Non-Contact Guard Monitoring

Safety System BNS/AES

SCHMERSAL

Contents

EN 60947-5-3

Machinery brought into circulation within the EC require a CE mark. This CE mark indicates that the essential health and safety requirements, specified in the relevant EC directives, are fulfilled.

For machines, the Machinery Directive EC 98/37/EC [1] is of particular importance. Standards, the so-called harmonised standards, are listed under this directive. These standards may be, but do not have to be applied in the design of machines. If, however, they are taken into account, it is assumed that the machines satisfy the above mentioned essential health and safety requirements and may bear the CE mark without special further tests (presumption of conformity).

An important aspect of the Machinery Directive is the protection of persons from hazards caused by machinery. To conform to this requirement machines are often fitted with safety guards.

The standard EN 1088 [6] listed under the Machinery Directive describes the principal construction of such safety guards and the principles involved in monitoring them.

Various systems can be employed in the monitoring of movable separating guard devices. One possible monitoring device is the magnetic proximity switch with safety function described in EN 1088.

Technical details and design features are described in the product standard for "Proximity devices with defined behaviour under fault conditions" (PDF), EN 60947-5-3 [9], which is also listed under the Machinery Directive.

In the literature such proximity switches have been given a variety of names including non-contact position switches.

Schmersal uses the term Safety Sensor.

PDF classification

PDF Classification – Relationship to Control Categories:
According to the Machinery Directive [1], the machine manufacturer is required to carry out a hazard and risk analysis according to EN 292-2 [3] and EN 1050 [5]. The manufacturer must select the necessary Control Category according to EN 954-1 [4] and design the safety related parts of his control system accordingly.

The choice of suitable Safety Sensors proves to be difficult because, although EN 954-1 [4] specifies Control Categories (B to 4), these categories cannot be found in the product standard, EN 60947-5-3 [9], which is relevant to Safety Sensors. Instead, the Safety Sensors are classified as show in Table 1.

The relationship between the Control Categories given in EN 954-1 and the PDF classes given in EN 60947-5-3 is shown in Table 2 below.

Since the relationship between Control Category and PDF is not clear, we recommend that products are used which conform to the required Control Category according to EN 954-1 and have been verified to the neccessary PDF classification.

Class	Meaning
PDF-D	Reliability through special design
PDF-T	With test capability
PDF-S	Single-fault tolerant
PDF-M	Self-monitoring

Tab. 1: Classification of PDFs

Control Category to EN 954-1	PDF Class to EN 60947-5-3
B	D
1	S
2	T
3	S
4	M

Tab. 2: Relationship between Control Category and PDF Classification for SCHMERSAL safety systems BNS/AES

EN 954-1

Safety Senso

Application:
Due to their non-contact principle of operation, Safety Sensors can be completely encapsulated. As a consequence they are particularly suitable for monitoring safety guards which, on account of their design restrains or due to strenuous environmental conditions, can only be monitored with a great deal of effort using classical safety switches. They are especially suitable for use in areas where high levels or dust of dirt prevail.

Complete encapsulation also allows a smooth and easily cleaned shape, as preferred in the food processing industry with its high standards of hygiene. Of course, the materials used for the Safety Sensors are compatible with foodstuffs.

Their non-contact principle of operation also facilitates hidden mounting behind panels. This is another advantage in the food processing industry, because correct sensor function is not affected by installation behind stainless steel.

Classical safety switches with a separate actuator need precise alignment of the switch and the actuator. Here, again due to their non-contact principle, Safety Sensors are easier to mount, as they are more tolerant to misalignment between the actuator and sensor.

Another advantage is the substantially smaller shape in comparison to electromechanical switches. Owing to their small size, Safety Sensors are found in applications where little space is available and also in the monitoring of small guard doors and flaps which demand a correspondingly small actuating radius.

Typical applications for Safety Sensors are printing machines, machinery in the food processing industry and packaging machines.

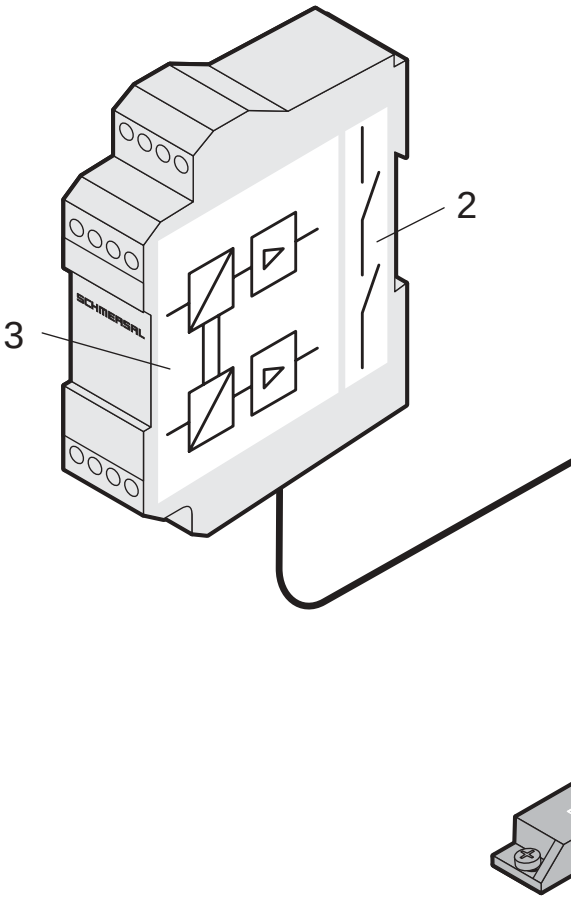


Fig. 1: Typical components of a PDF system

rs

Design /
Operating principle :
According to EN 60947-5-3 [9], proximity switches with defined behaviour under fault conditions (PDF) consist of three components.

Figure 1 shows the three typical components:

1 The active parts: Proximity switch plus actuator,
2 the output signal switching device (OSSD)
3 and (where required) a control and monitoring module.

These three components need not necessarily be separate from one another.

Schmersal offers these three components as a system. This system has been tested and approved by the German notified body BG. This ensures that all components are compatible with each other and optimally suite to the relevant safeguarding function.

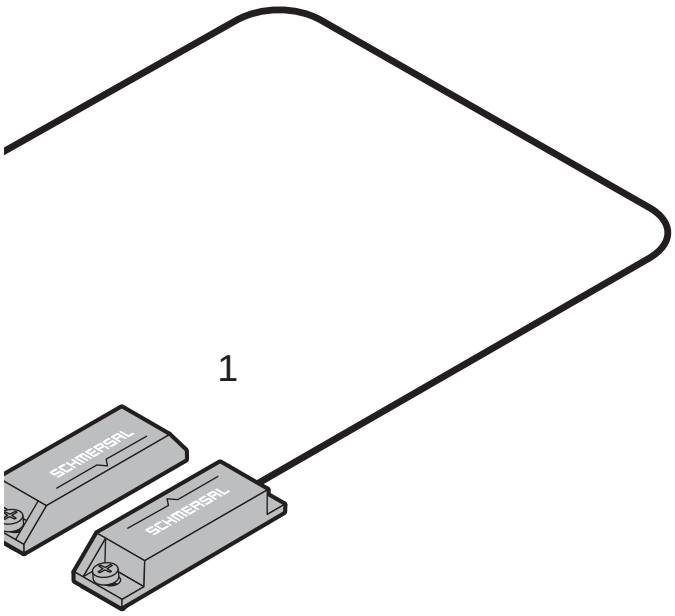
Safety Sensors in the series BNS have reed contacts as mechanical contacts. These contacts are either opened or closed by a magnetic field applied externally. The status of the contacts is monitored by a control module of the AES series.

This module also provides the current limit for the reed contacts. A current that is too high would lead to welding of the reed contacts and therefore to a malfunction of the Safety Sensor.

In addition, the control modules are tolerant to bouncing of the reed contacts causal by the impact of a closing guard – which can result in a short-term signal "Safety Guard open". This can lead to a premature switching-off of the control module and is prevented by a switch-on delay. This method helps ensure that no fault signals occur, thereby increasing the availability of the machinery.

For this sort of function the µP technology employed by Schmersal in its control modules offers advantages. Such "additional functions" can be realised more easily and with more space saving than when using conventional, discrete electronics.

In the terminology of EN 60947-5-3, the AES control module corresponds to the control and monitoring device with integrated OSSD.



Series BNS

Normally closed/ normally open principle:
The reed contacts used in Safety Sensors are not positive break contacts. This explains the necessity of equipping Safety Sensors (PDFs) with a control unit to ensure the correct functioning of the contacts and therefore of the PDF.

Schmersal has selected normally closed and normally open contact combinations in the Safety Sensors. In this way the sensor combines two properties which are particularly described in EN 60204-1 [7]: redundancy (two contacts) and diversity (different principles of operation). With higher Control Categories, EN 954-1 [4] suggests diversity as a way of preventing common cause failure (see [4]).

One such fault would be, for example, the welding of the NC contact due to a too high current when the safety guard is closed. This excessive current load may arise due to an excessive input capacitance on the connected control module. However, in the BNS/AES system Schmersal has taken appropriate precautions (diversity, current limit) to prevent this type of fault.

Coded and non-coded Safety Sensors:
Due to their operating principle, it is easy to tamper with magnetically operated Safety Sensors. The reed contacts change state in the presence of a simple magnetic field. In this case these devices are known as non-coded Safety Sensors. Where this type of sensor is used in applications for personnel protection, EN 1088 [6] requires the sensors to be mounted in a concealed position (Fig. 2).

To ensure better protection against tampering, which is particularly recommended with personnel

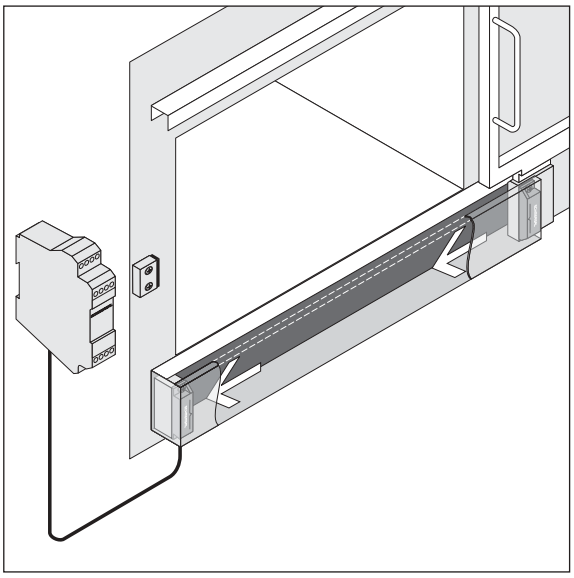


Fig. 2: Concealed installation of a non-coded Safety Sensor

protection applications, Schmersal offers coded magnetically Safety Sensors. In this case a special magnetic field with a particular polarisation and field strength must be applied to switch the reed contacts. A unique arrangement of the reed contacts within the switch has been chosen so that the contacts only switch with this special magnetic field.

According to EN 1088 [6], coded magnetically operated safety switches do not need to be mounted hidden – a fact that significantly simplifies the design effort and maintenance in operation (Fig. 3).

Switching distances / Hysteresis:
With Safety Sensors two important values are important:

One of them is the safe switching distance s_{ao} (assured operating distance) at which the Safety Sensor changes to the ON state under all defined ambient conditions and under consideration of all manufacturing tolerances [9].

The other is the safe distance for switching off s_{ar} (assured release distance) at which the Safety Sensor changes to the OFF state under all defined ambient conditions and under consideration of all manufacturing tolerances [9].

These two figures are limits which should be taken into account during the design of the safety guard. In practice, these figures deviate from the actual measured figures, because the ambient conditions have a significant effect on the sensitivity of the Safety Sensor. For this reason the following normally applies in practice: $s_{ON} > s_{ao}$ and $s_{OFF} < s_{ar}$.

It should be noted however that there is a region $s_{ON} < s_H < s_{OFF}$ in which the sensor is still in the ON state, although the actuator has been removed further than s_{ON} from the switch.

It is important to take this hysteresis zone into account when positioning the Safety Sensors. The guard door must be designed so that it always opens further than s_{ar} so that the control and monitoring device has definitely switched off before the guard door allows access to the hazardous area (see also Fig. 5, page 10).

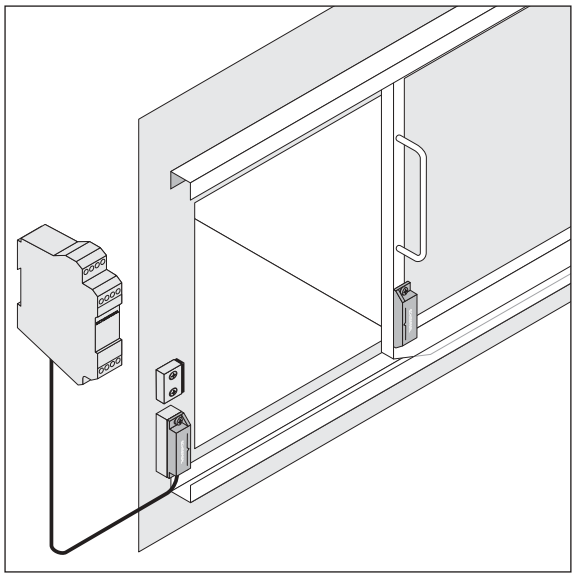


Fig. 3: Installation of a coded Safety Sensor non-concealed

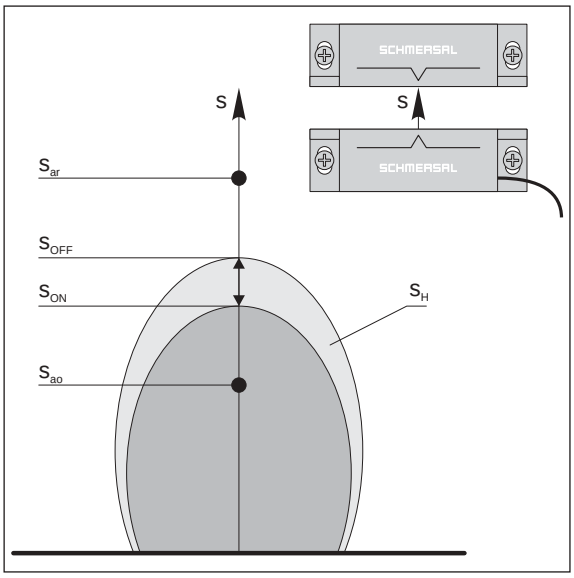


Fig. 4: Diagram of s_{ar}, s_{ao} and the hysteresis zone

Series AES

Mounting information:
As for all safety switches, the Safety Sensor must not be used as a mechanical stop [6]. Other components, such as dampers, must be provided for this.

EN 1088 [6] and also the information sheet from the German notified body BG (BGI 670) [10] give further information about the mounting of Safety Sensors:

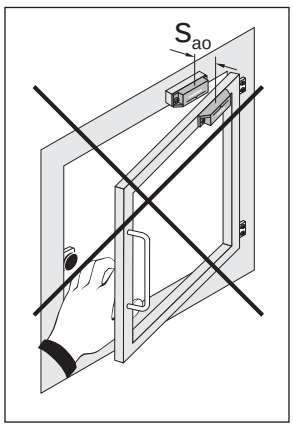
- positive locking mounting (dowel pin) against sensor and actuator rotation and movement,
- mounting using components that are not self-loosening or self-releasing,
- possibly hidden installation if no coded actuator is used.

The maintenance aspect must be taken into account when mounting. It is therefore recommended that the proximity switch and actuator are mounted in a maintenance-friendly manner.

For reasons of safety we recommend that the actuator and sensor are mounted so that if one of the two components falls off, it cannot lie on the other one. This also renders tampering of the Safety Sensor more difficult.

Due to the switching distances and hysteresis, it must be ensured when mounting the devices that, particularly with large guard doors, the doors cannot be opened so far that access to the hazard area can be obtained, although the proximity switch has not yet switched OFF. Here, mounting in the vicinity of the closing edge is recommended (Fig. 5).

Many Safety Sensors are supplied with ready made cable. When routing the cable, a minimum bending radius of $R_{min} \geq 5\ d$ must be maintained, where d is the external diameter of the cable, so as not to damage the cable (Fig. 6).



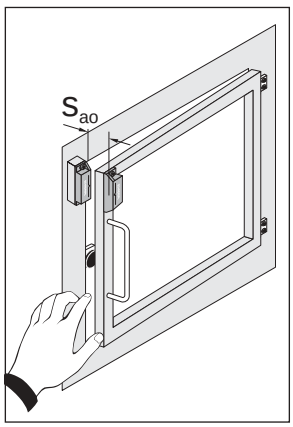


Fig. 5: Mounting the Safety Sensor on the closing edge

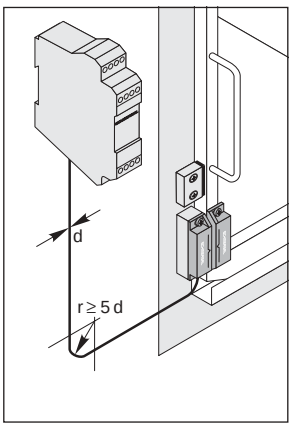


Fig. 6: Minimum radius of the cable should be observed

Wiring of the BNS:
The connection of a single Safety Sensor to a control unit is very easy, see Fig. 7.

Often, multiple sensors are connected to one control module, to reduce the number of control modules required.

If a number of sensors are linked in series to a control module, the connection of the sensors themselves must be taken into account. With an NC/NO system such as Schmersal reccomands, the NC contacts of the individual sensors must be connected in series and the NO contacts in parallel. Only by doing this it is ensured that both inputs on the control module change their state when the guard door is closed or opened. The control module only provides the release signal when both inputs have changed their state.

A disadvantage with series-parallel wiring is the possibility that faults in one of the connected Safety Sensors can be overwritten by others and therefore not be detected. Consequently, this type of arrangement is not suitable for higher Control Categories according to EN 954-1 [4].

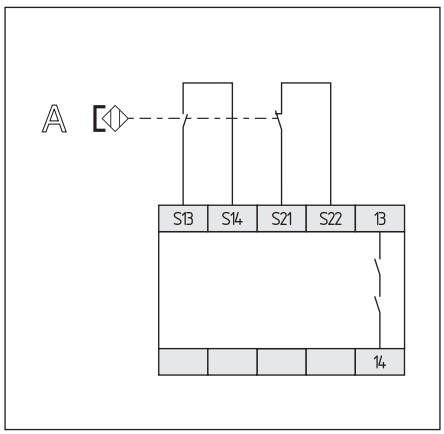


Fig. 7: Connection of a Safety Sensor to a control module

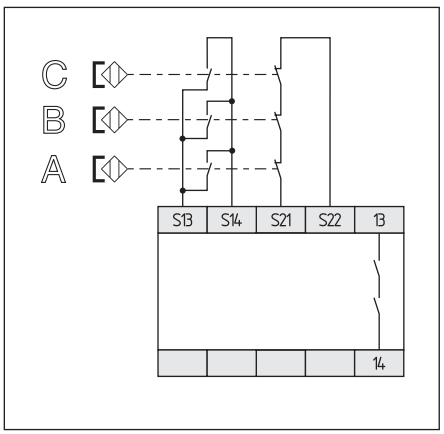


Fig. 8: Connection of multiple Safety Sensors to a control module

Selection

For the selection of a suitable BNS/AES safety system, the integration of the devices into the machine control plays a significant role.

This integration can be realised in numerous ways.

The following illustrations, Figs. 9 to 12, show four of the most common methods of integrating one or more Safety Sensors into a machine control. Below each figure a table is given with possible configurations, the Control Categories that can be achieved and reference to the corresponding wiring diagram.

Suitable BNS and AES device combinations can easily be found with the aid of these tables.

Selection of the required Safety Sensor can then be done with the aid of the selection table "BNS Safety Sensors" on page 17.

How to choose your BNS/AES system:

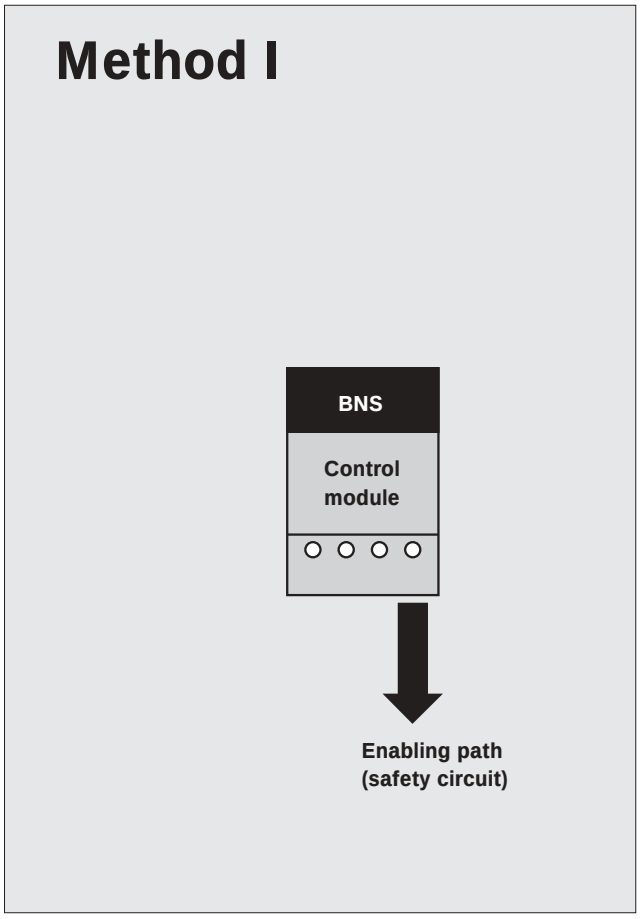
1. Select the desired method of integrating the BNS into the machine control (Method I to IV).
2. The table given for the selected method shows the achievable Control Categories according to EN 954-1 and classifications to IEC 60947-5-3 for certain BNS contacts in combination with a given AES.
3. Select the BNS/AES combination for the desired Control Category and classification.
4. Choose the required Safety Sensor based on the selected BNS contacts from the table "BNS Safety Sensors".
5. Check the technical data for the selected devices in the product section (pages 18 to 23).

Note:
With the BNS contacts the following should be noted:

The **1st figure** states the number of NO contacts on the selected BNS.

The **2nd figure** states the number of NC contacts on the selected BNS.

Method I

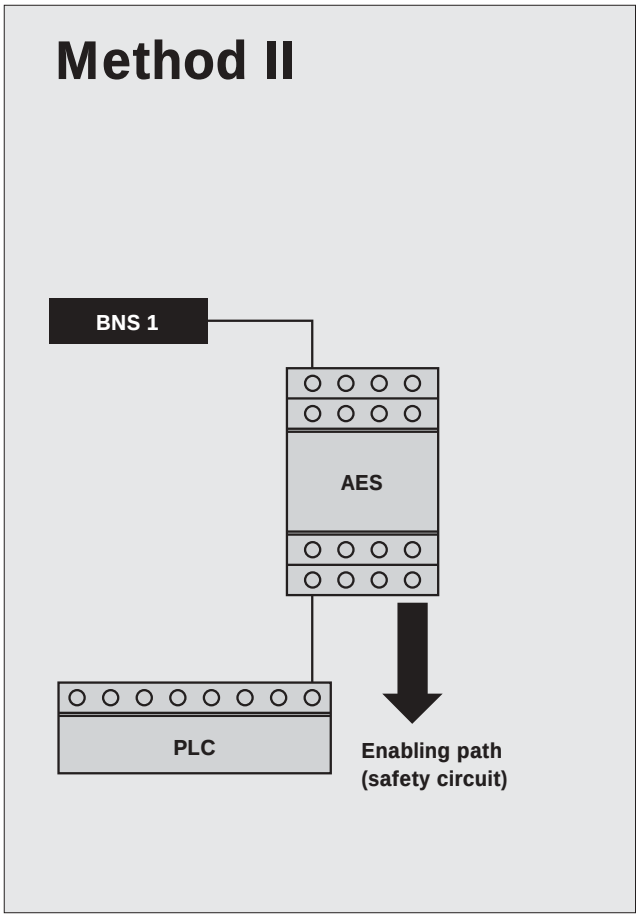


Description:
Monitoring of a Safety Sensor using an integrated control module.

Fig. 9: Individual monitoring with integrated control module

Category to 954-1	Classification to 60947-5-3	Max. no. of BNS	No. of enabling paths	Control module	BNS contacts	Wiring diagram
Cat. 1	PDF-S	1	1	Integrated	-01y -01zG	I.1

Method II



Description:
Monitoring of a Safety Sensor using a control module. Signal to the PLC via the control module.

Fig. 10: Individual monitoring in the control module

Category to 954-1	Classification to 60947-5-3	Max. no. of BNS	No. of enabling paths	Control module	BNS contacts	Wiring diagram
Cat. 1	PDF-S	1	1	AES 1102	-12z -12zG	II.1
Cat. 3	PDF-M	1	1	AES 1135	-11z -11zG	II.2
Cat. 3	PDF-M	1	2	AES 1235	-11z -11zG	II.3
Cat. 4	PDF-M	1	3	AES 1337	-11z -11zG	II.4

Method III

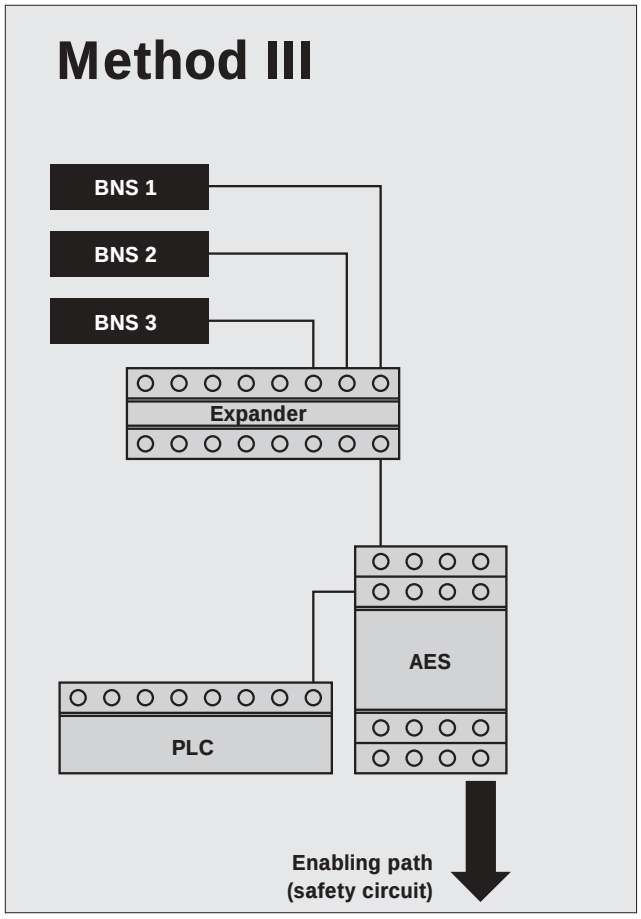


Fig. 11: Series/parallel wiring inside the expander

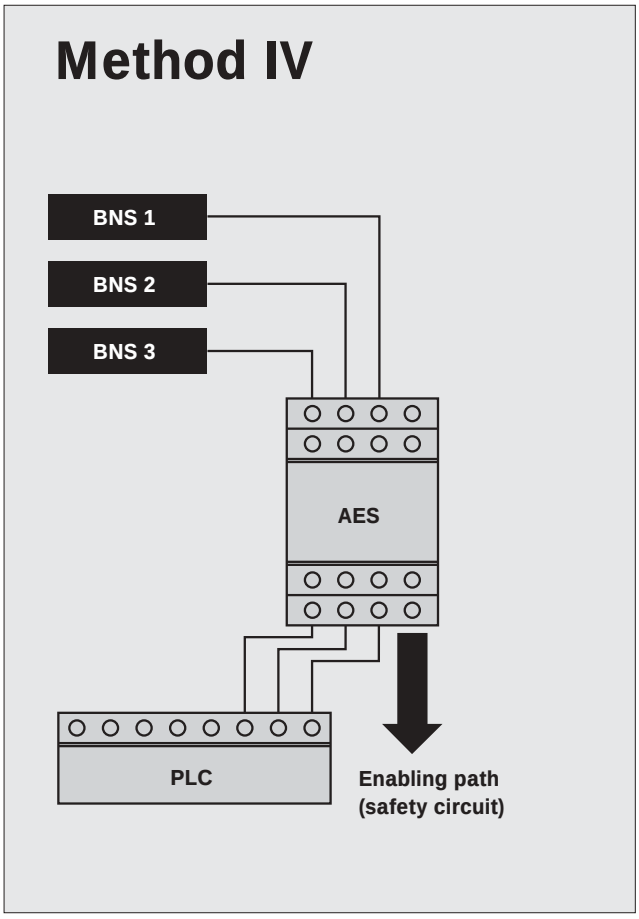
Description:
Monitoring of a number of Safety Sensors using a control module via a separate input expander. Only one signal to the PLC via the control module.

Note:
The series/parallel wiring of the individual contacts takes place inside the expander.

Category to 954-1	Classification to 60947-5-3	Max. no. of BNS	No. of enabling paths	Control module	BNS contacts	Wiring diagram
Cat. 1	PDF-S	20	1	AES 1102	-12z-2187 -12zG-2187	III.1
Cat. 3 *	PDF-S	20	1	AES 1135	-11z -11zG	III.2
Cat. 3 *	PDF-S	20	2	AES 1235	-11z -11zG	III.3
Cat. 3 *	PDF-S	20	3	AES 1337	-11z -11zG	III.4

* The malfunctioning of a sensor, e.g. due to a short circuit or a wire breakage, can be overwritten by the actuation of another sensor. This must be taken into account in the risk analysis.

Method IV



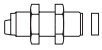
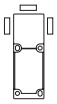
Description:
Monitoring of a number of Safety Sensors using a control module. Signalling of each Safety Sensor to the PLC via the control module.

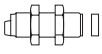
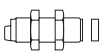
Fig. 12: Series/parallel circuit with individual monitoring in the control module

Category to 954-1	Classification to 60947-5-3	Max. no. of BNS	No. of enabling paths	Control module	BNS contacts	Wiring diagram
Cat. 3	PDF-M	6	2	AES 2285 *	-11z	IV.1
Cat. 3	PDF-M	2	1	AES 1165-2250	-11z -11zG	IV.2
Cat. 3	PDF-M	3	1	AES 1185 **	-11z -11zG	IV.3
Cat. 3	PDF-M	2	2	AES 1265	-11z -11zG	IV.4

* Internal series- and parallel connection of Safety Sensor contacts.
The malfunctioning of a sensor, e.g. due to a short circuit or a wire breakage, can be overwritten by the actuation of another sensor. This must be taken into account in the risk analysis.
** No individual signal output

Selection tables: BNS Safety Sensors

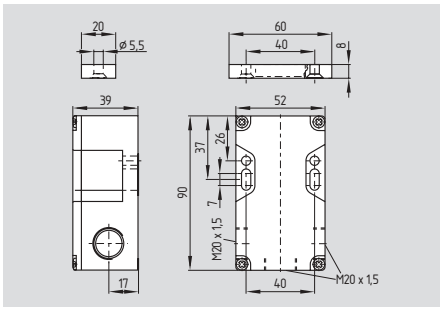
Standard switching distance							
Form	Sensor type	BNS contacts	Connection options	Actuator type	Coded	Distance s_{ao} / s_{ar} [mm]	Integrated monitoring
	BNS 33	-11z(G) -12z(G) -12z-2187 -12zG-2187-10	Ltg, ST Ltg, ST Ltg Ltg	BPS 33	•	5 / 15	
	BNS 250	-11z(G) -12z(G) -12z-2187	Ltg Ltg Ltg	BPS 250	•	4 / 14	
	BNS 303	-11z(G) -12z(G) -12z(G)-2187	Ltg, ST Ltg, ST Ltg	BPS 300 BPS 303	•	5 / 15	
	BNS 120	-11z -12z -12z-2187	Ltg Ltg Ltg	BP 8		10 / 22	
	BNS 180	-11z -12z -12z-2187	Ltg Ltg Ltg	BP 6		10 / 22	
	BNS 300	-01zG	Ltg, ST	BPS 300 BPS 303	•	5 / 15	•
	BNS 333	-01y	SK	BPS 300 BPS 303	•	4 / 14	•

Increased switching distance							
Form	Sensor type	BNS contacts	Connection options	Actuator type	Coded	Distance s_{ao} / s_{ar} [mm]	Integrated monitoring
	BNS 16	-11z -12z	SK SK	BPS 16	•	8 / 18	
	BNS 33	-11z(G) -12z(G) -12z-2187 -12zG-2187-10	Ltg, ST Ltg Ltg Ltg	BPS 33 -2326	•	8 / 15	
	BNS 303 -2211	-11z(G) -12z(G)	Ltg, ST Ltg, ST	BPS 300 BPS 303	•	8 / 18	
	BNS 120	-11z -12z -12z-2187	Ltg Ltg Ltg	BP 10 BP 15		20 / 32	
	BNS 180	-11z -12z -12z-2187	Ltg Ltg Ltg	BP 10 BP 15		20 / 32	
	BNS 300 -2211	-01zG	Ltg, ST	BPS 300 BPS 303	•	8 / 18	•
	BNS 30 -2211	-01z(G)	Ltg, ST	BPS 300 BPS 303	•	8 / 18	•

G = With LED (optional) Ltg = Cable
ST = Plug SK = Screw terminals

Technical data and ordering details can be obtained from the following pages.

BNS 16



Characteristics

Enclosure:	glass-fibre reinforced thermoplastic
Protection class:	IP 67
Termination:	screw terminals
Cable size:	max. 2 x 1.5 mm^2
Cable entry:	3 x M20
Mode of operation:	magnetic
Control Category:	up to 4*
Classification:	up to PDF-M*
Magnetic actuator:	coded BPS 16
S_{ao}:	8 mm
S_{ar}:	18 mm
Max. switching voltage without LED:	100 VAC/DC
Max. switching current without LED:	400 mA
Output:	
U_e:	–
I_e:	–
Max. switching capacity without LED:	10 VA/W

Standards
EN 60947-5-3; EN 954-1, BG-GS-ET-14; EN 1088

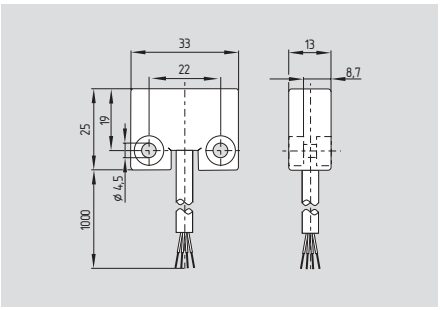
Approvals
H C D pending CE

Ordering details

BNS 16-①z② sensor
BPS 16 actuator

No.	Replace	Description
①	11	please order 12
	12	1NO/2NC
		Actuating plane:
②	V	top
	R	right
	L	left
	D	front (cover)
	U	rear

BNS 250



Characteristics

Enclosure:	glass-fibre reinforced thermoplastic
Protection class:	IP 67
Termination:	Boflex cable
Cable size:	4 x 0.25 mm^2
Mode of operation:	magnetic
Control Category:	up to 4*
Classification:	up to PDF-M*
Magnetic actuator:	coded BPS 250
S_{ao}:	4 mm
S_{ar}:	14 mm
Max. switching voltage with LED:	24 VDC
Max. switching current with LED:	10 mA
Output:	
U_e:	–
I_e:	–
Max. switching capacity with LED:	240 mW

Standards
EN 60947-5-3; EN 954-1, BG-GS-ET-14; EN 1088

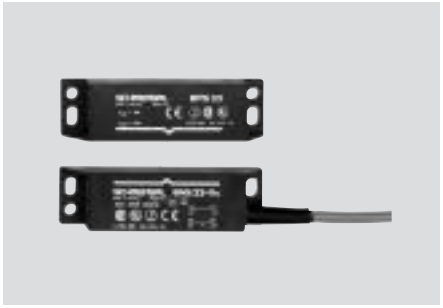
Approvals
H C D CE

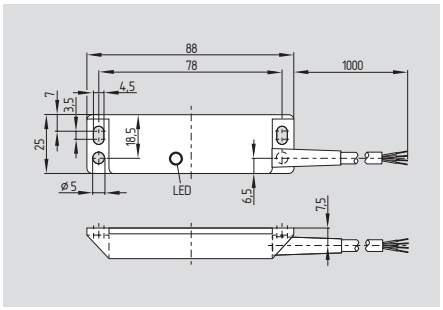
Ordering details

BNS 250-①z②-③ sensor
BPS 250 actuator

No.	Replace	Description
①	11	1NO/1NC
	12	1NO/2NC
②	G	with LED
		without LED
③	2187	only for Method III
		see page 15

BNS 33





Characteristics

Enclosure:	glass-fibre reinforced thermoplastic
Protection class:	IP 67
Termination:	Boflex cable, connector M8x1
Cable size:	4 x 0.25 mm^2
Mode of operation:	magnetic
Control Category:	up to 4*
Classification:	up to PDF-M*
Magnetic actuator:	coded BPS 33, BPS 33-2326
S_{ao}:	BPS 33: 5 mm
	BPS 33-2326: 8 mm
S_{ar}:	BPS 33: 15 mm
	BPS 33-2326: 15 mm
Max. switching voltage with LED:	24 VDC
Max. switching current with LED:	10 mA
Output:	
U_e:	–
I_e:	–
Max. switching capacity with LED:	240 mW

Standards
EN 60947-5-3; EN 954-1, BG-GS-ET-14; EN 1088

Approvals
H C D CE

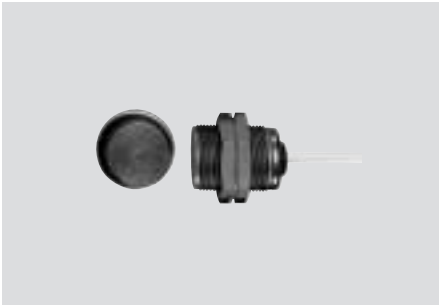
Ordering details

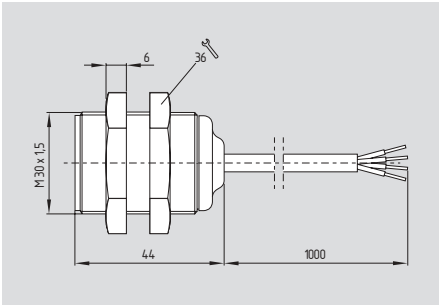
BNS 33-①z②-③-④ sensor
BPS 33 actuator
BPS 33 -2326 actuator

No.	Replace	Description
①	11	1NO/1NC
	12	1NO/2NC
②	G	with LED
		without LED
③	2187	only for Method III
		see page 15
④	ST	with connector M8x1

Note: * only in combination with AES safety control module

BNS 303





Characteristics

Enclosure:	glass-fibre reinforced thermoplastic
Protection class:	IP 67
Termination:	Boflex cable, connector M12x1
Cable size:	4 x 0.25 mm²
Mode of operation:	magnetic
Control Category:	up to 4*
Classification:	up to PDF-M*
Magnetic actuator:	coded BPS 300, BPS 303, BPS 303 SS
S_{ao}:	5 mm
	ordering suffix -2211: 8 mm
S_{ar}:	15 mm
	ordering suffix -2211: 18 mm
Max. switching voltage with LED:	24 VDC
Max. switching current with LED:	10 mA
Output:	
U_e:	–
I_e:	–
Max. switching capacity with LED:	240 mW

Standards
EN 60947-5-3; EN 954-1, BG-GS-ET-14; EN 1088

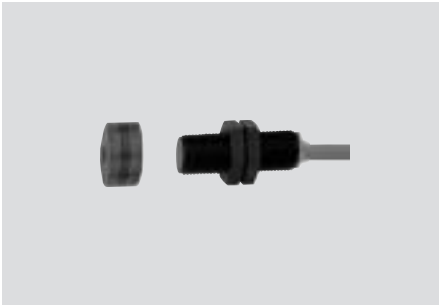
Approvals
H C D CE

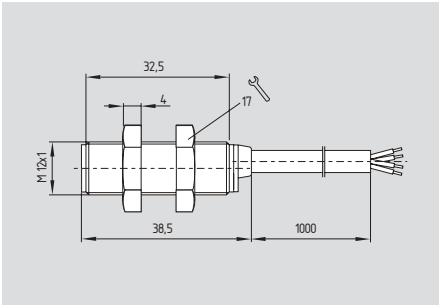
Ordering details

BNS 303-①z②-③-④ sensor
BPS ... (see page 21) actuator

No.	Replace	Description
①	11	1NO/1NC
	12	1NO/2NC
②	G	with LED
		without LED
③	2211	increased switching distance
	2187	only for Method III (p. 15)
④	ST	with connector M12x1

BNS 120





Characteristics

Enclosure:	glass-fibre reinforced thermoplastic
Protection class:	IP 67
Termination:	Boflex cable
Cable size:	4 x 0.25 mm²
Mode of operation:	magnetic
Control Category:	up to 4*
Classification:	up to PDF-M*
Magnetic actuator:	uncoded BP 8, BP 10, BP 15 SS
S_{ao}:	BP 8: 10 mm
	BP 10, BP 15 SS: 20 mm
S_{ar}:	BP 8: 22 mm
	BP 10, BP 15 SS: 32 mm
Max. switching voltage without LED:	100 VAC/DC
Max. switching current without LED:	250 mA
Output:	
U_e:	–
I_e:	–
Max. switching capacity without LED:	3 VA/W

Standards
EN 60947-5-3; EN 954-1, BG-GS-ET-14; EN 1088

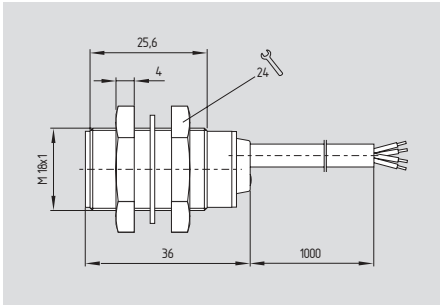
Approvals
H C D CE

Ordering details

BNS 120-①z-② sensor
BP ... (see page 21) actuator

No.	Replace	Description
①	11	1NO/1NC
	12	1NO/2NC
②	2187	only for Method III see page 15

BNS 180



Characteristics

Enclosure:	glass-fibre reinforced thermoplastic
Protection class:	IP 67
Termination:	Boflex cable
Cable size:	4 x 0.25 mm²
Mode of operation:	magnetic
Control Category:	up to 4*
Classification:	up to PDF-M*
Magnetic actuator:	uncoded BP 6, BP 10, BP 15 SS
S_{ao}:	BP 6: 10 mm
	BP 10, BP 15 SS: 20 mm
S_{ar}:	BP 6: 22 mm
	BP 10, BP 15 SS: 32 mm
Max. switching voltage without LED:	100 VAC/DC
Max. switching current without LED:	250 mA
Output:	
U_e:	–
I_e:	–
Max. switching capacity without LED:	3 VA/W

Standards
EN 60947-5-3; EN 954-1, BG-GS-ET-14; EN 1088

Approvals
H C D CE

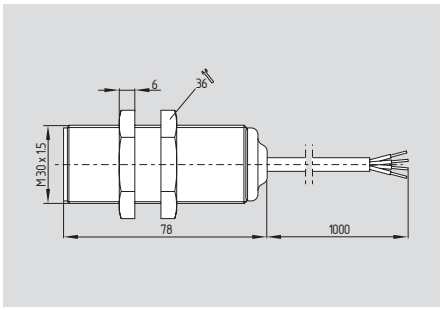
Ordering details

BNS 180-①z-② sensor
BP ... (see page 21) actuator

No.	Replace	Description
①	11	1NO/1NC
	12	1NO/2NC
②	2187	only for Method III see page 15

Note: * only in combination with AES safety control module

BNS 300



Characteristics

Enclosure:	glass-fibre reinforced thermoplastic
Protection class:	IP 67
Termination:	Boflex cable, connector M12x1
Cable size:	4 x 0.75 mm^2
Mode of operation:	magnetic
Control Category:	1 (integrated control module)
Classification:	PDF-S
Magnetic actuator:	coded BPS 300, BPS 303, BPS 303 SS
S_{ao}:	5 mm
	ordering suffix -2211: 8 mm
S_{ar}:	15 mm
	ordering suffix -2211: 18 mm
Max. switching voltage:	250 VAC
Max. switching current:	3 A
Output:	1 enabling path
U_e:	24 VDC
I_e:	30 mA
Max. switching capacity:	750 VA

Standards
EN 60947-5-3; EN 954-1, BG-GS-ET-14; EN 1088

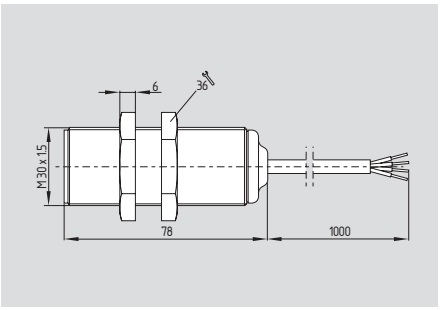
Approvals
H C D CE

Ordering details

BNS 300-01zG-①-② sensor
BPS ... (see page 21) actuator

No.	Replace	Description
①	2211	increased switching distance
	2230	additional signal output
	2246	U_e 42 VAC
②	ST	with connector M12x1

BNS 30



Characteristics

Enclosure:	brass, nickel-plated
Protection class:	IP 67
Termination:	Boflex cable, connector M12x1
Cable size:	4 x 0.75 mm^2
Mode of operation:	magnetic
Control Category:	1 (integrated control module)
Classification:	PDF-S
Magnetic actuator:	coded BPS 300, BPS 303, BPS 303 SS
S_{ao}:	5 mm
	ordering suffix -2211: 8 mm
S_{ar}:	15 mm
	ordering suffix -2211: 18 mm
Max. switching voltage:	250 VAC
Max. switching current:	3 A
Output:	1 enabling path
U_e:	24 VDC
I_e:	30 mA
Max. switching capacity:	750 VA

Standards
EN 60947-5-3; EN 954-1, BG-GS-ET-14; EN 1088

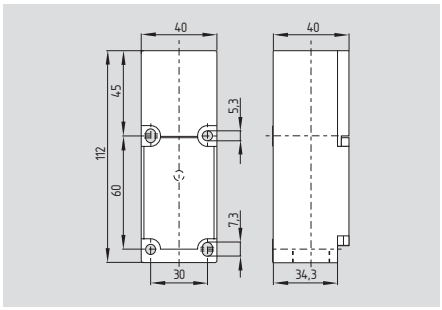
Approvals
H CE

Ordering details

BNS 30-01zG-① sensor
BPS ... (see page 21) actuator

No.	Replace	Description
①	2211	increased switching distance
	2230	additional signal output
	2246	U_e 42 VAC
②	ST	with connector M12x1

BNS 333



Characteristics

Enclosure:	glass-fibre reinforced thermoplastic
Protection class:	IP 65
Termination:	screw terminals
Cable size:	max. 2 x 1.5 mm^2
Cable entry:	1 x M20
Mode of operation:	magnetic
Control Category:	1 (integrated control module)
Classification:	PDF-S
Magnetic actuator:	coded , BPS 300, BPS 303, BPS 303 SS
S_{ao}:	4 mm
S_{ar}:	14 mm
Max. switching current:	5 A
Max. switching voltage:	250 VAC
Output:	1 enabling path
U_e:	24 VDC
I_e:	max. 40 mA
Max. switching capacity:	1250 VA

Standards
EN 60947-5-3; EN 954-1, BG-GS-ET-14; EN 1088

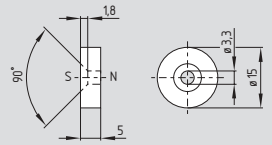
Approvals
H C D CE

Ordering details

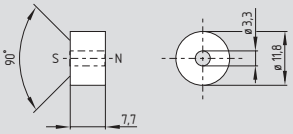
BNS 333-01y ① ② sensor
BPS ... (see page 21) actuator

No.	Replace	Description
		Actuating plane:
①	V	top
	R	right
	L	left
	D	front (cover)
	U	rear
②	M20	Cable entry M20

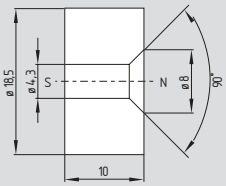
Actuators



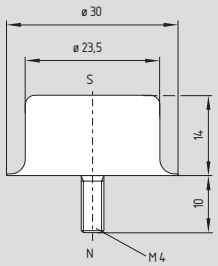
BP 6 without enclosure



BP 8 without enclosure

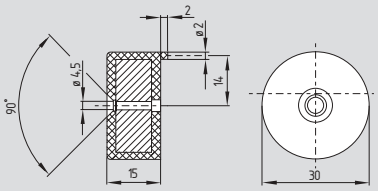


BP 10 without enclosure

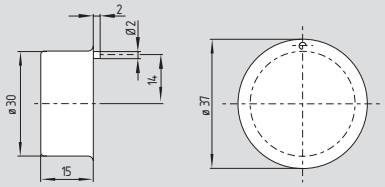


BP 15 SS stainless steel

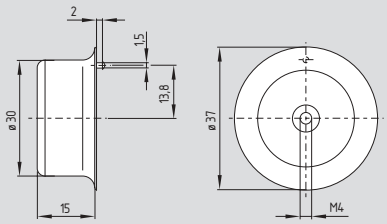
Actuators



BPS 300 with enclosure



BPS 303 with enclosure



BPS 303 SS stainless steel

Ordering details

Actuators:

Without enclosure:	**BP 6**
	BP 8
	BP 10
Stainless steel:	**BP 15 SS**

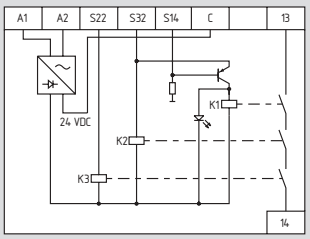
Ordering details

Actuators:

Thermoplastic:	**BPS 300**
Thermoplastic for food processing industry:	**BPS 303**
Stainless steel for food processing industry:	**BPS 303 SS**

Safety control modules

AES 1102



Characteristics

U_e:	24 VDC ± 15 %
	110 VAC
	230 VAC
	24 VAC
	42 VAC
I_e:	0.1 A
Start conditions:	automatic
Feedback circuit:	no
Stop category:	0
Control Category:	1
Monitored inputs:	2 NC / 1 NO
Enabling contacts:	1 enabling path
Contact load capacity:	max. 250 VAC, max. 4 A (cos φ = 1)
Termination:	screw terminals
Cable size:	max. 2.5 mm²
Status indicator:	LED
Dimensions:	22.5 x 75 x 110 mm

Standards
IEC/EN 60204-1; EN 954-1; EN 60947-5-3; BG-GS-ET-14; BG-GS-ET-20

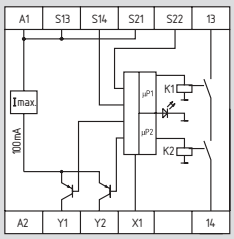
Approvals
C D CE

Ordering details

AES 1102 ① 2 NC / 1 NO

No.	Replace	Description
①		24 VDC
	.1	110 VAC
	.2	230 VAC
	.3	24 VAC
	.4	42 VAC

AES 1135/1165



Characteristics

U_e:	24 VDC ± 15%
I_e:	0.2 A
Start conditions:	automatic
Feedback circuit:	no
Stop category:	0
Control Category:	3
Monitored inputs:	1 NC / 1 NO
Enabling contacts:	1 enabling path
Contact load capacity:	max. 250 VAC, max. 6 A (cos φ = 1)
Signalling output:	2 transistor outputs, Y1 + Y2 = max. 100 mA, p-type, short-circuit proof
Termination:	screw terminals
Cable size:	max. 2.5 mm²
Status indicator:	LED (ISD)
Dimensions:	22.5 x 100 x 121 mm

Standards
IEC/EN 60204-1; EN 954-1; EN 60947-5-3; BG-GS-ET-14; BG-GS-ET-20

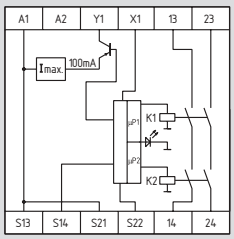
Approvals
H C D pending CE

Ordering details

AES 1135 ① 1 NC / 1 NO
AES 1165-2250 ① 2x 1 NC / 1 NO

No.	Replace	Description
①		24 VDC

AES 1235/1265



Characteristics

U_e:	24 VDC ± 15%
I_e:	0.2 A
Start conditions:	automatic or start button
Feedback circuit:	yes
Stop category:	0
Control Category:	3
Monitored inputs:	1 NC / 1 NO
Enabling contacts:	2 enabling paths
Contact load capacity:	max. 250 VAC, max. 6 A (cos φ = 1)
Signalling output :	1/2 transistor outputs Y1+Y2 = max. 100 mA p-type, short-circuit proof
Termination:	screw terminals
Cable size:	max. 2.5 mm²
Status indicator:	LED (ISD)
Dimensions:	22.5 x 100 x 121 mm

Standards
IEC/EN 60204-1; EN 954-1; EN 60947-5-3; BG-GS-ET-14; BG-GS-ET-20

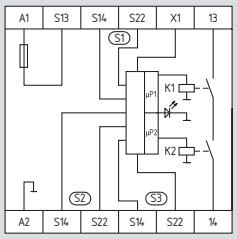
Approvals
H C D pending CE

Ordering details

AES 1235 ① 1 NC / 1 NO
AES 1265 ① 2x 1 NC / 1 NO

No.	Replace	Description
①		24 VDC

AES 1185



Characteristics

U_e:	24 VDC ± 15%
I_e:	0.2 A
Start conditions:	automatic or start button
Feedback circuit:	no
Stop category:	0
Control Category:	3
Monitored inputs:	3 x 1 NC / 1 NO
Enabling contacts:	1 enabling path
Contact load capacity:	max. 250 VAC, max. 4 A (cos φ = 1)
Termination:	screw terminals
Cable size:	max. 2.5 mm²
Status indicator:	LED (ISD)
Dimensions:	22.5 x 100 x 121 mm

Standards
IEC/EN 60204-1; EN 954-1; EN 60947-5-3; BG-GS-ET-14; BG-GS-ET-20

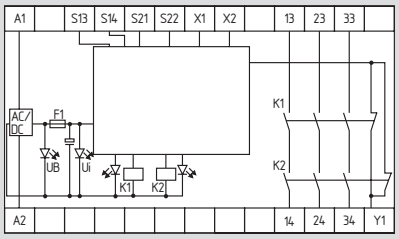
Approvals
H C D CE

Ordering details

AES 1185 ①

No.	Replace	Description
①		24 VDC

AES 1337



Characteristics

U_e:	24 VDC –15%/+20%, 24 VAC –15%/+10%
I_e:	0.08 A
Start conditions:	Start, reset button, (trailing edge), autostart
Feedback circuit:	yes
Stop category:	0
Control Category:	4
Monitored inputs:	1 NC / 1 NO
Enabling contacts:	3 enabling paths
Contact load capacity:	max. 250 VAC, max. 6 A (cos φ = 1)
Signalling output:	1 NC contact 100 mA, short-circuit proof
Termination:	plug-in screw terminals
Cable size:	max. 2.5 mm²
Status indicator:	4 LED
Dimensions:	22.5 x 100 x 121 mm

Standards
IEC/EN 60204-1; EN 954-1; EN 60947-5-3; BG-GS-ET-14; BG-GS-ET-20

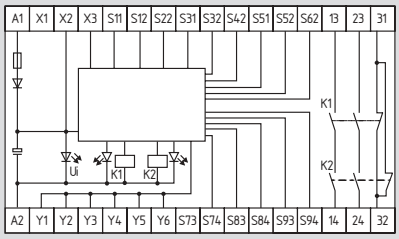
Approvals
H C D pending CE

Ordering details

AES 1337 ①

No.	Replace	Description
①		24 VAC/DC

AES 2285



Characteristics

U_e:	24 VDC –15%/+20% 24 VAC –15%/+10%
I_e:	0.11 A
Start conditions:	Start, reset button, (trailing edge), autostart
Feedback circuit:	yes
Stop category:	0
Control Category:	3
Monitored inputs:	6 x 1 NC / 1 NO
Enabling contacts:	2 enabling paths
Contact load capacity:	max. 250 VAC, max. 6 A (cos φ = 1)
Signalling output:	6 NC contacts 6 x 20 mA, short-circuit proof 1 NC contact 2 A
Termination:	plug-in screw terminals
Cable size:	max. 2.5 mm²
Status indicator:	3 LED
Dimensions:	45 x 100 x 121 mm

Standards
IEC/EN 60204-1; EN 954-1; EN 60947-5-3; BG-GS-ET-14; BG-GS-ET-20

Approvals
H C D pending CE

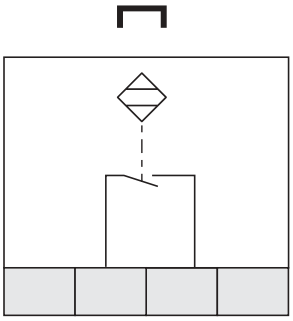
Ordering details

AES 2285 ①

No.	Replace	Description
①		24 VAC/DC

Wiring diagram No. I.1

BNS with integrated control module



Features

Description:	• Monitoring of one safety guard • Safety Sensor with integrated control module
Control Category of the system:	• 1 to EN 954-1
Classification of the system:	• PDF-S to EN 60947-5-3
Comments:	• Signal to PLC as an option (BNS 300-01zG-2230, BNS 30-01zG-2230)

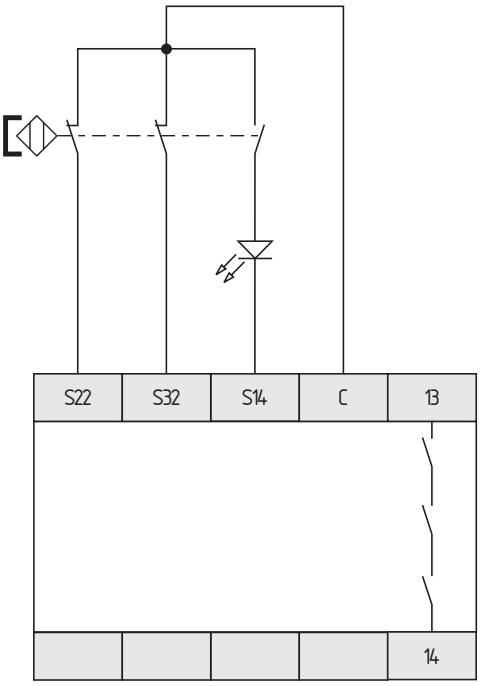
Product selection

Safety Sensors:	BNS 30-01zG BNS 300-01zG BNS 333-01y
Control module:	integrated

Note: The wiring diagram is shown with the safety guard closed and no power on the module.

Wiring diagram No. II.1

BNS + AES 1102



Features

Description:	• Monitoring of one safety guard • Connection of one Safety Sensor to one control module
Input circuit:	• 3 channel
Control Category of the system:	• 1 to EN 954-1
Classification of the system:	• PDF-S to EN 60947-5-3
Comments:	• No signal to PLC

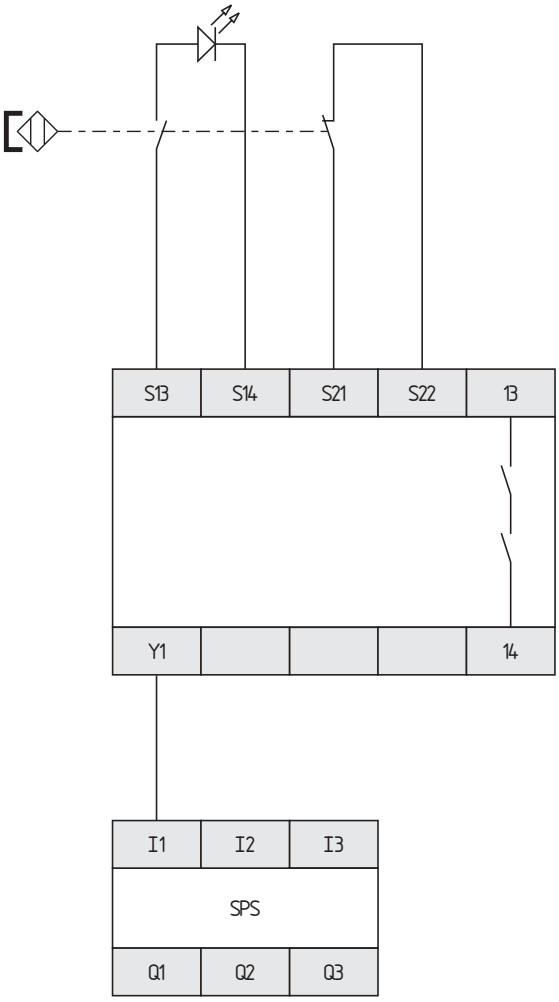
Product selection

Safety Sensors:	BNS 16-12z. BNS 33-12z BNS 33-12zG BNS 250-12z BNS 250-12zG BNS 303-12z BNS 303-12zG BNS 180-12z BNS 120-12z
Control module:	AES 1102

Note: The wiring diagram is shown with the safety guard closed and no power on the module.

Wiring diagram No. II.2

BNS + AES 1135



Features

Description:	• Monitoring of one safety guard • Connection of one Safety Sensor to one control module
Input circuit:	• 2 channel
Control Category of the system:	• 3 to EN 954-1
Classification of the system:	• PDF-M to EN 60947-5-3
Comments:	• Signal to PLC

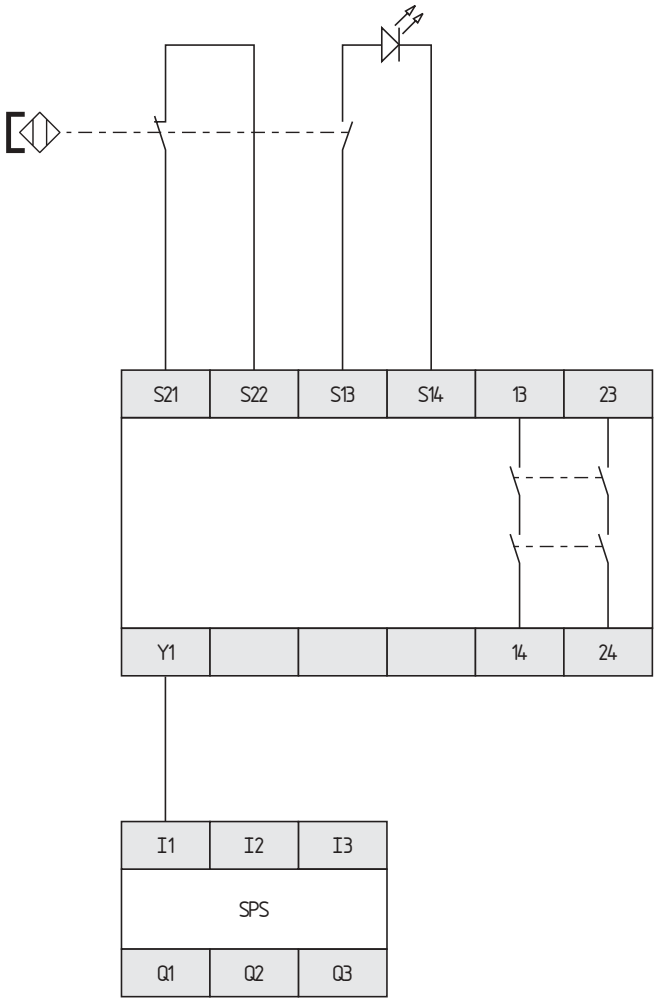
Product selection

Safety Sensors:	BNS 16-12z. BNS 33-11z BNS 33-11zG BNS 250-11z BNS 250-11zG BNS 303-11z BNS 303-11zG BNS 180-11z BNS 120-11z
Control module:	AES 1135

Note: The wiring diagram is shown with the safety guard closed and no power on the module.

Wiring diagram No. II.3

BNS + AES 1235



Features

Description:
- Monitoring of one safety guard
- Connection of one Safety Sensor to one control module

Input circuit:
- 2 channel

Control Category of the system:
- 3 to EN 954-1

Classification of the system:
- PDF-M to EN 60947-5-3

Comments:
- Signal to PLC

Product selection

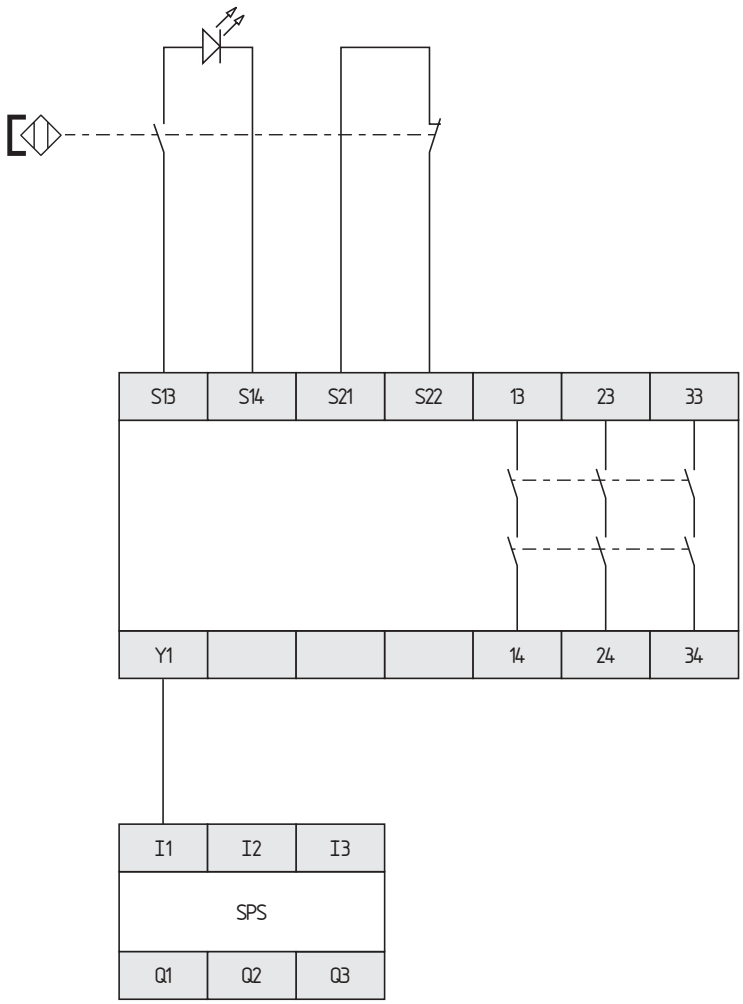
Safety Sensors:
BNS 16-12z.
BNS 33-11z
BNS 33-11zG
BNS 250-11z
BNS 250-11zG
BNS 303-11z
BNS 303-11zG
BNS 180-11z
BNS 120-11z

Control module:
AES 1235

Note: The wiring diagram is shown with the safety guard closed and no power on the module.

Wiring diagram No. II.4

BNS + AES 1337



Features

Description:	• Monitoring of one safety guard • Connection of one Safety Sensor to one control module
Input circuit:	• 2 channel
Control Category of the system:	• 4 to EN 954-1
Classification of the system:	• PDF-M to EN 60947-5-3
Comments:	• Signal to PLC

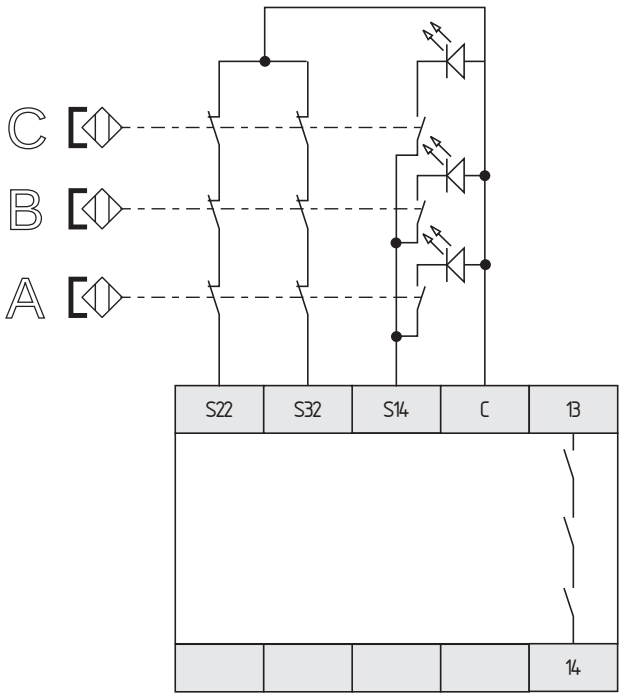
Product selection

Safety Sensors:	BNS 16-12z. BNS 33-11z BNS 33-11zG BNS 250-11z BNS 250-11zG BNS 303-11z BNS 303-11zG BNS 180-11z BNS 120-11z
Control module:	AES 1337

Note: The wiring diagram is shown with the safety guard closed and no power on the module.

Wiring diagram No. III.1

BNS + AES 1102



Features

Description:	• Monitoring of multiple safety guards • Connection of multiple Safety Sensors to one control module (possibly via an external expander)
Input circuit:	• 3 channel
Control Category of the system:	• 1 to EN 954-1
Classification of the system:	• PDF-S to EN 60947-5-3
Comments:	• No signal to PLC • Max. 20 Safety Sensors reccomended

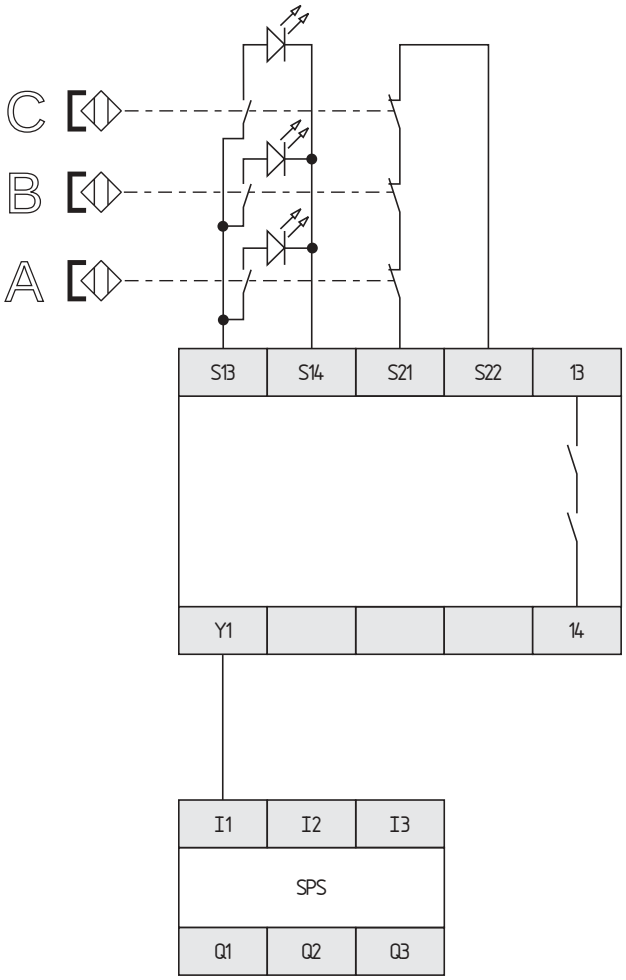
Product selection

Safety Sensors:	BNS 16-12z. BNS 33-12z-2187 BNS 33-12zG-2187-10 BNS 250-12z-2187 BNS 303-12z-2187 BNS 303-12zG-2187 BNS 180-12z-2187 BNS 120-12z-2187
Control module:	AES 1102

Note: The wiring diagram is shown with the safety guard closed and no power on the module.

Wiring diagram No. III.2

BNS + AES 1135



Features

Description:	• Monitoring of multiple safety guards • Connection of multiple Safety Sensors to one control module (possibly via an external expander)
Input circuit:	• 2 channel
Control Category of the system:	• 3 to EN 954-1
Classification of the system:	• PDF-S to EN 60947-5-3
Comments:	• Signal to PLC • Max. 20 Safety Sensors reccomended

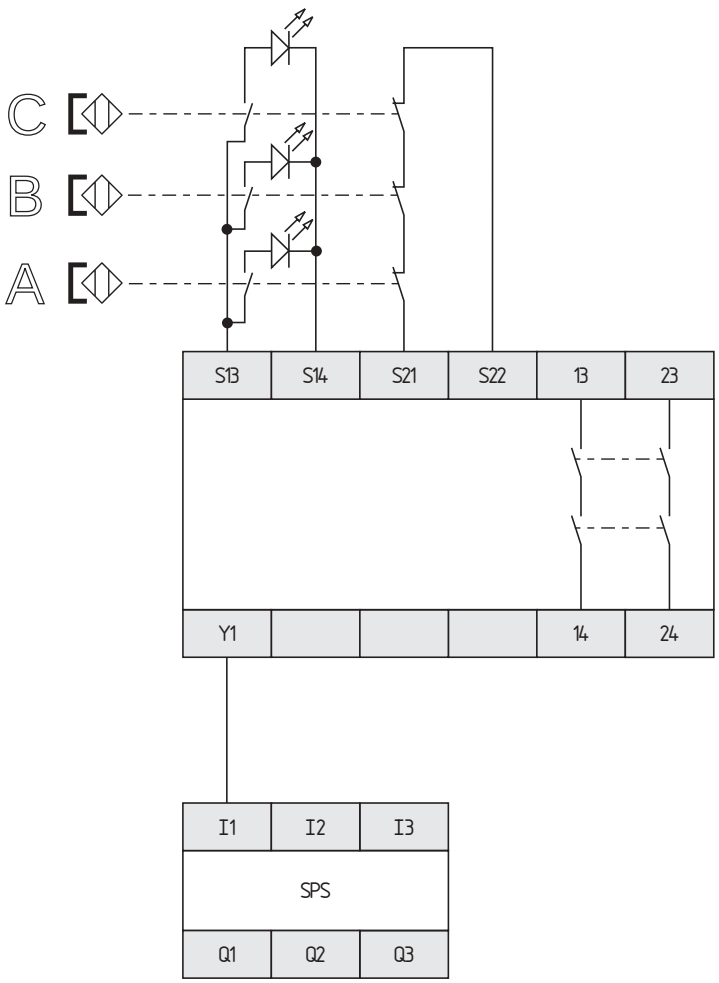
Product selection

Safety Sensors:	BNS 16-12z. BNS 33-11z BNS 33-11zG BNS 250-11z BNS 250-11zG BNS 303-11z BNS 303-11zG BNS 180-11z BNS 120-11z
Control module:	AES 1135

Note: The wiring diagram is shown with the safety guard closed and no power on the module.

Wiring diagram No. III.3

BNS + AES 1235



Features

Description:	• Monitoring of multiple safety guards • Connection of multiple Safety Sensors to one control module (possibly via an external expander)
Input circuit:	• 2 channel
Control Category of the system:	• 3 to EN 954-1
Classification of the system:	• PDF-S to EN 60947-5-3
Comments:	• Signal to PLC • Max. 20 Safety Sensors reccomended

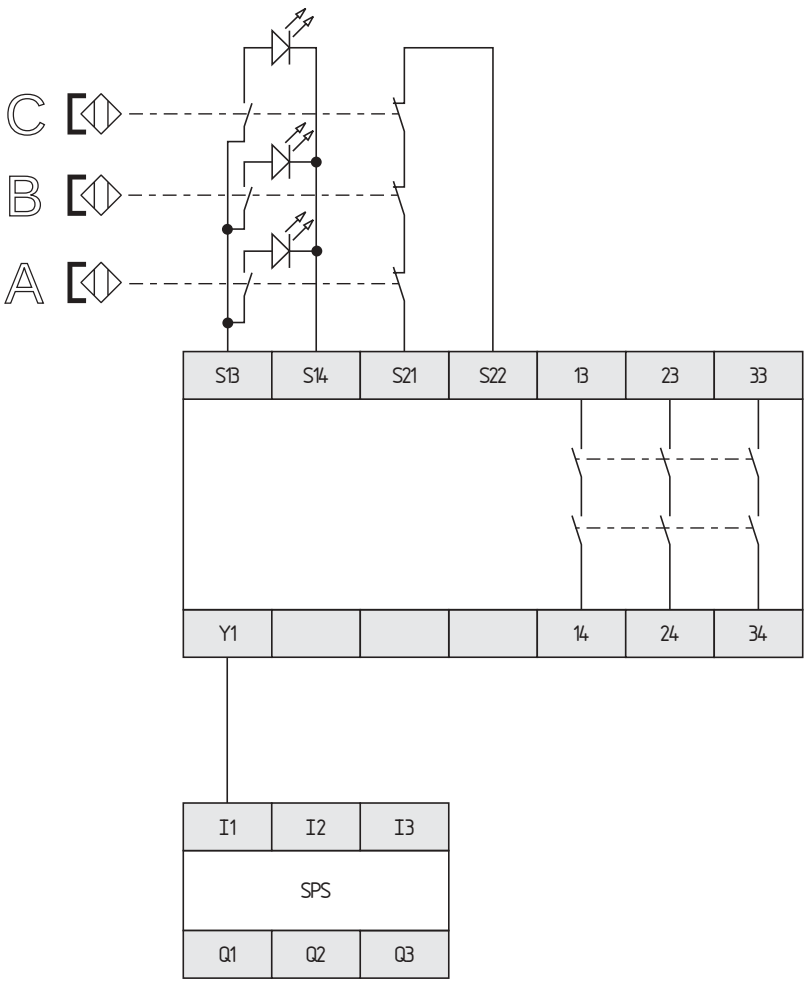
Product selection

Safety Sensors:	BNS 16-12z. BNS 33-11z BNS 33-11zG BNS 250-11z BNS 250-11zG BNS 303-11z BNS 303-11zG BNS 180-11z BNS 120-11z
Control module:	AES 1235

Note: The wiring diagram is shown with the safety guard closed and no power on the module.

Wiring diagram No. III.4

BNS + AES 1337



Features

Description:
- Monitoring of multiple safety guards
- Connection of multiple Safety Sensors to one control module (possibly via an external expander)

Input circuit:
- 2 channel

Control Category of the system:
- 3 to EN 954-1

Classification of the system:
- PDF-S to EN 60947-5-3

Comments:
- Signal to PLC
- Max. 20 Safety Sensors reccomended

Product selection

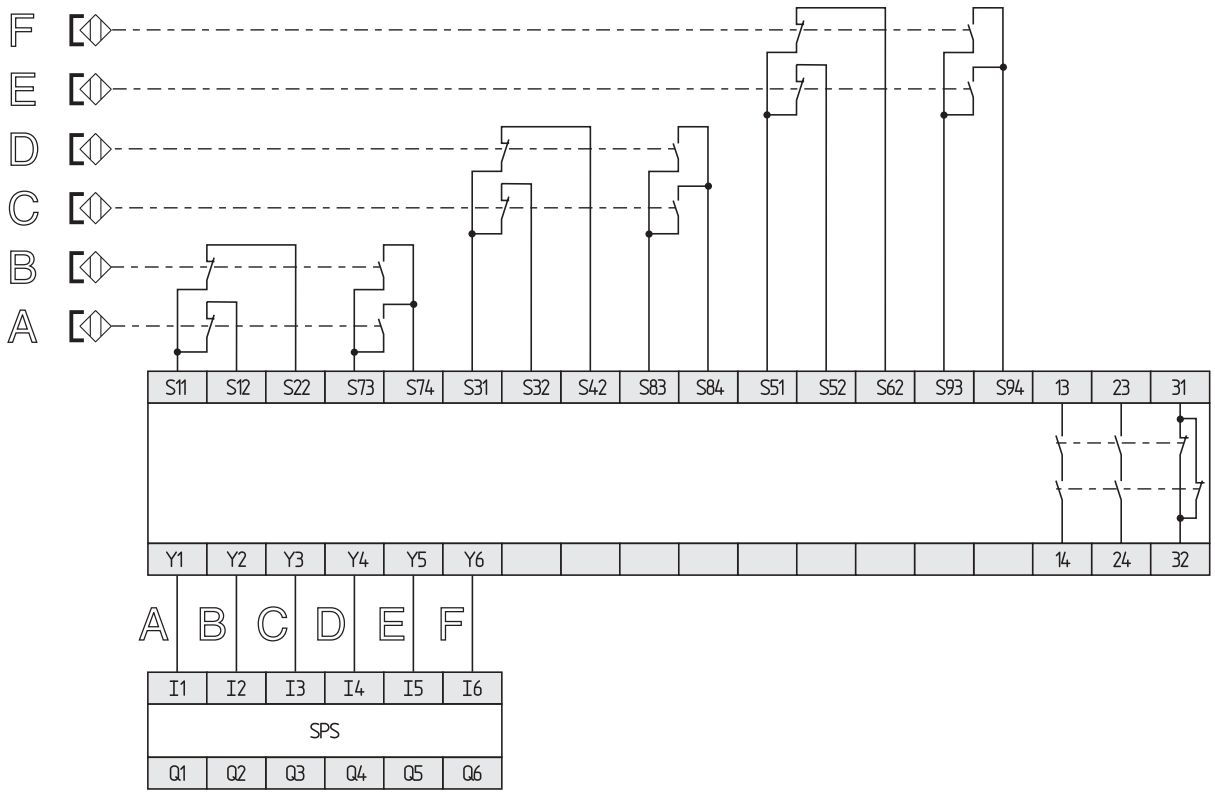
Safety Sensors:
BNS 16-12z.
BNS 33-11z
BNS 33-11zG
BNS 250-11z
BNS 250-11zG
BNS 303-11z
BNS 303-11zG
BNS 180-11z
BNS 120-11z

Control module:
AES 1337

Note: The wiring diagram is shown with the safety guard closed and no power on the module.

Wiring diagram No. IV.1

BNS + AES 2285



Features

Description:	• Monitoring of 6 safety guards • Connection of 6 Safety Sensors to one control module
Input circuit:	• 2 channel
Control Category of the system:	• 3 to EN 954-1
Classification of the system:	• PDF-M to EN 60947-5-3
Comments:	• Signal to PLC

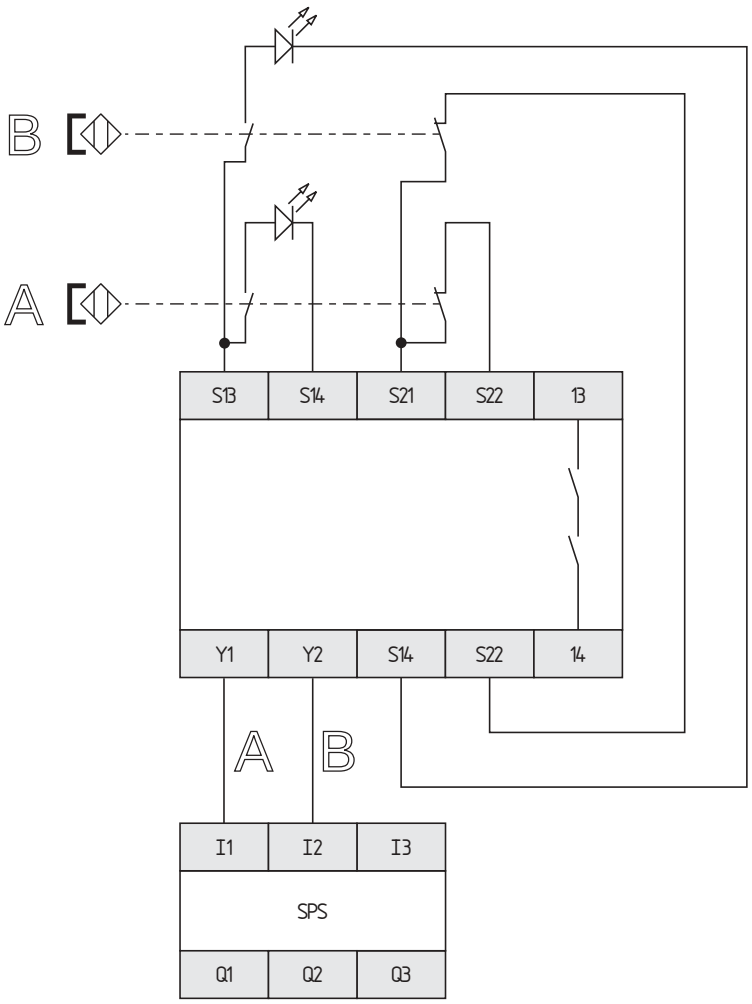
Product selection

Safety Sensors:	BNS 16-12z. BNS 33-11z BNS 250-11z BNS 303-11z BNS 180-11z BNS 120-11z
Control module:	AES 2285

Note: The wiring diagram is shown with the safety guard closed and no power on the module.

Wiring diagram No. IV.2

BNS + AES 1165-2250



Features

Description:	• Monitoring of 2 safety guards • Connection of 2 Safety Sensors to one control module
Input circuit:	• 2 channel
Control Category of the system:	• 3 to EN 954-1
Classification of the system:	• PDF-M to EN 60947-5-3
Comments:	• Signal to PLC

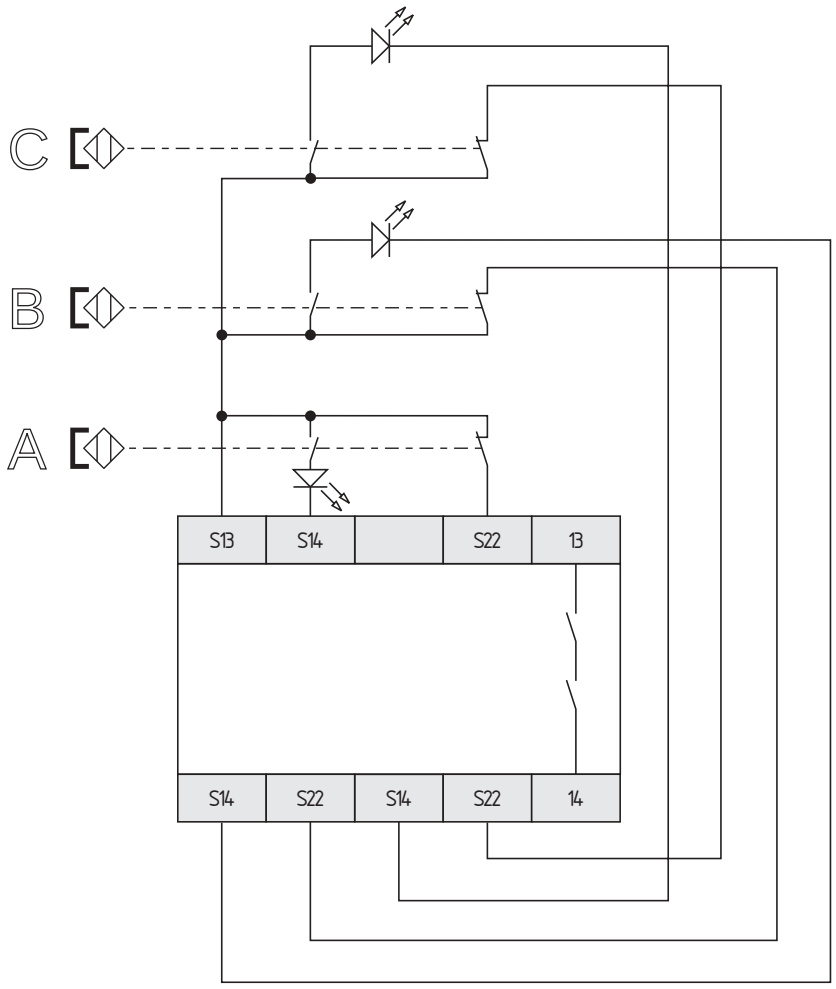
Product selection

Safety Sensors:	BNS 16-12z. BNS 33-11z BNS 33-11zG BNS 250-11z BNS 250-11zG BNS 303-11z BNS 303-11zG BNS 180-11z BNS 120-11z
Control module:	AES 1165-2250

Note: The wiring diagram is shown with the safety guard closed and no power on the module.

Wiring diagram No. IV.3

BNS + AES 1185



Features

Description:	• Monitoring of 3 safety guards • Connection of 3 Safety Sensors to one control module
Input circuit:	• 2 channel
Control Category of the system:	• 3 to EN 954-1
Classification of the system:	• PDF-M to EN 60947-5-3
Comments:	• No signal to PLC

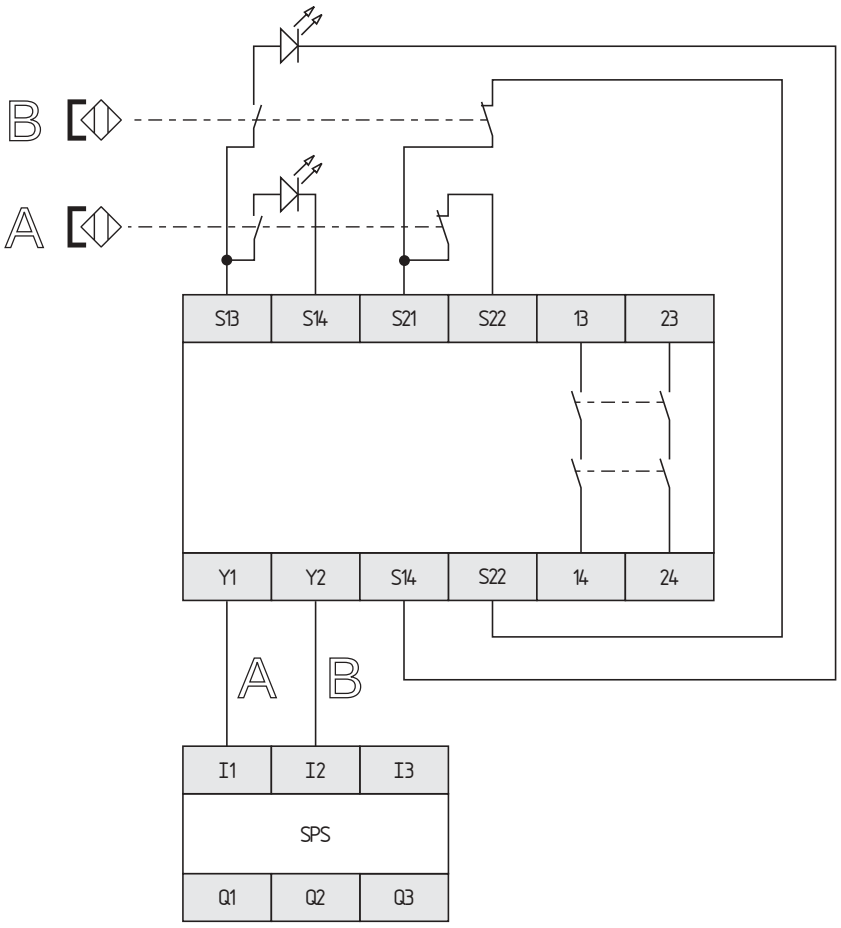
Product selection

Safety Sensors:	BNS 16-12z. BNS 33-11z BNS 33-11zG BNS 250-11z BNS 250-11zG BNS 303-11z BNS 303-11zG BNS 180-11z BNS 120-11z
Control module:	AES 1185

Note: The wiring diagram is shown with the safety guard closed and no power on the module.

Wiring diagram No. IV.4

BNS + AES 1265



Features

Description:	• Monitoring of 2 safety guards • Connection of 2 Safety Sensors to one control module
Input circuit:	• 2 channel
Control Category of the system:	• 3 to EN 954-1
Classification of the system:	• PDF-M to EN 60947-5-3
Comments:	• Signal to PLC

Product selection

Safety Sensors:	BNS 16-12z. BNS 33-11z BNS 33-11zG BNS 250-11z BNS 250-11zG BNS 303-11z BNS 303-11zG BNS 180-11z BNS 120-11z
Control module:	AES 1265

Note: The wiring diagram is shown with the safety guard closed and no power on the module.

Up to Date

The latest product information and news at:
www.schmersal.com

Explanation of symbols

Control Category 1 to EN 954-1 . . . . . SK1

Control Category 2 to EN 954-1 . . . . . SK2

Control Category 3 to EN 954-1 . . . . . SK3

Control Category 4 to EN 954-1 . . . . . SK4

PDF with reliability
through special design . . . . . **PDF-D**

PDF with test capability . . . . . **PDF-T**

PDF with single-fault tolerance . . . . . **PDF-S**

PDF with self-monitoring . . . . . **PDF-M**

Conforms to European Directives
see Declaration of conformity . . . . . CE

UL approval, USA C

UL/CSA approval, USA . . . . . c UL us

CSA approval, Canada . . . . . D

CSA/UL approval, Canada . . . . . c SA us

TÜV prototype-tested . . . . . F

BG prototype-tested . . . . . H

Safety Sensor . . . . . S

Spanner size across flats . . . . . ⚷

Integrated system diagnosis . . . . . **ISD**

Rated insulation voltage . . . . . $\mathbf{U_i}$

Thermal current test . . . . . $\mathbf{I_{th}}$

Rated operating voltage . . . . . $\mathbf{U_e}$

Rated operating current . . . . . $\mathbf{I_e}$

Rated control voltage . . . . . $\mathbf{U_s}$

Assured operating distance . . . . . $\mathbf{S_{ao}}$

Assured release distance . . . . . $\mathbf{S_{ar}}$

Information About Standards and Literature

Standards:

[1] Machinery Directive 98/37/EC
of the European Parliament and of the Council of 22nd June 1998 on the approximation of the laws of the Member States relating to machinery (formerly 89/392/ECC)

[2] EN 292-1
Safety of machinery -
basic concepts, general principles for design;-
basic terminology, methodology

[3] EN 292-2
Safety of machinery -
basic concepts, general principles for design;-
technical principles and specifications

[4] EN 954-1
Safety of machinery -
Safety-related parts of control systems -
General principles for design

[5] EN 1050
Safety of machinery -
Principles for risk assessment

[6] EN 1088
Safety of machinery -
Interlocking devices associated with guards -
Principles for design and selection

[7] EN 60204-1
Safety of machinery -
Electrical equipment of machines -
General requirements

[8] EN 60947-5-2
Low-voltage switchgear and controlgear -
Control circuit devices and switching elements -
Proximity switches

[9] EN 60947-5-3
Low-voltage switchgear and controlgear -
Control circuit devices and switching elements -
Requirements for proximity devices with defined behaviour under fault condition

[10] BGI 670
Selection and Installation of proximity switches
for safety functions

The Schmersal Group has published a technical book about machine safety available in English in one volume or German in two volumes.

Several chapters of these books also contain detailed notes for the selection and the design of safety guards fitted with Safety Sensors.

- Werner Defren/ Franz Kreutzkampf:
  Machine Safety in the European Community.
  Wuppertal, 1. Edition 2003,
  ISBN 3-926069-13-9

- Werner Defren/ Dr. Karl Wickert:
  Sicherheit für den Maschinen- und Anlagenbau.
  Wuppertal, 2. Auflage 2001,
  ISBN 3-926069-10-4

- Werner Defren/ Franz Kreutzkampf:
  Personenschutz in der Praxis.
  Wuppertal 2001,
  ISBN 3-926069-11-2

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