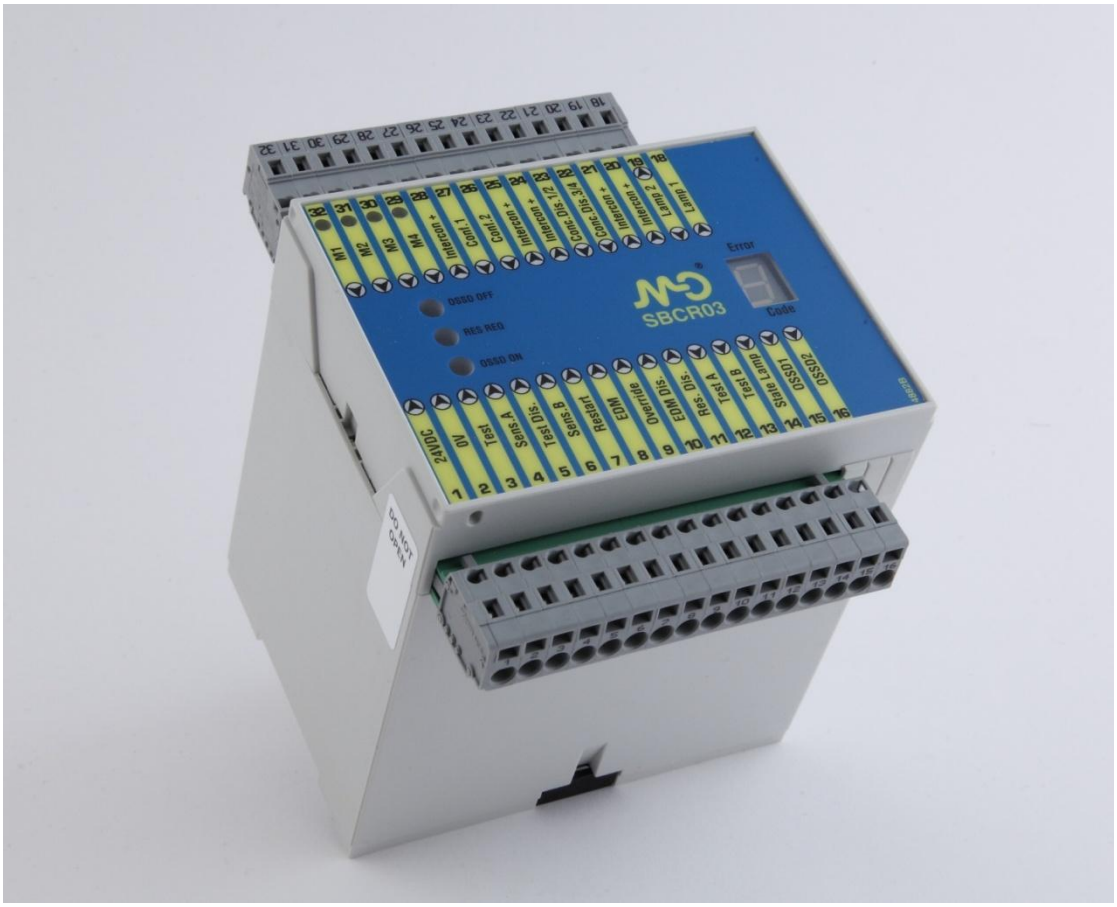
INSTALLATION MANUAL

ENGLISH VERSION



Safety Control Unit

SBCR03

SUMMARY

References used in this document

Some information in this document has been emphasized for increased ease of use, associating a symbol with a particular description. This will draw reader's attention in cases requiring recommendations to be followed or particular action to be performed.

A note informs you of any special features of the control unit and provides a description to complete information of the related paragraph, with regard to a function or a state of the device

A recommendations advises and suggests actions to be undertaken in a stated situation, directed to simplify and make easy installation and use of the device.

A warning note is to protect you from potential accidents.
The warning note appears every time conditions or actions that could lead to hazardous situations are referred to. The warning description safeguards the operator from accidents. Always read warnings carefully and follow them exactly.

1. Safety

The SBCR03 control unit can only carry out its safety functions if it is installed correctly and it has been connected to the shut-down system without any errors. The SBCR03 control unit complies with the requirements of EN 61496-1, safety Type 2.

1.1 Using the control unit correctly

The SBCR03 control unit can only be used in conjunction with suitable testable single beam photoelectric switches, suitable testable multiple beam photoelectric safety switches, suitable self-tested multiple beam photoelectric safety switches and suitable self-tested safety light curtains.
The SBCR03 control unit represents the connection between the photoelectric switches and the machine's control system. As required by Category 2, the SBCR03 control unit regularly checks the operation of the photoelectric switches connected to it and stops any dangerous movement whenever a fault is detected.
Moreover, it is equipped with further safety and monitoring functions. The use of the control unit is only guaranteed if operated in accordance with the technical specifications. M.D. Micro Detectors is absolved of all responsibility if the control unit is put to a different use or it is modified in any way whatsoever, even with regards to the mounting or installation.

1.2 General safety advice

To install the SBCR03 control unit safely and to ensure its correct use, pay particular attention to the following paragraphs.

1.2.1 General safety advice and measures

The safety functions can only be fully guaranteed if the following points are observed:

- The installation must be carried out respecting the technical specifications of the applicable safety sensors and the SBCR03 control unit.
- In compliance with EN 60204, the external power supply must be able to withstand a power failure lasting 20 ms.
- The checks which take place before the machine is started up for the first time must be to verify that the SBCR03 control unit complies with the national/international safety regulations, in particular the machinery directive and those concerning safety in the workplace (EC Declaration of Conformity).

1.2.2 Instructions and descriptions regarding safety

With regard to the use, installation, starting-up and routine technical checks of the SBCR03 control unit, national and international regulations are valid and in particular:

- the machinery directive 2006/42/EC
- the equipment usage directive 2009/104/EC
- safety and accident prevention regulations

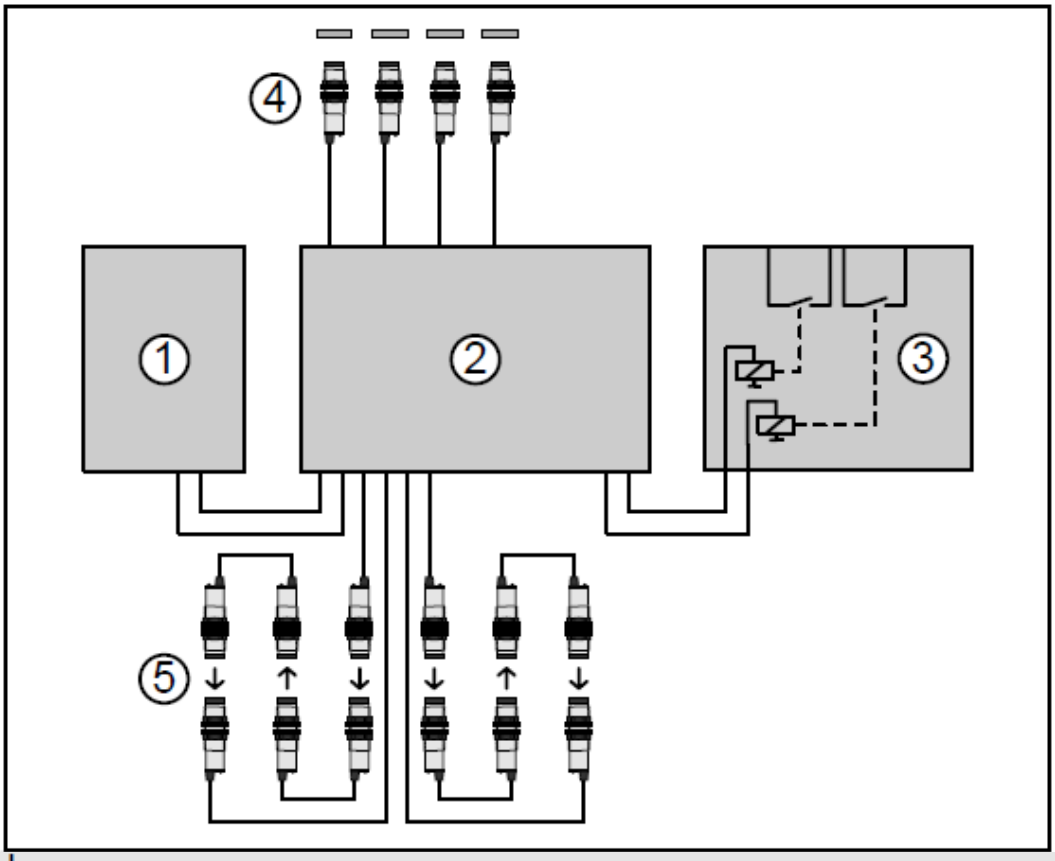
The manufacturers and users of the machines which contain our safety devices are responsible for the observation of all the rules and regulations currently in force and laid

down by the competent authorities regarding safety. Furthermore, the warnings must always noted and acted on accordingly, in particular the prescribed checks (see *Par.3.3* Commissioning) contained in this manual (for example, the installation and connection to the machine's control system).
The checks must be carried out by skilled personnel, that is to say, authorized staff employed for this purpose. The said checks must be fully documented each time.
This installation manual must be available to all users of the machine which contains our safety device.
The machine must be operated by a member of staff trained in this field.

2. Description of SBCR03 control unit

2.1 System description

By using single beam photoelectric safety switches, multiple beam photoelectric safety switches and safety light curtains, in combination with the SBCR03 control unit, a complex safety system for the protection of people can be constructed.



Legend:

1 power supply
2 SBCR03-Muting
3 relay module
4 Muting sensors
5 chain of testable photoelectric switches

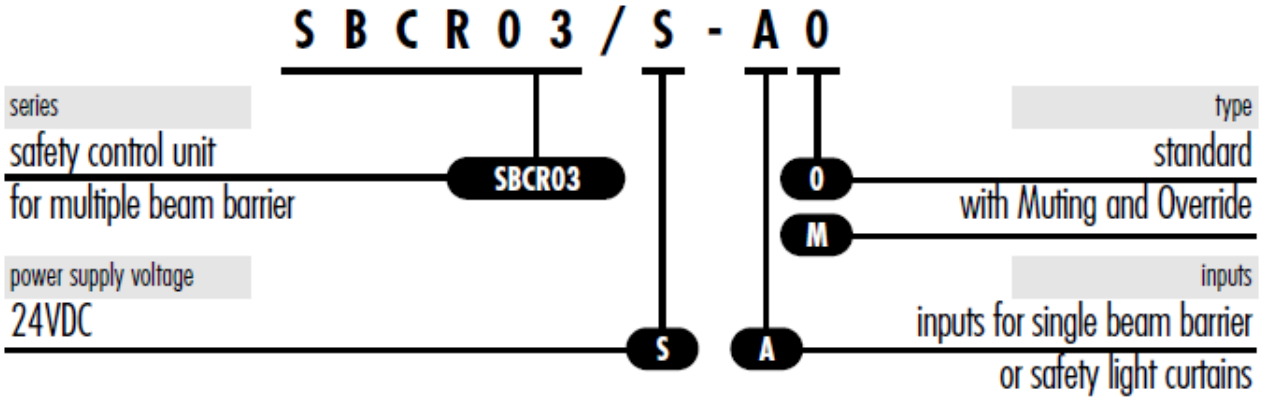
Fig.2.1 Maximum system configuration with testable single beam photoelectric switches

In the maximum configuration (see Fig.2.1), the system is made up of two sets (one set per channel) each one containing three pairs of single senders/receivers in cascade, the SBCR03 control unit and four Muting sensors (one pair per channel). The said system is capable of differentiating between people and objects that may enter two different access areas of a danger zone.

The photoelectric safety systems stop any dangerous movements as soon as a person enters one of the two access areas; if, however, an object such as a pallet with material loaded on it enters the danger zone via the access areas, the machine will continue to operate without interruption.

2.2 Models available

The SBCR03 control unit is available in the following models:



2.3 Control unit structure and operation

The SBCR03 control unit carries out a test of the photoelectric switches connected to it on a regular basis, and makes the Restart Interlock and external contact monitoring (EDM) functions available. The complete version of the SBCR03 control unit with Muting can, with the help of special sensors, differentiate between people and pre-determined objects, making it possible for these latter to enter the danger zone without involving the machine stopping.

2.4 Functions of the SBCR03 control unit

2.4.1 Test functions

Testable photoelectric safety switch checks

The SBCR03 control unit configured for use with suitable testable sensors (Test. Dis. terminal disconnected) regularly checks that the single photoelectric switches connected to it are working correctly. Every 4 ms the SBCR03 control unit sends a test signal, via the terminals Test A and Test B, to the photoelectric senders located at the beginning of the two sensor chains, and checks the response from the receivers located at the end of the chains via the input terminals Sens. A and Sens. B. In this case, each chain has only one communication channel in the direction of the SBCR03 control unit which is tested regularly. The SBCR03 control unit's outputs, OSSD1 and OSSD2, are immediately deactivated if a malfunction is detected or an opaque object is present in the detection zone.

External test

The available Test input is only used to make it possible to test a device connected up and downstream of the SBCR03 control unit. This device can be activated if necessary by the machine control. If this input is not used it must be connected to +24 VDC. When the Test input has a voltage level of 24V, the control unit functions normally by carrying out the internal self-test.

When the voltage at the Test input is low for a period of at least 30 ms, the SBCR03 control unit simulates the obscuring of the optics of the photoelectric safety switches. As a result, both the OSSD outputs deactivate. To finish the cycle it is necessary to apply +24 VDC to the Test terminal once again. The machine's control system shall cause the machine to shutdown if the response time from the SBCR03 control unit to the external test signal exceeds 150 ms.

OSSDs test

Every 4 ms the SBCR03 control unit carries out a check of the OSSDs in order to verify that there are not short to ground or to +24 VDC or other faults. In normal operation, every 2 s, it also carries out a check that it's able to detect any short between OSSD1 and OSSD2. This check involves the OSSDs going to the OFF-state for a short time (between 150 and 450µs). This interruption does not affect the state of the external contactors, connected to the OSSDs, but could generate a mistake if OSSDs are evaluated by a PLC.

2.4.2 Restart Interlock

If a light beam generated by the photoelectric safety switches has been broken, the OSSDs go to the OFF-state, causing machine stopping. The Restart Interlock function prevents the machine starting up again until the light beam is clear and the Start/Restart button (connected to the Restart terminal) has been pressed and then released. It is therefore necessary to use the Start/Restart button also on starting up the system.

Choosing the correct location for the Start/Restart button!
The Start/Restart button must be installed in a position, which cannot be accessed from inside the danger zone, and in such a way that the danger zone is visible when it is actuated.

When the SBCR03 control unit is awaiting the Restart command (OSSDs in the OFF-state and detection zone clear), yellow LED (RES REQ) located on the control unit's panel and the lamp (optional), connected to the State Lamp output terminal, illuminate. Applying 0V to the Res. Dis. terminal activates the Restart Interlock function and applying +24V to the same terminal deactivates it. If the lamp is faulty, the code "7" will be displayed but the control unit does not go to a lock-out condition.

In this case, the state indicator lamp must be yellow, since it signals a wait condition.

2.4.3 Automatic Restart Mode (Restart Interlock function disabled)

In the Automatic Restart Mode the state of the OSSD outputs reflects exactly the state of the safety sensor outputs: if the light grid is engaged, the OSSD outputs are in the OFF-state and if the light grid is clear the OSSD outputs are in the ON-state.

The Restart Interlock is still a necessary part of the device!
If the Restart Interlock has been deactivated by means of the Res. Dis. terminal, the said function must be actuated by the machine's control system.

In this configuration, the state indicator lamp connected to the terminal State Lamp signals the light grid OFF-state, copying exactly the state of the red “OSSD OFF” LED.

In this case, the state indicator lamp must be red, since it signals that the light grid is engaged.

State indicator lamp technical data:	
Power supply voltage	24VDC
Power	1…10W
Maximum cable length.	10m
Colour yellow.	(Restart Interlock Mode)
Colour red	(Automatic Restart Mode)

It is advisable to install the state indicator lamp near the Start/Restart button and in such a way that it is visible from the danger zone.

2.4.4 External relay contact control (EDM)

The external relay control function is active if the EDM Dis. terminal has a low voltage level while it is disabled if +24 VDC are applied to it and to the EDM terminal.
The EDM checks that external contactors (relays, starters, etc.), connected to the control unit, function correctly, and that the relative contacts respond to the change of state within 300 ms. To do this, the control unit processes the checkback signal at the EDM terminal giving the state of the contactors’ N/C contacts. When the contacts are closed (both the external contactors in the OFF-state), to the EDM there must be applied +24 VDC.

- Any error at the EDM input during the OSSD’s transition from ON-state to OFF-state, causes the SBCR03 control unit to go to a Lock-out condition (the error code “8” appears, flashing, on the 7-segment display).
- When an error is detected during the transition in the opposite direction (from OFFstate to ON-state), there are two possibilities:
  1. If the SBCR03 control unit is in Automatic Restart Mode, it goes to a Lock-out condition (error code “8” flashing).

2. If the Restart Interlock is enabled, the SBCR03 goes to the restart waiting state, but every attempt to reset the Restart Interlock does not allow the OSSDs to go to the ON-state.

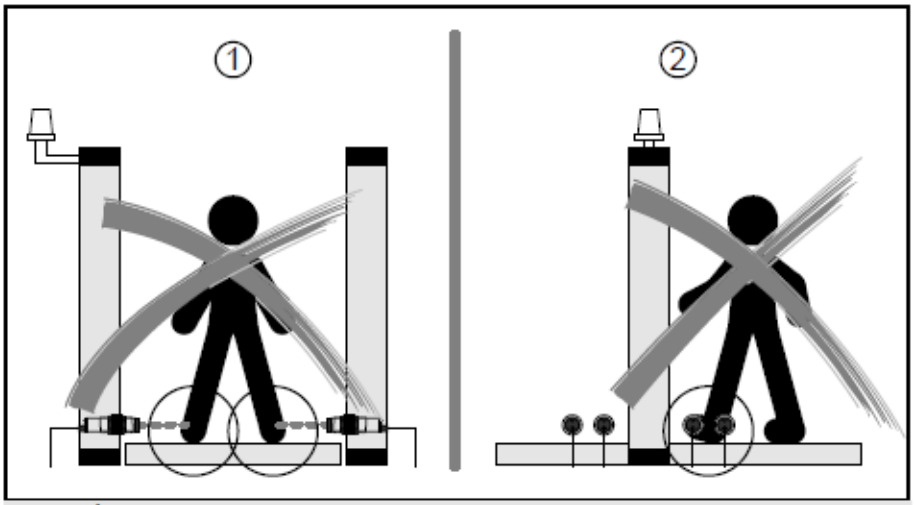
- An incorrect state at the EDM input while OSSDs are in the ON-state will not be detected immediately but at the following switching of OSSDs to the OFF-state (see previous case).
- If an incorrect state is detected from the EDM input, while OSSDs are in the OFF-state, the SBCR03 control unit will go immediately to a Lock-out condition (error code “8” flashing).

2.5 The SBCR03 muting function

The SBCR03 control unit with Muting is used when certain objects, for example pallets for loading materials, must pass through the danger zone. The control unit then suspends control of the light beam for the entire duration of the “authorized” material’s transit through the detection zone. To record the presence of material in transit during this period, there must be additional Muting sensors positioned: by selecting the said sensor type and position carefully, it is possible to differentiate between objects and people. Either 2, 3 or 2+2 Muting sensors can be connected to the SBCR03 control unit.

During installation, follow the instructions below

- The Muting sensors must be arranged in such a way that they cannot be accidentally activated by a person (see *Fig.2.3*).
- The Muting condition can only occur during the period when the material in transit covers the access and makes the danger zone inaccessible.
- The Muting condition shall occur automatically, but must not be based on a single electrical signal.
- The Muting condition must not be based on software commands only.
- The Muting condition must end immediately after the object has passed by so that the safety function is reactivated.



Legend:

1 it must not be possible to activate opposing sensors simultaneously
2 it must not be possible to activate neighbouring sensors simultaneously

Fig.2.3 Muting sensors arrangement

- The Start/Restart and Override buttons, which can release, in certain conditions, the lock on the machinery, must be positioned in such a way that they cannot be operated from the danger zone.
- The entire danger zone must be fully visible from the point at which the tart/Restart and Override buttons are positioned.
- If there are 2 or 3 sensors, it is essential to install at least one lamp, which signals the suspension of the safety function during the Muting phase. If there are 2+2 sensors, both of the Muting lamps are essential. These lamps are compulsory: without them the Muting function is non-operative.

The number of Muting sensors is configured by inserting jumpers between the terminals Conf.1 and Conf.2 and the Intercon+ terminals adjacent to these, as shown in Tab.3.2.

2.5.1 Muting action

The Muting action takes place only after a well defined combination of the related muting signals. The following table shows the correct activation order of the muting signals in relation to the selected configuration:

Nr. Muting sensors installed	Muting Conditions
2	M1 & M2
3	First M3 then M1 & M2 (direction recognition)
2+2	M1 & M2 and/or M3 & M4 The Muting conditions of the two pairs M1-M2 and M3-M4 are independent.

Tab.2.1 Muting conditions

Concurrence monitoring and maximum duration of Muting

As well as the Muting conditions described above, a further control can be added: the Concurrence monitoring together with the control function for the maximum duration of Muting (see the next note). By means of the Concurrence monitoring, the muted condition is permitted only if, with reference to a determined pair of Muting sensors (M1-M2 or M3-M4), the activation of the second sensor occurs within 3 seconds after the activation of the first sensor (see *Tab.2.2*). In all other cases, the sequence will be ignored.

Nr. Muting sensors installed	Muting Conditions + Concurrence monitoring
2	M1 & M2 must be activated within 3s
3	M1 & M2 must be activated within 3s (if M3 is already activated)
2+2	M1 & M2 and/or M3 & M4 must be activated within 3s The Concurrence monitoring of each one of the two pairs M1-M2 and M3-M4 is independent of the other one.

Tab.2.2 Muting conditions and Concurrence monitoring

With reference to a definite channel, if the concurrence monitoring is activated, Muting status will be continuously maintained for a maximum of three minutes. After this period the muted condition will be deactivated, even if the Muting sensors are still active. At the same time, the SBCR03 control unit will stay in the On-state if the light grid is free or it causes the OSSDs to go to the OFF-state and signals the possibility of the activation of the Override function if the light grid is engaged.

Sequence monitoring

Sequence monitoring is always carried out in the three-sensor configuration (see *Tab.2.3*). The three Muting sensors must be activated in a particular sequence.
No monitoring will be carried out on the sensors' deactivation sequence.

Nr. Muting sensors installed	Muting Conditions + Sequence monitoring
2	Sequence monitoring unavailable
3	The Muting sensors must be activated in the following sequence: M3 first, then M1 & M2 afterwards (direction recognition).
2+2	Sequence monitoring unavailable

Tab.2.3 Muting conditions and Sequence monitoring

The Muting conditions can only be satisfied if the object passes through the Muting light beams and the protective field in the way previously described.

2.5.2 Muting control configurations

The configurations of the Muting functions depend on the number of Muting sensors connected. The concurrence monitoring can be disabled independently in both channels (A and B), by inserting jumpers between the Conc. Dis. 1/2, Conc. Dis. 3/4 terminals and the adjacent Intercon+ terminals (see *Tab.3.2* in *Chap.3*).

2-sensor configuration

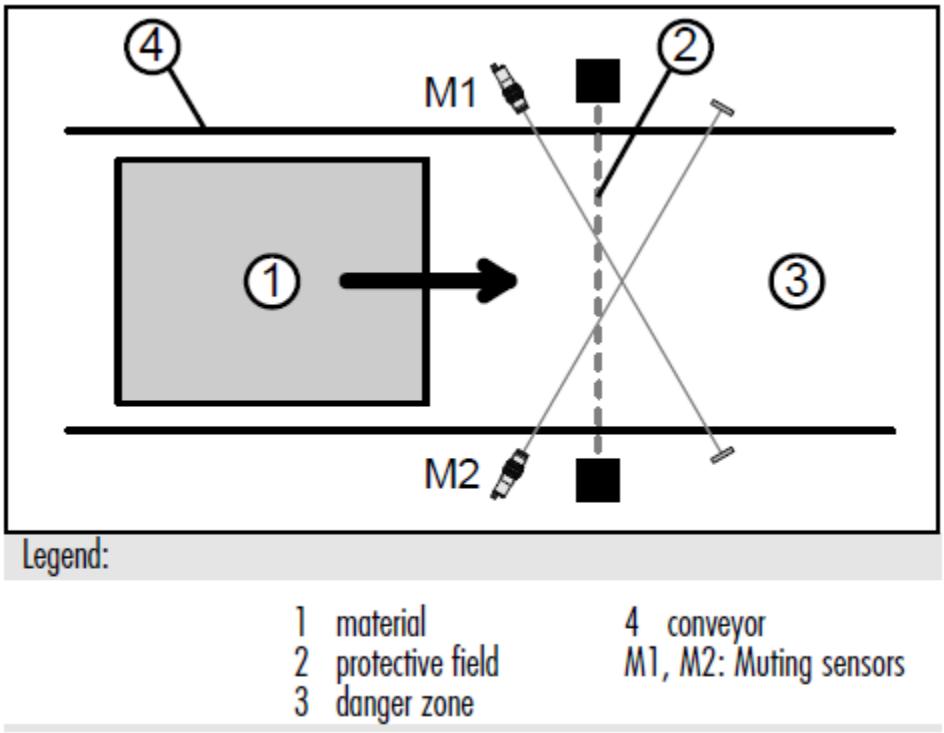


Fig.2.4 2-Muting sensor configuration

In this configuration the pair of sensors M1 and M2 must be installed in such a way that the point of intersection of the two Muting optical beams is located, in relation to the protective field, on the internal side of the danger zone, in order to ensure only the material in transit can activate the Muting sensors at the same time (see *Fig.2.4*).
It must also be guaranteed that the Muting sensors are activated before the optical safety beams are obscured, and that they are deactivated after the optical safety beams have been restored to their original condition. The Muting condition begins the instant the second of the two sensors is obscured (see *Tab.2.1*), and stops when one of the two (it does not matter which) becomes clear again. The sequence in which the sensors were activated does not necessarily have to be the same when they are deactivated. If one of the sensors is active when the machine is turned on, the normal Muting sequence is prevented until all the sensors have been deactivated; in this case it's available the Override function (see *Par.2.5.4*).
If the concurrence is enabled after M1 (or M2) has been activated, M2 (or M1) must be activated within 3 seconds (see *Tab.2.2*). The timing is only controlled during the sensor

activation phase and not the sensor deactivation phase since, in any case, another Muting condition is only permitted when both the sensors have switched to OFF.

3-sensor configuration

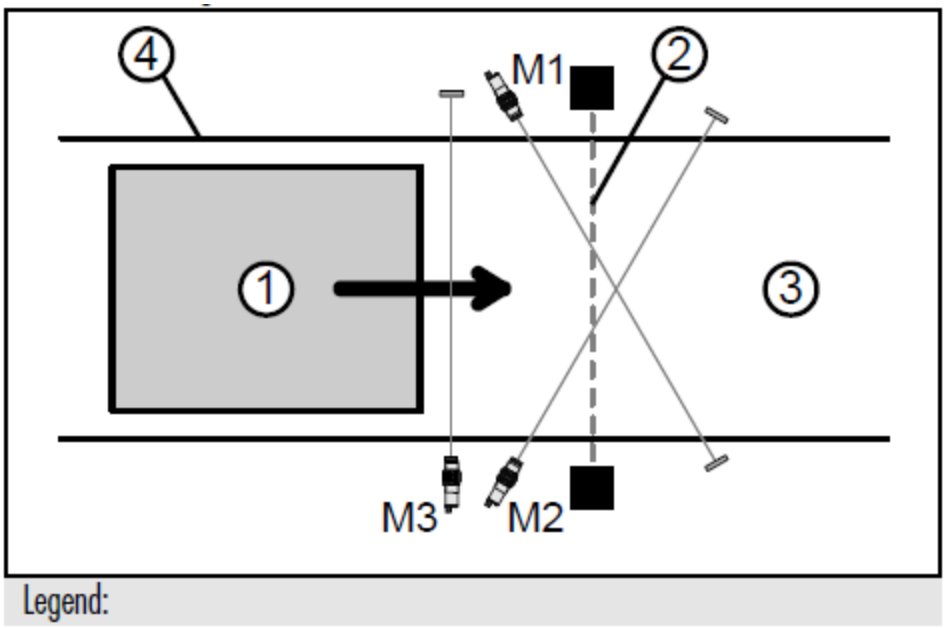
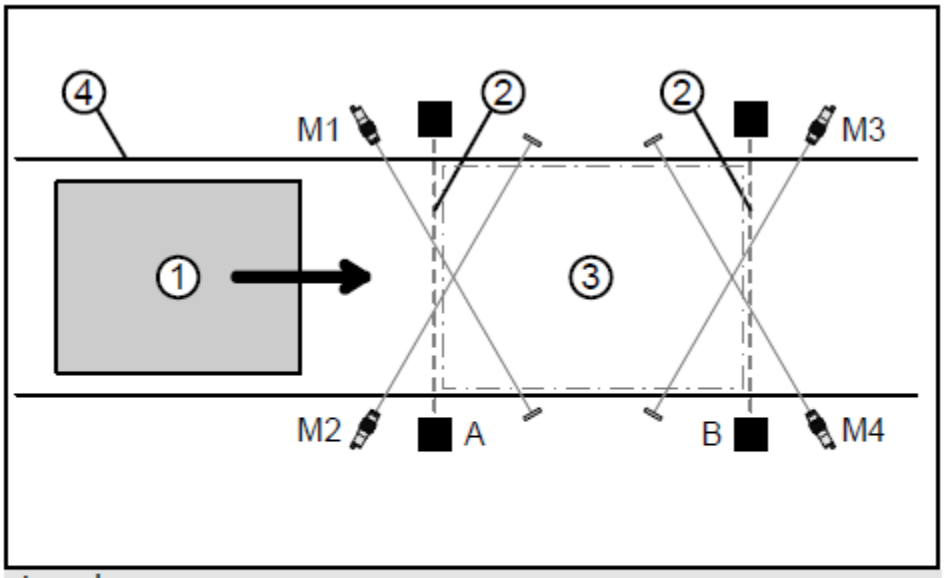


Fig.2.5 3-Muting sensor configuration

In this configuration, the sensors M1 and M2 must be installed as in the previous case, and M3 must be positioned in such a way that it becomes active before either M1 or M2. The sensor M3 recognises the direction from which the pallet or material is coming and therefore it must be the first sensor to be obscured.
After this, the other two sensors are activated according to the rules of the previous case (see *Tab.2.1*), and therefore they must respect the concurrence if enabled (and the maximum duration of the Muting condition that is equal to 3 min.).
M3 must then remain active until both the other two sensors have been activated in their turn, and only when this has been done can the Muting condition commence. The Muting condition terminates when one of the two sensors, M1 or M2, is deactivated, independently of the status of M3.
There is no time limit between the moment M3 is activated and the moment M1 (or M2) is activated, but it is essential that M3 is activated before the other two. It is also necessary in this case for all the sensors to have switched OFF before a new Muting condition can begin; therefore, the Override function is available at the moment of starting up (see *Par.2.5.4*) if there is at least one sensor active.

2+2-sensor configuration



Legend:

1 material	4 conveyor
2 protective field	M1, M2, M3: Muting sensors
3 danger zone	

Fig.2.6 4-Muting sensors configuration

In such a configuration, the inputs Sens. A and Sens. B are associated respectively with the pair of Muting sensors M1-M2 and the pair of Muting sensors M3-M4. The pairs of Muting sensors M1-M2 and M3-M4 must respect the same limits as those for the two-sensor configuration, exactly as two separate light grids were installed.

It is also possible to create systems with partial Muting functions. For example, in the configuration with the double Muting, by only connecting the sensors M1 and M2, a system with two channels, A and B, can be created wherein the first channel carries out the Muting function and the second does not (see *Fig.3.7*).

2.5.3 Location of Muting sensors

As well as the general safety recommendations given in *Par.2.2*, we strongly recommend that these instructions are followed:

- The Muting sensors must always be positioned in such a way that they can distinguish between the transit of material and the transit of a person
- There must not be any interruptions in the output signals sent by the Muting sensors, during the transit of the material through the detection zone. If the sizes of the material may vary or material has holes or apertures, to remedy any signal interruptions it is possible to connect supplementary sensors in parallel with each Muting sensor.

- If there is a series of pallets which are very close to each other and they keep the Muting sensors continually active, the distance between the pallets must be checked to make sure is not big enough to allow a person to enter.
  If the Muting is used continuously, take care when using the Override function as following an Override action the Muting status cannot last longer than 30 minutes. After this time the SBCR03 control unit, unable to check the operation of the Muting sensors dynamically (via a correct Muting sequence), will go into Lock-out.
- The sensors must detect the material and not the pallet or the means of transport, in this way preventing anyone from getting on to the means of transport and entering the danger zone.

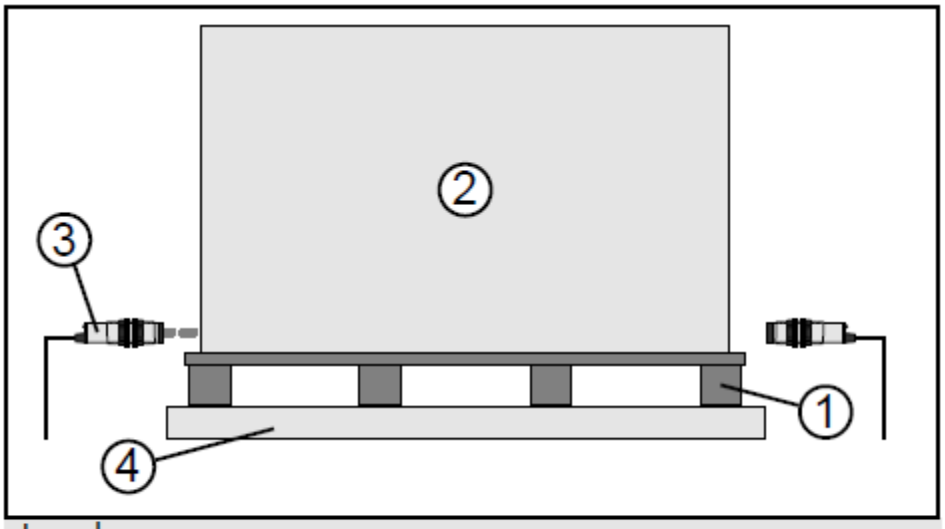


Fig.2.7 The Muting sensors must detect the material and not the pallet

- The optical safety beams can only be obscured after 270 ms from the activation of the Muting sensors since this is the minimum period required for the processing of the signals sent by the sensors.

2.5.4 Override

The Override function allows the user to remove any objects remaining stationary in the monitored area as a result of an error during the Muting action, setting the system in a forced Muting status. The protection system can be suspended even though the light beams remain obscured. The Muting sensors must supply the SBCR03 control unit with a configuration of signals which is valid for the activation of the Override function. This possibility is signaled by the Muting indicator lamps with a flashing light of 1 s ON and 1 s OFF. The Override button must be pressed and then released again. The SBCR03 control unit will only return to its normal operating mode when all the muting sensors have been deactivated.

If an error in the Muting device occurs repeatedly the system, and in particular the arrangement of the Muting sensors, must be checked.

After the Override function has been activated, the forced Muting status cannot go on for longer than 30 minutes. Once this period has finished, the control unit will stop the process. Moreover, the system must carry out a new correct Muting sequence within 30 minutes otherwise the control unit will stop the process the next time the Override function is used.
If the Muting indicator lamps are faulty, the Override function can no longer be activated.

Choose the correct locations for the Override button and indicator lamp!
The Override button must be installed so that it cannot be operated from inside the danger zone and so that the danger zone is clearly visible when the button is pressed. The Muting indicator lamps (which signal both the Muting condition and the Override one) must also be visible from the system's control panel.

The Override button must be a N/O button, which connects 24 VDC to the Override input of the SBCR03 control unit.

2.6 System components

To construct a valid safety system the following components are necessary:

Muting Sensors
In general, any type of Muting sensor can be connected to the SBCR03 control unit:

- Optical sensors
- Inductive sensors
- Mechanical switches
- PLC signals

They must all comply with the following technical specification:

Technical data of the Muting sensors:	
Nominal voltage	24VDC
Type of output.	PNP (or relay)
Voltage level when	
the object is recognized.	high (> 15,5VDC)
the object is not recognized.	low (< 10,5VDC)

The Muting sensors and the safety sensors cannot be supplied by the power coming from the SBCR03 control unit.

Relay module

The OSSD outputs of the SBCR03 control unit are static and capable of providing a maximum current of 0.5 A.
If there is insufficient current, it is necessary to control an alternate load, or if any potential-free contacts are needed, a relay module can be connected with two potential-free contacts (see *Chap.7*).

Muting indicator lamps

As required by standards, the Muting function, when it is active, must be indicated by a white lamp: two PNP outputs are supplied for this purpose which can control two lamps with a power of 1 to 10 W.
It is essential to have two lamp outputs when working with 2+2 sensors (double Muting), and it is simply convenient when not working in this way. The operation then is closely linked to the configuration, according to the following specifications:

- 2 and 3 Muting sensors:
  1 If one Muting indicator lamp is installed it must be connected to the LAMP1 terminal, and it is necessary to connect the LAMP 2 output to the nearest Intercon+ terminal to inform the Muting unit that the second lamp has not been installed. The lamp lit permanently when the muting action is in progress and off when the function is deactivated. If the lamp breaks while it is on, the Muting action will terminate normally, but at the next attempt to switch it on, the system will go to Lock-out state.
  2 If there are two lamps, when the Muting function is activated both of the lamps are tested: if both function, lamp 1 will remain on constantly, while if lamp 2 is broken, lamp 1 will start to flash. On the other hand, if lamp 1 is broken, lamp 2 will start flashing, and if they are both broken, the system will go into Lock out. In this case the broken lamp can be replaced while the system is running: the next time the function is started up both the lamps will be tested once again, and any new situations will be recognized. The flashing mode which informs the user that one of the lamps has failed is 3.5 s ON, 0.5 s OFF.
- 2+2 Muting sensors: in this case, both of the lamps must be installed but they will work independently of each other. Lamp 1 will light up constantly when the sensors M1 and M2 activate their Muting function, while lamp 2 will light up when M3 and M4 activate their Muting function. If one of the two lamps breaks, at the next attempt to switch it on, the system will go to Lock-out state.

Visibility of Muting indicator lamps!
The Muting indicator lamps must be visible from the system's control panel and from the monitored access areas.

Technical data:	
Power supply	24VDC (from SBCR03 control unit)
Lamp power.	1 . . . 10W
Maximum cable length.	10m
Minimum advised working life.	ca. 2500h

2.7 Display elements

There are 7 LEDs and a 7-segment display on the SBCR03 panel, which display the relevant diagnostic information.

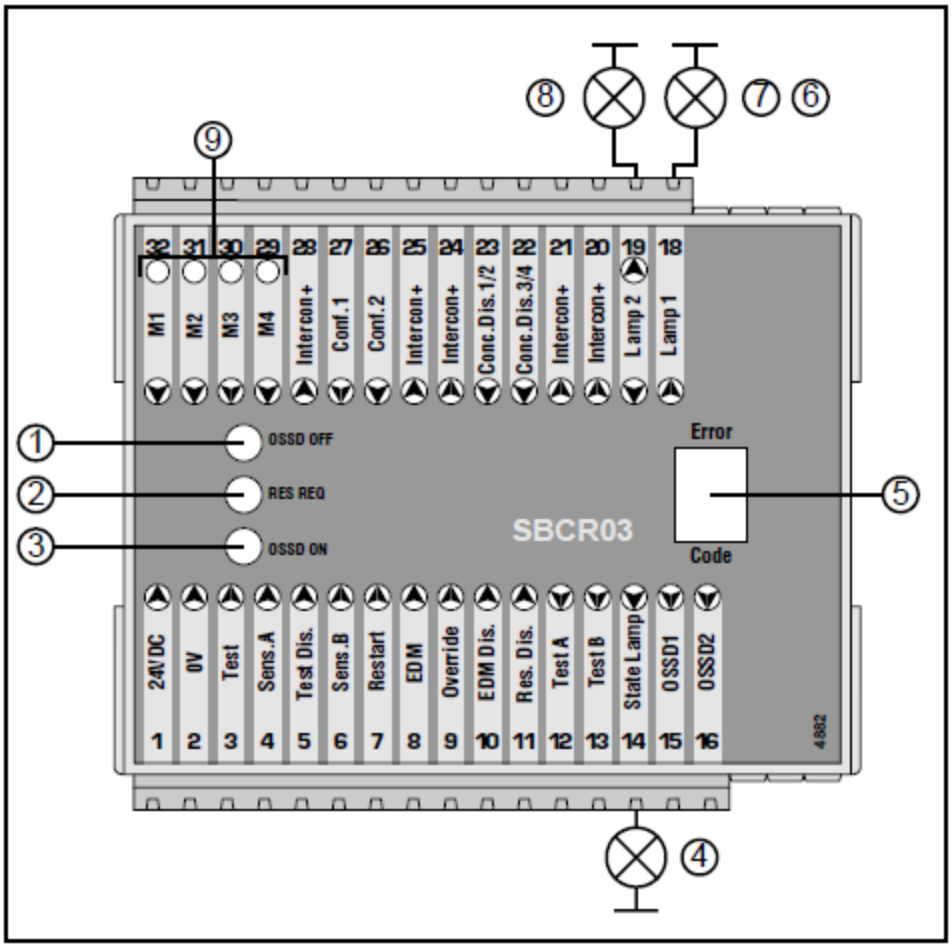


Fig.2.8 Display elements of the SBCR03 control unit with Muting

Nr.	Status Indicator	Meaning/function
1	LED "OSSD OFF" red	ON: indicates the OSSD outputs are switched OFF (light beam broken)
2	LED "RES REQ" yellow	ON: indicates the control unit is awaiting the restart command (light beams clear)
3	LED "OSSD ON" green	ON: indicates the OSSD outputs are active (light beams clear)
4	STATE LAMP	ON, in Automatic Restart Mode: indicates the OSSD outputs are in the OFF-state (red lamp) ON, in Restart Interlock Mode: indicates the unit is awaiting restart (yellow lamp)
5	7-segment display	Displays the error codes (see *Tab.A.1*) OFF: control unit is operating normally "C": Muting function is active (1)
6 (1)	LAMP 1 and/or LAMP 2	ON: Muting condition is active on channels 1 and/or 2. Flashing 1 s ON/1 s OFF: Override function is active on channels 1 and/or 2
7 (1)	LAMP 1	Flashing 3.5 s ON/0.5 s OFF: the Muting indicator lamp 2 is broken or there is no jumper between LAMP 2 and Intercon+
8 (1)	LAMP 2 (if connected)	Flashing 3.5 s ON/0.5 s OFF: the Muting indicator lamp 1 (in LAMP 1) is broken or disconnected
9 (1)	LED "M1", "M2", "M3", "M4" yellow	ON: the corresponding Muting inputs are active

Tab.2.4 Display elements for SBCR03 control unit with and without Muting.

(1) Available only in the SBCR03 control unit with Muting.

3. Installation of the SBCR03 control unit

3.1 Mounting

Only install the IP 20 housing in a control panel with a minimum protection degree of IP 54!
The IP 20 model is fastened by inserting the housing in a DIN rail.
Make sure the working temperature limits are respected inside the panel.

3.2 Electrical installation

Disconnect the system from the power supply
The system could start up accidentally or the control unit could be damaged if the electrical connections are made while the system is still connected to the main power supply.

Make sure the system is not live during the electrical installation.

The sensor and input cables must not run alongside power cables.

Anticipate the possibility that cables with two separate channels can short circuit.

Make the electrical connections following the enclosed drawings and using the following tables with the terminals descriptions.

SBCR03/S-A0 control unit (without Muting) and SBCR03/S-AM control unit (with Muting)

Nr.Pin	Marking	IN/OUT	Terminal description
1	24VDC	-	Power supply input +24 VDC
2	0V	-	Power supply reference, 0V
3	Test	IN	External test control input, not compulsory. If not used, connect to +24 VDC 0V = external test activated, +24 VDC = external test deactivated;
4	Sens.A (*)	IN	Input for photoelectric switch, channel A
5	Test Dis.	IN	Test function programming input 0V = testable sensors (SH, TH, SBA). 24 VDC = SBL, SBH self-tested sensors with double output
6	Sens.B (*)	IN	Input for photoelectric switch, channel B
7	Restart	IN	Start/Restart command input, connection to N/O button and to +24 VDC
8	EDM	IN	Input for checking the correct switching of the external relays. Connect to the series of N/C contacts and +24 VDC for monitoring the external relays. With EDM function deactivated (EDM Dis. to +24 VDC), connect EDM to +24 VDC.
9	Override	IN	Override control input, connection to N/O button and to 24 VDC. Not available in the models without Muting
10	EDM Dis.	IN	External contacts monitoring EDM function programming input. 0V = EDM activated +24 VDC = EDM deactivated (in this case connect EDM to +24 VDC)
11	Res. Dis.	IN	Restart Interlock function programming input. 0V = Restart Interlock activated +24 VDC = Restart Interlock deactivated
12	Test A (**)	OUT	Output for the Test signal of the photoelectric switch, channel A. Level of test pulse: low level (0V) if the control unit is configured for testable sensors, no test pulse if the control unit is configured for self-tested sensors
13	Test B (**)	OUT	Output for the Test signal of the photoelectric switch, channel B. Level of test pulse: low level (0V) if the control unit is configured for testable sensors, no test pulse if the control unit is configured for self-tested sensors
14	State Lamp	OUT	State indicator lamp output, +24 VDC, PNP, 40…500mA. Automatic Restart Mode: this lamp must be red. When lit it indicates the control unit is OFF (light beam broken), when not lit it indicates the control unit is ON (light beams clear). Restart Interlock Mode: this lamp must be yellow. When lit it indicates the control unit is awaiting the restart (light beams clear), when not lit it indicates the safety control unit has been restarted (light beams clear) or is OFF (light beam broken).
15	OSSD1	OUT	Safety output 1, PNP, 500 mA
16	OSSD2	OUT	Safety output 2, PNP, 500 mA

Tab.3.1 Connections for SBCR03 control unit with and without Muting.

(*) If only one channel is used, Sens. A (4) and Sens. B (6) must be connected via a jumper and either Test A or Test B can be connected to the sender test input.
(**) If the control unit is configured for testable sensors, this output is normally at high voltage level and it goes to low voltage level on every Test occurrence.
If the control unit is configured for self-tested sensors, this output is always at high voltage level.

SBCR03/S-AM control unit (with Muting)

Pin Nr.	Marking	IN/OUT	Terminal Description
18	Lamp 1	OUT	Output for Muting indicator lamp, +24 VDC, PNP, 40…500 mA.
19	Lamp 2	IN/OUT	Output for Muting indicator lamp, +24 VDC, PNP, 40…500 mA or configuration input. If only LAMP 1 is used, this terminal must be connected to Intercon+.
20	Intercon+	OUT	Voltage available for configuration, does not use for other purposes.
21	Intercon+	OUT	Voltage available for configuration, does not use for other purposes.
22	Conc.Dis.3/4	IN	Concurrence monitoring configuration input (sensors 3 and 4), see *Tab.3.3*
23	Conc.Dis.1/2	IN	Concurrence monitoring configuration input (sensors 1 and 2), see *Tab.3.3*
24	Intercon+		Voltage available for configuration, does not use for other purposes.
25	Intercon+		Voltage available for configuration, does not use for other purposes.
26	Conf.1	IN	Configuration of the number of Muting sensors installed:
			Conf.1 / Conf.2 / Nr. Muting sensors
			0V (nc) / 0V (nc) / 2+2 sensors
27	Conf.2		+24 VDC (Intercon+) / 0V (nc) / 3 sensors
		IN	0V (nc) / +24 VDC (Intercon+) / 2 sensors
			+24 VDC (Intercon+) / +24 VDC (Intercon+) / Not possible
28	Intercon+	OUT	Voltage available for configuration, does not use for other purposes.
29	M4	IN	Input for Muting sensor 4
30	M3	IN	Input for Muting sensor 3
31	M2	IN	Input for Muting sensor 2
32	M1	IN	Input for Muting sensor 1

Tab.3.2 Connections for SBCR03 control unit with Muting, nc = not connected

SBCR03/S-AM control unit (with Muting)

Nr. Muting sensors	Conc. 3/4	Conc.Dis. 1/2	Muting operational mode:
4	nc	nc	Concurrence monitoring M1-M2, M3-M4 activated
	nc	Intercon+	Concurrence monitoring M3-M4 activated, M1-M2 deactivated
	Intercon+	nc	Concurrence monitoring M1-M2 activated, M3-M4 deactivated
	Intercon+	Intercon+	No concurrence monitoring
3	nc	nc	Concurrence monitoring M1-M2 Direction recognition from M3 to M1-M2
	nc	Intercon+	Only direction recognition
2	nc	nc	Concurrence monitoring M1-M2
	nc	Intercon+	No concurrence monitoring

Tab.3.3 Muting monitoring configurations, nc = not connected

3.3 Commissioning

3.3.1 An overview of the commissioning

Check the danger zone!
Before commissioning commences, make sure that there is no one inside the danger zone. Check the danger zone and prevent anyone entering it (put up hazard warning signs, for example, block off the access areas or other such methods). Take note of the laws concerning this and local regulations.

When the SBCR03 control unit is put to use, all its functions must be checked to guarantee its safe installation. When putting the device to use, follow these steps:

3.3.2 Inspection of the SBCR03 control unit

The following points must be noted for the control unit's safe operation to be guaranteed:

- The wiring harnesses for the electrical connections must only be made by specialized personnel. The term 'specialized' means someone with a sufficient knowledge of the field of electrical operations checks, said knowledge having been gained from specific training and experience. Furthermore, the person must know the national regulations regarding safety in the workplace and accident prevention, the directives and the recognized technical standards in general. As a result, the person will be competent enough to judge the safe operating status of the electrical operations. The specialist must also be competent within the field of non-contact safety systems.
- When the control unit is started up for the first time a check must be made on the machine's safety system by specialized staff:
    - Before using the control unit, check the national and international regulations have been observed, in particular the machine directives and those concerning safety in the workplace (EC Declaration of Conformity)

  - Check the efficiency of the machine's safety system in all the possible configurations of the operating modes.
  - The staff who uses the machine protected by the safety devices must be trained by specialized personnel before they begin work.
  - The machine purchaser is responsible for the staff training.
- Routine checks with intervals as prescribed by the national regulations in force:
  - These checks are useful to see if the safety devices have been modified or tampered with after the first use.
  - The checks must be carried out every time any essential modifications are made to the machine or the control unit and after any machine parts have been replaced or the electric panel has been repaired in the event of damage to the housing, to the front panel, to the connection cables etc.
- Daily checks of the safety device must be carried out by trained personnel:
  - Check that the safety system is efficient in all the pre-determined operating modes.

SBCR03 control unit with single beam or multiple beam sensors (body protection)
Every day, on starting work, the user must completely obscure each of the optics at three different points:

1. Near the sender
2. Near the receiver
3. At a central point between the sender and the receiver, near the optical axis.

During these operations, the control unit must switch off and the state indicator lamp (yellow lamp) must remain off if the control unit is configured in the Restart Interlock mode. If, however, the control unit is configured in Automatic Restart Mode, the red lamp must be on.

SBCR03 control unit with safety light curtain (hand protection)
Slowly run the test rod (whose diameter is equal to the resolution of the light curtain used) through the protected zone at three different points:

1. Near the sender
2. Near the receiver
3. At a central point between the sender and the receiver.

During these operations, the SBCR03 control unit must switch off and the state indicator lamp (yellow lamp) must remain off if the control unit is configured in the Restart Interlock mode. If, however, the control unit is configured in Automatic Restart Mode, the red lamp must be on constantly.

3.4 Technical data

Technical data of the SBCR03 control unit:	
Supply voltage U_B	24VDC -30%. . . +20%, 5% maximum ripple (1) (2)
Current consumption	I_{max}=100mA, Muting version: I_{max}=150mA
Power consumption.	4W (without loads or lamps)
Response time.	With fast reponse time sensors: 12ms(3) With self_tested sensors:sensor response time + 5 ms
Response time for Test input.	max. 30ms
Restart time	max. 50ms
Reaction time for Muting	max. 270ms
Connection cables	0,5mm^2, L≤30m; 2,5mm^2, 30<L≤60m (power) 0,2mm^2, L≤100m (sensors)
Inputs: high/low signal	High: 15V. . .U_B, low: 0V. . .10V
Test	High: external test inactive, Low: external test active Pulse duration > 30ms
Concurrence monitoring	Time windows available: 3s or ∞
Self-test cycle duration	4ms
OSSD 1, 2 outputs (the level refers to the external connections in the control unit connector)	PNP, monitored and with short circuit protection Max. switching current I_{max} = 500mA Max. switching voltage U_{max} = UB - 2,0V with 500mA Max. switching power P_{max} = 13,2W Inductive switching power P_{maxind} = 1VA Output level with protected zone clear: U = U_{max} Output level with protected zone engaged: U = 0V Residual current with output OFF I_{Leak} = 0mA Max. capacitive load 10µF
Test A, Test B (inactive/active)	UB - 2,65V/0V total current for Test A + Test B < 10 mA
State Lamp	24VDC, 1…10W
Lamp1, Lamp2	24VDC, 1…10W
Protection class	III(2)
Enclose rating	IP 20
Type	Type 2, EN61496
Safety integrity level	SIL CL 1, EN62061
Category	Cat. 2, EN ISO 13849-1
Performance level	PL c, EN ISO 13849-1
Operating temperature	-20°C…+60°C
Storage temperature	-25°C…+75°C
Air humidity	15%…95%
Vibration resistance	5 g/10 Hz…55 Hz according to IEC 68-2-6
Shock resistance	10 g/16 ms according to IEC 68-2-29

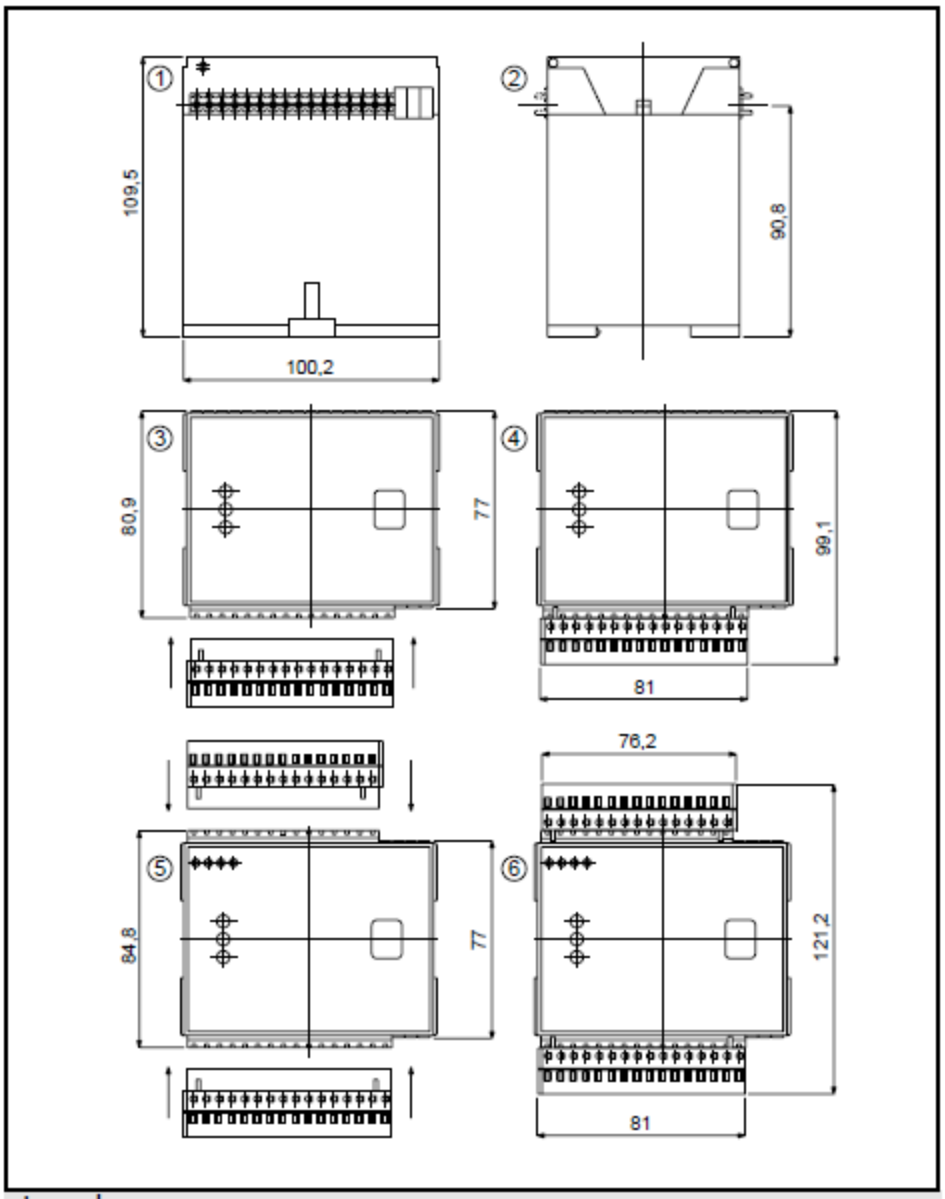
Tab.3.2 Technical data for SBCR03 control unit with Muting

(1) The voltage limits cannot be exceeded.

(2) In compliance with EN 60204 the external power supply voltage must be able to withstand a power failure lasting 20 ms.

(3) Fast response time means that the single or cascade sensors must react to the Dark/Light transition of the test signal within a time window of 200 to 800 µs.

3.5 Installation drawings

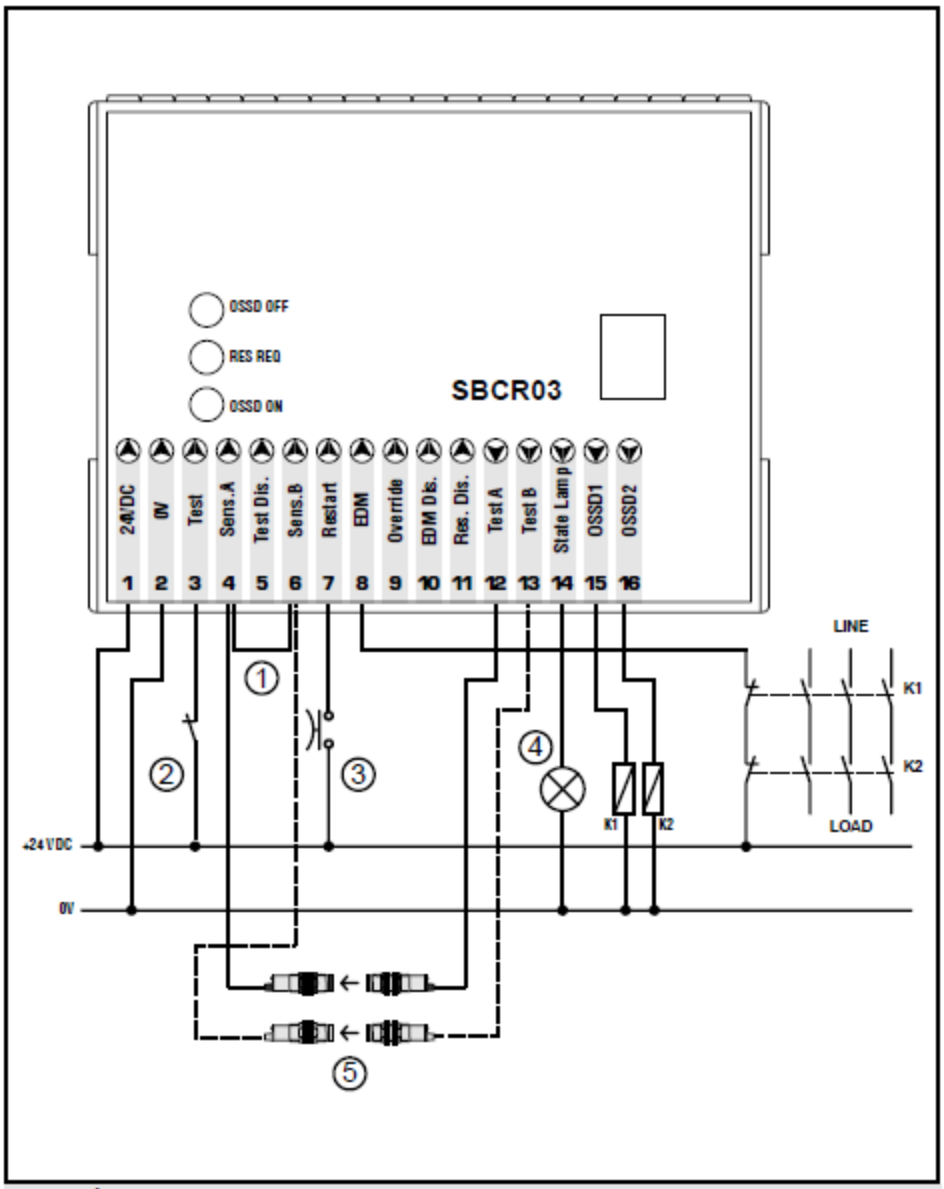


Legend:

1 front view
2 side view
3 top view (model without Muting)
4 top view with connectors fitted (model without Muting)
5 top view (model with Muting)
6 top view with connectors fitted (model with Muting)

Fig.3.1 Main dimensions of SBCR03-Muting control unit housing with connectors

3.6 Sample circuits

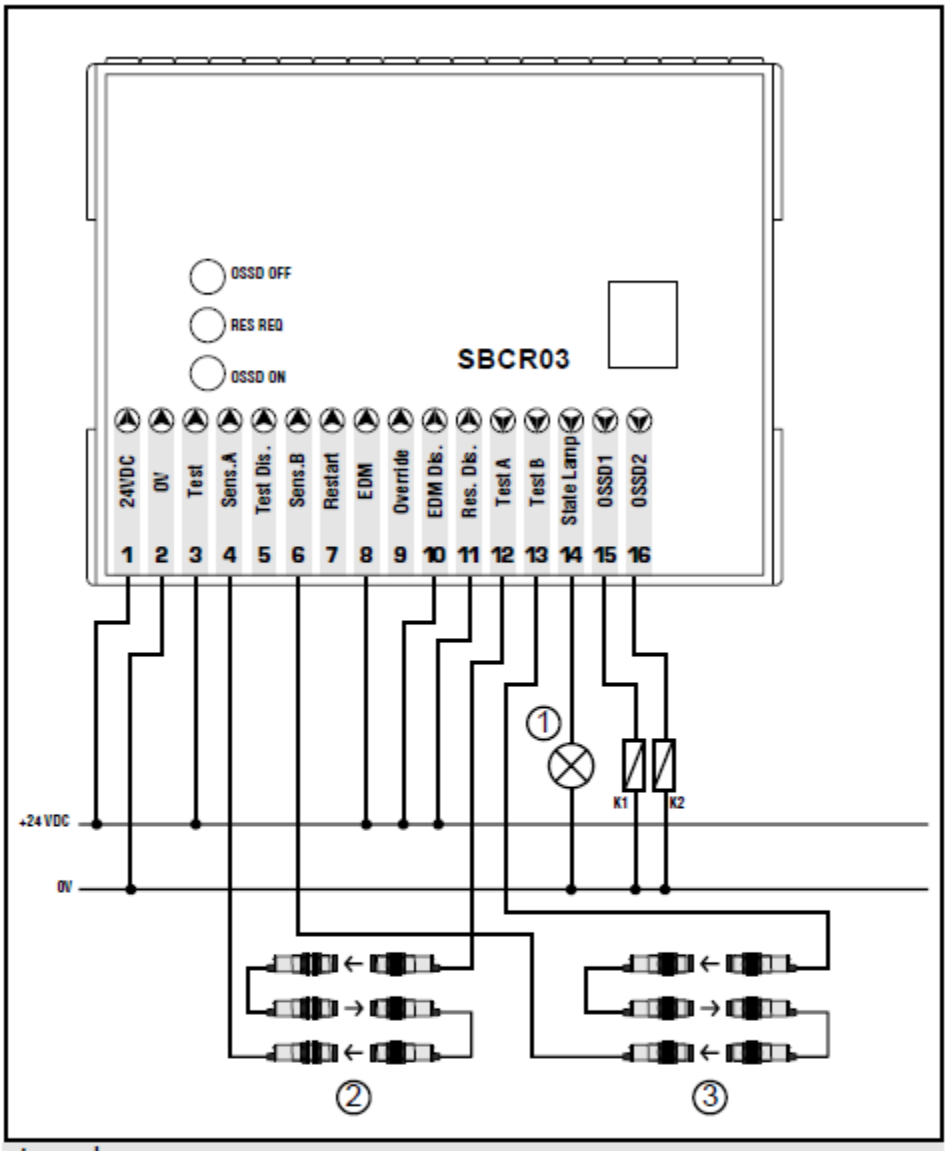


Legend:

1 if only channel A is used, a jumper must be inserted between Sens. A (4) and Sens. B (6)
2 test button
3 Start/Restart button
4 state indicator lamp
5 light grid

Configured functions:
- Relays check
- Restart interlock
- External test available

Fig.3.2 SBCR03 control unit with 2 photoelectric safety switches



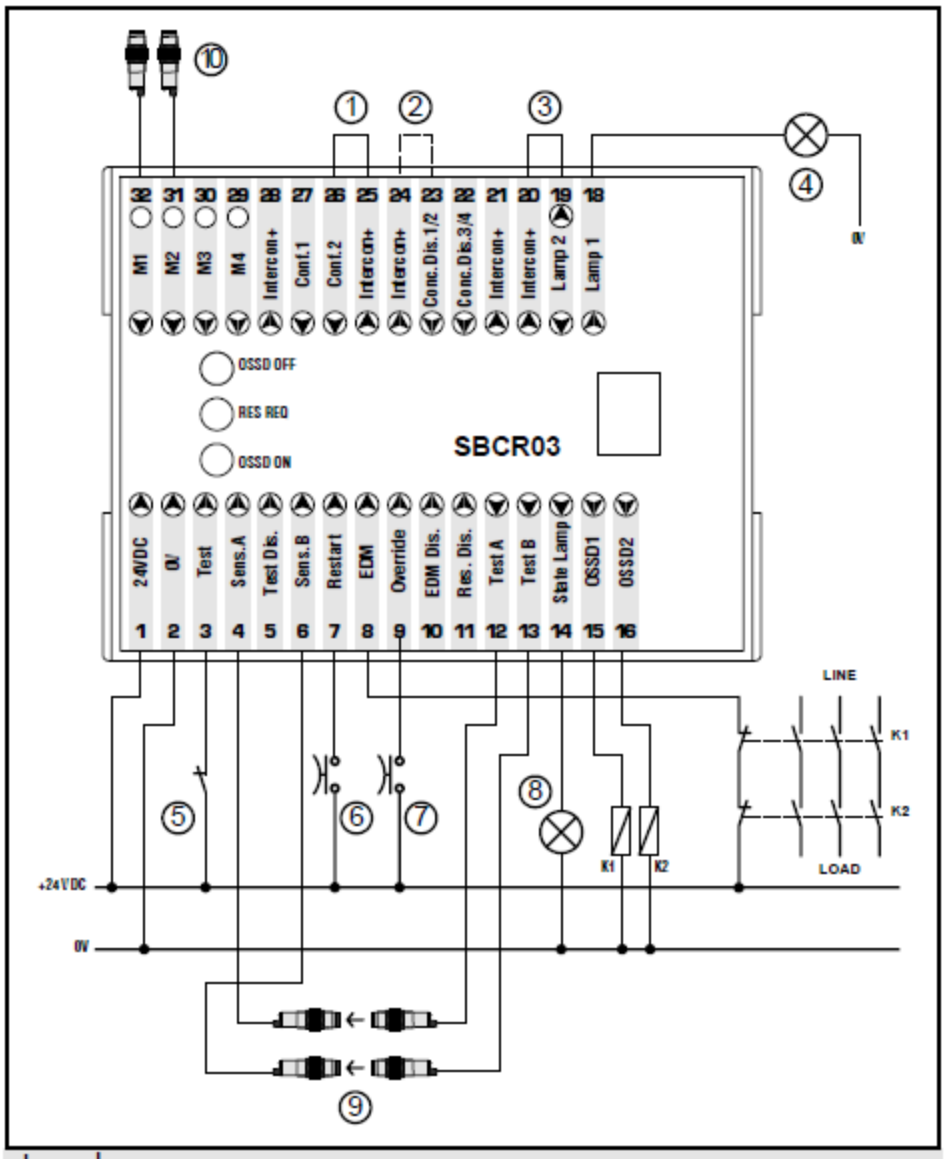
Legend:

1 state indicator lamp
2 light grid (channel A)
3 light grid (channel B)

Configured functions

- External test not available
- External relays check not implemented
- Automatic Restart Mode

Fig.3.3 SBCR03 control unit with 6 photoelectric safety switches



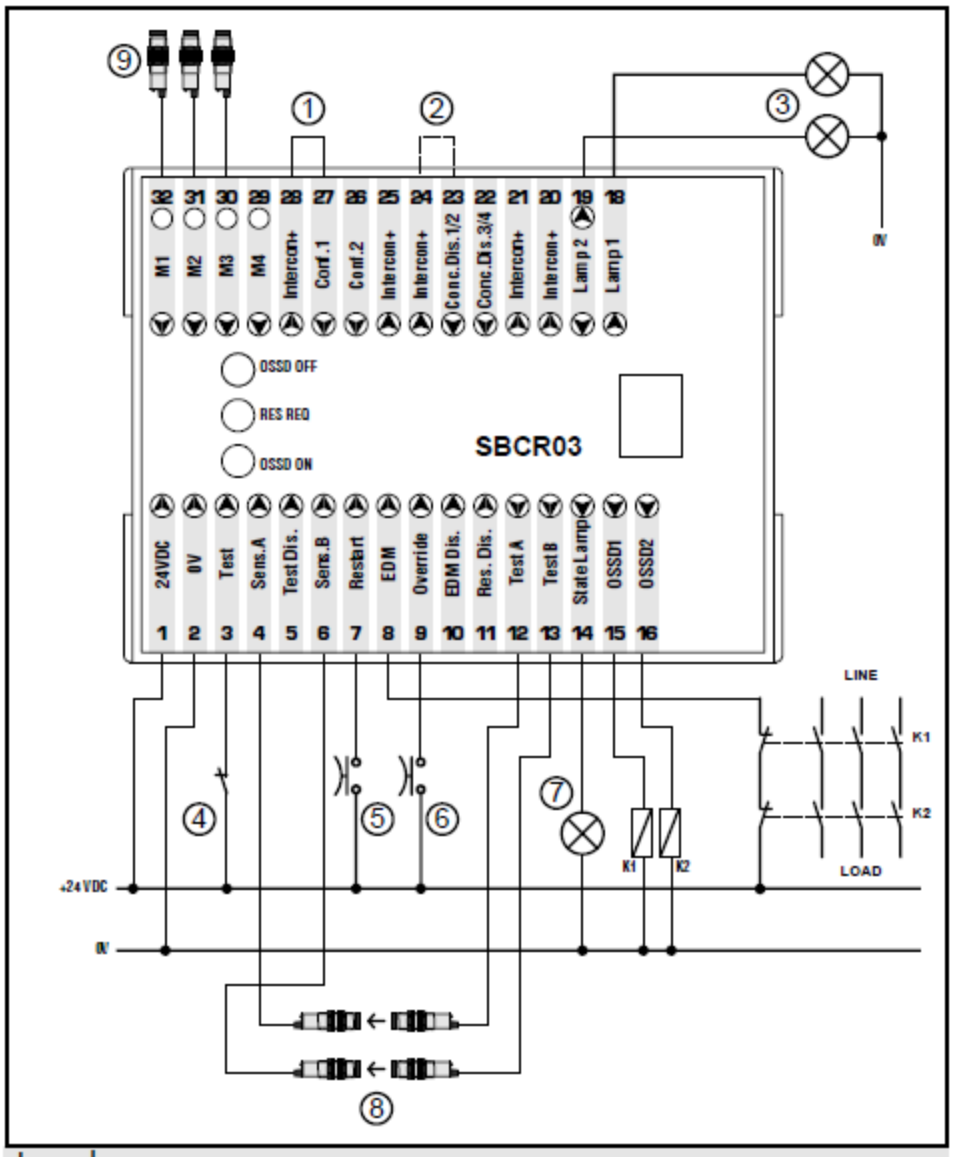
Legend:

1 jumper for 2 Muting-sensor configuration
2 insert this jumper to disable the concurrence monitoring on the M1-M2 pair
3 jumper for configuration with only one Muting lamp
4 Muting lamp
5 test button
6 Start/Restart button
7 Override button
8 state indicator lamp
9 light grid
10 Muting sensors

Funzioni configurate:

- Relays check
- 2 Muting sensors
- Override
- External test available
- Restart interlock
- Concurrence monitoring

Fig.3.4 SBCR03-Muting control unit with 2 photoelectric safety switches, 2 Muting sensors and 1 Muting lamp



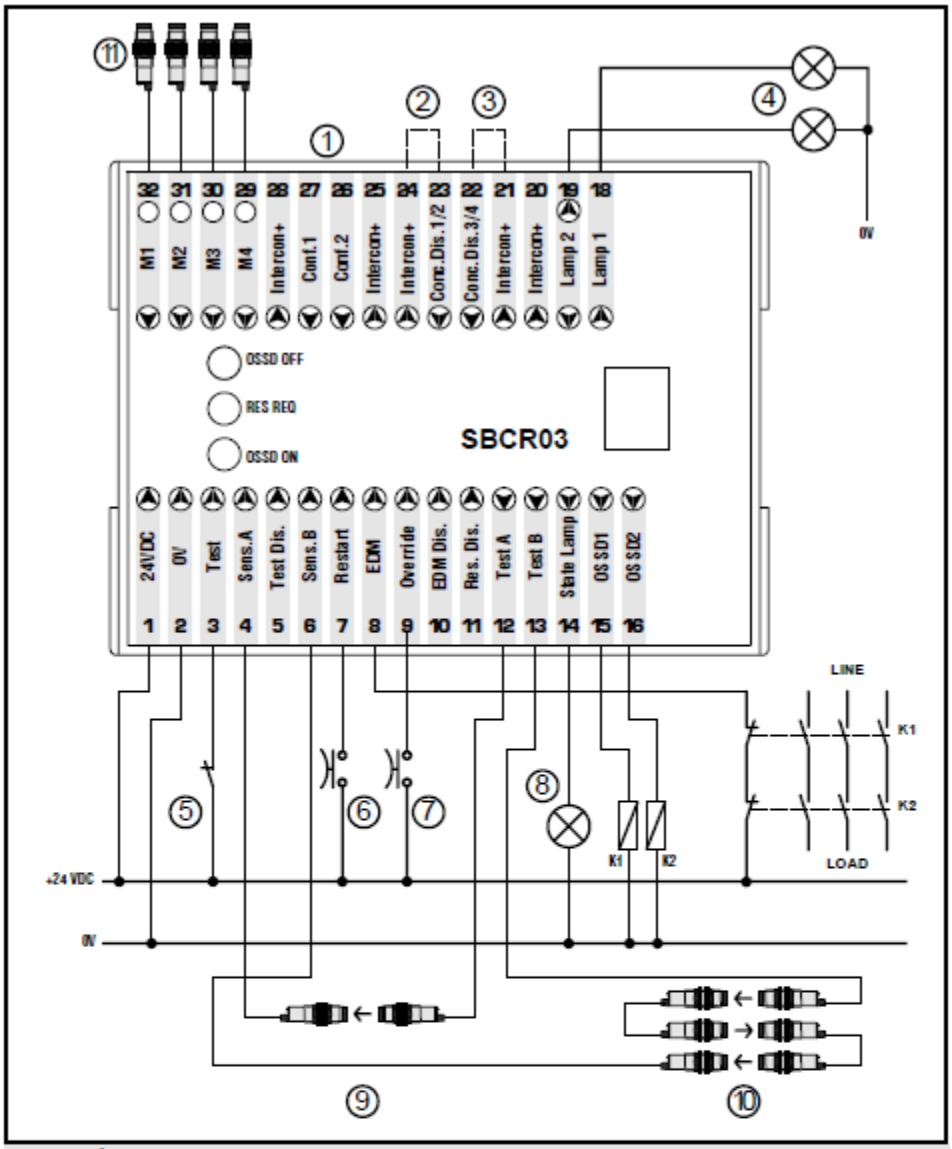
Legend:

1 jumper for 3 Muting sensor configuration
2 insert the jumper to disable the concurrence monitoring on the M1-M2 pair
3 Muting lamps
4 test button
5 Start/Restart button
6 Override button
7 state indicator lamp
8 light grid
9 Muting sensors

Configured functions:

- Relays check
- 3 Muting sensors
- Override
- External test available
- Restart interlock
- Concurrence monitoring

Fig.3.5 SBCR03-Muting control unit with 2 photoelectric safety switches, 3 Muting sensors and 2 Muting lamps



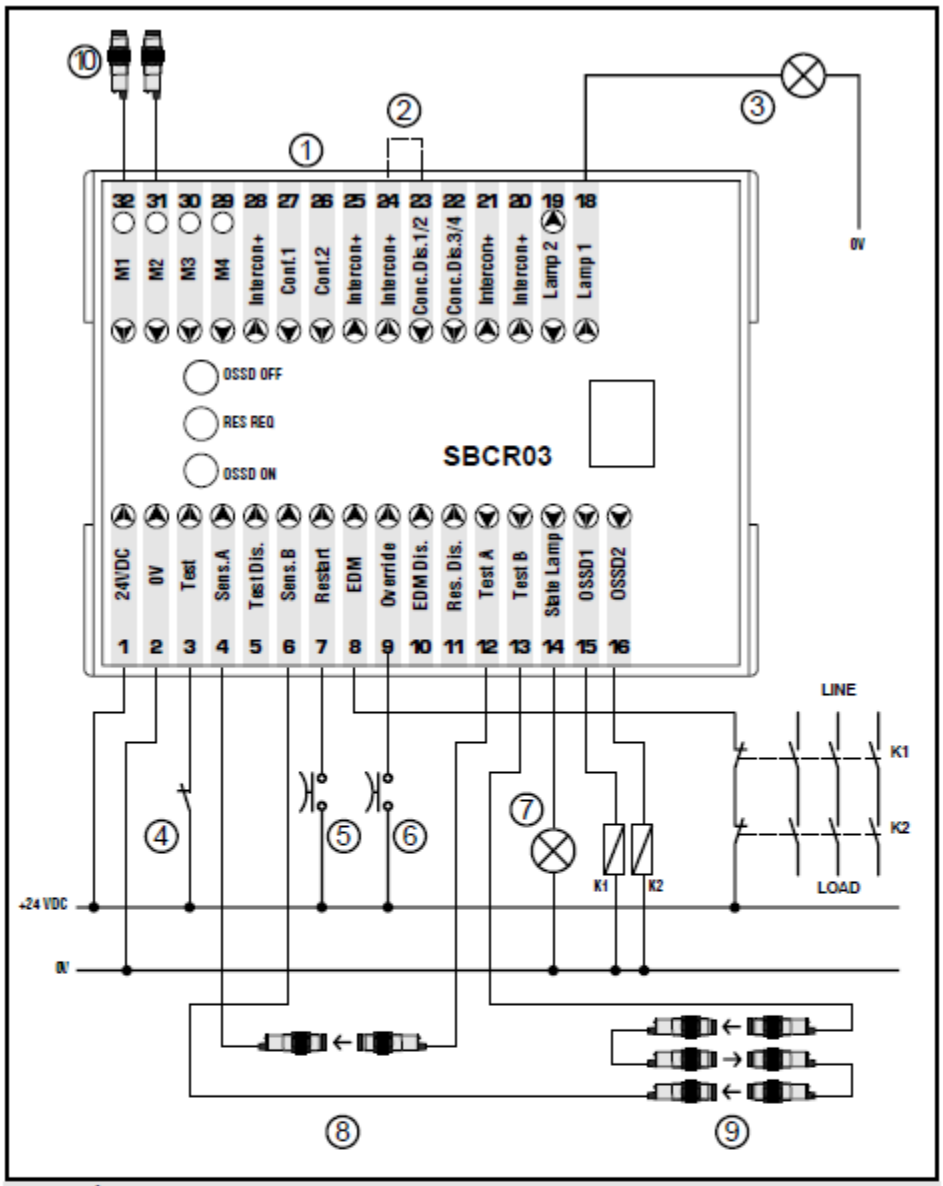
Legend:

1 for a 4 Muting-sensor configuration leave the Conf.1 and Conf.2 terminals disconnected
2 insert the jumper to disable the concurrence monitoring on the M1-M2 pair
3 insert the jumper to disable the concurrence monitoring on the M3-M4 pair
4 Muting lamps
5 test button
6 Start/Restart button
7 Override button
8 state indicator lamp
9 light grid A (Muting: M1-M2)
10 light grid B (Muting: M3-M4)
11 Muting sensors

Configured functions:

- Relays check
- 2+2 Muting sensors
- Override
- External test available
- Restart interlock
- Concurrence monitoring

Fig.3.6 SBCR03-Muting control unit with 2 photoelectric safety switches 2+2 Muting sensors and 2 Muting lamps



Legend:

1 for a mixed Muting configuration leave the Conf.1 and Conf.2 terminals disconnected
2 insert the jumper to disable the concurrence monitoring on the M1-M2 pair
3 Muting lamp
4 test button
5 Start/Restart button
6 Override button
7 state indicator lamp
8 light grid A (Muting: M1-M2)
9 light grid B (without Muting)
10 Muting sensors

Configured functions:

- Relays check
- 2+2 Muting sensors
- Override
- External test available
- Restart interlock
- Concurrence monitoring

Fig.3.7 Safety system with 2 light grids one of which with Muting and the other one without Muting

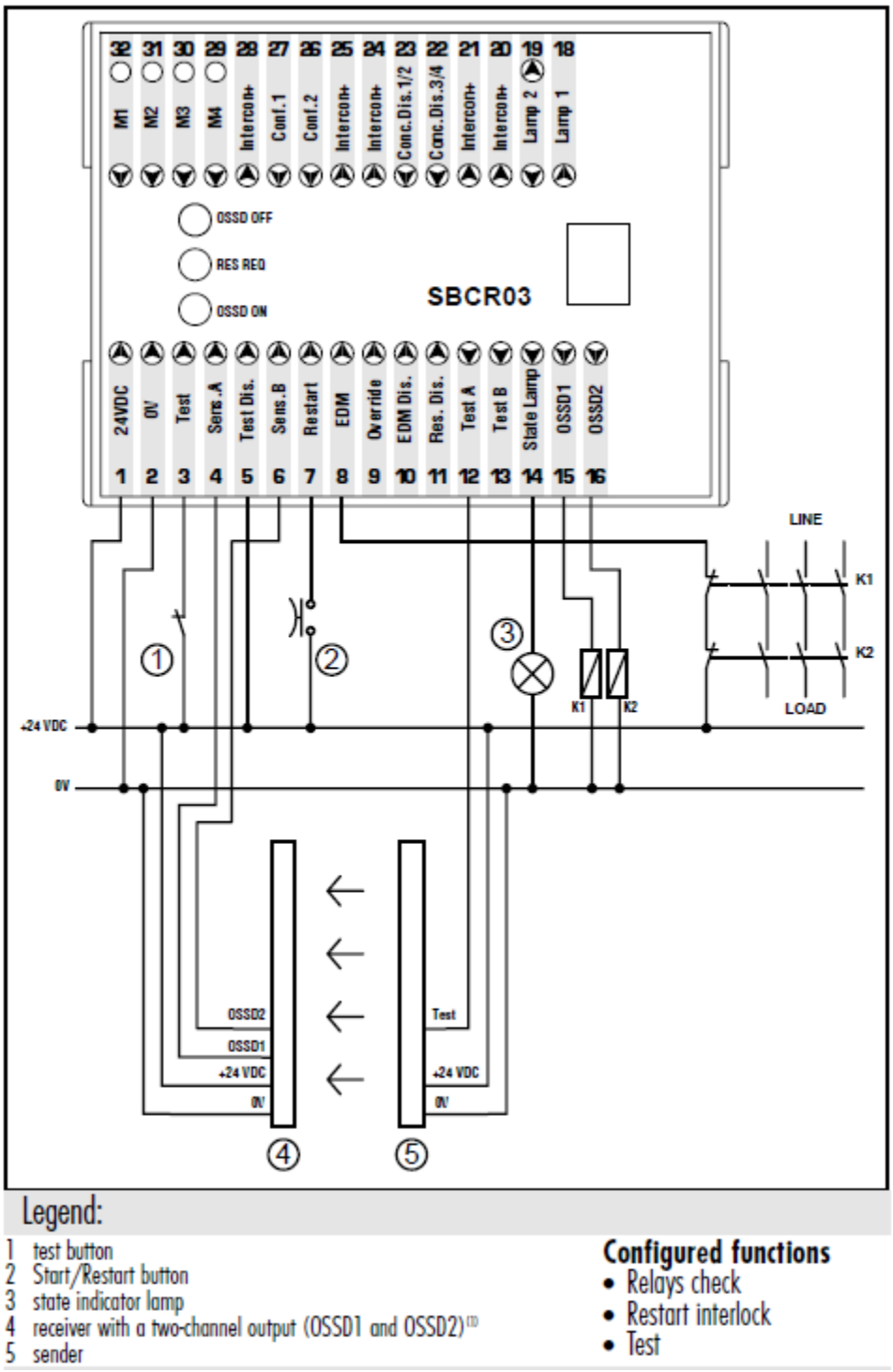
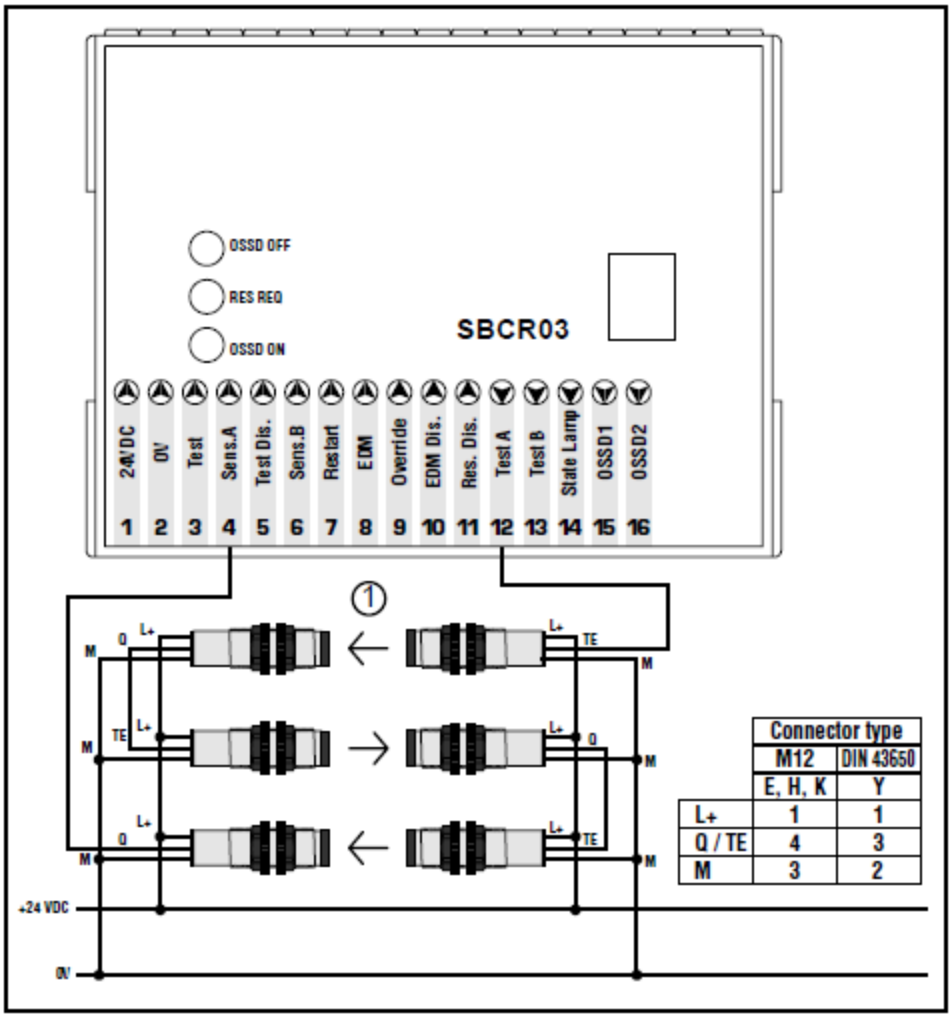


Fig.3.10 SBCR03 control unit with self-tested safety light curtain with OSSD output



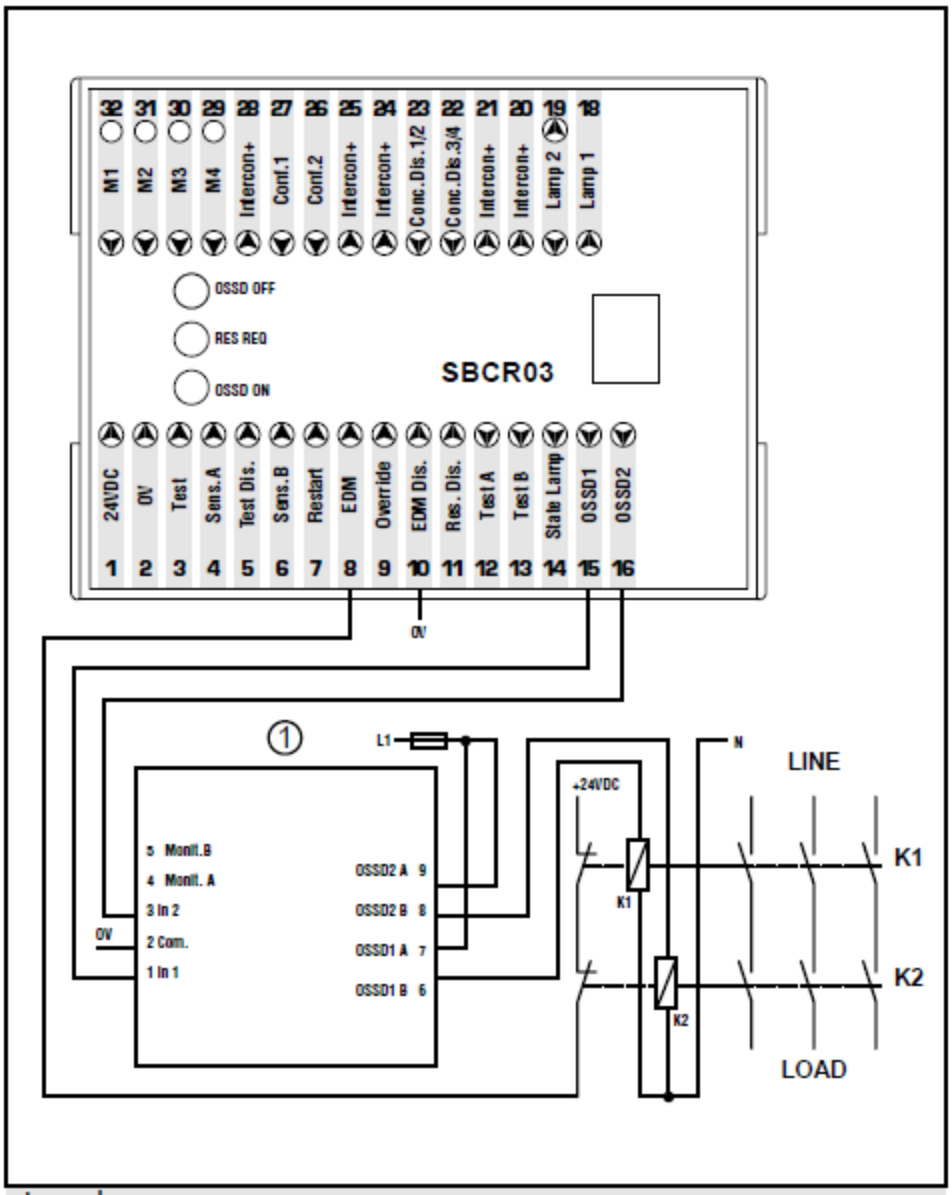
	Connector type	
	M12	DIN 43650
	E, H, K	Y
L+	1	1
Q / TE	4	3
M	3	2

Legend:

1 chain of testable single-beam photoelectric switches, SH or TH model
L+ pin 1 (connettor E,H,K,Y)
Q pin 4 (connettor E,H,K); pin 3 (connettor Y)
TE pin 4 (connettor E,H,K); pin 3 (connettor Y)
M pin 3 (connettor E,H,K); pin 2 (connettor Y)

Fig.3.11 Connection in cascade of 3 sender/receiver pairs for testable, single beam photoelectric safety switches, SH or TH model

Alternation between senders and receivers will avoid interference between two adjacent pairs of sensors. Check however that there is no interference between the first and the third pair of sensors, keeping suitable distance between the two optical axes.



Legend:

1 Realy module SB300 connected to the SBCR03 control unit

Fig.3.12 Relay module connected to the SBCR03 control unit

4. General rules for the installation of opto-electronic safety devices

Opto-electronic safety devices can only be used in machines where dangerous movements can be stopped immediately if the protected zone is obscured.
The machine must be fitted with supplementary safety devices, such as fixed screens which are duly locked into position, welded to the structure or fastened in such a way that to dismount them would require a tool, or other opto-electronic light grids and movable screens which make it impossible to access the protected zone or enter the area between the protected field and the dangerous movement, without obscuring the protected field. If the protected field is engaged, the movable screens have been removed or are not closed correctly, this must obscure the field and not allow the machine's movements to be restarted until the protected field has been cleared (unless there is a special control to do so). If the machine is fitted with an automatic restart which functions as soon as the protected area is clear, it must not be possible to enter the area between the protected zone and the danger zone without obscuring the protected zone. It must not be possible for anyone to tamper with the monitoring devices if the movable screens are positioned correctly. For machines in which two elements will approach each other (presses, cutters, etc…), the expression 'dangerous closing movement' refers to the moving parts which could cause accidents by crushing or cutting any body parts which may be placed between them; this movement terminates when the elements approach each other in such a way that no longer allows any body parts to be inserted.

4.1 Safety distance

Calculate the safety distance before installation!
Before installing an opto-electronic safety device, the safety distance must be calculated, that is the minimum distance from the danger zone at which the device must be positioned. In fact, it is not sufficient for the opto-electronic safety device to detect an intrusion and turn the outputs to the OFF-state, it must also do it quickly enough to stop the dangerous movement. It is necessary, then, to take into account the opto-electronic safety device's response time and above all, the machine's response time.

The safety distance (in compliance with EN ISO 13855 and EN ISO 13857) depends on:

- The response time of the system with the safety device, for example, the response time of the sensors, added to the SBCR03's response time, as well as that of the external contactors (for response times, see Technical Data in Par.3.4).
- The machine's stopping time.
- Speed of the hand or of approach.
- Resolution of the light curtain or distance between the beams.

The general formula for calculating the minimum safety distance is as follows:

$$S = K (t1 + t2) + C$$

where:

S: minimum distance between the protective field and the danger zone [mm].

K: speed of the approaching body or body part [mm/s].

t1: control unit response time [s].

t2: time required to stop the machine or remove the risk calculated from when the machine receives the output signal from the safety device [s].

C: additional distance based on intrusion towards the danger zone prior to actuation of the protective equipment.

The following parameters must also be taken into account:

P: height of the lowest beam [mm].

H: height of the highest beam [mm].

R: resolution or detection capacity (the smallest object that can be detected throughout the entire protected zone with absolute certainty [mm]). In the case of safety device with separate beams, the resolution is given by the step of the optics plus the diameter of the optics, as shown in *Fig.4.1*.

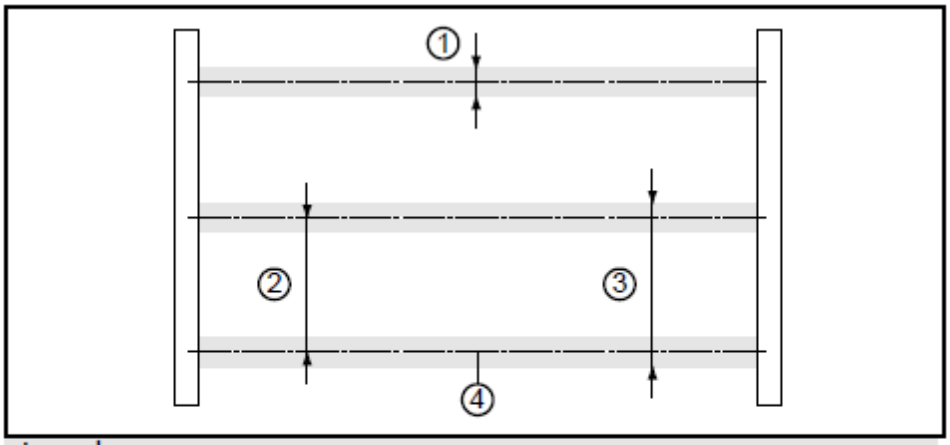


Fig.4.1 Parameters of light grids

The regulations outline three main cases based on the direction of approach to the detection zone:

- Perpendicular approach
- Parallel approach
- Angled approach

Perpendicular approach

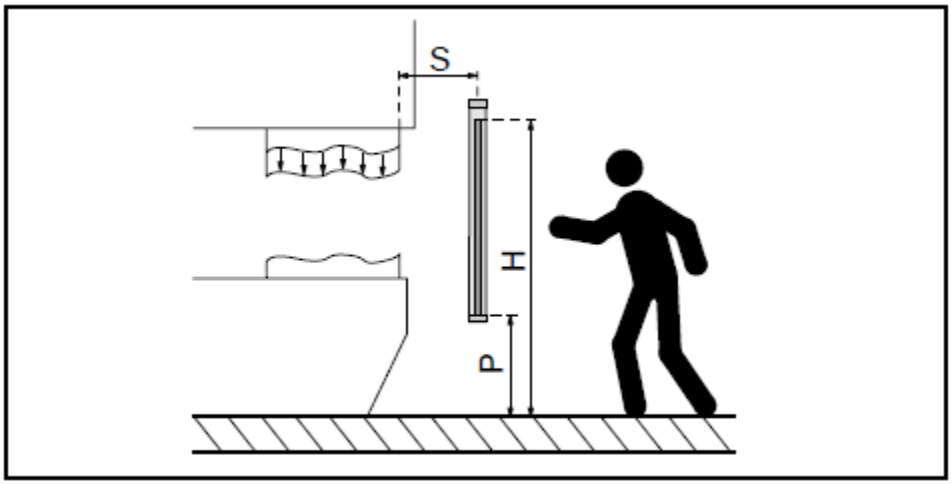


Fig.4.2 Self-tested light curtain, perpendicular approach

a) R ≤ 40 mm (protection of fingers and hands)
The safety distance must be calculated using the following formula:

$$S = 2000 (t1 + t2) + 8 (R - 14) [mm]$$

if 8 (R - 14) < 0 assume this quantity is 0
if S < 100 mm assume S = 100 mm

The formula is valid if S ≤ 500 mm
If S > 500 mm the distance must be calculated using the following formula:

$$S = 1600 (t1 + t2) + 8 (R - 14) [mm]$$

If 8 (R - 14) < 0 assume this quantity is 0

b) 40 mm ≤ R ≤ 70 mm (for protection of wrists and arms)
The safety distance must be calculated using the following formula:

$$S = 1600 (t1 + t2) + 850 [mm]$$

In each case the conditions H ≥ 900 mm and P ≤ 300 mm must be fulfilled, or access from above and below must be prevented by fixed screens.

c) R ≥ 70 mm (body protection), for this resolution light grids manufactured with separate sensors can be used.

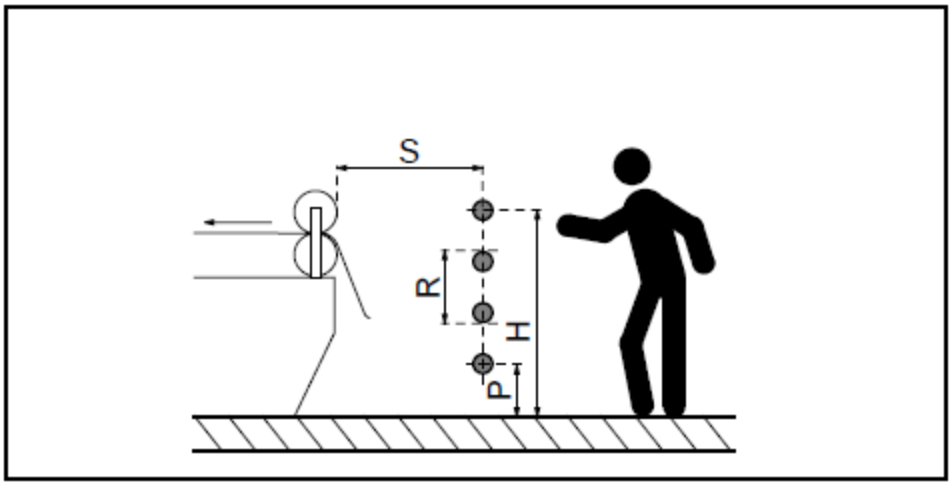


Fig.4.3 Multiple beam safety light grid: perpendicular approach

The safety distance must be calculated using the following formula:

$$S = 1600 (t1 + t2) + 850 \text{ [mm]}$$

Tab.4.1 shows the heights which are generally used with this type of light grid according to the number of beams.

N. of beams	Height from the reference level, for example the floor (mm)	Distance between the beams (mm)
1	750	-
2	400, 900	500
3	300, 700, 1100	400
4	300, 600, 900, 1200	300

Tab.4.1 Number of beams, height from the reference level and distance between the beams for a light grid and single photoelectric safety switches

d) Single beam

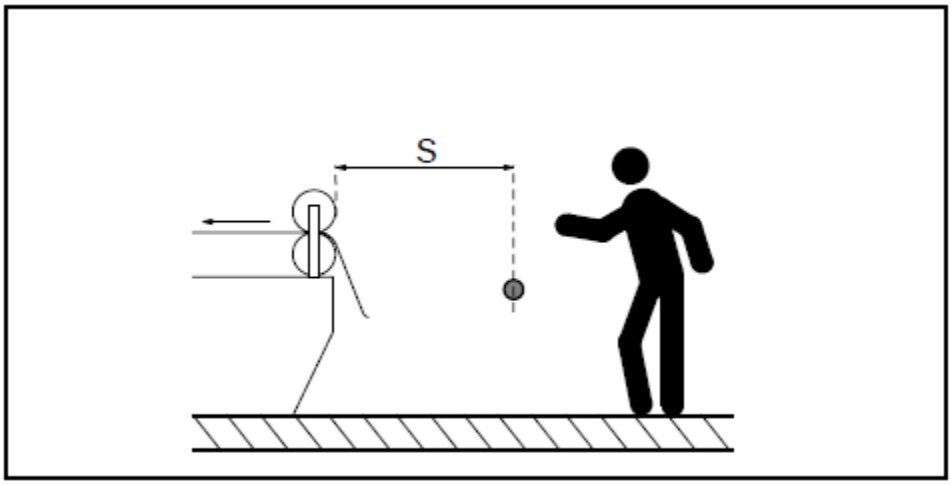


Fig.4.4 Single beam safety barrier

The approach distance must be calculated using the following formula:

$$S = 1600 (t1 + t2) + 1200 \text{ [mm]}$$

When the risk analysis accepts that a single beam can be used, the height of 750 mm from the floor is considered a practical solution to prevent people passing under or over the beam.

Parallel Approach

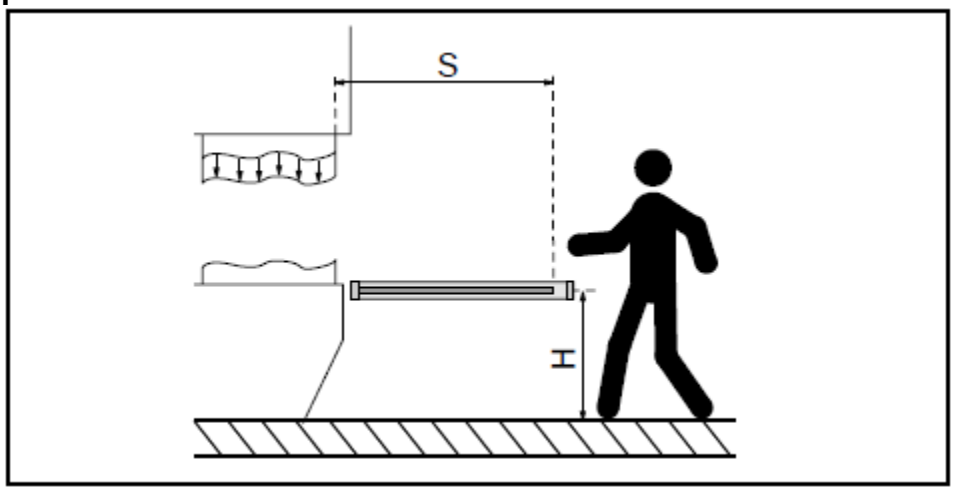


Fig.4.5 Self-tested light curtain: parallel approach

The safety distance must be calculated using the following formula:

$$S = 1600 (t1 + t2) + (1200 - 0,4 H) \text{ [mm]}$$

where:

H: height of protected field from the reference level, the floor for example, [mm]
If (1200 - 0,4 H) < 850 assume this quantity is 850 mm.
If H ≥ 300 mm, there is a risk that the device may fail to detect something entering below the beam. The height H of the protective field must not be lower of a value that depends on the resolution:

$$H \geq 15 (R - 40)$$

where:

R: resolution of light grid [mm]= step of the optics +width of beams (*Fig.4.1*). Thus for a given height of the protective field, the corresponding resolution shall be calculated using formula:

$$R \leq H / 15 + 40$$

Height of the protected zone H < 1000 mm!
The height H from the reference level must not exceed 1000 mm.
Safety distance S must be applied to the furthest beam, whose height is ≤1000 mm (see *Fig.4.5*).

Angled approach

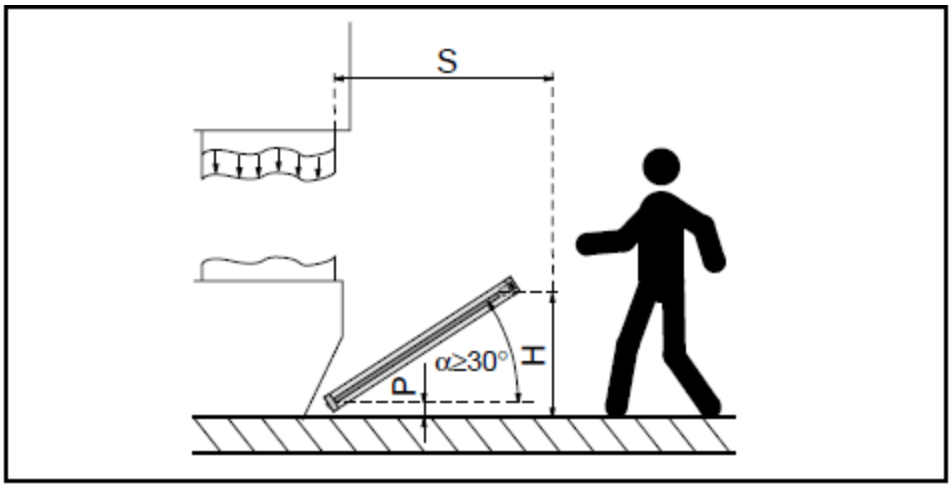


Fig.4.6 Self-tested light curtain: angular approach

α > 30°, calculate as for the perpendicular approach
α < 30°, calculate as for the parallel approach

Example of a calculation of the safety distance for a multiplebeam photoelectric safety switch (SH, TH sensors), with a perpendicular and parallel approach angle
The surrounding area must be protected by a multiple beam photoelectric safety switch (sensors SH, TH). The machine's feed time is 50 ms, the response time of the electrical parts of the safety system, including the multiple beam photoelectric safety switch, is 15 ms.

a) How much must the safety distance S be when the approach is both perpendicular and parallel? When the approach is parallel, the height is H = 300 mm.

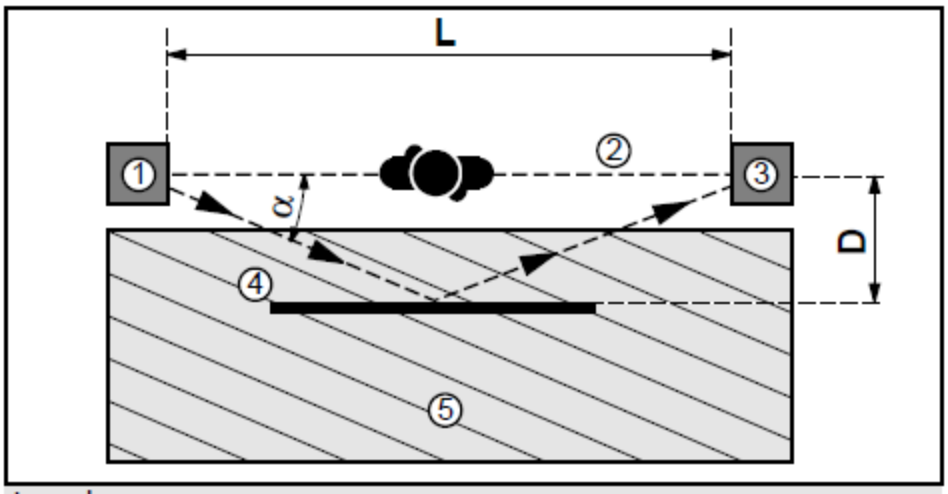
- Perpendicular
  (t1 + t2) = 50 ms + 15 ms = 65 ms, so:
  S = 1600 (t1 + t2) + 850 = 1600 • 0.065 + 850 = **954 mm**

- Parallel (H = 300 mm)
  The condition 1200 - 0.4 H > 850 mm is fulfilled
  1200 - 0.4 • 300 = 1080 mm
  S = 1600 (t1 + t2) + (1200 - 0.4 H)
  S = 1600 • 0.065 + (1200 - 0.4 • 300) = **1184 mm**

b) When the approach is parallel, the light beams must be installed 300 mm from the floor. What resolution is required for the photoelectric switches?
H = 300 mm R ≤ H / 15 + 50
R = 300 / 15 + 50 mm = **70 mm**

c) If for a parallel approach, a model with a resolution of 116 mm is used, at what height from the floor must it be installed?
R = 116 mm H ≥ 15 (R - 50)
H = 15 (116 - 50) = **990 mm**

4.2 Distance from reflecting surfaces



Legend:

1 sender	5 danger zone
2 optical axis	L distance sender to receiver
3 receiver	D minimum distance form reflecting surface to beam axis
4 reflecting surface	

Fig.4.7 Distance from reflecting surfaces, correct installation and alignment

⚠	Reflecting surfaces inside the active zone of the sender and the receiver can create a disturbing reflection and a deflection of the beam which could lead to the failure to detect objects entering the zone.

That is why a minimum distance must be maintained between the reflecting objects, and the optical axes (see *Fig.4.7*). This distance depends on the distance between the sender and the receiver and the aperture angle of the optical beam.
Fig.4.8 shows the minimum distances between any reflecting surfaces which may be positioned there, for safety devices with aperture angle of 5° (maximum aperture of type 2) and 2,5° (maximum aperture of type 4) for ranges of up to 10 m.

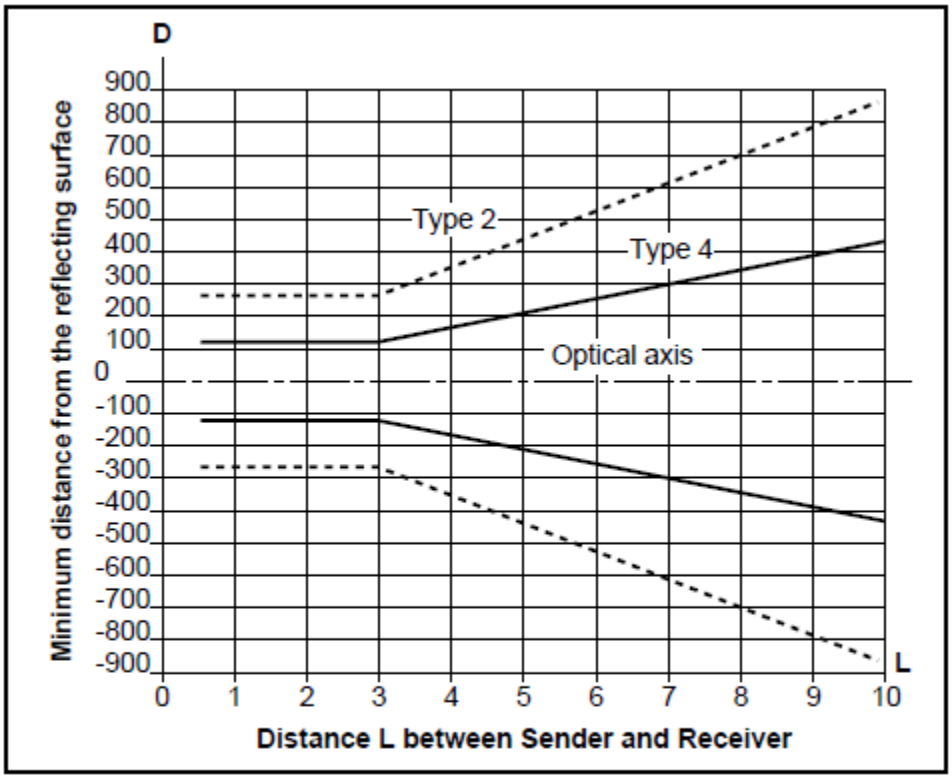


Fig.4.8 Minimum distance from the reflecting surface depending on the distance between sender and receiver

The most universal formula used for distances D ≥ 3m is:

$$D \geq \tan(\alpha) \cdot L$$

(note: tan(5°) = 0,0875, tan(2,5°) = 0,0436).
For the calculation, use the aperture angle specified in the technical feature of the applied model.
The aperture angles of safety devices are very acute and they require the alignment to be carried out with extreme care, but this ensures an increased safety level.

5 Installation

The typical application is for detection of the human body using 1, 2 or 3 vertically-spaced beams that carry out perimeter guarding of machines and access guarding of danger zones in which the risk analysis or specific Type-C standard confirms that a safety Type 2 device will be sufficient (see *Par.4.1 c*).

During the installation, respect the fundamental following conditions.

- Do not situate where direct exposure to strong sources of natural or artificial light will occur.
- Prevent the possibility of mechanical damage caused by accidental knocks, liquid spillage, dust, and chips.
- In case of chains of two or three pairs of sensors, prevent the possibility of interference between Sender and Receiver belonging to adjacent pairs by alternation of Sender and Receiver in the same side of the safety light grid (see electrical diagram in *Fig.3.11*).
- Prevent the possibility of interfering between two photoelectric safety chains connected with the same control unit or with photoelectric devices of other safety control units or with photoelectric devices of another type, by paying careful attention to beam direction and/or establishing rules of behavior.

5.1 Connections

Suitable single beam photoelectric safety switches can be connected to the SBCR03 control unit in single Sender/Receiver pairs or in a chain of up to three pairs.
Up to two chains of three pairs can be applied. We mark these two pair with A and B.

Do not take the sensors' power supply directly from the safety control unit: there are no terminals on the SBCR03 control unit which can be used to supply the sensors.

The chain A begins at the connection of the first sender's test wire to the Test A terminal of the SBCR03 control unit, the corresponding receiver's output can be connected to the Test wire of the second sender in the chain, and so on until the third receiver whose output must be connected to the Sens. A input of the SBCR03 control unit (see *Fig.3.11*).
The chain B must start at Test B and finish at Sens. B.
If only one chain is used, the output of the last receiver must be connected either to a Sens. A or Sens. B.

5.2 Alignment of the sensors

Before proceeding with the alignment, make sure the output of the SBCR03 control unit cannot cause the accidental activation of dangerous parts.
The simplest way of aligning the sensors is to leave the black cable (pin 4) of the first sender disconnected (do not connect it to the control unit's Test A terminal). In this way, the light beam emitted is more intense and easier to see; the following senders in the chain will also emit a light of the maximum intensity.
The alignment procedure can even be carried out without the control unit.
Begin with the alignment of the first pair in the chain and proceed in order so that if the preceding pair is not aligned, the following sender is not enabled to emit.

1. Install the sender and the receiver opposite each other, trying to make them match up as much as possible with the mechanical axes, and fasten them temporarily.
2. Turn on the power supply to the SBCR03 control unit or only the sensors.
3. Apply a reflector to the receiver or near the optical head (the perfect solution is a piece of RL100 type reflex reflector paper, 100x100 mm with a hole in the centre and applied so that the hole corresponds to the receiver).
4. Observing the reflector placed on the receiver, adjust the position of the sender so that the light reflected on the reflector placed on the receiver has the maximum intensity.
   N.B.: the more the line of observation skims the optical axis, the more visible the reflected light will be.
5. Adjust the position of the receiver in relation to the sender in order to activate the output and cause the yellow LED to light up.
6. If the nominal range is respected, the alignment will be simple as a minimum signal excess of 4 is guaranteed. To check, however, the signal that has been received is strong enough, gradually obscure the beam: the intensity of the signal is sufficient if the yellow LED switches off when the optics are obscured by at least half of its diameter.
   It is possible to improve the positioning of the sensors by creating a temporary reduced sensitivity condition. This is done by partially obscuring the optics of the receiver and/or the sender with a small piece of sticky tape.
7. Fasten the system in place definitively.
8. Restore the control unit's normal electrical connections.

6 Check the system

Check the system is functioning correctly: make sure the safety system intervenes by intercepting the beams with a test rod. The obscuring of the beams must be checked in at least three different positions: near the senders' optics, near the receivers' optics, and at a central point between the sender and the receiver, near the optics axis.

7 . SB300 Relay module

The SB300 relay module is an interface device composed of 2 safety relays (shown in *Fig.7.1* with K1 and K2) with DC coils. The module has two safety outputs, one per relay, and a monitoring output. Both safety outputs are composed of N/O main contacts without potential. The monitoring output provides the series of two N/C auxiliary contacts, one per relay, for the monitoring of the safety contacts. This output is used by EDM function.

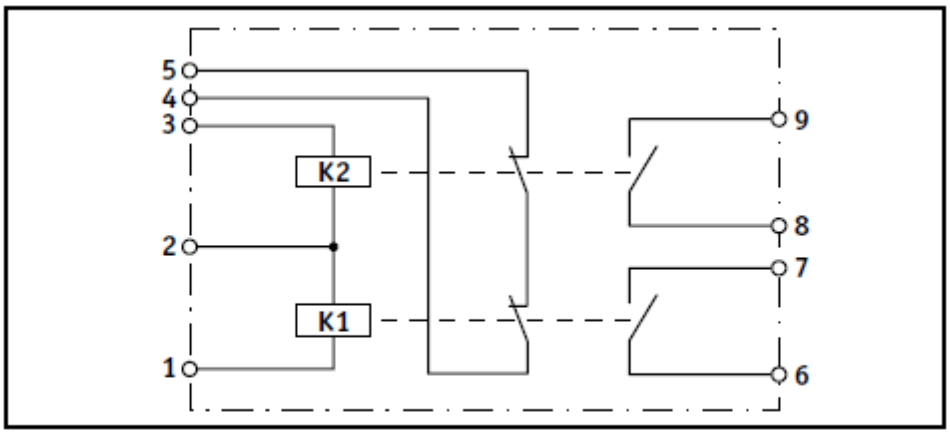


Fig.7.1 Electrical diagram of SB300 relay module

7.1 Connections

P	Meaning	Connections to SBCR03 control unit
1	IN 1	I: K1 relay excitation coil. Connect to OSSD1 terminal of SBCR03 control unit
2	COM	K1 and K2 relay excitation coils common Connect to 0V
3	IN 2	I: K2 relay excitation coil. Connect to OSSD2 terminal of SBCR03 control unit
4	Monit.A	O: checking output, A side of N/C contacts series. Connect to 24V
5	Monit.B	O: checking output, B side of N/C contacts series. Connect to EDM input of SBCR03 control unit
6	OSSD 1B	O: work output, B side, of K1 relay N/O contact
7	OSSD 1A	O: work output, A side, of K1 relay N/O contact
8	OSSD 2B	O: work output, B side, of K2 relay N/O contact
9	OSSD 2A	O: work output, A side, of K2 relay N/O contact

Tab.7.1 Connections of the SB300 module to the SBCR03 control unit

7.2 Technical data

Technical data for the SB300 relay module:	
Nominal coils voltage	24VDC (-10%...+20%)
Temperature range	-20...+60°C
Coil resistance	820Ω ±10%
Output contacts	2 NA
Control contacts	1+1 NC serial connection
Max. switching voltage	250V AC/DC
Contact rating	690VA @ 230 VAC 72W @ 24VDC
Max. inrush current	15A / 20ms
Switching current range	20mA...3A
Release time	≤15ms
Operating time	≤10ms
Mechanical life	5×10^7
Electrical life	1×10^5
Material	PA6
Mounting	DIN rail (EN 50022-35)

Tab.7.2 SB300 relay module technical card

7.3 Installation drawing

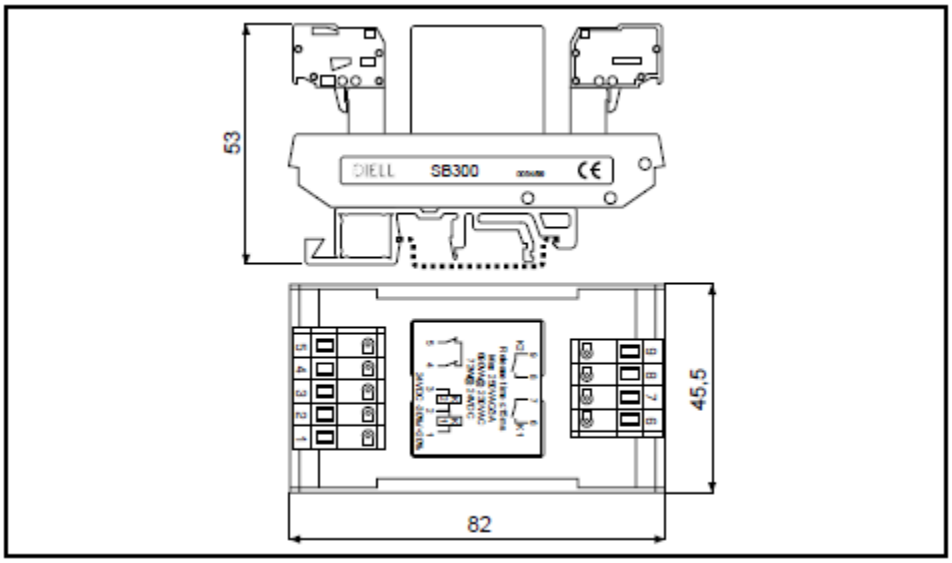


Fig.7.2 Installation drawing of SB300 relay module

7.4 Installation

A machinery guarding could requires the use of more than one control safety unit, which must be able to stop the normal machine operation if any hazardous condition is detected. In this case every relay modules (final switching devices FSD), each controlled by its own safety control unit, must be connected in series to a safety emergency stop module machine primary control element MPCE which controls directly the hazardous motion).
In such a way, any relay module is able to interrupt the circuit to the primary control element. Figures in this section show various systems, which fulfill the requirements of category 2:

7-5 Cascade of relay modules with double controlled line that provide a further redundancy. The two channels are connected to an emergency stop module, which must carry out a parity check and monitor its own contacts. Note that the contacts of the emergency stop module cannot be checked from the EDM function because the state of the stop module does not necessarily match the state of any safety control unit.

7-6 This figure shows a slightly more simple circuit which will satisfy the requirements of category 2 using only one channel connection. Note that in this case EDM is compulsory because otherwise single fault might not be detected and it could lead to dangerous conditions.

7-7 As shown on *Fig.7.5* and *Fig.7.6* it is recommended to employ the emergency stop module which carry out a self control of its own contacts. So, it is not advisable to employ contactors unless particular expedients are adopted, as shown in *Fig.7.7*. In this case, any safety control unit has to be configured in Restart Interlock mode. The start/restart buttons are enabled only if the N/C contacts of the two contactors

are correctly closed. If any single fault occurs on the contacts, at the next restart it will not be possible to remove the stop condition.

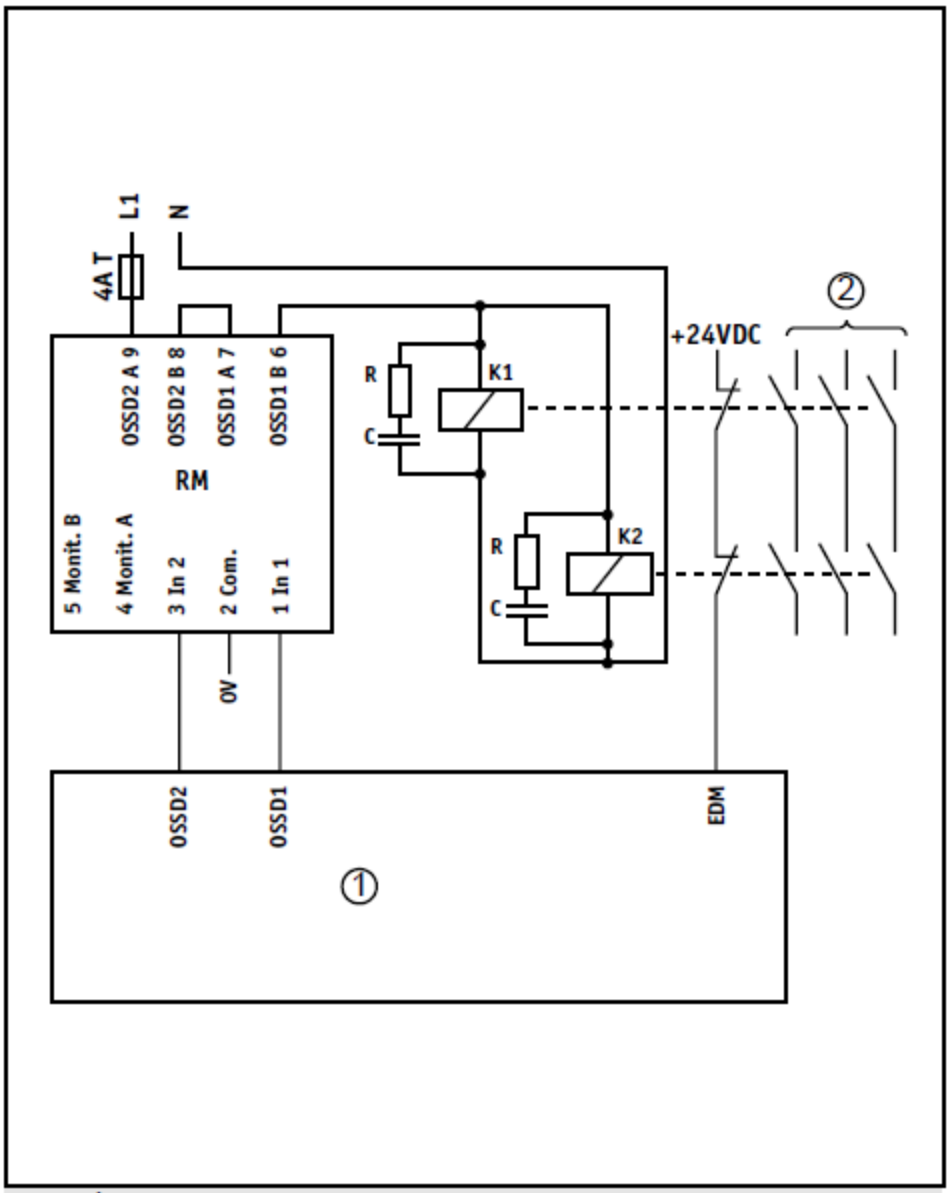
Arc suppression devices

Generally, the main relay contacts are subject to high switching voltages because of inductive loads. Connecting arc suppression devices in parallel with the load is recommended, to protect relay module against overvoltages and, therefore, to avoid contact stresses and achieve long life. The following table lists recommended values for the RC network.

Switched voltage	Values of RC network	
230VAC	R = 220Ω	C = 0,15µF
115VAC	R = 220Ω	C = 0,15µF
24…48VAC	R = 100Ω	C = 1,5µF
24VDC	R = 47Ω	C = 3,3µF

Tab.7.3 Recommended values for RC network

7.5 Sample circuits

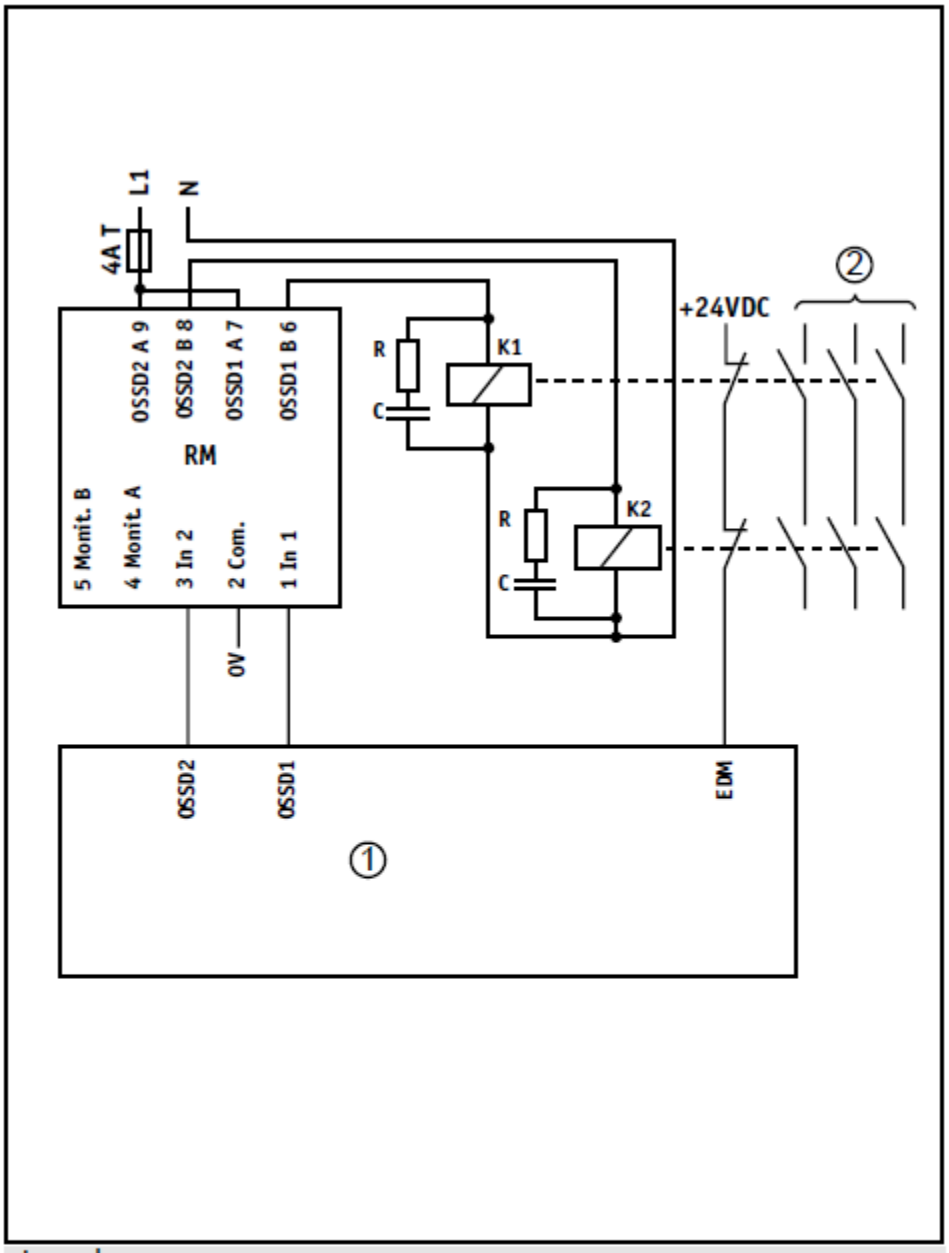


Legend:

1 safety control unit or safety light curtain having EDM function
2 main power
RM SB300 relay module R, C arc suppression device [1]

[1] The contacts of the relay module must be protected against overvoltages by connecting an arc suppression device in parallel with the load. Recommended value: see *Tab.7.3.*

Fig.7.3 Single channel connection for SB300 relay module

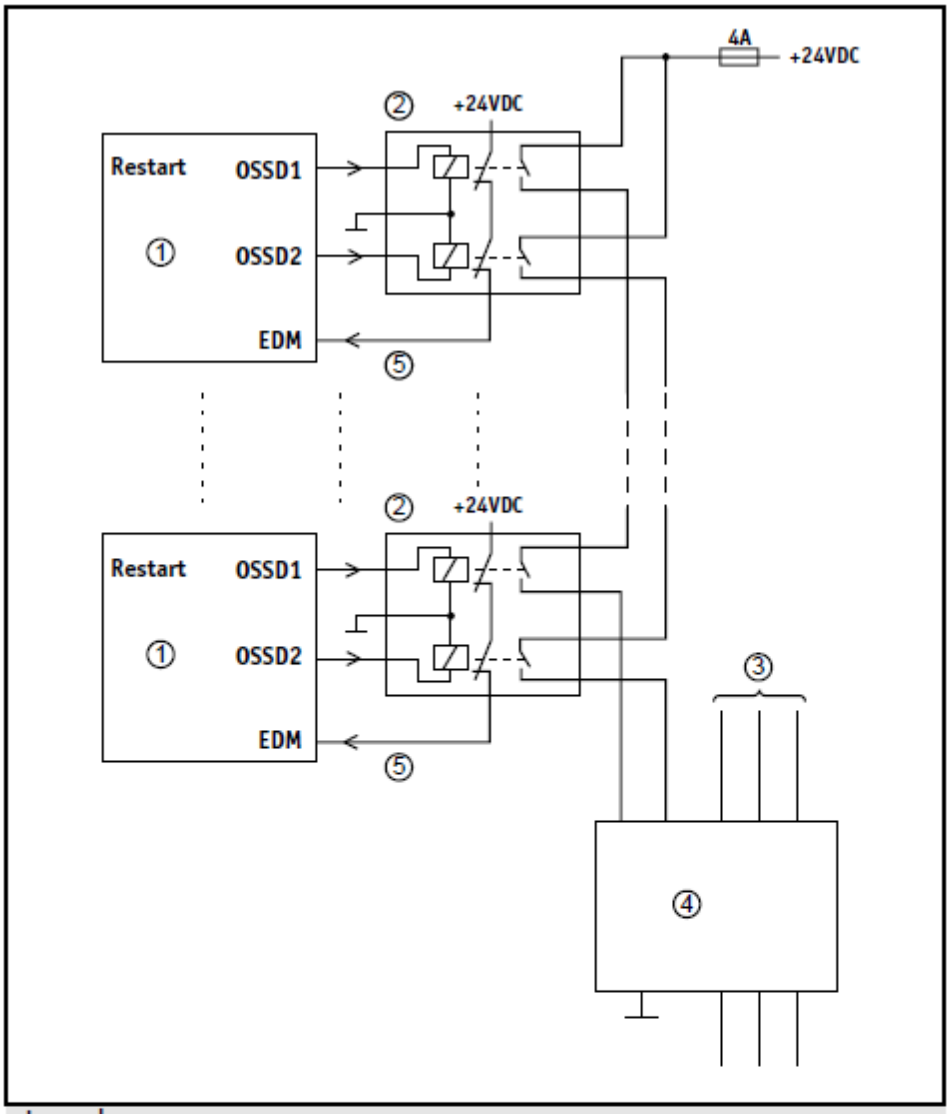


Legend:

1 safety control unit or safety light curtain having EDM function
2 main power
RM SB300 relay module R, C arc suppression device [1]

[1] The contacts of the relay module must be protected against overvoltages by connecting an arc suppression device in parallel with the load. Recommended value: see *Tab.7.3.*

Fig.7.4 Double channel connection for SB300 relay module

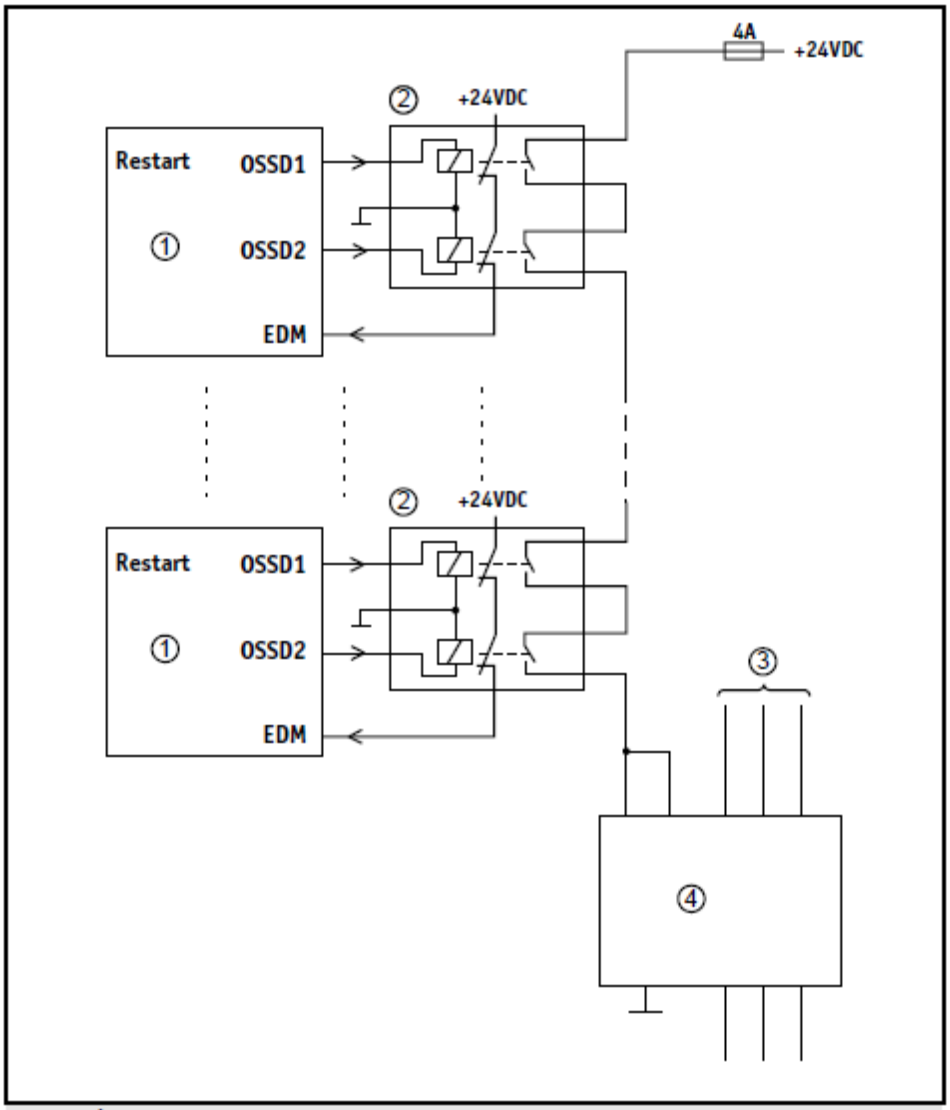


Legend:

1 safety control unit
2 SB300 relay module
3 main power
4 emergency stop module
5 EDM check signal [1]

[1] In this scheme, the EDM function provides an additional check of the system in order to monitor the relay contacts and discover where the failure is located. On the other hand, in order to achieve the safety type 2 level, the EDM function is not indispensable, but only the emergency stop module, which carry out a parity check of the two channels, and is able to detect every single fault on the wiring and contactors.

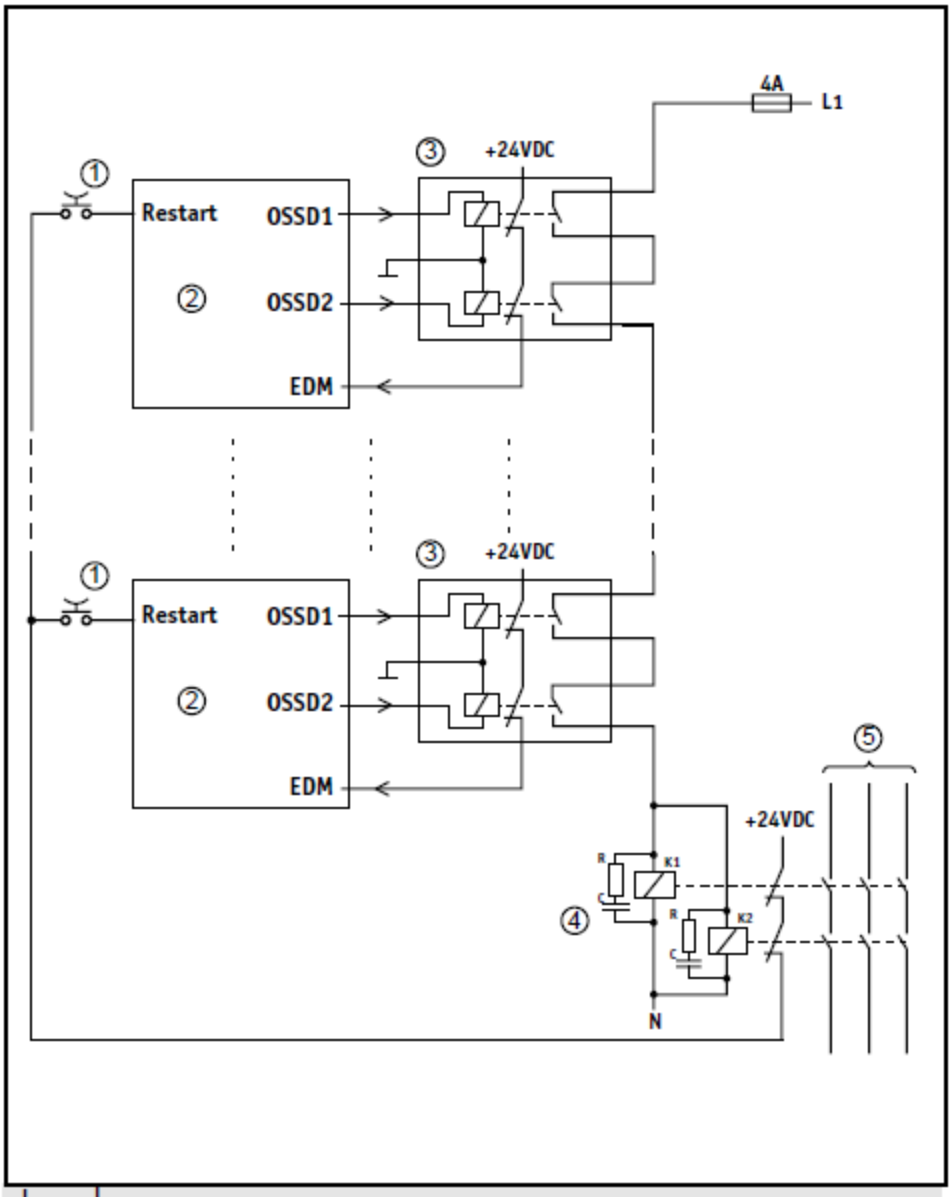
Fig.7.5 Cascade of SB300 relay modules with double controlled line and connection of the EDM terminal



Legend:

1 safety control unit
2 SB300 relay module
3 main power
4 safety emergency stop module

Fig.7.6 Cascade of SB300 relay modules with single controlled line and connection of the EDM terminal



Legend:

1 start/restart button
2 safety control unit
3 SB300 relay module
4 power contactors
5 main power
R, C arc suppression network [1]

[1] The contacts of the relay module must be protected against overvoltages by connecting an arc suppression device in parallel with the load. Recommended value: see *Tab.7.3*.

Fig.7.7 Cascade of SB300 relay modules with single controlled line and connected to power contactors

Appendix

A Troubleshooting

The SBCR03 control unit carries out a self-test while it is operating: the control unit displays an error message on the 7-segment display and prevents any dangerous operations if the self-test has detected an error. (see *Tab.A.1*).

Display	Meaning	Action
7, flashing[1]	State indicator lamp is faulty	Check the connections, replace the lamp
8, flashing	Fault in external relay control	Check the relay connections
A(2), alternating	Fault in photoelectric switches	Correct the connections and check the photoelectric switches
A(3), alternating[4]	Override timeout	Check the Muting sensors and disconnect then reconnect the power supply.
A(4), alternating[4]	Muting timeout	Check the Muting sensors and disconnect then reconnect the power supply
A(6), alternating[2] [4]	Override function available	Press and release the Override key to activate the Override function
A(7), alternating[4]	Muting Lamps are faulty	Check the connections, replace the lamps
C, steady[2] [4]	Muting A and/or B active	The material can transit through the danger zone
E, steady	System error	Replace the control unit
F(1) or F(4), alternating	Overcurrent at OSSD1 and OSSD2	Measure the current absorbed from the load (max. 500mA)
F(2) or F(5), alternating	OSSD1 or OSSD2 has a short circuit to 24V	Repair the short circuit
F(3) or F(6), alternating	OSSD1 or OSSD2 has a short circuit to 0V	Repair the short circuit
F(7), alternating	Short circuit between OSSD1 and OSSD2, or to 24V	Repair the short circuit
L(2), alternating	Fault in photoelectric switches, Invalid configuration in check control unit	Correct the connections and check the photoelectric switches

Display	Meaning	Action
L(3), alternating[4]	Invalid configuration in Muting Unit	Correct the wiring harness
Decimal point	Power supply voltage outside permissible limits	Check the wiring harness and power supply
No indication	No power supply or internal fuse has blown.	Check the wiring harness and power supply, replace the unit.
No indication, control unit OFF (LED "OSSD OFF" is ON) and senders OFF	Connection to Sens. A and/or Sens. B is lost or faulty	Connect the last receiver to Sens.A and/or Sens.B. If only one channel is used, an additional wire bridge must be fitted between Sens.A and Sens.B
Every restart attempt is ignored and the SBCR03 control unit remains in the restart waiting state (OSSD outputs in OFF-state).[3]	Fault in external relay control	Check the relay connections

Tab.A.1 Table of error codes and operating status for SBCR03 control unit with and without Muting

(1) The control unit displays this error only in Restart Interlock mode (state lamp is yellow and indicates the control unit is awaiting restart).
(2) This indication does not reveal a fault condition; on the contrary, it shows a specific operating status for control unit.
(3) This behavior happens only when the Restart interlock mode is selected. In each other case, every incorrect state of the EDM signal cause the SBCR03 control unit to go to lock-out condition and signaling of the error code "8" flashing (see *Par.2.4.4*).

Comments: powering up the device with M1 & M2 inactive and Lamp 1 shorted to 0Vdc, at the occurrence of a muting condition the device locks out signaling A2 as error. This is due to the fact that if the supplied current isn't enough to keep on the photoelectric switches in presence of voltage supply holes caused by a short circuit, the photoelectric switches will turn off while the control unit is kept on by a capacitance, so in this interval of time the device will behave as if there is a fault in photoelectric switches.

B Checklist for the manufacturer

Checklist for the manufacturer/installer for the installation of electrosensitive protective equipment (ESPE).

Details about the points listed below must be present at least during initial commissioning - they are, however, dependent on the respective application, the specifications of which are to be controlled by the manufacturer/installer.

This checklist should be retained and kept with the machine documentation to serve as a reference during recurring tests.

1	Have the safety rules and regulations been observed in compliance with the directives/standards applicable to the machine?	YES	NO
2	Are the applied directives and standards listed in the declaration of conformity?	YES	NO
3	Does the protective device full the required PL/SILCL and PFHd according to EN ISO 138491/EN 62061 and the type according to EN 614961?	YES	NO
4	Is the access to the hazardous area/hazardous point only possible through the protective field of the ESPE?	YES	NO
5	Have appropriate measures been taken to prevent (mechanical protection) or monitor unprotected presence in the hazardous area when protecting a hazardous area/hazardous point and have these been secured against removal?	YES	NO
6	Are additional mechanical protective measures fitted and secured against manipulation which prevent reaching under, over or around the ESPE?	YES	NO
7	Has the maximum stopping and/or stopping/run-down time of the machine been measured, specified and documented (at the machine and/or in the machine documentation)?	YES	NO
8	Has the ESPE been mounted such that the required safety distance from the nearest hazardous point has been achieved?	YES	NO
9	Are the ESPE devices correctly mounted and secured against manipulation after adjustment?	YES	NO
10	Are the required protective measures against electric shock in effect (protection class)?	YES	NO
11	Is the control switch for resetting the protective device (ESPE) or restarting the machine present and correctly installed?	YES	NO
12	Are the outputs of the ESPE (OSSDs, AS-Interface Safety at Work) integrated in compliance with the required PL/SILCL according to EN ISO 13849/EN 62061 and does the integration comply with the circuit diagrams?	YES	NO
13	Has the protective function been checked in compliance with the test notes of this documentation?	YES	NO
14	Are the given protective functions effective at every setting of the operating mode selector switch?	YES	NO
15	Are the switching elements activated by the ESPE, e.g. contactors, valves, monitored?	YES	NO
16	Is the ESPE effective over the entire period of the dangerous state?	YES	NO
17	Once initiated, will a dangerous state be stopped when switching the ESPE on or o- and when changing the operating mode, or when switching to another protective device?	YES	NO
18	Has an information label for the daily check been attached so that it is easily visible for the operator?	YES	NO

This checklist does not replace the initial commissioning, nor the regular inspection by qualified safety personnel.

C Declaration of Conformity

Micro Detectors
Italian Sensors Technology

Declaration of Conformity
Dichiarazione di Conformità

CE

The manufacturer / Il produttore,

M.D Micro Detectors S.p.A con Unico Socio
Strada S. Caterina 235, 41122 Modena - Italy

Declare conformity of the products / Dichiara la conformità dei prodotti :

Control box incl. muting extension with Relay Module (AOPD Type2 in combination with suitable opto-electronic Light Barriers and Light Grids)/ Unità di controllo compresa estensione muting con modulo relè (AOPD Tipo2 in combinazione con adeguate barriere ottiche monoraggio e multi raggio)

SBCR03/S-Ax SB300

models Electro-sensitive protective equipment, ESPE type 2
dispositivi di protezione elettro-sensibili, ESPE di tipo 2

***Type of safety component:* / Tipo di componente di sicurezza:**
***sender and receiver* / emettitore e ricevitore**

having the following specifications / avente le seguenti specifiche

Cat. 2 / PL c ; SILCL1

according to / secondo le

EN 61496-1:2013
EN ISO 13849-1:2008+AC:2009
EN 62061:2005+AC:2010+A1:2013
IEC 61496-1:2012
IEC 61508 Parts 1-7:2010
EN 60204-1:2006+A1:2009+AC:2010
IEC 61496-2:2013
EN 50178 :1997
EN 50581:2012

with requirement according to / in accordo ai requisiti di

2006/42/EC
(Machinery Directive)
(Direttiva Macchine)

2014/35/UE
(Low Voltage Directive)
(Direttiva Bassa tensione)

2014/30/UE
(Electromagnetic Compatibility)
(Compatibilità Elettromagnetica)

Registration-No.* / Registrazione *N.: 01/205/0562.02/15

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Modena, 04th January 2016

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(Chief Executive Officer)

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