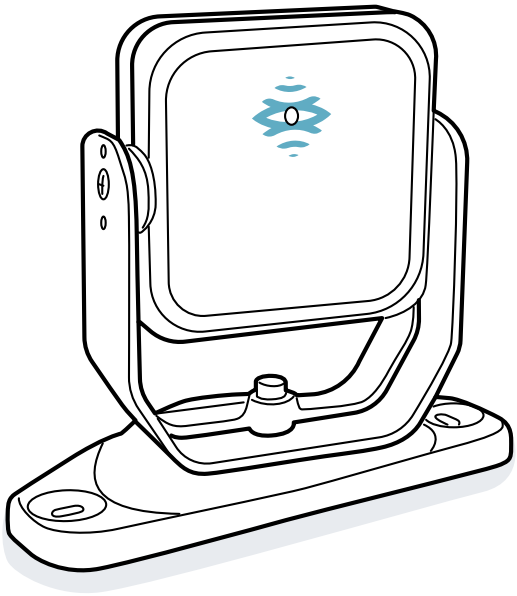
INXPECT

SBV System BUS

SRE - Safety Radar Equipment



Instruction manual
v1.0 - EN

Original instructions

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

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Requests for authorizations, additional copies of this manual or technical information about this manual must be addressed to:

Inxpect SpA
Via Serpente, 91
25131 Brescia (BS)
Italy
safety-support@inxpect.com
+39 030 5785105

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Glossary of terms

A

Activated output (ON-state)

Output that switches from OFF to ON-state.

Angular coverage

Property of the field of view that corresponds to the coverage on the horizontal plane.

D

Dangerous area

Area to be monitored because it is dangerous for people.

Deactivated output (OFF-state)

Output that switches from ON to OFF-state.

Detection distance x

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

Detection field x

Portion of the field of view of the sensor. Detection field 1 is the field closer to the sensor.

Detection signal x

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

E

ESPE (Electro-Sensitive Protective Equipment)

Device or system of devices used for the safety-related detection of people or parts of the body. ESPEs provide personal protection at machines and plants/systems where there is a risk of physical injury. These devices/systems cause the machine or plant/system to switch over to a safe status before a person is exposed to a dangerous situation.

F

Field of view

Sensor area of vision characterized by a specific angular coverage.

Fieldset

Structure of the field of view which can be composed of up to four detection fields.

FMCW

Frequency Modulated Continuous Wave

I

Inclination

Sensor rotation around the x-axis. The sensor inclination is the angle between the center of the field of view of the sensor and a line parallel to the ground.

M

Machinery

The system for which the dangerous area is monitored.

Monitored area

Area that is monitored by the system. It is composed of all the detection fields of all the sensors.

O

OSSD

Output Signal Switching Device

R

RCS

Radar Cross-Section. Measure of how detectable an object is by radar. It depends, among other factors, on the material, dimension and position of the object.

T

Tolerance area

Area of the field of view where detection or not of a moving object/person depends on the characteristics of the same object itself.

1. This manual

1.1 Information on this manual

1.1.1 Objectives of this instruction manual

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

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

1.1.2 Obligations with regard to this manual

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

1.1.3 Provided documentation

Document	Code	Date	Distribution format
Instruction manual (this manual)	SAF-UM-SBVBus-en-v1.0-print	JAN 2021	online PDF PDF downloadable from the site www.inxpect.com/industrial/tools

1.1.4 Instruction manual updates

Publication date	Code	Hardware version	Firmware version	Updates
JAN 2021	SAF-UM-SBVBus-en-v1.0-print	• ISC-B01: 2.1 • SBV-01: 2.1	• ISC-B01: 1.3.0 • SBV-01: 1.0	First publication

1.1.5 Intended users of this instruction manual

The recipients of the instruction manual are:

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

2. SAFETY

2.1 Safety information

2.1.1 SAFETY MESSAGES

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

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

***NOTICE**: indicates obligations that if not observed may cause harm to the equipment.*

2.1.2 Safety symbols on the product

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

- wiring of the connections (see "Terminal blocks and connector pin-outs" on page 73 and "Electrical connections" on page 75)
- cable operating temperature (see "Terminal blocks and connector pin-outs" on page 73)
- controller cover, which was subjected to an impact test at low energy (see "Technical data" on page 71)

2.1.3 PERSONNEL SKILLS

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

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

2.1.4 INTENDED USE

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

It performs the following safety functions:

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

It performs the following optional safety functions:

- Stop signal: force all the safety outputs to OFF-state.
- Restart signal: enables the controller to switch the safety outputs related to all the detection fields that are free of motions to ON-state.
- Muting (see "Muting" on page 31).

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

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

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

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

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

2.1.5 GENERAL WARNINGS

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

2.1.6 WARNINGS FOR THE RESTART PREVENTION FUNCTION

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

2.1.7 RESPONSIBILITY

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

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

2.1.8 LIMITS

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

2.2 Conformity

2.2.1 STANDARDS AND DIRECTIVES

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

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

The EU Declaration of Conformity can be downloaded from www.inxpect.com.

2.2.2 CE

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

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

3. Get to know SBV System BUS

Contents

This section includes the following topics:

3.1 SBV System BUS 10
3.2 ISC-B01 controller 12
3.3 SBV-01 sensors 16
3.4 Inxpect BUS Safety application 18
3.5 Fieldbus communication 19
3.6 System configuration 20

3.0.1 Product label description

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

Part	Description
SID	Sensor ID
DC	"yy/ww" : year and week of the product manufacture
SRE	Safety Radar Equipment
Model	Model of the product (e.g. SBV-01, ISC-B01)
Type	Product variant, used for commercial purposes only
S/N	Serial number

3.1 SBV System BUS

3.1.1 Definition

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

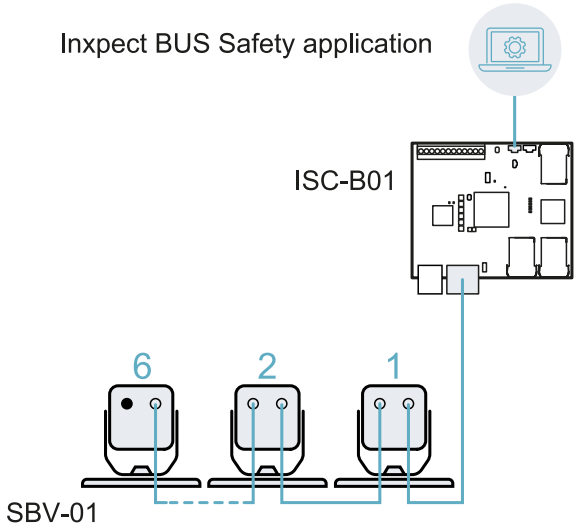
3.1.2 Special features

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

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

3.1.3 Main components

SBV System BUS is composed of a controller and up to six sensors. The Inxpect BUS Safety software application allows system operation configuration and checks.



3.1.4 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 an identification (Node ID).

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

3.1.5 Controller - machinery communication

The controller is provided with a safety communication on a Fieldbus interface. The Fieldbus interface allows the ISC-B01 controller to communicate in real-time with the PLC of the machinery in order to do what follows:

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

See "Fieldbus communication" on page 19.

3.1.6 Applications

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

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

SBV System BUS does not perform normal machinery control functions.

For connection examples, see "Electrical connections" on page 75.

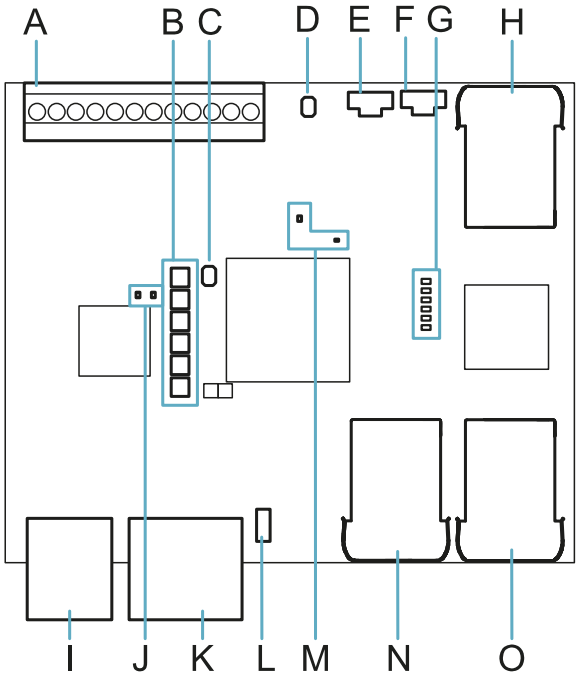
3.2 ISC-B01 controller

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 thresholds.
- Deactivates the safety output when at least one sensor detects motion in the detection field.
- Deactivates the safety output if a failure is detected in one of the sensors or the controller.
- Manages the inputs and outputs.
- Communicates with the Inxpect BUS Safety application for all configuration and diagnostic functions.
- Allows dynamically switching between different configurations.
- Communicates with a safety PLC through the Fieldbus connection

3.2.2 Structure



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

Part	Description

M	CPU LEDs:
	• on the right: status of hardware functionalities of the primary micro-controller
	  • off: normal behavior
	  • steady red: contact assistance service
	• on the left: status of hardware functionalities of the secondary micro-controller
	  • slow flashing orange: normal behavior
	  • other status: contact assistance service

N	Ethernet Fieldbus port n. 1 with LEDs
O	Ethernet Fieldbus port n. 2 with LEDs

3.2.3 System status LEDs

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

Status	Meaning
Steady green	Normal sensor function and no motion detected
Orange	Normal sensor function and some motion detected
Flashing red	Sensor in error. See "Controller LED" on page 59
Steady red	System error. See "Controller LED" on page 59
Flashing green	Sensor in boot status. See "Controller LED" on page 59

3.2.4 Fieldbus status LEDs (Ethernet)

The meaning of the LEDs depends on the protocol in use. For details, refer to the proper safety Fieldbus manual.

The meaning of the LEDs for the PROFInet and PROFIsafe protocols are reported below:

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

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

3.2.5 Inputs

The system has two type3 digital inputs (according to IEC/EN 61131-2). Each digital input is dual channel, and the ground reference is common for all the inputs (for details, see "Technical references" on page 70).

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

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

The function of each digital input must be programmed through the Inxpect BUS Safety application. The available functions are the following:

- **Stop signal**: optional safety function, manages a specific signal to force all the safety outputs (detection signals, if present) to OFF-state.
- **Restart signal**: optional safety function, manages a specific signal which enables the controller to switch the safety outputs related to all the detection fields that are free of motions to ON-state.
- **Muting group "N"**: optional safety functions, manages a specific signal which allows the controller to ignore the information coming from a selected group of sensors.
- **Activate dynamic configuration**: allows the controller to select a specific dynamic configuration.
- **Fieldbus controlled**: monitors the input status through Fieldbus communication. For example, a generic ESPE can be connected to the input, respecting electrical specifications.

For details about digital input signals, see "Digital input signals" on page 82.

3.2.6 Input variable behavior

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

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

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

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

3.2.7 SNS input

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

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

3.2.8 Outputs

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

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

The function of each digital output must be programmed through the Inxpect BUS Safety application.

***NOTICE**: Each programmed OSSD output must be connected to something. If not, the system generates an OSSD error.*
The available functions are the following:

- **System diagnostic signal**: switches the selected output to OFF-state when a system fault is detected and switches all the OSSD related to detection signals, if any, to OFF-state.
- **Muting enable feedback signal**: switches the selected output to ON-state in the following cases:
  - when a muting signal is received over the configured input and at least one group is in muting
  - when a muting command is received through Fieldbus communication and at least one sensor is in muting
- **Detection signal 1**: (e.g. alarm signal) switches the selected output to OFF-state when a sensor detects a motion in detection field 1, or when a stop signal is received from the related input. The selected output remains in OFF-state for at least 100 ms.
  ***Note**: when an OSSD is configured as detection signal 1, a second OSSD is automatically assigned to it to provide a safe signal.*
- **Detection signal 2**: switches the selected output to OFF-state when a sensor detects a motion in detection field 2, or when a stop signal is received from the related input. The selected output remains in OFF-state for at least 100 ms.
  ***Note**: when an OSSD is configured as detection signal 2, a second OSSD is automatically assigned to it to provide a safe signal.*
- **Detection signal 3**: switches the selected output to OFF-state when a sensor detects a motion in detection field 3, or when a stop signal is received from the related input. The selected output remains in OFF-state for at least 100 ms.
  ***Note**: when an OSSD is configured as detection signal 3, a second OSSD is automatically assigned to it to provide a safe signal.*
- **Detection signal 4**: switches the selected output to OFF-state when a sensor detects a motion in detection field 4, or when a stop signal is received from the related input. The selected output remains in OFF-state for at least 100 ms.
  ***Note**: when an OSSD is configured as detection signal 4, a second OSSD is automatically assigned to it to provide a safe signal.*
- **Fieldbus controlled**: allows setting the specific output through the Fieldbus communication.
- **Restart Feedback signal**: switches the selected output to ON-state when it is possible to restart at least one detection field (Restart signal). In case of:
  - automatic restart prevention, the dedicated output is always in OFF-state;
  - manual restart prevention, the dedicated output remains in OFF-state as long as a motion is detected in all the detection fields with detection signal in OFF-state; then it is activated (ON-state) and the ON-state lasts as long as at least one detection field with detection signal in OFF-state is free of motions and until the restart signal is activated on the dedicated input;
  - safe manual restart prevention, the dedicated output remains in OFF-state as long as a motion is detected in all the detection fields with detection signal in OFF-state; then it is activated (ON-state) if at least one detection field with detection signal in OFF-state is free of motions. The ON-state lasts as long as one or more detection field with detection signal in OFF-state remains free of motions and until the restart signal is activated on the dedicated input.

Each output status can be retrieved by Fieldbus communication.

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

- two dual channel safety outputs (e.g. detection signal 1 and detection signal 2, usually alarm and warning signals), or
- one dual channel safety output (e.g. detection signal 1) and two single channel output (e.g. system diagnostic and muting enable feedback), or
- each output as a single output (e.g. system diagnostic, muting enable feedback and two Fieldbus controlled outputs).

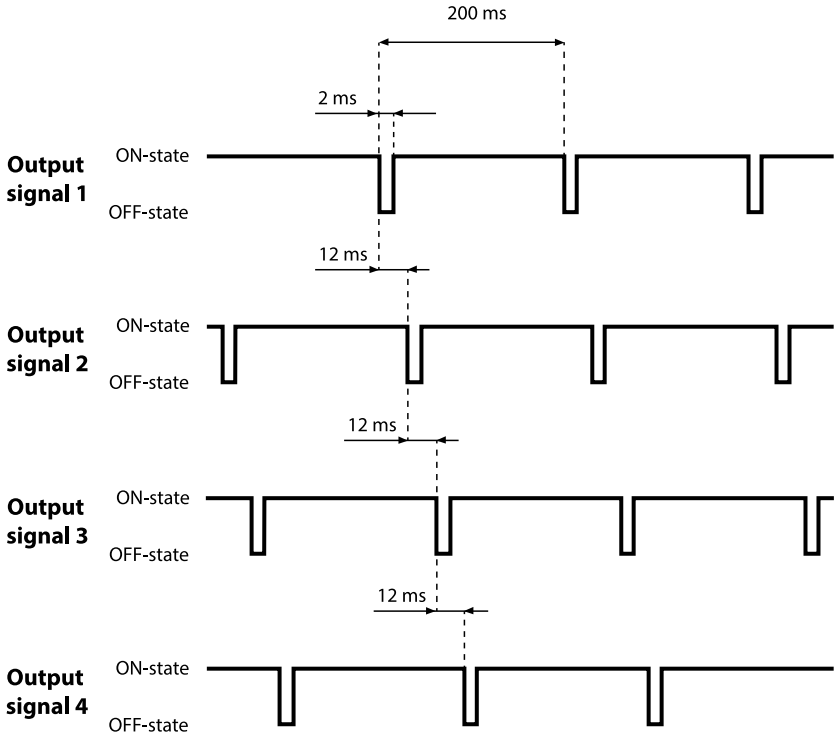
The dual channel safety output is automatically obtained by the Inxpect BUS Safety application and it matches the single OSSD outputs only as follows:

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

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

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

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



For details, see "Technical references" on page 70.

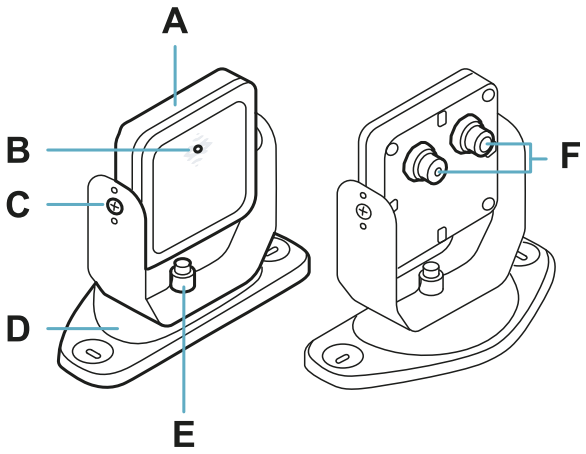
3.3 SBV-01 sensors

3.3.1 Functions

The sensors perform the following functions:

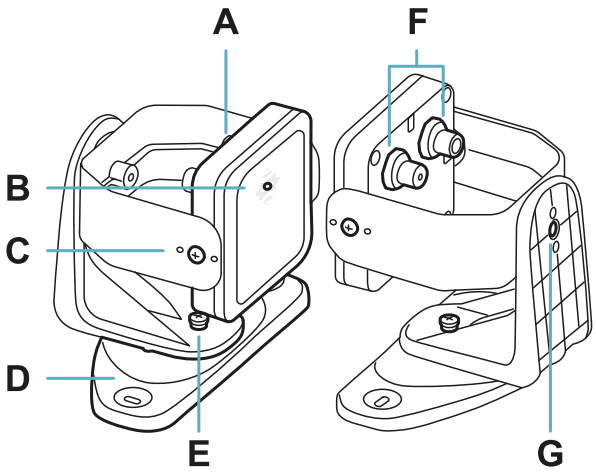
- Detect motion in their field of view.
- Send the motion detection signal to the controller through CAN bus.
- Signal to the controller through CAN bus the failures or faults detected on the sensor during diagnostics.

3.3.2 2-axes structure



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

3.3.3 3-axes structure



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

3.3.4 Status LED

Status	Meaning
Steady blue	Sensor is working. No motion detected.
Flashing blue	Sensor is detecting motion. Not available if the sensor is in muting.
Purple	Firmware update conditions. See "Sensor LED" on page 58
Red	Error conditions. See "Sensor LED" on page 58

3.4 Inxpect BUS Safety application

3.4.1 Functions

The application permits the following main functions to be performed:

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

WARNING! The Inxpect BUS Safety application must be used only for the system configuration and for the first validation. It cannot be used for monitoring the system continuously during the regular operation of the machinery.

3.4.2 Access

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

To use the application, the computer must be connected to ISC-B01 controller using a data micro-USB cable or an Ethernet cable.

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

Available functions	Access type
• Display the system status (**Dashboard**) • Display the sensors configuration (**Configuration**) • Restore factory default settings, if not using Ethernet connection (**Settings** > **General**) • Back up the configuration (**Settings** > **General**)	without password
• Synchronize more ISC-B01 controllers (**Settings** > **Multi-controller synchronization**) • Validate the system (**Validation**) • Restore factory default settings, if using Ethernet connection (**Settings** > **General**) • Download the system log and display reports (**Settings** > **Activity History**) • Configure the system (**Configuration**) • Load a configuration (**Settings** > **General**) • Change the admin password (**Settings** > **Account**) • Update the firmware (**Settings** > **General**) • Show and change the network parameters (**Settings** > **Network Parameters**) • Show and change the Fieldbus parameters (**Settings** > **Fieldbus Parameters**)	with password

3.4.3 Main menu

Page	Function
Dashboard	Display main information on the configured system.
Configuration	Define the monitored area. Configure the sensors and the detection fields. Define the dynamic configurations
Validation	Start the validation procedure.

Page	Function
Settings	Configure the sensors. Choose the detection fields dependency. Enable the anti-tampering functions. Synchronize more ISC-B01 controllers. Configure the inputs and outputs function. Configure network parameters. Configure Fieldbus parameters. Show and change the network parameters. Show and change the Fieldbus parameters. Update the firmware. Perform the configuration backup and load a configuration. Download the log. Other general functions.
REFRESH CONFIGURATION	Refresh configuration or ignore unsaved changes.
User	Enable access to the configuration functions. Admin password required.
Disconnect	Close the connection with the device and allow to connect to another device.
	Change the language.

3.5 Fieldbus communication

3.5.1 Communication with the machinery

The Fieldbus makes the following actions possible:

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

3.5.2 Data exchanged through Fieldbus

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

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

Data type	Description	Communication direction
Safe	SYSTEM STATUS DATA ISC-B01 controller: • internal status • real time status of each of the four outputs • real time status of each of the two inputs SBV-01 sensor: • status of each detection field (target detected or not) or error status • muting status	from the controller
Safe	SYSTEM SETTING COMMAND ISC-B01 controller: • set the ID of the dynamic configuration that shall be activated • set the status of each of the four outputs • fix the current accelerometer information SBV-01 sensor: • set the muting status	to the controller
Safe	DYNAMIC CONFIGURATION STATUS • ID of the dynamic configuration currently active • signature (CRC32) of the dynamic configuration ID currently active	from the controller
Safe	TARGET DATA • Current distance and angle of the targets detected by each sensor. For each detection field of each sensor, only the closest target to the sensor is considered.	from the controller
Unsafe	SYSTEM EXTENDED STATUS ISC-B01 controller: • internal status with an extended description of the error condition SBV-01 sensor: • internal status with an extended description of the error condition	from the controller
Unsafe	TARGET DATA • Current distance and angle of the targets detected by each sensor. For each detection field of each sensor, only the closest target to the sensor is considered.	from the controller

3.6 System configuration

3.6.1 System configuration

The controller parameters have their own default values that can be modified via the Inxpect BUS Safety application (see "Parameters" on page 80).

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

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

3.6.2 Dynamic system configuration

SBV System BUS allows a real-time adjustment of the most important system parameters, providing the means to switch dynamically among different preset configurations. Via the Inxpect BUS Safety application, once the first system configuration (default configuration) has been set, it is possible to set up to 31 alternative presets to allow a dynamic real-time reconfiguration of the monitored area.

These are the programmable parameters for each sensor:

- detection field (from 1 to 4)

These are the programmable parameters for each detection field:

- angular coverage (from 10° to 100° on the horizontal plane)
- safety working mode (**Both (default)**, **Always access detection** or **Always restart prevention**) (see "Safety working modes and safety functions" on page 27)
- restart timeout

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

3.6.3 Dynamic system configuration activation

The dynamic system configuration can be activated through the digital inputs or the safety Fieldbus . Depending on this choice, it will be possible to switch dynamically among two, four or 32 alternative preset configurations.

3.6.4 Inxpect BUS Safety application usage

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

The Ethernet communication between the ISC-B01 and the Inxpect BUS Safety application is secured by the most advanced security protocols (TLS).

3.6.5 Dynamic configuration through the digital inputs

To activate the dynamic system configuration, one or both the digital inputs of the ISC-B01 controller can be used. The result is the following:

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

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

Example 1

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

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

0 = signal deactivated; 1 = signal activated

Example 2

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

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

0 = signal deactivated; 1 = signal activated

Example 3

Both digital inputs have been linked to the dynamic configuration.

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

0 = signal deactivated; 1 = signal activated

3.6.6 Dynamic configuration through the safety Fieldbus

To activate the dynamic system configuration, connect an external safety PLC that communicates through the safety Fieldbus to the ISC-B01 controller. This makes it possible to dynamically switch between all the preset configurations, therefore up to 32 different configurations. For all the parameters used for each configuration, see "Dynamic system configuration" on the previous page.

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

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

3.6.7 Safe configuration change

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

4. Functioning principles

Contents

This section includes the following topics:

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4.6 Safety working mode: Always restart prevention 29
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4.10 Anti-tampering functions: anti-masking 34

4.1 Sensor functioning principles

4.1.1 Introduction

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

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

Each sensor has its own fieldset. The fieldset corresponds to the structure of the field of view, which is composed of detection fields, see "Detection fields" on the next page.

4.1.2 Factors that influence the reflected signal

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

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

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

4.1.3 Detected and missed objects

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

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

4.2 Detection fields

4.2.1 Introduction

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

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

4.2.2 Detection field parameters

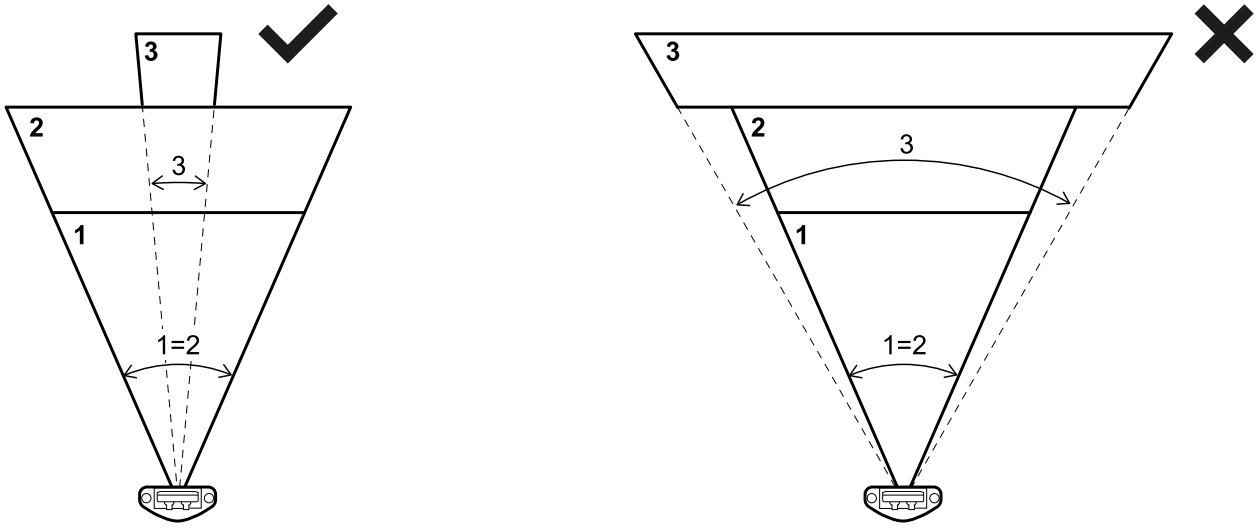
These are the programmable parameters for each detection field:

- angular coverage
- detection distance
- safety working mode (**Both (default)**, **Always access detection** or **Always restart prevention**) (see "Safety working modes and safety functions" on page 27)
- restart timeout

4.2.3 Angular coverage

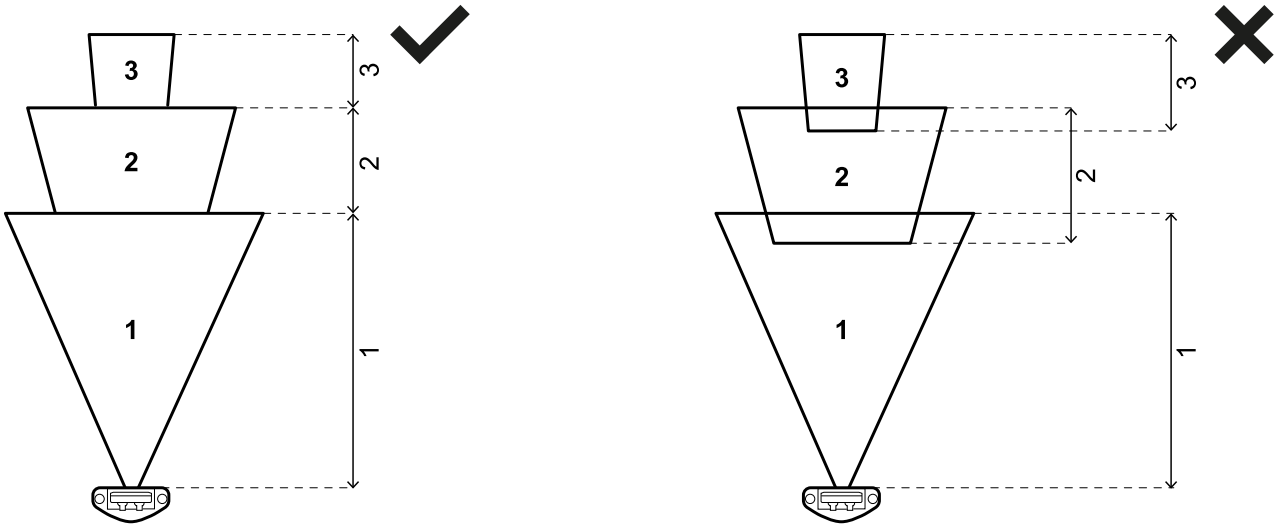
The angular coverage has a fixed value in a range from 10° to 100°.

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

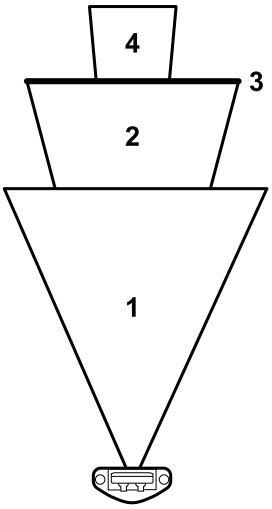


4.2.4 Detection distance

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



The detection distance of one or more fields can be 0 (e.g. detection field 3).



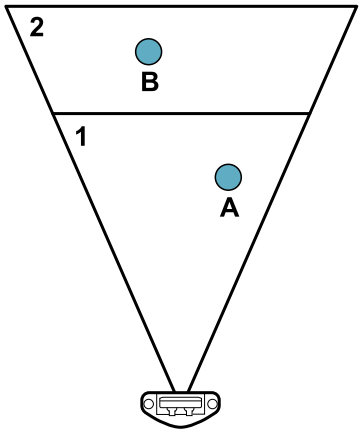
4.2.5 Detection fields dependency and detection signal generation

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

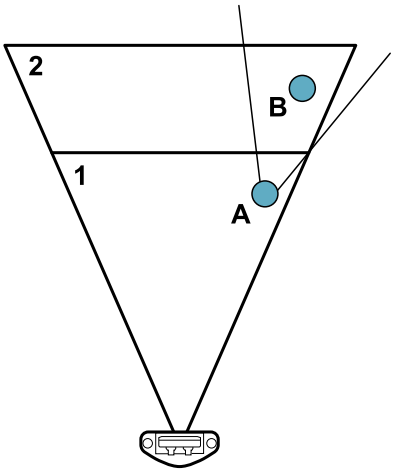
If...	Then...
the **Dependent mode** is set and thus detection fields are dependent on each other	if a sensor detects motion within a detection field, all the outputs related to the following detection fields are deactivated too. Example Detection field configured: 1, 2, 3 Detection field with target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

WARNING! If detection fields are independent, an evaluation of the safety of the monitored area must be performed during the risk assessment. The blind area generated by a target can prevent the sensor from detecting targets in the following detection fields.

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



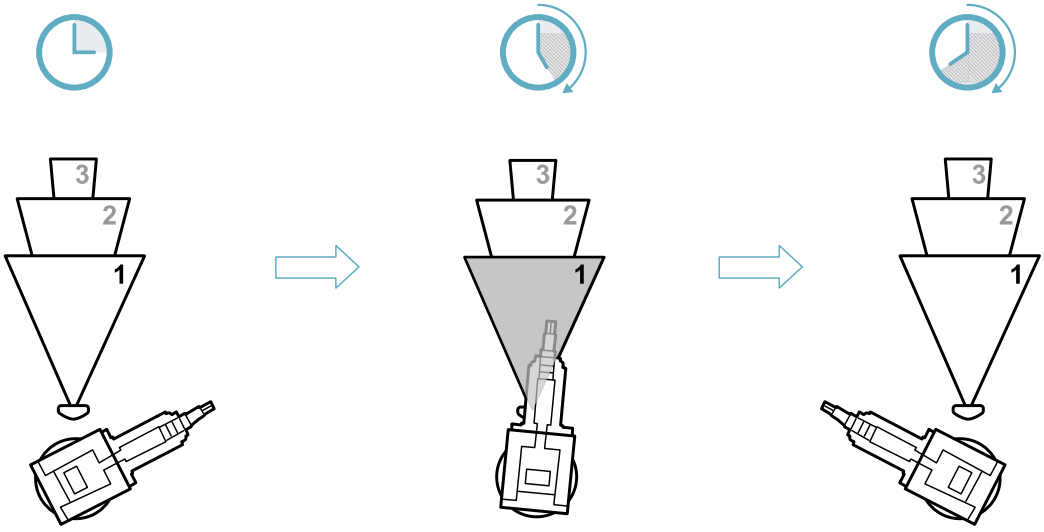
In this example, detection field 1 generates a detection signal for target **[A]** but target **[B]** could not be detected.



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

4.2.6 Independent detection fields: a use case

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



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

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

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

4.3 Safety working modes and safety functions

4.3.1 Introduction

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

- **Both (default)**
- **Always access detection**

- **Always restart prevention**

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

Function	Description
Access detection	The machinery is reverted into a safe status when a person enters the dangerous area.
Restart prevention	The machinery is prevented from restarting if people are in the dangerous area.

4.3.2 Safety working modes

Via the Inxpect BUS Safety application, you can select which safety working mode each sensor will perform for each of its detection fields:

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

4.4 Safety working mode: Both (default)

4.4.1 Introduction

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

- access detection
- restart prevention

4.4.2 Safety function: access detection

Access detection allows what follows:

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

4.4.3 Safety function: restart prevention

The restart prevention function remains active and the safety outputs deactivated as long as motion is detected in the detection field.

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

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

WARNING! When the restart prevention function is active the monitored area may be affected by the position and inclination of the sensors, as well as by their installation height and angular coverage (see "Sensor position" on page 37).

4.4.4 Restart timeout parameter

When the system does not detect motion anymore, the OSSD outputs remain in OFF-state for the time set in the **Restart timeout** parameter.

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

The parameter is valid only for the restart prevention function.

4.5 Safety working mode: Always access detection

4.5.1 Safety function: access detection

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

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

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

4.5.2 T_{OFF} parameter

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

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

4.6 Safety working mode: Always restart prevention

4.6.1 Safety function: restart prevention

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

The restart prevention allows what follows:

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

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

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

WARNING! When the restart prevention function is active the monitored area may be affected by the position and inclination of the sensors, as well as by their installation height and angular coverage (see "Sensor position" on page 37).

4.6.2 Restart timeout parameter

When the system does not detect motion anymore, the OSSD outputs remain in OFF-state for the time set in the **Restart timeout** parameter.

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

4.7 Features of the restart prevention function

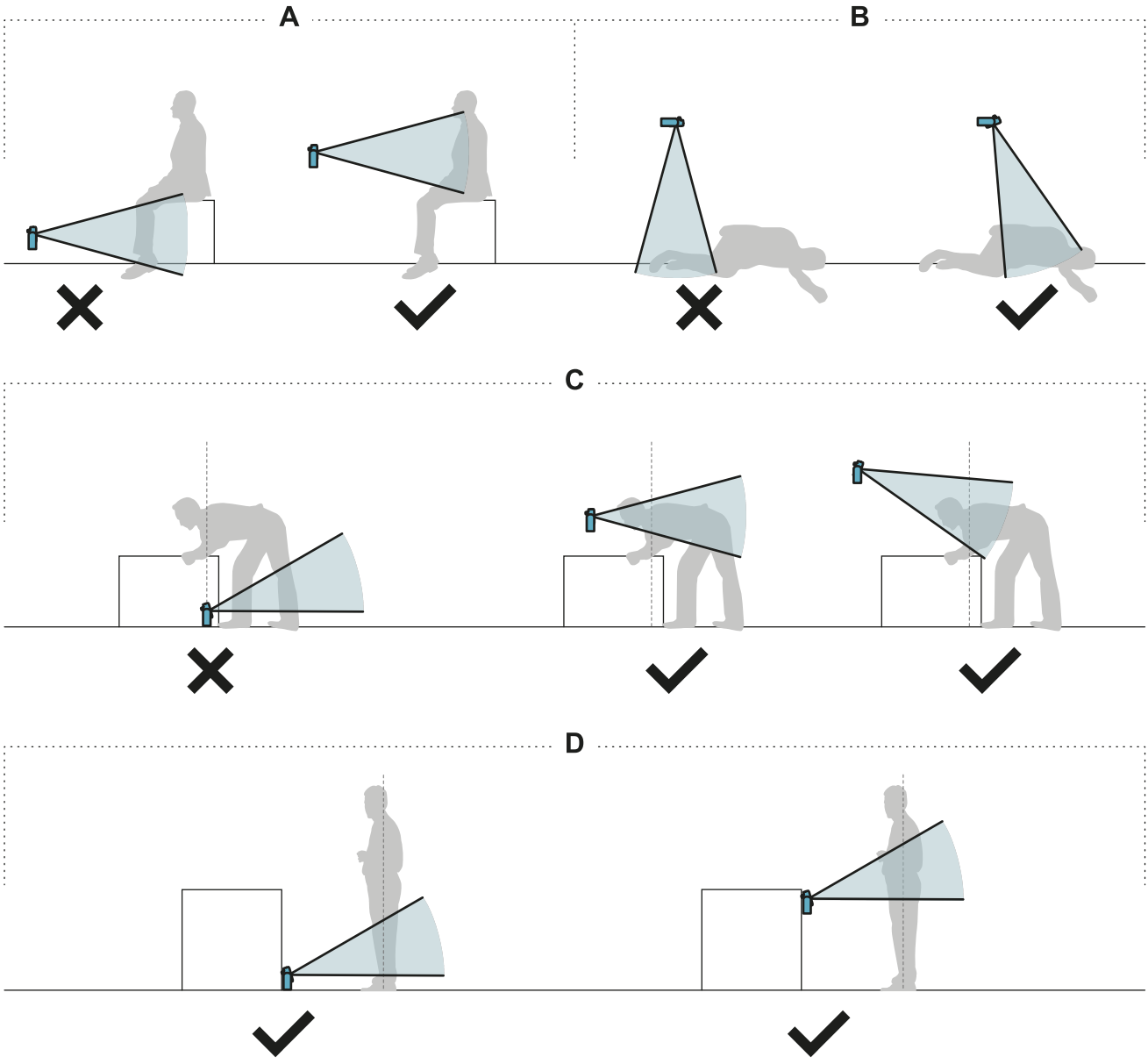
4.7.1 Cases of non-guaranteed function

The function is not guaranteed in the following cases:

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

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

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



4.7.2 Types of managed restart

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

The system manages three types of restart prevention:

Type	Conditions for enabling machinery restart
Automatic	The time interval set through the Inxpect BUS Safety application (**Restart timeout**) has passed since the last motion detection*.
Manual	The **Restart signal** was received correctly** (see "Restart signal" on page 84).
Safe manual	1. The time interval set through the Inxpect BUS Safety application (**Restart timeout**) has passed since the last motion detection* and 2. the status of the restart signal indicates that the restart is now possible (see "Restart signal" on page 84).

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

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

4.7.3 Precautions for preventing unexpected restarting

To prevent unexpected restarting the following rules must be followed:

- the set restart timeout must be greater than or equal to 4 s.
- if the sensor is installed at a height of less than 30 cm from the ground, a minimum distance of 50 cm from the sensor must be guaranteed.
  ***Note**: if the sensor is installed at a height of less than 30 cm from the ground, an option is to enable the masking function to generate a system error if a person stands in front of the sensor.*

4.7.4 Enable the restart prevention function

Type	Procedure
Automatic	In the Inxpect BUS Safety application **Configuration** > **Settings** > **Sensors**, set the **Restart timeout**.
Manual	1. Connect the machinery button for the restart signal conveniently, see "Electrical connections" on page 75. 2. In the Inxpect BUS Safety application **Configuration** > **Settings** > **Sensors**, set **Restart timeout** = 0.
Safe manual	1. Connect the machinery button for the restart button conveniently, see "Electrical connections" on page 75. 2. In the Inxpect BUS Safety application **Configuration** > **Settings** > **Sensors**, set the **Restart timeout**.

4.8 Muting

4.8.1 Description

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

4.8.2 Muting enabling

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

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

Through the Inxpect BUS Safety application, the following must be defined:

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

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

See "Configure the inputs and outputs" on page 46.

Through the safety Fieldbus the muting function can be enabled for each sensor singularly.

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

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

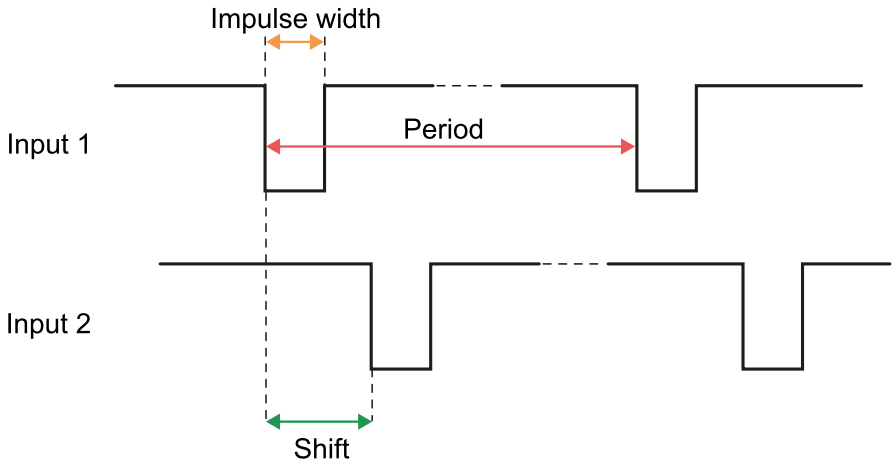
4.8.3 Muting activation

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

4.8.4 Enable muting signal characteristics

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

Below is a graphic representation of the signal characteristics.



In the **Inxpect BUS Safety** application, in **Configuration** > **Settings** > **Digital Input-Output** it is necessary to set the parameters that define the characteristics of the signal.

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

4.8.5 Muting status

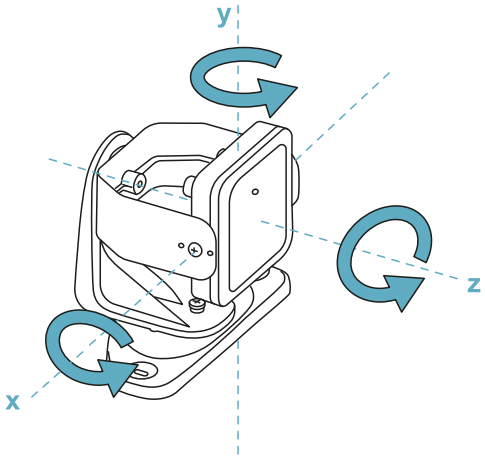
Any output dedicated to the muting status (Muting enable feedback signal) is activated if at least one of the groups of sensors is in muting.

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

4.9 Anti-tampering functions: anti-rotation around axes

4.9.1 Anti-rotation around axes

The sensor detects rotation around its axes.



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

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

4.9.2 Disable the anti-rotation around axes function

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

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

The function can be disabled for each axis individually. In the Inxpect BUS Safety application, in **Configuration** > **Settings** click **Sensors** to disable the anti-rotation around axes function.

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

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

Safety function	Schedule	Action
Access detection function	Before each machinery restart	Check that the sensor position is that defined by the configuration. Check that the monitored area is the same as defined by the configuration. See "Validate the safety functions" on page 53.
Restart prevention function	Each time the safety outputs are deactivated	

4.9.4 When to disable

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

4.10 Anti-tampering functions: anti-masking

4.10.1 Masking signal

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

4.10.2 Environment memorization process

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

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

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

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

4.10.3 Causes of masking

Possible causes of masking signals are presented as follows:

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

4.10.4 Masking signal when the system is turned on

If the system was off for several hours and there were temperature fluctuations, the sensor might send a false masking signal when it is turned on. The safety outputs activate automatically within 3 minutes when the sensor reaches its working temperature.

4.10.5 Settings

The anti-masking settings are the following:

- distance from the sensor (max. 1 m) in which the function is active.
- sensitivity

These are the four levels of sensitivity:

Level	Description	Example application
High	The system has the highest sensitivity to changes in the environment.	Installations with a static environment and a height of less than one meter, where objects could occlude the sensor.
Medium	The system has low sensitivity to changes in the environment. Occlusion must be evident (deliberate tampering).	Installations with a height of more than one meter, where masking is likely to occur only if voluntary.

Level	Description	Example application
Low	The system detects masking only if the sensor occlusion is complete and the objects are highly reflective (e.g. metal, water) near the sensor.	Installations on moving parts, where the environment is changing continuously, but where static objects may be near the sensor (obstacles on the route).
Disabled	The system does not detect changes in the environment. **WARNING! If the function is disabled the system cannot signal the presence of objects that might impede normal detection. See "Checks when the anti-masking function is disabled" below.**	See "When to disable" below.

To set the distance, in the Inxpect BUS Safety application, click **Settings** and then **Sensors**.

To change the sensitivity level or disable the function, in the Inxpect BUS Safety application click **Settings** and then **Sensors**.

4.10.6 Checks when the anti-masking function is disabled

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

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

4.10.7 When to disable

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

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

5. Sensor position

Contents

This section includes the following topics:

5.1 Basic concepts 37
5.2 Sensor field of view 38
5.3 Dangerous area calculation 40
5.4 Calculation of range of distances 41
5.5 Sensor position recommendations 42
5.6 Installations on moving elements 42
5.7 Outdoor installations 44

5.1 Basic concepts

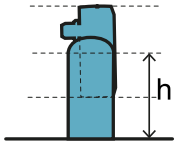
5.1.1 Determining factors

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

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

5.1.2 Sensor installation height

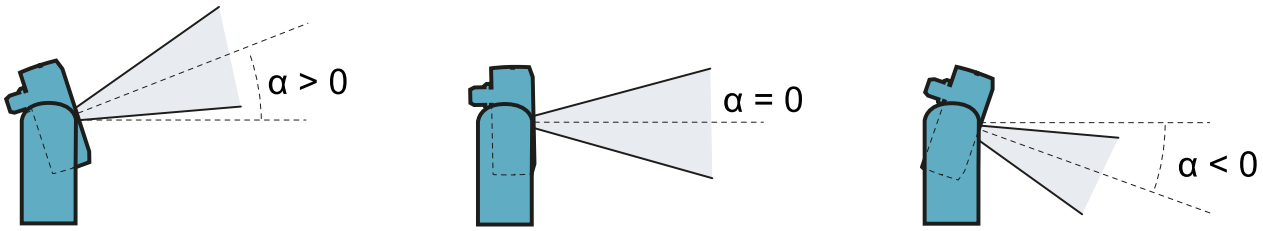
The installation height (h) is the distance between the center of the sensor and the ground or reference plane of the sensor.



5.1.3 Sensor inclination

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

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



5.2 Sensor field of view

5.2.1 Types of field of view

During the configuration phase, for each sensor it is possible to select the angular coverage of each field in a range from 10° to 100°. See "Angular coverage" on page 24.

The actual detection field of the sensor also depends on the sensor installation height and inclination. See "Calculation of range of distances" on page 41.

5.2.2 Areas and dimensions of the field of view

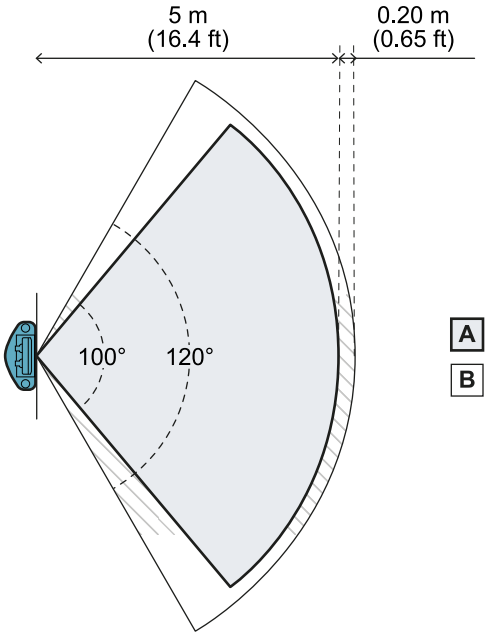
The sensor field of view is composed of two areas:

- detection field **[A]**: where detection of objects similar to humans in any position is guaranteed.
- tolerance area **[B]**: where the actual detection of a moving object/person depends on the characteristics of the object itself (see "Factors that influence the reflected signal" on page 23).

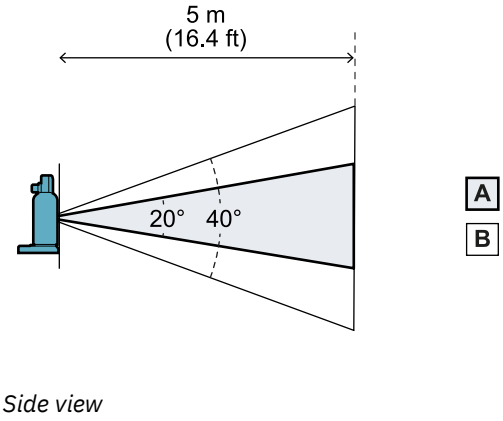
Dimensions for the access detection function

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

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



Top view

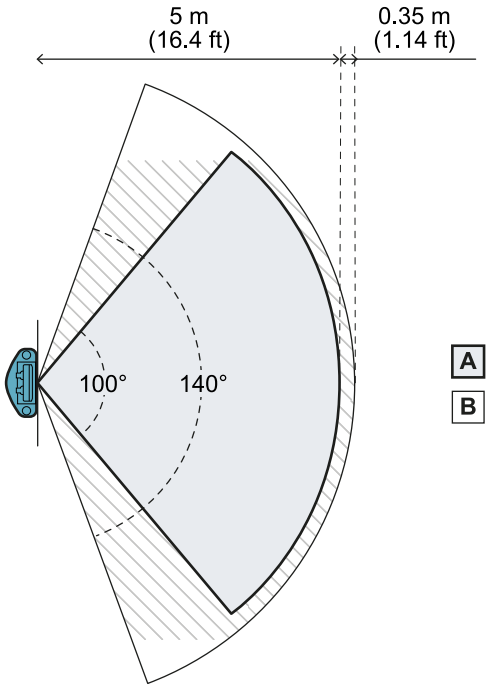


Side view

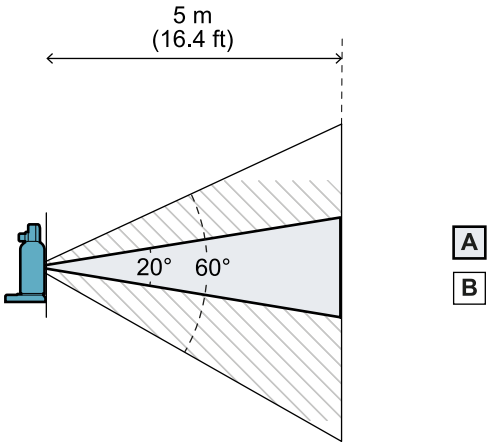
Dimensions for the restart prevention function

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

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



Top view

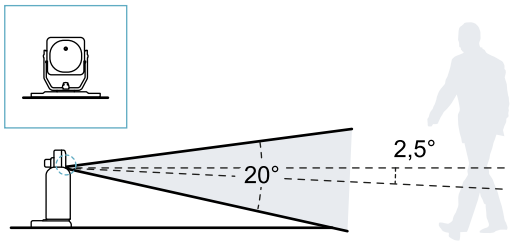


Side view

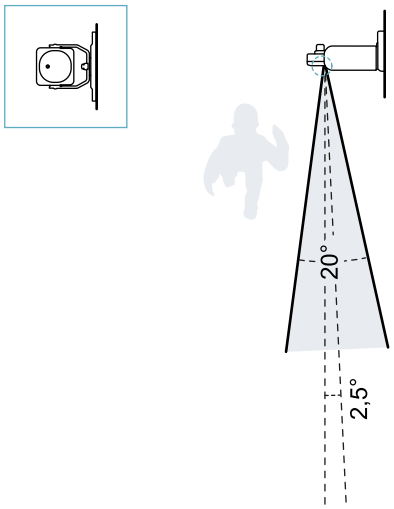
5.2.3 Position of the field of view

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

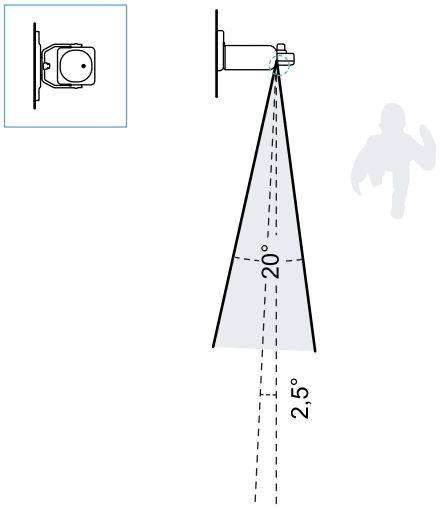
- downward with sensor LED up
- right with sensor LED on the left (with respect to the sensor center, facing the sensor)
- left with sensor LED on the right (with respect to the sensor center, facing the sensor)



Side view with sensor inclination 0°.



Top view with sensor inclination 0°.



Top view with sensor inclination 0°.

5.3 Dangerous area calculation

5.3.1 Introduction

The dangerous area of the machinery to which SBV System BUS is applied must be calculated as indicated in standards ISO 13855:2010. For SBV System BUS the fundamental factors for calculation are height (h) and inclination (α) of the sensor, see "Sensor position" on page 37.

5.3.2 Formula

To calculate the depth of the dangerous area (S), 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 (SBV System BUS + machinery)	0.1 + Machinery stopping time (calculated in accordance with ISO 13855:2010 standard)	s
C_h	Constant that takes into account the sensor installation height (h) according to standard ISO 13855:2010	850	mm

Example 1

- Machinery stopping time = 0.5 s

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

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

5.4 Calculation of range of distances

5.4.1 Introduction

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

The formulas for calculating the distances are reported as follows.

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

5.4.2 Legend

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

5.4.3 Installation configurations

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

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

5.4.4 Calculate the range of distances

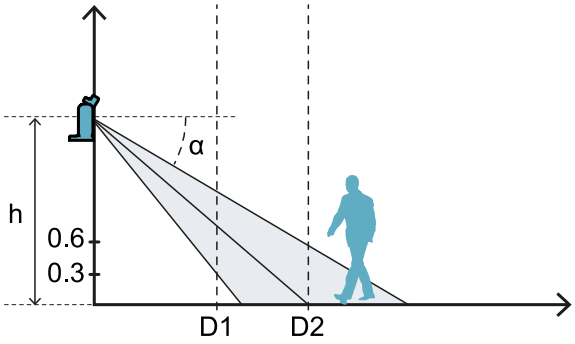
The range of detection distances for a sensor depends on the configuration:

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

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

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

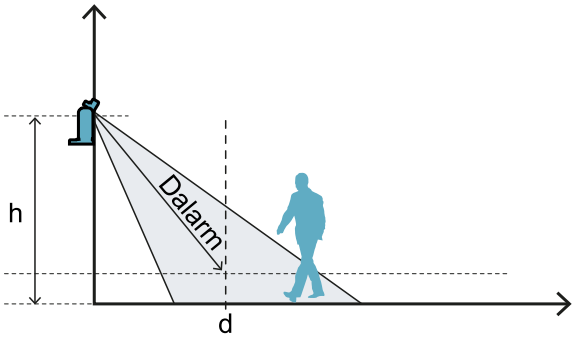
Below is an example for configuration 3, with D_1 = 0.9 m and D_2 = 1.6 m.



5.4.5 Calculate the real detection distance

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

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



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

5.5 Sensor position recommendations

5.5.1 For access detection function

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

- if the distance between the ground and the bottom portion of the field of view is greater than 30 cm, take precautions to prevent that a person that enters in the dangerous area crawling on the floor is not detected.
- if the height above the ground is less than 30 cm, install the sensor with an inclination of minimum 10° upwards.

5.5.2 For access control of an entrance

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

- height above the ground: maximum 30 cm
- angular coverage: 90°
- inclination: 40° upwards

5.6 Installations on moving elements

5.6.1 Introduction

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

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

5.6.2 Speed limits

The detection is guaranteed only if the speed of the vehicle or of the part of machinery is from 0.1 m/s to 1.6 m/s .

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

5.6.3 Detection signal generation conditions

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

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

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

5.6.4 Prevention of unexpected restart

As for static installations, when the moving part where the sensor is installed is arrested because of a detection, the system will switch to restart prevention safety function and the sensor will detect the presence of static people (for details, see "Cases of non-guaranteed function" on page 30). Static objects are then automatically filtered out and no longer detected.

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

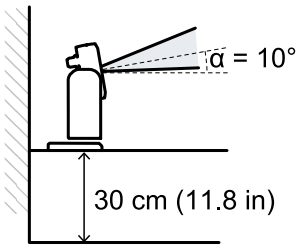
- Anti-masking function: if the function is enabled, an error will occur when the static object will be close enough to limit the detection of the sensor.
  ***Note**: if the anti-masking function is active also when the sensor is moving, this could generate false alarms since the environment change during movement could be detected as a tampering.*
- Manual restart: the restart is triggered externally and only once the static object is removed from the trajectory of the moving vehicle or moving part.
- Application logic on PLC/Controller that permanently stops the moving part if multiple stops occur immediately after the restart of the part. If the vehicle or the part stops very quickly after the restart, this probably means that there is a static obstacle. Once the moving part is stopped, the sensor does not detect the object anymore and therefore the part moves but it stops again as soon as it detects the object again.

5.6.5 Recommendations for positioning the sensor

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

Below are some recommendations for the sensor positioning:

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



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

5.7 Outdoor installations

5.7.1 Position exposed to precipitation

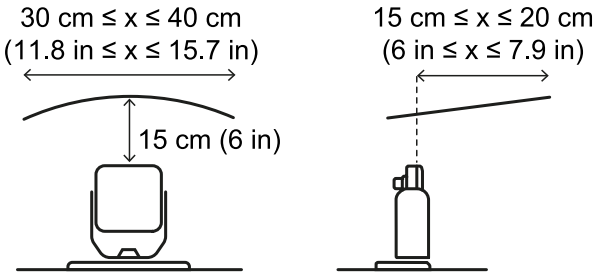
If the sensor installation position might be exposed to precipitation that can cause undesired alarms, it is recommended to take the following precautions:

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

5.7.2 Recommendations for covering the sensor

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

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

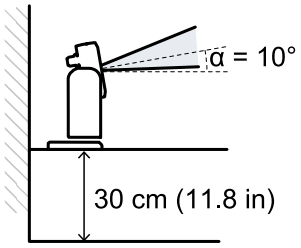


5.7.3 Recommendations for positioning the sensor

Below are some recommendations for defining the sensor position:

- height above the ground: minimum 10 cm
- suggested inclination: minimum 15°

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



5.7.4 Position not exposed to precipitation

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

6. Installation and use procedures

Contents

This section includes the following topics:

6.1 Before installation **45**
6.2 Install and configure SBV System BUS **46**
6.3 Validate the safety functions **53**
6.4 Manage the configuration **55**
6.5 Other functions **56**

6.1 Before installation

6.1.1 Materials required

- Two tamper-proof screws to fasten the sensors to the floor or machinery, see "Side screws specifications" on page 72.
- Cables to connect the controller to the first sensor and the sensors to one another, see "CAN bus cables recommended specifications" on page 72.
- A data micro-USB cable or an Ethernet cable to connect the controller to the computer.
- A bus terminator (product code: 07000003) with resistance of 120 Ω for the last sensor of the CAN bus.
- A six-pointed star head screwdriver or an accessory for tamper-proof screws with button head ("Side screws specifications" on page 72).

6.1.2 Operating system required

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

6.1.3 Install the Inxpect BUS Safety application

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

1. Download the application from the www.inxpect.com/industrial/tools website and install it on the computer.
2. Start the application.
3. Choose the connection mode (data micro-USB or Ethernet).
   ***Note**: the default IP address for the Ethernet connection is 192.168.0.20. The computer and the controller must be connected to the same network.*
4. Set a new admin password, memorize it and provide it only to people who are authorized to change the configuration.
5. Select the device (SBV System BUS).
6. Set the number of sensors connected.

6.1.4 Initiate SBV System BUS

1. Calculate the position of the sensor (see "Sensor position" on page 37) and the depth of the dangerous area (see "Dangerous area calculation" on page 40).
2. "Install the controller" on the next page.
3. Open the Inxpect BUS Safety application.
4. "Define the area to be monitored" on the next page.
5. "Configure the inputs and outputs" on the next page.
6. Optional. "Mount bracket for z-axis rotation (roll)" on page 49.
7. "Install the sensors" on page 47
8. "Connect the controller to the sensors" on page 51.
   ***Note**: connect the sensors to the controller off-site if access to the connectors becomes difficult once they are installed.*
9. "Assign the Node IDs" on page 51

10. "Save and print the configuration" on page 52.
11. "Validate the safety functions" on page 53.

6.2 Install and configure SBV System BUS

6.2.1 Install the controller

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

1. Mount the controller on the DIN rail.
2. Make electrical connections, see "Terminal blocks and connector pin-outs" on page 73 and "Electrical connections" on page 75.
   ***NOTICE**: if at least one input is connected, the SNS input "V+ (SNS)" and the GND input "V- (SNS)" must also be connected.*
   ***NOTICE**: when powered, the system takes about 20 s to start. During that period the outputs and the diagnostic functions are deactivated and the green sensor status LEDs of the connected sensors flash.*
   ***Note**: to correctly connect the digital inputs, see "Voltage and current limits for digital inputs" on page 74.*

6.2.2 Synchronize the controllers

If there are more than one ISC-B01 controller in the area, perform the following steps:

1. In the Inxpect BUS Safety application, click **Settings** > **Multi-controller synchronization**.
2. Assign a different **Controller channel** to each controller.

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

6.2.3 Define the area to be monitored

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

1. In the Inxpect BUS Safety application, click **Configuration**.
2. Add the desired number of sensors in the plane.
3. Define the position and inclination of each sensor.
4. For each detection field of each sensor define the selected safety working modes, the detection distance, the angular coverage and the restart timeout.

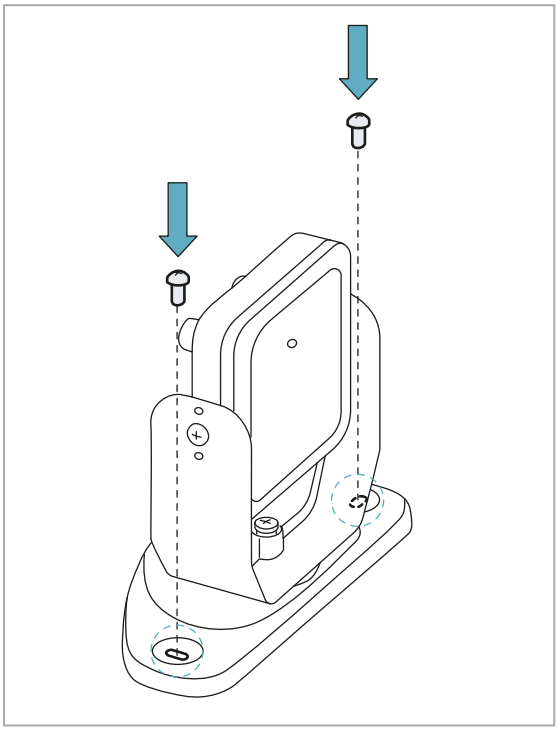
6.2.4 Configure the inputs and outputs

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

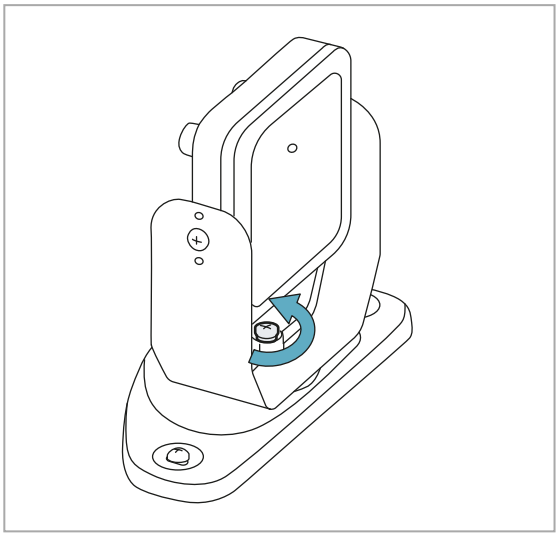
6.2.5 Install the sensors

***Note**: for an example of sensor installation, see "Examples of sensor installation" on page 50.*

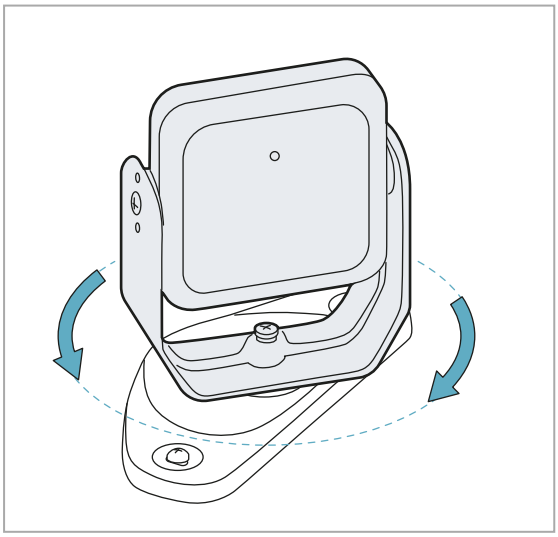
1. Position the sensor as indicated in the configuration report and fasten the bracket with two tamper-proof screws directly onto the floor or another support.
   ***NOTICE**: make sure the support does not inhibit machinery commands.*



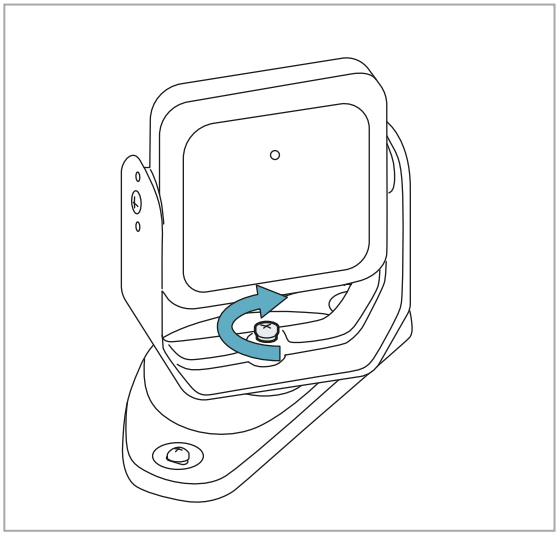
2. With an Allen key, loosen the screw at the bottom to pan the sensor.



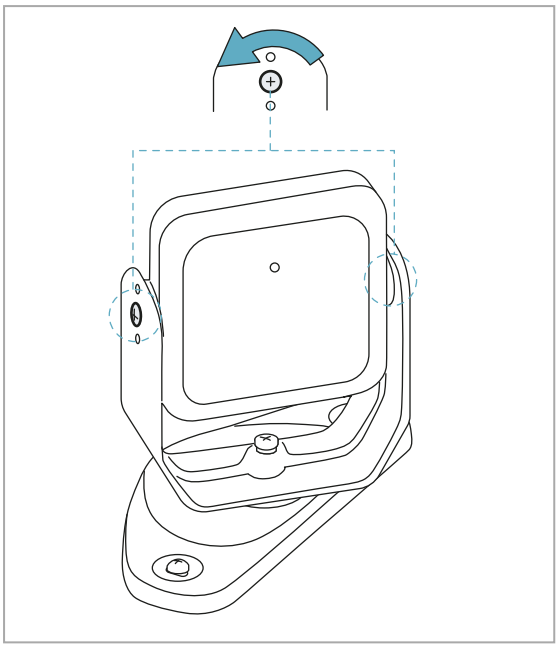
3. Pan the sensor until it reaches the desired position.
   ***Note**: a notch is equal to 10° of rotation.*



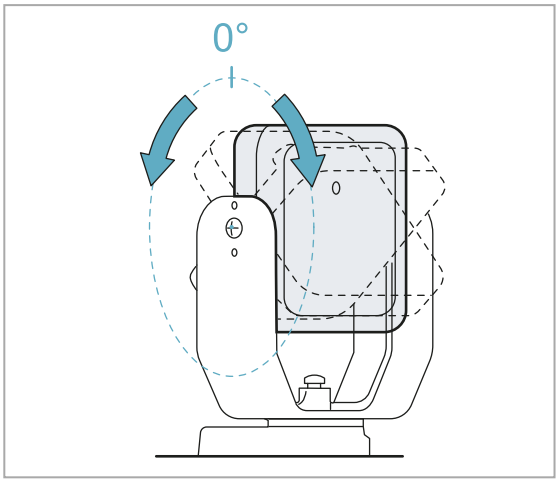
4. Tighten the screw.



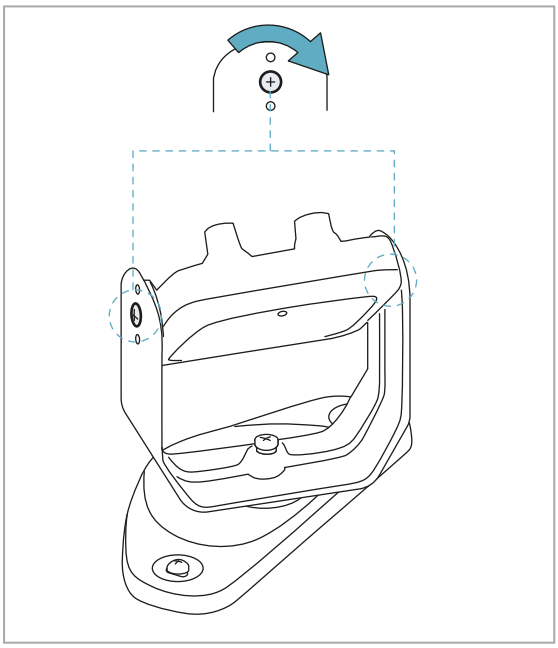
5. Loosen the side screws to tilt the sensor.



6. Direct the sensor up to the desired inclination, see "Sensor position" on page 37.
***Note**: a notch is equal to 10° of inclination.*



7. Tighten the screws.

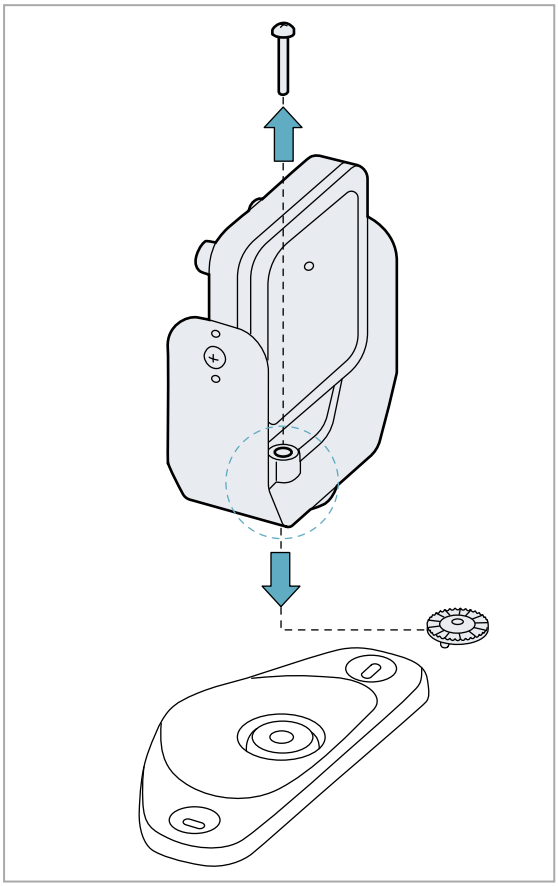


6.2.6 Mount bracket for z-axis rotation (roll)

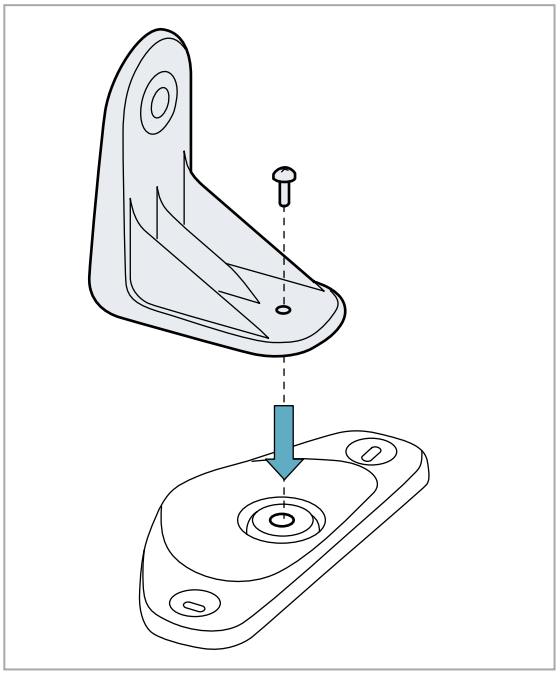
***Note**: for an example of sensor installation, see "Examples of sensor installation" on the next page.*

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

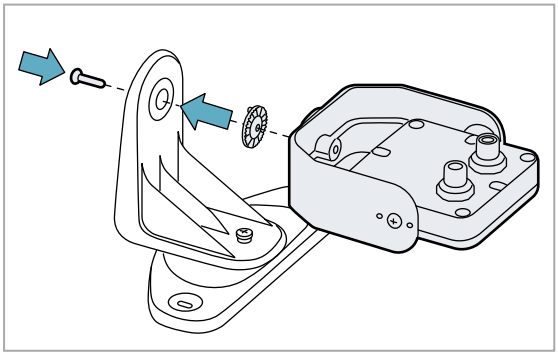
1. Unscrew the screw at the bottom and remove the bracket with the sensor and the aligning ring.



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

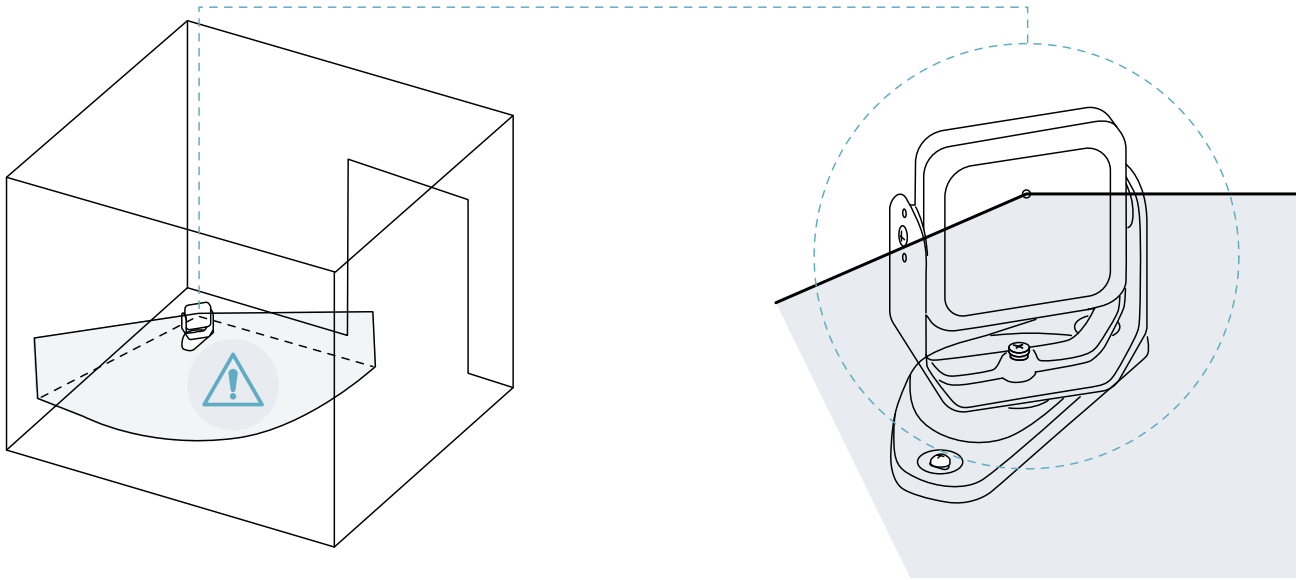


3. Mount the bracket with the sensor and the aligning ring.

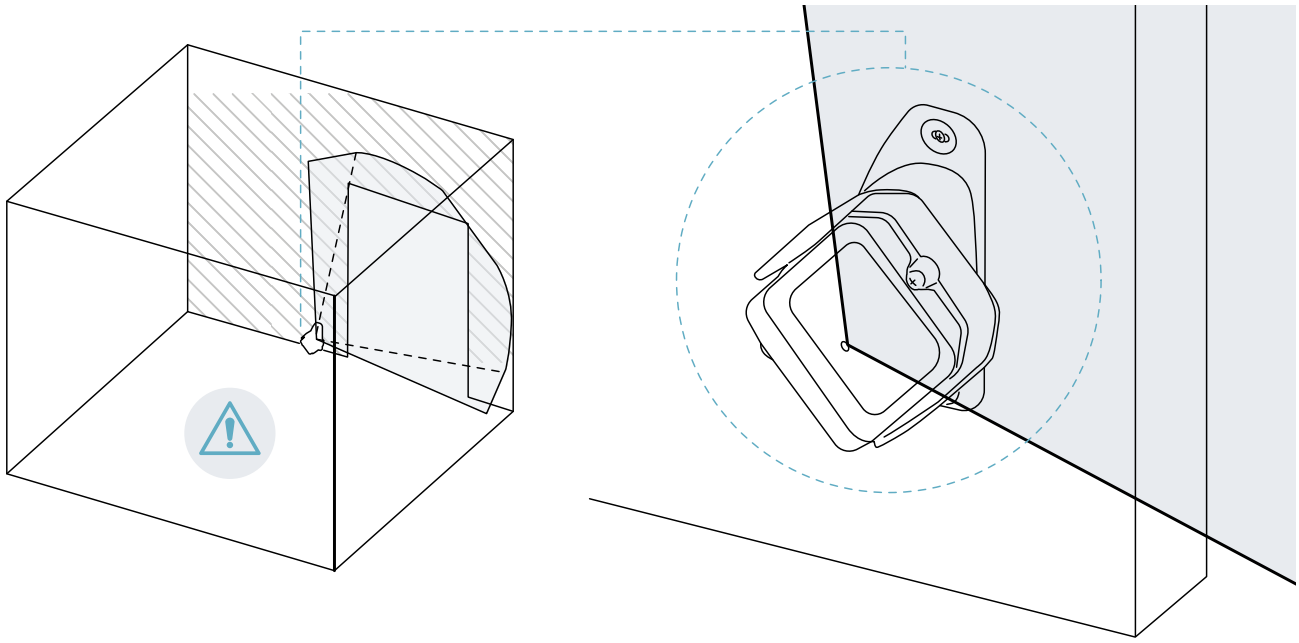


6.2.7 Examples of sensor installation

***NOTICE**: refer to the sensor LED position to identify the sensor field of view. See "Position of the field of view" on page 39.*

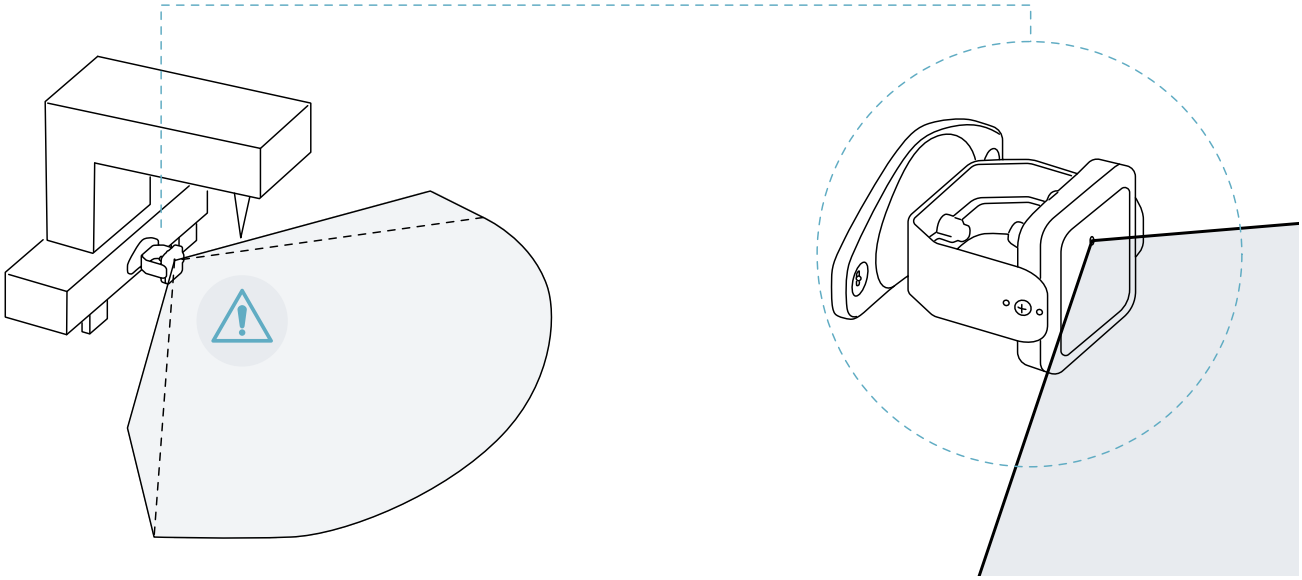


Floor installation



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

***Note**: install the sensor so that the field of view is shifted towards the outside of the hazardous area to avoid false alarms, see "Position of the field of view" on page 39.*



Installation on the machinery.

6.2.8 Connect the controller to the sensors

1. Decide if the controller will be positioned at the end of the chain or inside it (see "Chain examples" on the next page).
2. Set the DIP switch of the controller based on its position in the chain.
3. Connect the desired sensor directly to the controller.
4. Insert the bus terminator (product code: 07000003) into the free connector of the sensor.
5. To connect another sensor, connect the sensor directly to the controller or to the last sensor of the chain.
6. To insert the bus terminator, perform the following steps:

If the sensor has been connected...	Then...
to the controller	insert a new bus terminator into the free connector of the sensor just connected.
to the last sensor of the chain	move the bus terminator of the previous sensor and insert it into the free connector of the sensor just connected.

6.2.9 Assign the Node IDs

Type of assignment

Three types of assignment are possible:

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

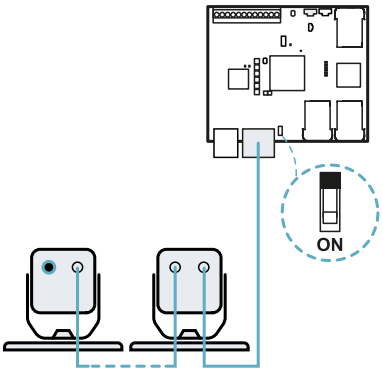
Procedure

1. Start the application.
2. Click **User** > **Configuration** and verify that the number of sensors in the configuration is the same of the sensors installed.

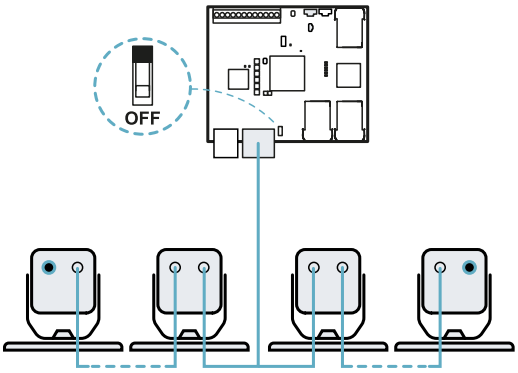
3. Click **Settings** > **Node ID Assignment**.
4. Proceed according to the type of assignment:

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

6.2.10 Chain examples



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



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

6.2.11 Save and print the configuration

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

6.2.12 Reset the controller Ethernet parameters

1. Ensure the controller is turned on.
2. Press the Network parameter reset button and hold it down during steps 3 and 4.
3. Wait for five seconds.

4. Wait until the S6 LED on the controller turns steady red: the Ethernet parameters are set to their default values (see "Ethernet connection" on page 71).
5. Configure the controller again.

6.3 Validate the safety functions

6.3.1 Validation

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

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

6.3.2 Validate the access detection function

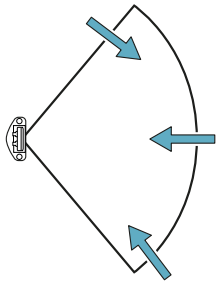
Example 1

Starting conditions	• Detection field dependency: Dependent mode • All the safety outputs activated
Validation procedure	1. Access the first detection field . 2. Check that the system deactivates the safety output related to this detection field and to the following fields. See "Validate the system with Inxpect BUS Safety" on page 55. 3. Move inside the area and check that the target position moves in the Inxpect BUS Safety app. 4. Repeat step 1 and 3 for each detection field . 5. If the safety outputs are not deactivated, see "Troubleshooting validation" on page 55.
Specifications	• Access from several points with particular attention to the side areas of the field of view and the limit areas (e.g. intersection with any side guards), see "Example of access points" on the next page. • Access standing as well as crawling. • Access moving slowly and quickly.

Example 2

Starting conditions	• Detection field dependency: Independent mode • All the safety outputs activated
Validation procedure	1. Access the first detection field . 2. Check that the system deactivates only the safety output related to this detection field. See "Validate the system with Inxpect BUS Safety" on page 55. 3. Move inside the area and check that the target position moves in the Inxpect BUS Safety app. 4. Repeat step 1 and 3 for each detection field . 5. If the safety outputs are not deactivated, see "Troubleshooting validation" on page 55.
Specifications	• Access from several points with particular attention to the side areas of the field of view and the limit areas (e.g. intersection with any side guards), see "Example of access points" on the next page. • Access standing as well as crawling. • Access moving slowly and quickly.

6.3.3 Example of access points



Access points for 100° field of view

6.3.4 Validate the restart prevention function

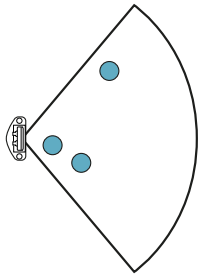
Example 1

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

Example 2

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

6.3.5 Example of stopping points



Stopping points for 100° field of view

6.3.6 Validate the system with Inxpect BUS Safety

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

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

1. Click **Validation**: the validation starts automatically.
2. Move in the monitored area as indicated in "Validate the access detection function" on page 53 and "Validate the restart prevention function" on the previous page.
3. Check that the sensor behaves as expected .
4. Check that the distance and the angle where the motion is detected are the expected values.

6.3.7 Troubleshooting validation

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

Cause	Solution
Presence of objects obstructing the field of view	If possible, remove the object. Otherwise, implement additional safety measures in the area where the object is present.
Position of sensors	Position the sensors to ensure that the monitored area is adequate for the dangerous area ("Sensor position" on page 37).
Inclination and installation height of one or more sensors	1. Change the inclination and installation height of the sensors to ensure that the monitored area is adequate for the dangerous area, see "Sensor position" on page 37. 2. Note or update the inclination and installation height of the sensors in the printed configuration report.
Inadequate restart timeout	Change the restart timeout through the Inxpect BUS Safety application (**Configuration** > select the affected sensor and detection field)

6.4 Manage the configuration

6.4.1 Configuration reports

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

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

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

6.4.2 Change the configuration

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

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

To change...	Then...
Monitored area and sensors configuration	Click **Configuration**
System sensitivity	Click **Settings** > **Sensors**
Node ID	Click **Settings** > **Node ID Assignment**
Function of inputs and outputs	Click **Settings** > **Digital Input-Output**

To change...	Then...
Muting	Click **Settings** > **Muting**
Sensor inclination	Loosen the side screws on the sensor and orient the sensors to the desired inclination.
Sensor number and positioning	Click **Configuration**

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

6.4.3 Back up the configuration

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

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

6.4.4 Load a configuration

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

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

6.4.5 Display previous configurations

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

In **Configuration** click .

6.5 Other functions

6.5.1 Change language

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

6.5.2 Application type selection

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

6.5.3 Locate the area with detected motion

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

6.5.4 Restore factory default settings

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

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

For the default values of the parameters, see "Parameters" on page 80.

6.5.5 Identify a sensor

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

6.5.6 Change network parameters

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

6.5.7 Change Fieldbus parameters

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

7. Maintenance and troubleshooting

Machinery maintenance technician

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

Contents

This section includes the following topics:

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7.4 ERROR events (controller) **65**
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7.6 ERROR events (CAN BUS) **69**
7.7 Cleaning and spare parts **69**

7.1 Troubleshooting

7.1.1 Sensor LED

Status	Problem	Remedy
Steady purple	Sensor in boot state	Perform a sensor firmware update or contact technical support.
Flashing purple	Sensor receiving a firmware update	Wait for the update to be completed without disconnecting the sensor.
Flashing red. Two flashes followed by a pause **	Sensor without a valid identifier assigned	Assign a Node ID to the sensor, see "Connect the controller to the sensors" on page 51.
Flashing red. Three flashes followed by a pause **	Sensor does not receive valid messages from the controller	Verify the connection of all sensors in the chain since the last sensor in error
Flashing red. Four flashes followed by a pause **	Sensor in temperature error or is receiving an incorrect supply voltage	Check the sensor connection and that the cable length is within the maximum limits. Verify that the temperature of the environment in which the system is operating conforms to the operating temperatures listed in the technical data in this manual.
Flashing red. Six flashes followed by a pause **	Sensor detected a variation in rotation around the axes (tampering)	Not available if the sensor is in muting. Check if the sensor has been tampered with or if the side or mounting screws have loosened.
Flashing red. Five flashes followed by a pause **	Sensor detected a masking (tampering) or there are other errors	Not available if the sensor is in muting. Check that the sensor is installed correctly and that the area is clear of objects that obstruct the sensor's field of view.

Note *: *flashes at 100 ms intervals without pause*

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

7.1.2 Controller LED

LED	Status	Problem	Remedy
S1*	Steady red	At least one voltage value on the controller is wrong	If at least one digital input is connected, check that the SNS input and the GND input are connected. Check that the input power supply is the specified type (see "General specifications" on page 71).
S2	Steady red	Controller temperature value is wrong	Check that the system is operating at the correct operating temperature (see "General specifications" on page 71).
S3	Steady red	At least one input or output is in error	If at least one input is used, check that both the channels are connected and that there is no short circuit on the outputs. If the problem persists, contact assistance for output replacement.
S4	Steady red	At least one of the controller peripherals is in error	Check the status of the terminal block and connections.
S5	Steady red	Communication error with at least one sensor	Check connections of all sensors in the chain starting from the last sensor in error. Check that all the sensors have an assigned ID (in Inxpect BUS Safety **Settings** > **Node ID Assignment**). Check that the firmware of the controller and sensors are updated to the compatible versions.
S6	Steady red	Configuration saving error, configuration not performed or memory error	Reconfigure or configure the system, see "Manage the configuration" on page 55. If the error persists, contact the assistance service.
Only one LED	Flashing red	Sensor corresponding to the flashing LED in error	Check the problem through the LED on the sensor.
Only one LED	Flashing green	Sensor corresponding to the flashing LED in boot status	Contact the assistance service.
S1–S6 together	Steady red	Communication error on the Fieldbus	At least one input or output is configured as "Fieldbus controlled". Check that the cable is correctly connected.
S1–S5 together	Steady red	Error in the selection of the dynamic configuration: invalid ID	Check the preset configurations within the Inxpect BUS Safety application.
All the six sensors	Steady orange	The system is starting up.	Wait some seconds.
All the six sensors	Flashing green one after the other in sequence	The controller is in boot state.	Contact the assistance service.

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

Note: S1 is the first from the top.*

7.1.3 Other problems

Problem	Cause	Remedy
Undesired alarms	Transit of people or objects in close proximity to the detection field	Change the sensors sensitivity, "Change the configuration" on page 55.
Machinery in safe status without motions in the detection field	No power supply	Check electrical connection. Contact the assistance service if necessary.
	Failure 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 application Inxpect BUS Safety, on the **Dashboard** page, click ⊗ in correspondence with the controller or the sensor.
The voltage value detected on the SNS input is zero	The chip that detects inputs is faulty	Contact the assistance service.
The system does not function correctly	Controller error	Check the status of the LEDs on the controller, see "Controller LED" on the previous page. Access the application Inxpect BUS Safety, on the **Dashboard** page, click ⊗ in correspondence with the controller or the sensor.
	Sensor error	Check the status of the LEDs on the sensor, see "Sensor LED" on page 58. Access the application Inxpect BUS Safety, on the **Dashboard** page, click ⊗ in correspondence with the controller or the sensor.

7.2 Event log management

7.2.1 Introduction

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

7.2.2 Download the system log

1. Start the Inxpect BUS Safety application.
2. Click **Settings** and then **Activity History**.
3. Click **DOWNLOAD LOG**.

7.2.3 Log file sections

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

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

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

7.2.4 Log line structure

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

- Timestamp (seconds counter from the latest boot)
- Timestamp (absolute/relative value)

- Event type:
  - [ERROR]= diagnostic event
  - [INFO]= information event
- Source
  - CONTROLLER = if the event is generated by the ISC-B01 controller
  - SENSOR ID= if the event is generated by a sensor. In this case is provided also the node ID of the sensor.
- Event description

Timestamp (seconds counter from the latest boot)

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

Example: 92
Meaning: the event occurred 92 seconds after the latest boot

Timestamp (absolute/relative value)

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

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

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

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

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

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

  Example: Rel. 0 d 00:01:32

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

***Note**: during system configuration, the ISC-B01 controller is getting the local time of the machine where the software is running.*

Event description

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

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

Examples

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

System configuration #15

CAN error (Code: 0x0010) COMMUNICATION LOST

CAN error (disappearing)

7.2.5 Log file example

Event logs of ISC NID UP304 updated 2020/11/18 16:59:56
[Section 1 - Event logs]

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

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

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

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

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

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

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

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

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

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

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

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

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

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

[Section 2 - Diagnostic events log]

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

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

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

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

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

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

7.2.6 Event list

The event logs are listed below:

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

For further information about the events, see "INFO events" on the next page and " ERROR events (controller)" on page 65.

7.2.7 Verbosity level

There are five verbosity levels of the log. The verbosity can be set during the configuration of the system via the Inxpect BUS Safety application (**Settings** > **Activity History** > **Log verbosity level**).

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

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

7.2.8 Verbosity level for detection access and exit events

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

- LEVEL 0: the events are logged at controller level and the additional information are the detection distance (in mm) and the detection angle (°) in detection access.

  Format:

  CONTROLLER Detection access (distance mm/azimuth°)

  CONTROLLER Detection exit

- LEVEL 1: the events are logged on single field at controller level and the additional information are: the detection field, detection distance (in mm) and the detection angle (°) in access, the detection field in exit.

  Format:

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

  CONTROLLER Detection exit (field #n)

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

  Format:

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

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

  CONTROLLER Detection exit (field #n)

  SENSOR #k Detection exit

7.3 INFO events

7.3.1 System boot

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

Format: *System Boot #n*

Example:

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

7.3.2 System configuration

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

Format: *System configuration #3*

Example:

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

7.3.3 Factory reset

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

Format: *Factory reset*

Example:

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

7.3.4 Stop signal

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

Format: *Stop signal ACTIVATION/DEACTIVATION*

Example:

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

7.3.5 Restart signal

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

Format: *Restart signal WAITING/RECEIVED*

Example:

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

7.3.6 Detection access

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

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

Example:

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

7.3.7 Detection exit

After at least one field detection access, the field detection exit is logged when the detection signal goes back to its default no-motion status.

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

Format: *Detection exit (field #n)*

Example:

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

7.3.8 Dynamic configuration in use

At every change of the dynamic configuration, the new ID of the dynamic configuration selected is logged.
Format: *Dynamic configuration #1*

Example:

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

7.3.9 Muting status

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

***Note**: the event indicates a change of the muting status of the system. It does not correspond to the muting request.*
Format: *Muting disabled/enabled*

Example:

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

7.4 ERROR events (controller)

7.4.1 Introduction

A diagnostic error is logged every time the periodic diagnostic functions detect a coming or going fault on the ISC-B01 controller.

7.4.2 Temperature errors (TEMPERATURE ERROR)

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

7.4.3 Controller voltage errors (POWER ERROR)

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

The following table describes the controller voltage:

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

7.4.4 Peripheral error (PERIPHERAL ERROR)

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

7.4.5 Configuration errors (FEE ERROR)

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

7.4.6 Output errors (OSSD ERROR)

Error	Meaning
BAD MOSFET1 STATUS	Error on diagnostic signal of MOS output 1
BAD MOSFET2 STATUS	Error on diagnostic signal of MOS output 2
BAD MOSFET3 STATUS	Error on diagnostic signal of MOS output 3
BAD MOSFET4 STATUS	Error on diagnostic signal of MOS output 4

7.4.7 Flash errors (FLASH ERROR)

A flash error represents an error on the external flash.

7.4.8 Dynamic configuration error (DYNAMIC CONFIGURATION ERROR)

Error	Meaning
INVALID FIELDSET ID	Invalid fieldset ID

7.4.9 Internal communication error (INTERNAL COMMUNICATION ERROR)

Indicates that there is an internal communication error.

7.4.10 Input redundancy error (INPUT REDUNDANCY ERROR)

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

7.4.11 Fieldbus error (FIELDBUS ERROR)

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

Error	Meaning
NOT VALID COMMUNICATION	Error on the Fieldbus

7.4.12 RAM error (RAM ERROR)

Error	Meaning
INTEGRITY ERROR	Wrong integrity check on the RAM

7.4.13 Radar signal errors (SIGNAL ERROR)

Error	Meaning
HEAD FAULT	Radar not functioning
HEAD POWER OFF	Radar off

Error	Meaning
MASKING	Presence of object obstructing the field of view 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

7.4.14 CAN errors (CAN ERROR)

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

7.4.15 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

7.4.16 System boot (SYSTEM BOOT)

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

7.4.17 System safety alarm (SYSTEM SAFETY ALARM)

Component	Possible event details
Controller	**1**: after the previous detection, the area is now empty. Consequence: the safety outputs are activated.
Sensor	*xxxxxxx*: distance in millimeters between the detected motion and the sensor. Consequence: the safety outputs are deactivated.

7.5 ERROR events (sensor)

7.5.1 Introduction

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

7.5.2 Misconfiguration error (MISCONFIGURATION ERROR)

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

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

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

7.5.4 Protocol error (PROTOCOL ERROR)

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

7.5.5 Sensor voltage errors (POWER ERROR)

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

The following table describes the sensor voltage:

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

7.5.6 Sensor anti-tampering (TAMPER ERROR)

Error	Meaning
TILT ANGLE ERROR	Sensor inclination around the x-axes
ROLL ANGLE ERROR	Sensor inclination around the z-axes
PAN ANGLE ERROR	Sensor inclination around the y-axes

Note*: an information in degree related to the angle is reported.*

7.5.7 Signal error (SIGNAL ERROR)

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

Error	Meaning
MASKING	The sensor is occluded;
MASKING REFERENCE MISSING	During the configuration process, it was not possible to get the masking reference.

7.5.8 Temperature errors (TEMPERATURE ERROR)

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

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

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

7.6 ERROR events (CAN BUS)

7.6.1 Introduction

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

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

7.6.2 CAN errors (CAN ERROR)

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

7.7 Cleaning and spare parts

7.7.1 Cleaning

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

7.7.2 Spare parts

Part	Product code
Sensor	SBV-01
Controller	ISC-B01

8. Technical references

Contents

This section includes the following topics:

8.1 Technical data **71**
8.2 Terminal blocks and connector pin-outs **73**
8.3 Electrical connections **75**
8.4 Parameters **80**
8.5 Digital input signals **82**

8.1 Technical data

8.1.1 General specifications

Detection method	Inxpect motion detection algorithm based on FMCW radar
Frequency	Working band: 60.6–62.8 GHz Transmission power: ≤ 13 dBm Radiated power: ≤ 16 dBm mean EIRP Modulation: FMCW
Detection interval	From 0 to 5 m , depending on the installation conditions.
Detectable target RCS	0.17 sqm
Field of view	• programmable: from 10° to 100° horizontal plane and 20° vertical plane.
Decision probability	> 1-(2.5E-07)
CRT (Certified Restart Timeout)	4 s
Guaranteed response time	< 100 ms
SIL (Safety Integrity Level)	2
PL (Performance Level)	d
Category (EN ISO 13849)	3 equivalent for SBV-01 and ISC-B01
Class (IEC TS 62998-1)	D
Total consumption	21.8 W (controller and six sensors)
Communication protocol (sensors-controller)	CAN complies with standard EN 50325-5
Mission time	20 years
MTTFd	38 years
PFHd	Access detection: 1.66E-08 [1/h] Restart prevention: 1.66E-08 [1/h] Muting: 6.13E-09 [1/h] Stop signal: 6.14E-09 [1/h] Restart signal: 6.14E-09 [1/h]
SFF	≥ 99.89%
DCavg	≥ 99.48%
Electrical protections	Polarity inversion Overcurrent through resettable integrated fuse (max. 5 s @ 8 A)
Overvoltage category	II
Altitude	Max 1500 m ASL
Air humidity	Max 95%
Noise emission	Negligible

8.1.2 Ethernet connection

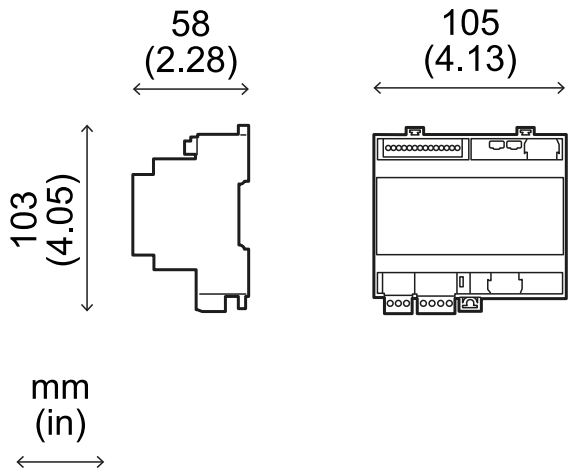
Default IP address	192.168.0.20
Default TCP port	80
Default netmask	255.255.255.0
Default gateway	192.168.0.1

8.1.3 Controller features

Outputs	Configurable as follows: • 4 Output Signal Switching Devices (OSSDs) (used as single channels) • 2 dual channel safety outputs • 1 dual channel safety output and 2 Output Signal Switching Devices (OSSDs)
OSSD characteristic	• Maximum load resistance: 100 K Ω • Minimum load resistance: 70 Ω
Safety outputs	High-side outputs (with extended protection function) • Max current: 0.4 A • Max power: 12 W The OSSDs provide what follows: • ON-state: from Uv-1V to Uv (Uv = 24V +/- 4V) • OFF-state: from 0 V to 2.5 V r.m.s.
Inputs	2 dual channel type 3 digital inputs with common GND See "Voltage and current limits for digital inputs" on page 74.
Fieldbus interface	Ethernet based interface with different standard Fieldbus (e.g. PROFIsafe)
Power supply	24 V dc (20–28 V dc) * Maximum current: 1 A
Consumption	Max 5 W
Assembly	On DIN rail
Weight	with cover: 170 g
Degree of protection	IP20
Terminals	Section: 1 mm² max Max current: 4 A with 1 mm cables²
Impact test	0.5 J, 0.25 kg ball from a 20 cm height
Pollution degree	2
Outdoor use	No
Operating temperature	From -30 to +60 °C
Storage temperature	From -40 to +80 °C

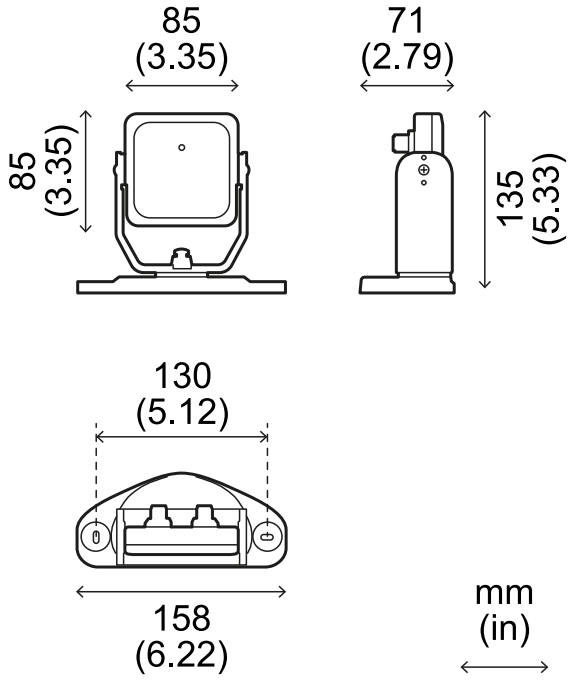
Note*: the unit shall be supplied by an isolated power source which fulfils the requirements of:*

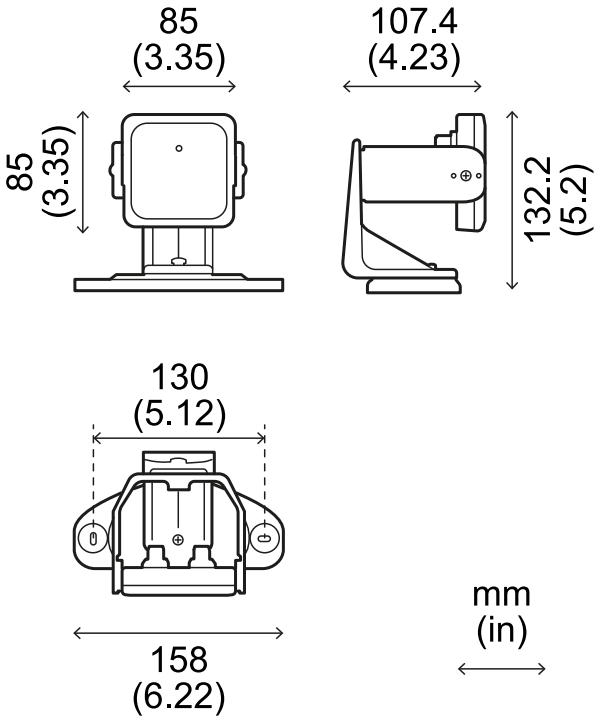
- *Limited-Energy Circuit in accordance with IEC/UL/CSA 61010-1/ IEC/UL/CSA 61010-2-201 or*
- *Limited Power Source (LPS) in accordance with IEC/UL/CSA 60950-1 or*
- *(For North America and/or Canada only) a Class 2 supply source which complies with the National Electrical Code (NEC), NFPA 70, Clause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



8.1.4 Sensor features

Connectors	2 5-pin M12 connectors (1 male and 1 female)
CAN bus termination resistance	120 Ω (not supplied, to be installed with a bus terminator)
Power supply	12 V dc ± 20%, through controller
Consumption	Max 2.8 W
Degree of protection	Type 3 enclosure, according to UL 50E, in addition to IP 67 rating
Material	Sensor: PA66 Bracket: PA66 and glass fiber (GF)
Frame rate	62 fps
Weight	With 2-axes bracket: 300 g With 3-axes bracket: 355 g
Pollution degree	4
Outdoor use	Yes
Operating temperature	From -30 to +60 °C
Storage temperature	From -40 to +80 °C





8.1.5 CAN bus cables recommended specifications

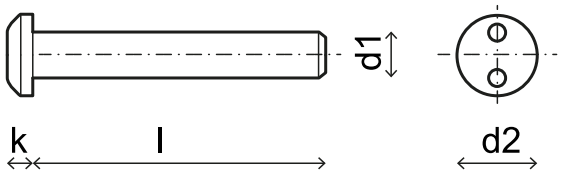
Section	2 x 0.50 mm2 power supply 2 x 0.25 mm² data line
Type	Two twisted pairs (power supply and data) and one drain wire (or shield)
Connectors	5-pole M12, see "Connectors M12 CAN bus" on page 74 Connectors shall be type 3 (raintight)
Impedance	120 Ω ±12 Ω (f = 1 MHz)
Shield	Shield with twisted wires in tin-plated copper. To be connected to earth circuit on the power supply terminal block of the controller.
Standards	Cables shall be listed in accordance with application as described in the National Electrical Code, NFPA 70, and in the Canadian Electrical Code, C22.1.

8.1.6 Side screws specifications

The side screws can be:

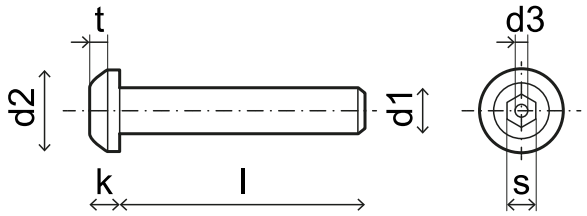
- cheese head and two-hole drive
- button head

Cheese head and two-hole drive screws



d_1	M4
l	10 mm
d_2	7.6 mm
k	2.2 mm

Button head screws



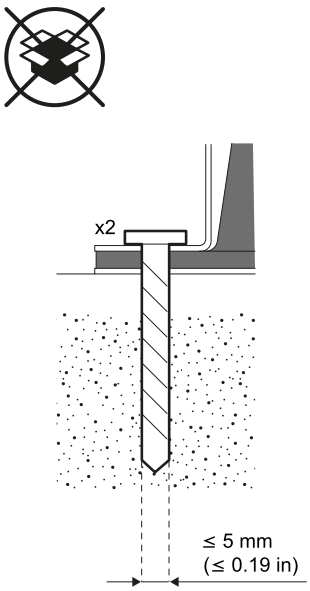
d_1	M4
l	10 mm
d_2	7.6 mm
k	2.2 mm
t	min 1.3 mm
s	2.5 mm
d_3	max 1.1 mm

8.1.7 Bottom screws specifications

The bottom screws can be:

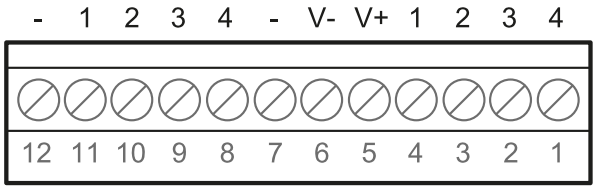
- cheese head
- button head

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



8.2 Terminal blocks and connector pin-outs

8.2.1 Digital inputs and outputs terminal block



***Note**: facing the controller in such a way that the terminal block is top left, number 12 is the nearest to the controller corner.*

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

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

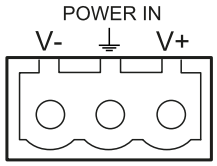
***Note**: use only copper wires with a minimum gauge of 18 AWG and a torque of 0.62 Nm.*

8.2.2 Voltage and current limits for digital inputs

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

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

8.2.3 Power supply terminal block



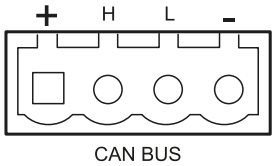
***Note**: connector front view.*

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

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

***Note**: use only copper wires with a minimum gauge of 18 AWG and a torque of 0.62 Nm.*

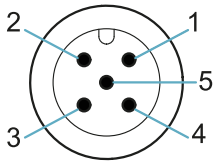
8.2.4 CAN bus terminal block



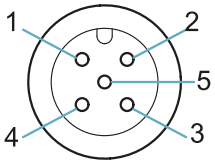
Symbol	Description
+	+ 12 V dc
H	CAN H
L	CAN L
-	GND

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

8.2.5 Connectors M12 CAN bus



Male connector

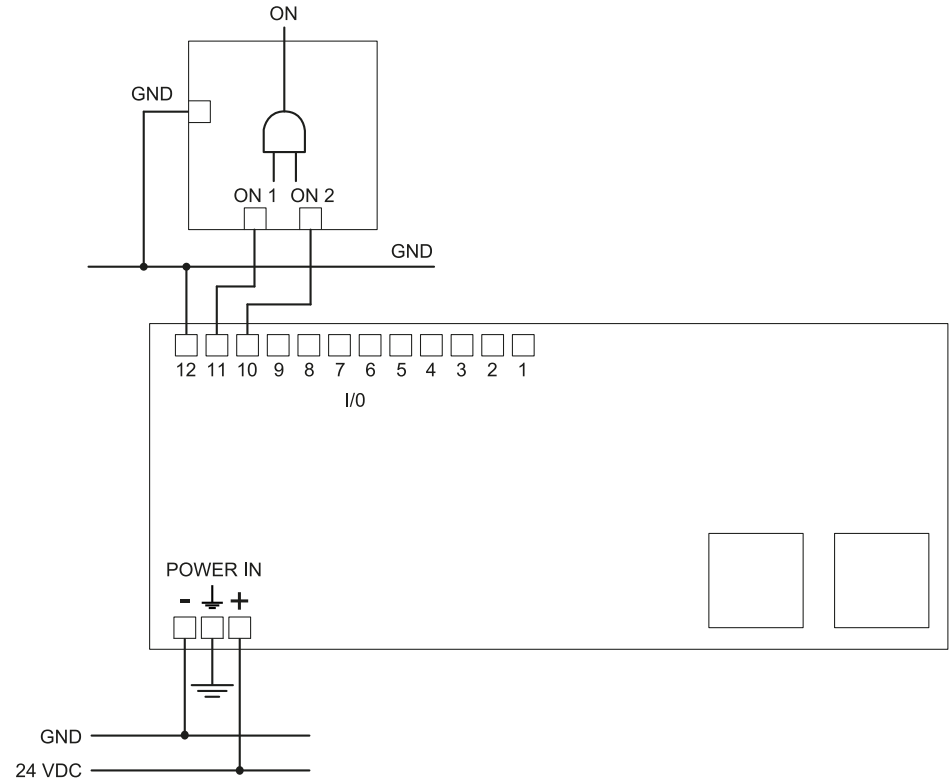


Female connector

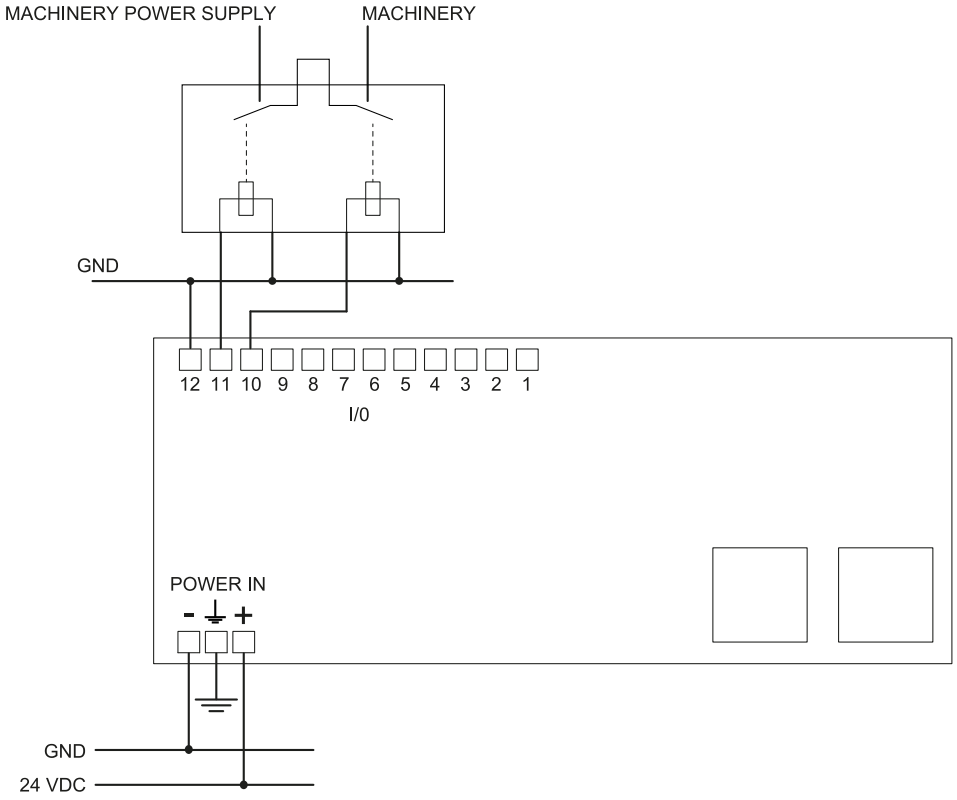
Pin	Function
1	Shield, to be connected to earth circuit power supply terminal block of the controller.
2	+ 12 V dc
3	GND
4	CAN H
5	CAN L

8.3 Electrical connections

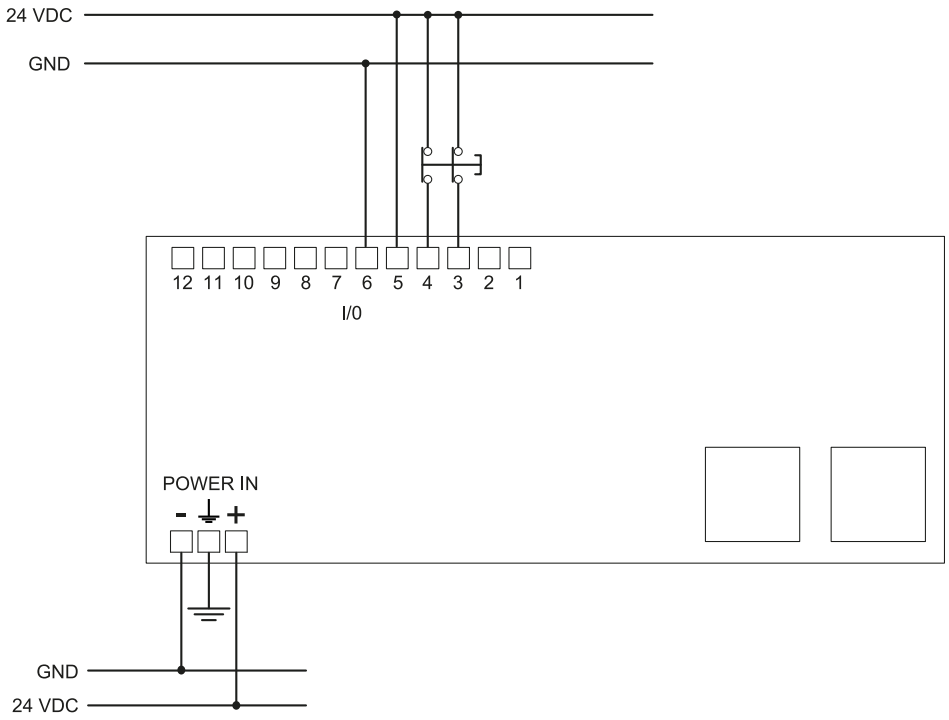
8.3.1 Connection of safety outputs to the machinery control system



8.3.2 Connection of safety outputs to an external safety relay



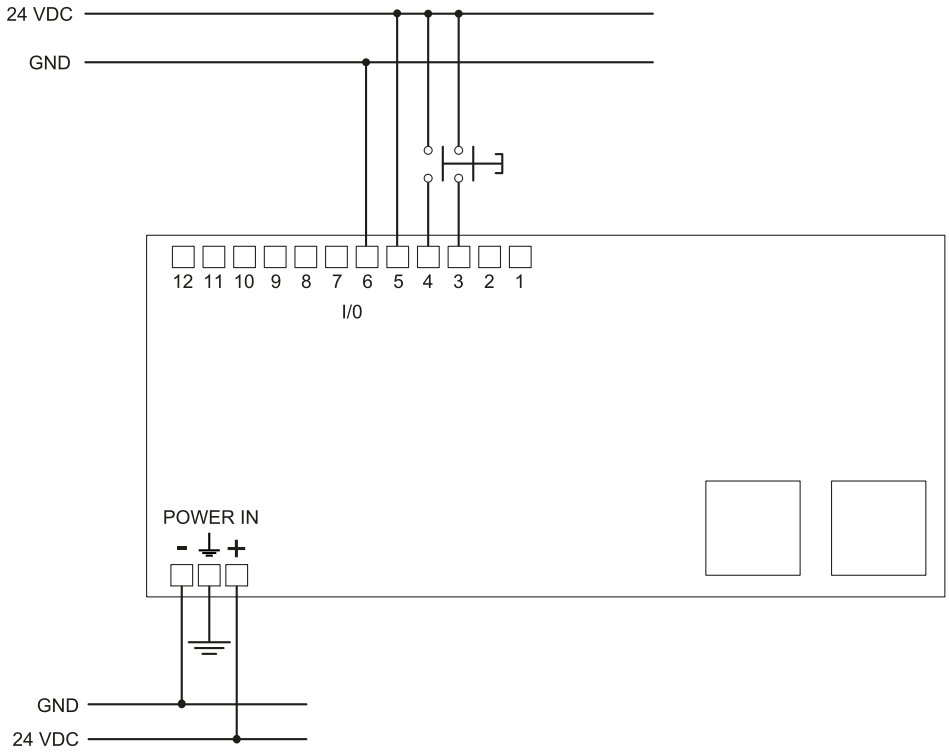
8.3.3 Connection of stop signal (emergency button)



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

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

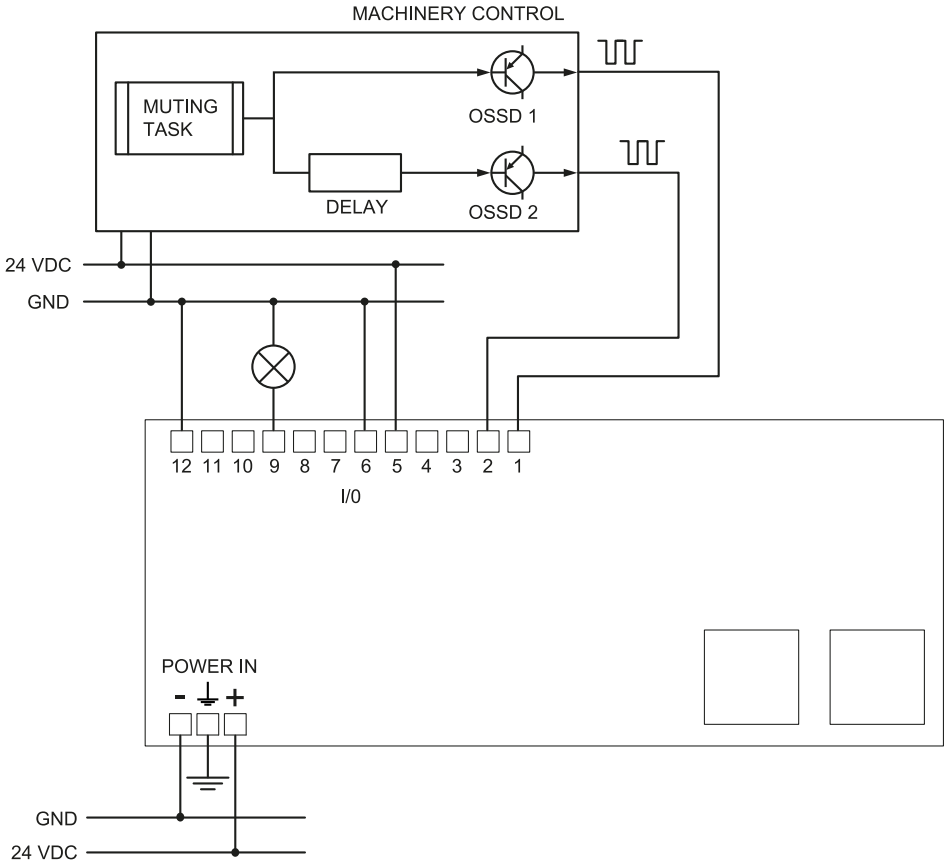
8.3.4 Connection of restart signal



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

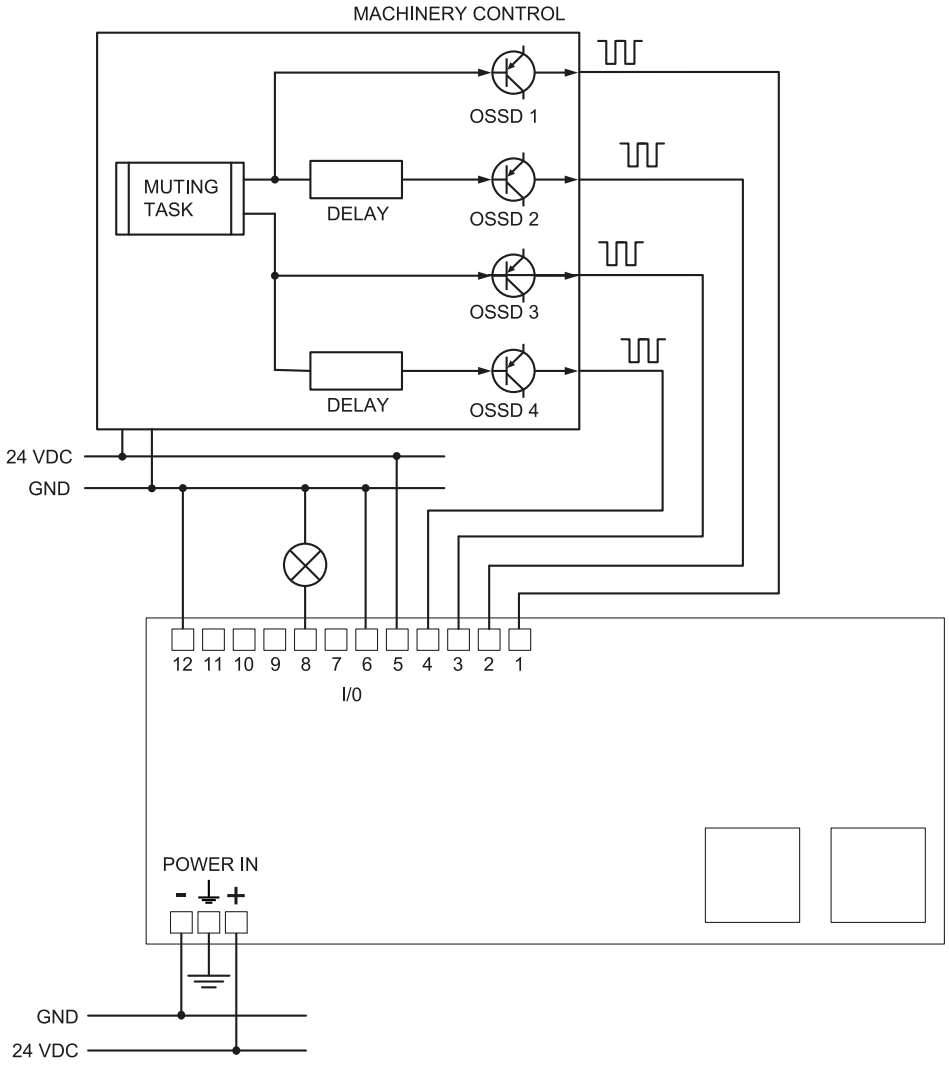
***Note**: the cables used for wiring the digital inputs must have a maximum length of 30 m.*

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



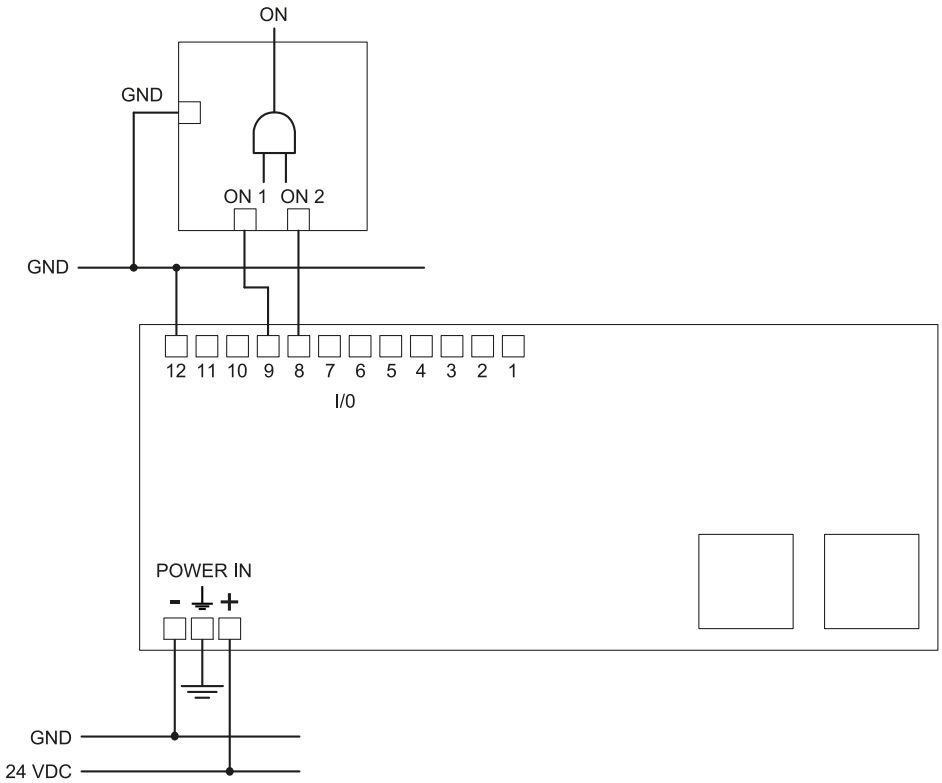
***Note**: the cables used for wiring the digital inputs must have a maximum length of 30 m.*

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

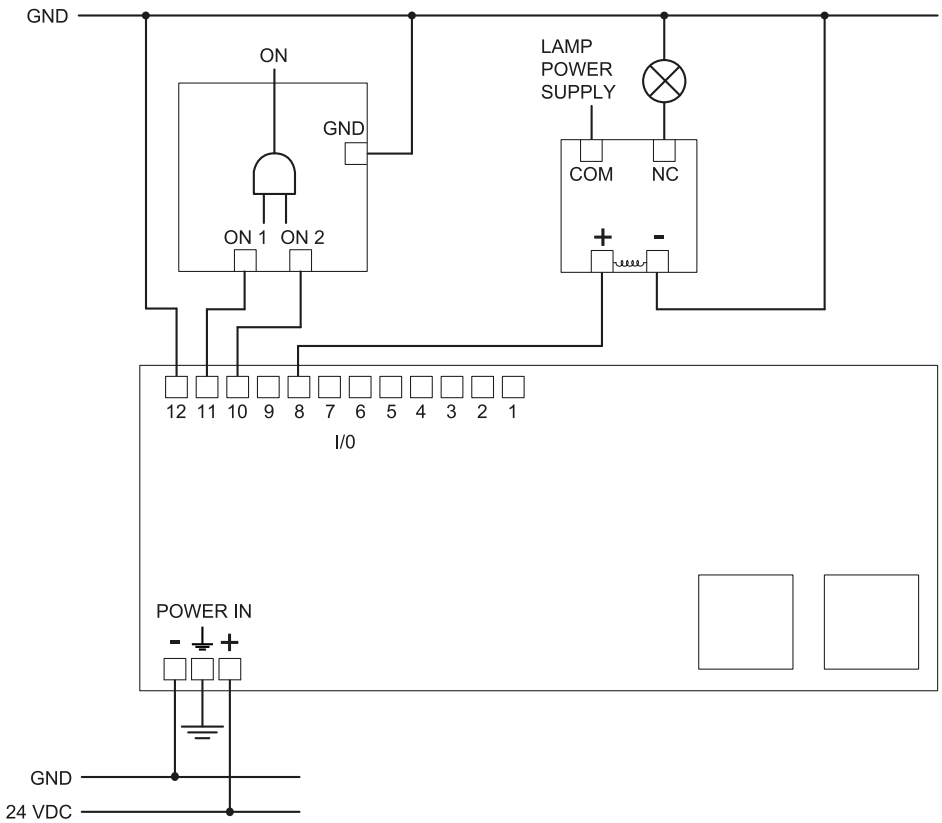


***Note**: the cables used for wiring the digital inputs must have a maximum length of 30 m.*

8.3.7 Detection signal 2 connection



8.3.8 Diagnostic output connection



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

8.4 Parameters

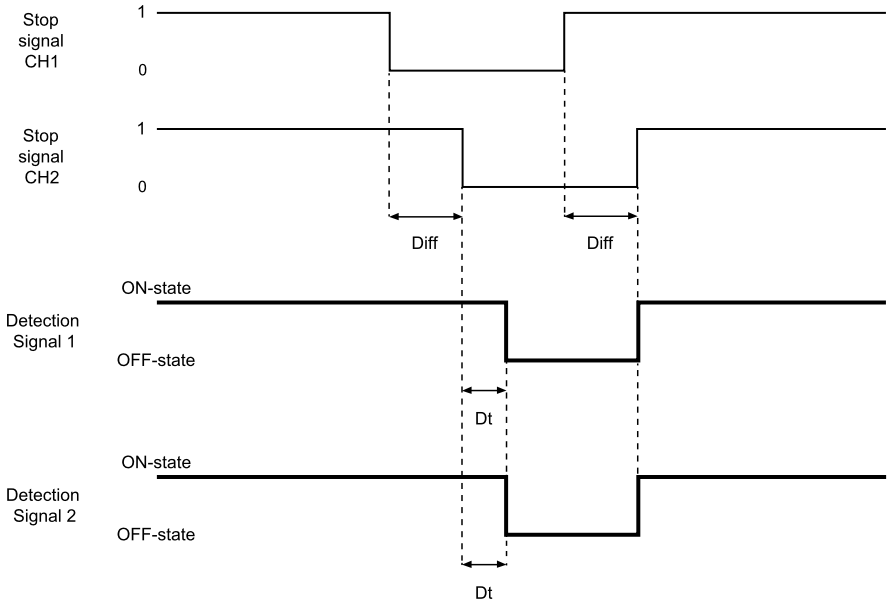
8.4.1 Parameter list

Parameter	Min	Max	Default value
Settings > Account			
Password	-	-	Not available
Settings > General			
Operational frequency	Full BW, Restricted BW		Full BW
Application type selection	Fixed, Vehicle mount		Fixed
Configuration			
Number of installed sensors	1	6	1
Plane	Dim. X: 1000 mm Dim. Y: 1000 mm	Dim. X: 65000 mm Dim. Y: 65000 mm	Dim. X: 8000 mm Dim. Y: 6000 mm
Position (for each sensor)	X: 0 mm Y: 0 mm	X: 65000 mm Y: 65000 mm	Default position of sensor #1: X: 1000 mm Y: 1000 mm
Rotation (for each sensor)	0°	359°	0°
Inclination (for each sensor)	-90°	90°	0°
Sensor installation height (for each sensor)	0 mm	10000 mm	0 mm
Detection Distance 1(for each sensor)	0 mm	5000 mm	1000 mm
Detection Distance 2, 3 and 4 (for each sensor)	0 mm	5000 mm ***Note**: the sum of all the detection distances (for each sensor) must not exceed 5000 mm.*	0 mm
Angular coverage	10°	100°	100°
Safety working mode (for each detection field of each sensor)	Both (default), Always access detection, Always restart prevention		Both (default)
Restart timeout for each detection field	4000 ms	60000 ms	4000 ms
T_{OFF}	100 ms	60000 ms	100 ms
Settings > Sensors			
Detection field dependency	Enabled, Disabled		Enabled
Anti-masking	Disabled, Low, Medium, High		High
Anti-masking distance	0 mm	1000 mm	1000 mm
Anti-rotation around axes	Disabled, Enabled		Enabled
Anti-rotation around axes - Enable specific axes - Tilt	Disabled, Enabled		Enabled
Anti-rotation around axes - Enable specific axes -Roll	Disabled, Enabled		Enabled
Anti-rotation around axes - Enable specific axes - Pan	Disabled, Enabled		Enabled
Settings > Digital Input-Output			
Digital input (for each input)	Stop signal, Restart signal, Muting group “N”, Activate dynamic configuration, Fieldbus controlled		Not configured
Digital output (for each output)	System diagnostic signal, Muting enable feedback signal, Fieldbus controlled, Restart Feedback signal, Detection signal "N"		Not configured

Parameter	Min	Max	Default value
Settings > Muting			
Group for muting (for each sensor)	No group, Group 1, Group 2, both		Group 1
Pulse width (for each Input TYPE)	0 µs (= Period and Phase shift disabled) 200 µs	2000 µs	0 µs
Period (for each Input TYPE)	200 ms	2000 ms	200 ms
Phase shift (for each Input TYPE)	0.4 ms	1000 ms	0.4 ms
Settings > Multi-controller synchronization			
Controller channel	0	3	0
Settings > Activity History			
Log verbosity level	0	4	0
Settings > Network Parameters			
IP Address	-		192.168.0.20
Netmask	-		255.255.255.0
Gateway	-		192.168.0.1
TCP port for configuration	1	65534	80
Settings > Fieldbus Parameters			
System configuration and status PS2v6	1	65535	145
Sensors information PS2v6	1	65535	147
Sensor 1 detection status PS2v6	1	65535	149
Sensor 2 detection status PS2v6	1	65535	151
Sensor 3 detection status PS2v6	1	65535	153
Sensor 4 detection status PS2v6	1	65535	155
Sensor 5 detection status PS2v6	1	65535	157
Sensor 6 detection status PS2v6	1	65535	159
System configuration and status PS2v4	1	65535	146
Sensors information PS2v4	1	65535	148
Sensor 1 detection status PS2v4	1	65535	150
Sensor 2 detection status PS2v4	1	65535	152
Sensor 3 detection status PS2v4	1	65535	154
Sensor 4 detection status PS2v4	1	65535	156
Sensor 5 detection status PS2v4	1	65535	158
Sensor 6 detection status PS2v4	1	65535	160

8.5 Digital input signals

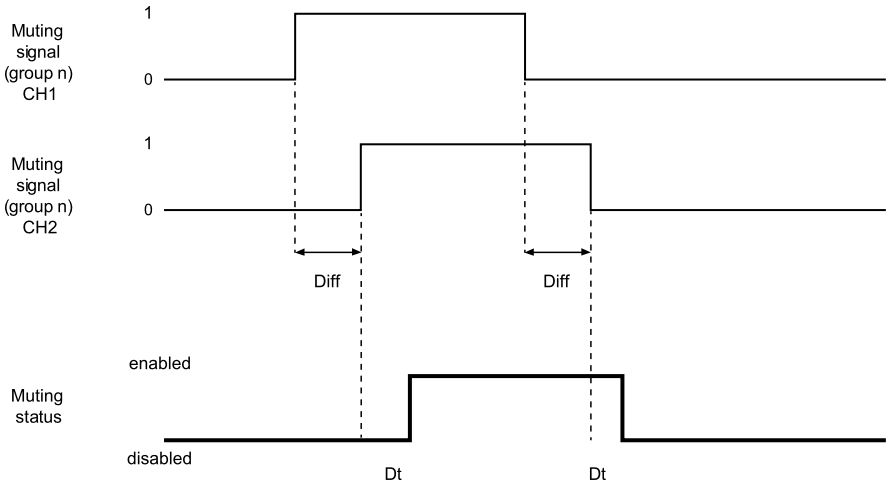
8.5.1 Stop signal



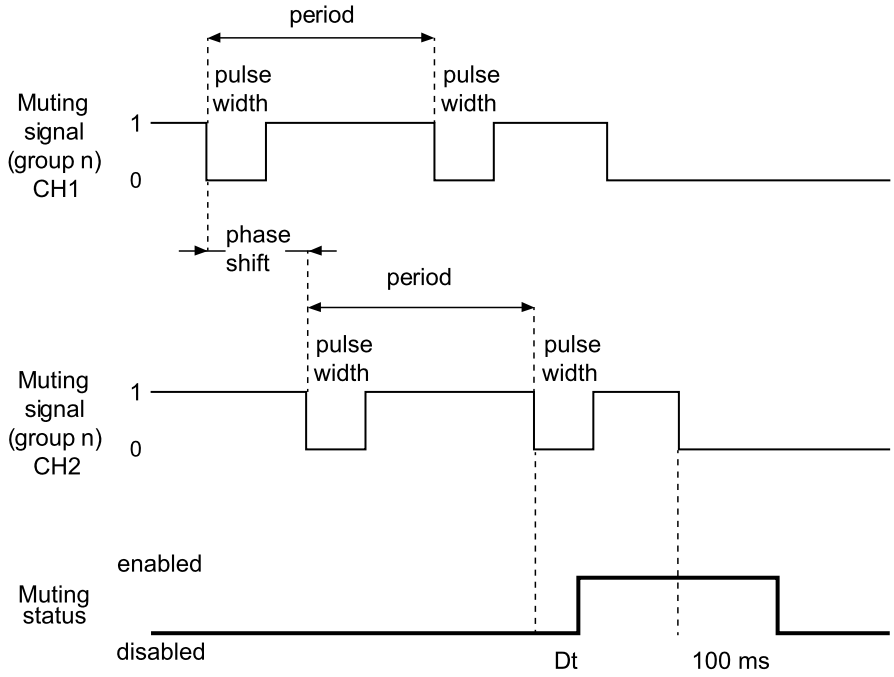
Part	Description
Detection signal 1 **Detection signal 2**	Both deactivate on the falling edge of the input signal. They remain in OFF-state as long as one of the two input channels remains to the low logic status (0).
Stop signal CH1 **Stop signal CH2**	Interchangeable channel. Both channels must go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

8.5.2 Muting (with/without pulse)

Without pulse

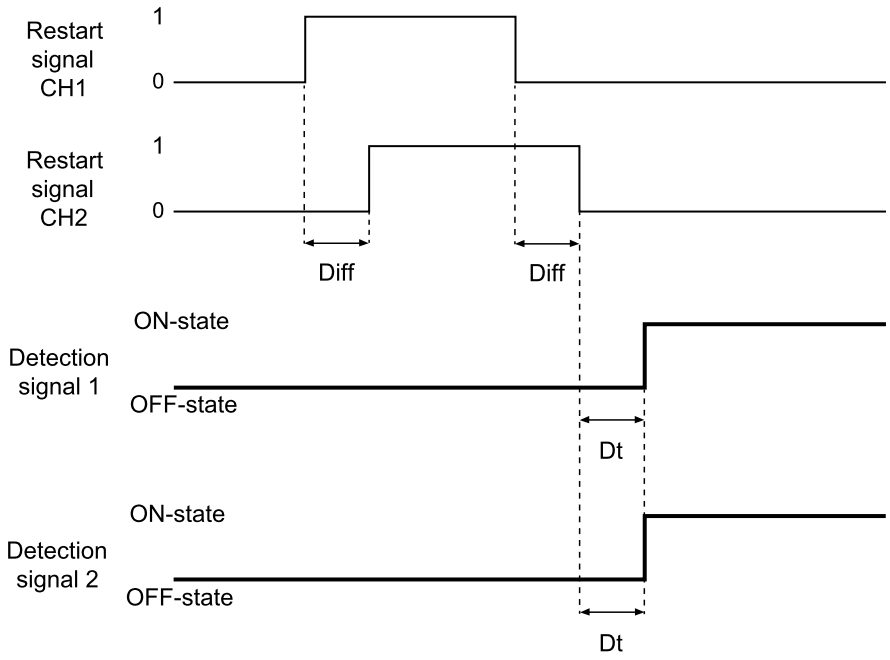


With pulse



Part	Description
Diff	Minor than 50 ms. If the value is greater than 50 ms, the diagnostic alarm starts and the system deactivates the safety outputs.
Muting signal (group *n*) CH 1 **Muting signal (group *n*) CH 2**	Interchangeable channel.
Muting status	• Without pulse: enabled as long as both channels are at a high logic level (1), and deactivated when both channels go to low logic level (0). • With pulse: enabled as long as both the input signals follow the configured muting parameters (pulse width, period and phase shift).
Dt	Activation/deactivation delay. Minor than 200 ms.

8.5.3 Restart signal



Part	Description
Detection signal 1 **Detection signal 2**	The Detection signal 1 and Detection signal 2 outputs go to ON-state as soon as the last channel has correctly completed the transition 0 -> 1 -> 0.
Restart signal CH1 **Restart signal CH2**	Interchangeable channel. Both channels of Restart signal must have a transition of logical level 0 -> 1 ->0. The time they stay at high logical level (t) must be at least 400 ms.
Dt	Activation delay. Minor than 200 ms.
Diff	Minor than 50 ms. If the value is greater than 50 ms, the diagnostic alarm starts and the system deactivates the safety outputs.

9. Appendix

Contents

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9.1 Disposal

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

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

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

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

9.2 Service and warranty

9.2.1 Customer service

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

9.2.2 How to return the product

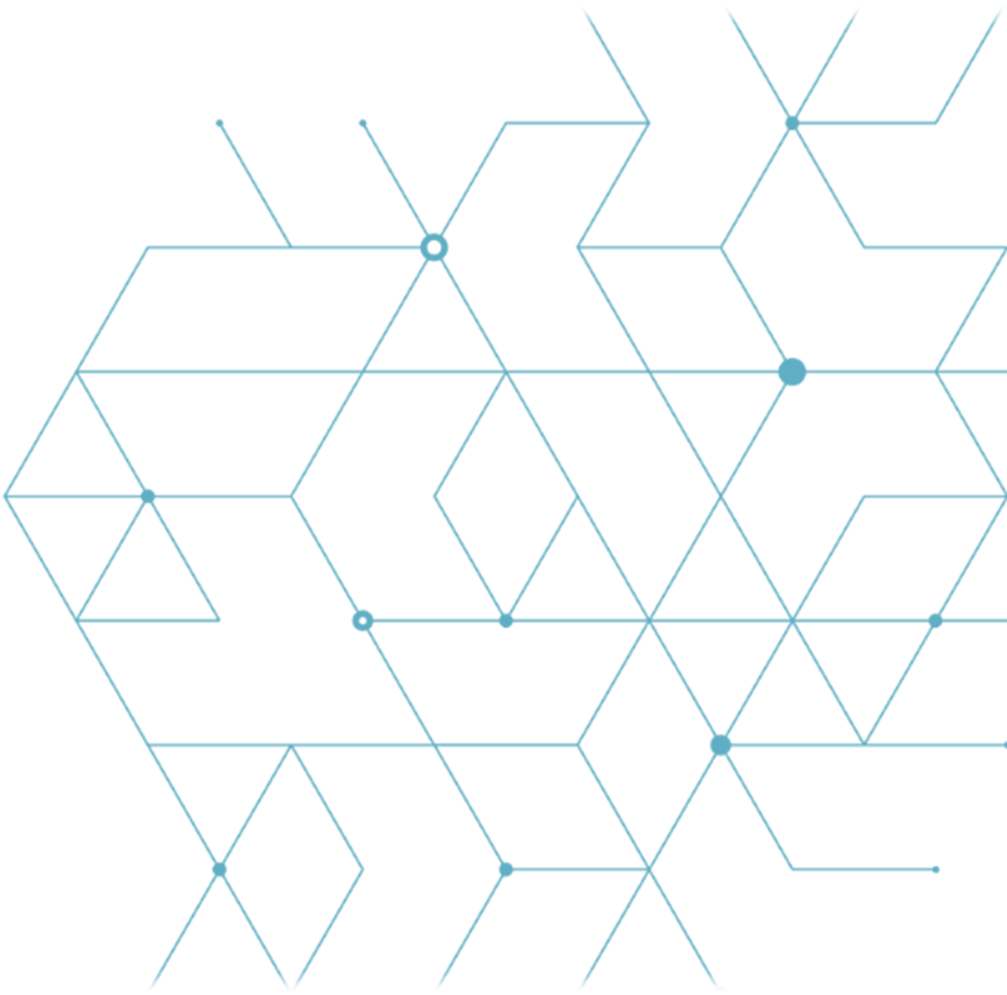
If necessary, complete the request with information about the return on the website www.inxpect.com/industrial/rma. Then, return the product to the local distributor or exclusive distributor. **Use original packaging. Shipping costs are at the customer's expense**.

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

9.2.3 Service and warranty

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

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



INXPECT

Inxpect SpA
Via Serpente, 91
25131 Brescia (BS)
Italy
www.inxpect.com
safety-support@inxpect.com
+39 030 5785105

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