Safety

Good equipment is **safe** equipment, which combines:

- **Safety:** of personnel (equipment that does not pose a hazard),
- **Reliable Operation:** of production machinery (equipment in working order at all times).

Safety is achieved by:

- Simultaneously optimizing safety and reliability,
- Applying fundamental principles: redundancy, and self-testing,
- Making reliability a design consideration (failure potential determining the design of the machine in a specified position, pro-active safety features),
- Ease of maintenance.

Safety and Automation

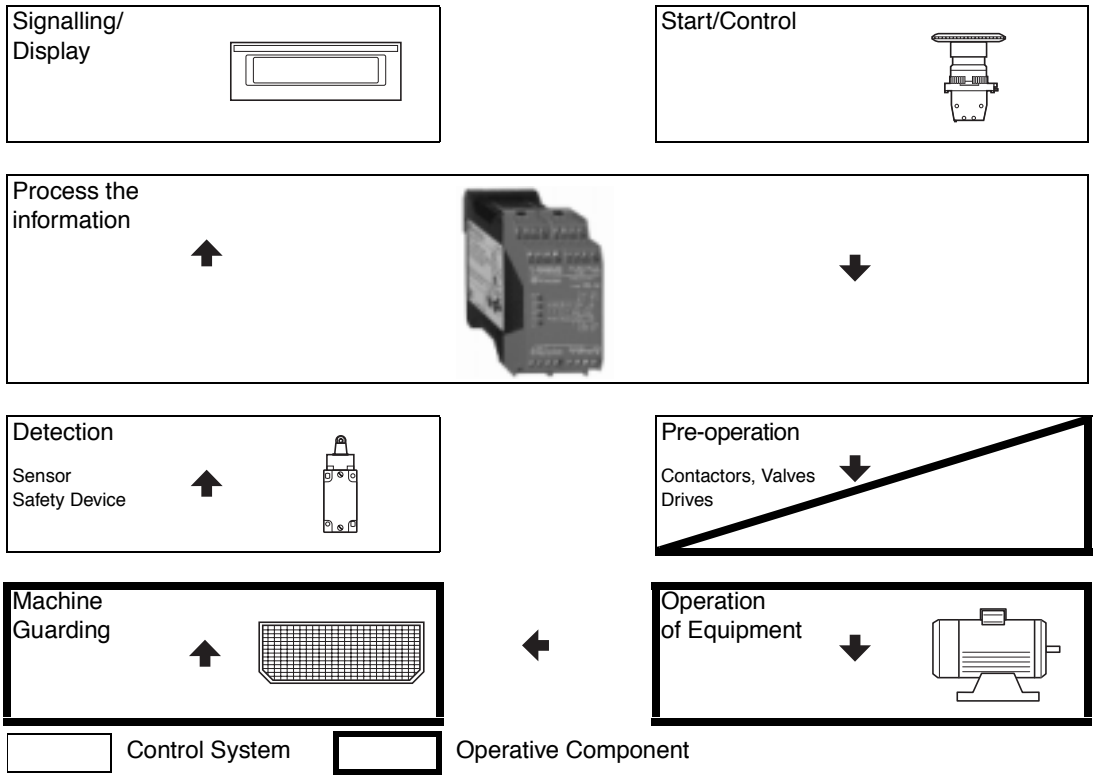
All hazardous areas must be identified and their access restricted and controlled, that is to say that no failure or tampering should render the automated equipment hazardous to personnel.

Please note that the use of safety products does not necessarily assure the equipment is compliant with the European Machinery Safety Directive, OSHA, ANSI, or other USA safety requirements.

Rather, proper use, wiring, connections and planning contribute to the safety of the equipment as a whole.

Safety systems are comprised of many components. No one safety component will ensure the safety of the system. The design of the complete safety system should be considered before you begin. It is very important to follow applicable safety standards when installing and wiring these components.

General Model of an Automated Machine



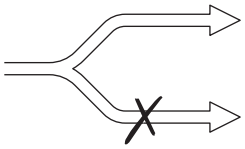
Objective

- Open outputs upon occurrence of the first fault.
- Provide non-hazardous positioning (machine stops in a safe state).
- Enhance the safety of personnel operating industrial machinery.

Basic Principles

Redundancy

To compensate for the failure of one component with another properly operating component, with the assumption that both components will not fail simultaneously.



Reliability

If an initial fault is not detected, there is no corrective action, allowing a second fault to occur, thereby compromising safety.

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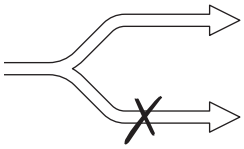
Redundancy

To compensate for the failure of one component with another properly operating component, with the assumption that both components will not fail simultaneously.



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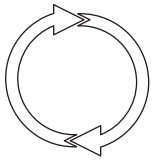
Self-Testing

To automatically test the operation of each component which changes state with each operating cycle.
The next cycle can be inhibited or enabled.



Reliability + Safety

An initial fault in a safety circuit will be detected before a second fault can occur (next cycle inhibited).

The use of a Preventa™ XPS safety relay module allows a Category 4 control system to be designed in compliance with standard EN 954-1 (for safety-related control system components).

Definitions

Redundancy

This function is achieved by integrating dual circuitry into the design, combined with a test function which authorizes a control action only when at least two output signals are identical.

Self-Test Function

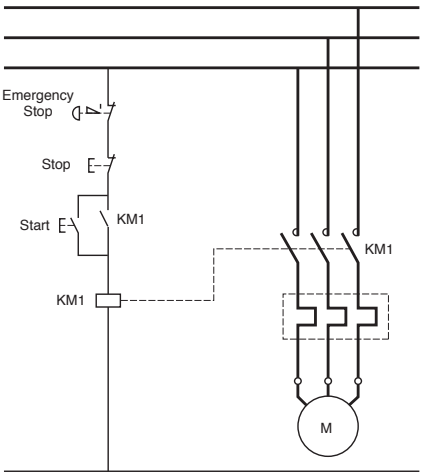
Preventa™ safety relay modules use mechanically-linked N.O. and N.C. contact relays.

These relays ensure the uniform operation of their additional N.C. and N.O. contacts.

The reliability of the self-test function is ensured by verifying the proper operation of the contact relays during the current cycle.

To detect the failure of a mechanically-linked N.O. relay contact requires that the proper operation of its N.C. contacts be tested at the time of their integration into a self-test circuit. This detection is made possible only by using mechanically-linked contact relays.

Effect on the Control Circuit without Interposing Relays/Contactors



The control signal issued by the protective device (emergency stop circuit illustrated to the left) acts directly on the power contactor of the machine.

In this diagram, the possible fault conditions are:

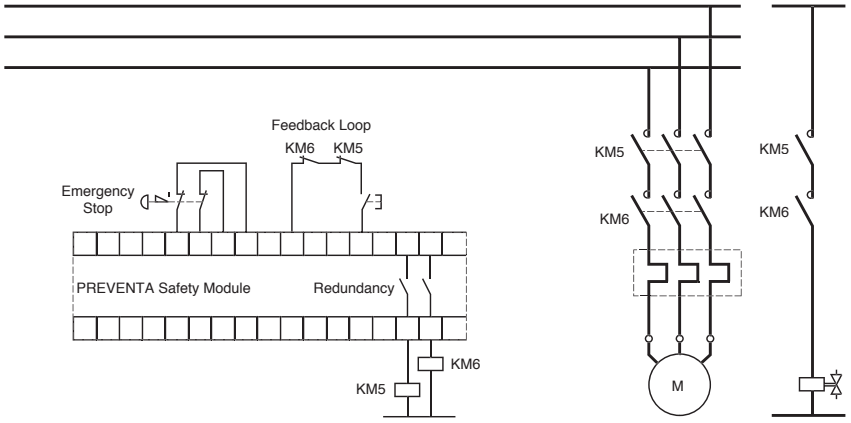
- emergency stop button being shorted or jumpered.
- KM1 contactor sticking or welded.

When the emergency stop is operated, the signal is not recognized, and another sequence can begin following the emergency stop, despite the presence of the fault condition.

In this case of failure, the safety function▲ is compromised. Therefore, reliable interposing relays/ contactors must be used.

▲ A safety function is a function whose non-execution or untimely execution results in the immediate placement of the equipment into a non-hazardous condition.

Effect on the Control Circuit with Interposing Relays/Contactors



KM5 and KM6 Relays/Contactors with Mechanically-Linked Contacts

Independent Safety Circuits

Preventa™ safety relay modules provide **reliable** interposing relaying by eliminating the risks of a:

- control circuit fault (inputs),
- power circuit fault (outputs),
- safety module internal component fault.

The safety function remains operative in all occurrences of one of these faults.

Relays and Contactors in the Safety Circuit

Use relays or contactors with mechanically-linked contacts on the safety outputs of the safety relay such as the Square D or Telemecanique products found in Appendix B, pages 303-306, of this catalog.

Category Requirements

To meet the requirements of Category 3 per EN 954-1 (this standard deals with safety related parts of control systems), the output devices must be redundant - meaning there must be two relays/contactors in series controlling the load which can cause a hazardous movement. Using only one relay/contactor will reduce the control system to a **maximum Category 2**.

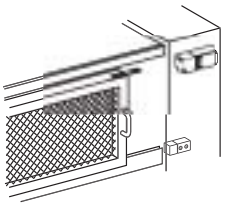
To meet the requirements of Category 4 per EN 954-1, the requirements for Category 3 need to be met, **plus** one of the N.C. auxiliary contacts from **each** of the two relays/contactors in series must be wired in series in the feedback loop. Without both of these N.C. contacts wired in series in the feedback loop, the control system is reduced to a **maximum Category 3.**

Selection Criteria

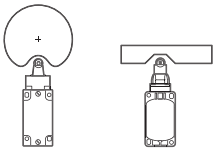
Low Potential of Hazard to Personnel

Locking or interlocking device based on the principle of intrinsically safe design (proven components and principles)

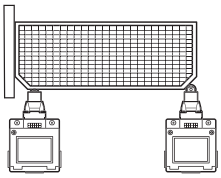
Quick-Stop Machinery. Locking (stop time < access time) ∗



Locking by actuating key



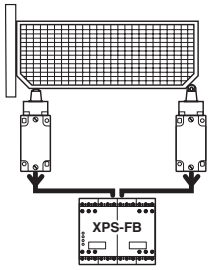
Positive Mode Activation



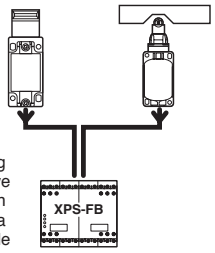
Positive and Negative Mode Activation

High Potential of Hazard to Personnel

Locking or interlocking device based on redundancy and self-testing. The safety relay modules provide these functions.

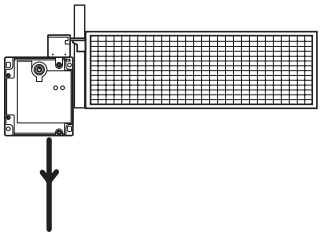


Positive and negative mode activation wired to a safety relay module

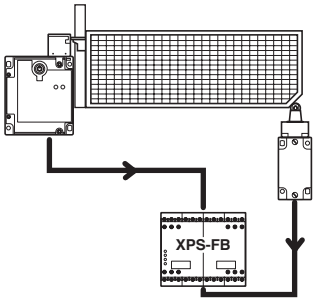


Locking by actuating key with positive mode activation wired to a safety relay module

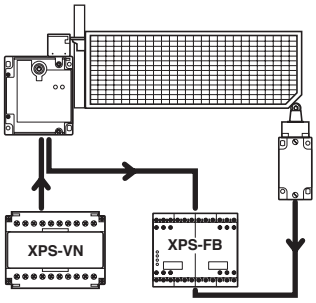
Inertia-Based Machinery; Long Stopping Times. Interlocking (stop time > access time)∗



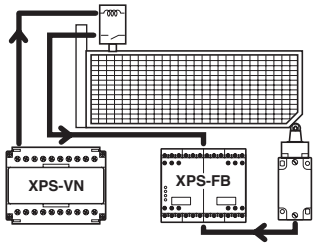
Interlocking Device with Electromagnetic Guard Lock



Interlocking Device with Electromagnetic Guard Lock



Interlocking Device with Electromagnetic Guard Lock and Zero Speed Sensing



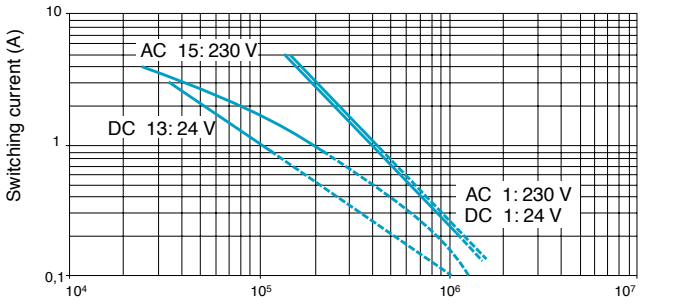
Interlocking Device with Electromagnetic Lock

∗ Stop time: time elapsed between issuance of the machine stop command and the moment at which the machine stops (risk elimination). Access time: time required for a person to access the hazardous area (calculated using an approach speed as the basis).

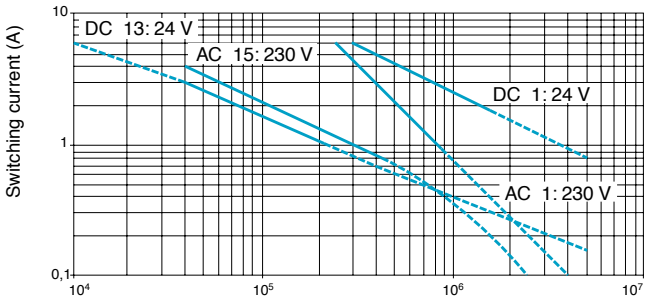
Lifetime Curve and Switching Capability with N.O. Contacts

Determined by EN 60947-5-1 Table C2

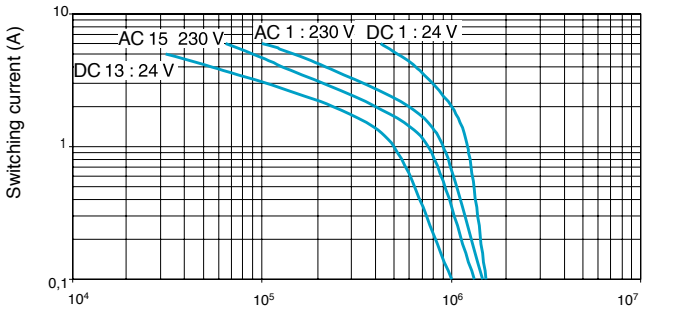
XPSAC, **XPSAT** (time delay contacts), **XPSTSA, XPSTSW, XPSBA**, **XPSBC**, **XPSCM**, **XPSDA, XPSFB, XPSNS, XPSOT, XPSPVK**, **XPSPVT**, **XPSVN, GNKL**



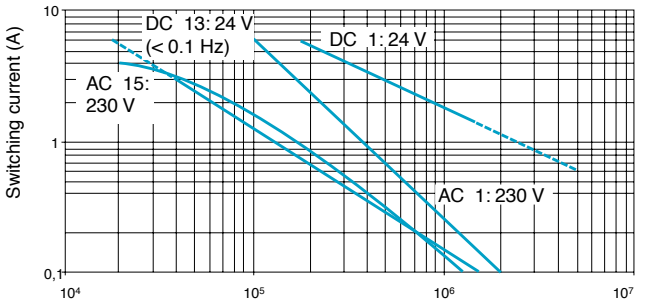
XPSAT (instantaneous contacts), **XPSECM**, **XPSECP, GBS**



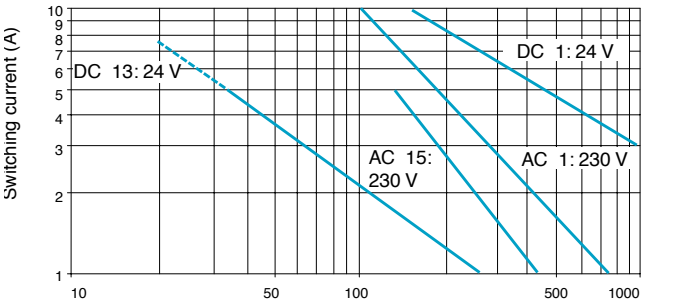
XPSAF, **XPSAK**, **XPSAFL**



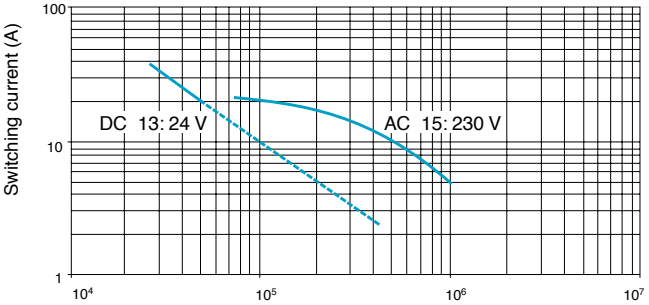
XPSAV, **XPSMP, XPSBF**



XPSAR



XPSDMB/DME



The product life expressed above is based on average usage and normal operating conditions.
Actual operating life will vary with conditions. The above statements are not intended to nor shall they create any express or implied warranties as to product operation or life. For information on the limited warranty offered on this product please refer to the Square D terms and conditions of sale found in the Square D Digest.

Determining the Electrical Life According to EN 60947-5-1 (Table C2)

Type of Current	Utilization Category	Start-up			Breaking		
		Current	Voltage	Cos φ	Current	Voltage	Cos φ
AC supply	AC-15	10 x Ie	Ue	0.7	Ie	Ue	0.4
Type of Current	**Utilization Category**	**Start-up**			**Breaking**		
		Current	**Voltage**	**T 0.95**	**Current**	**Voltage**	**T 0.95**
DC supply	DC-13	Ie	Ue	50 ms	Ie	Ue	50 ms

Ie: Operational current measured.
Ue: Operational voltage measured.
Cos φ: Power factor.
T 0.95: Time taken to reach 95% of rated current.

The tests are carried out with a frequency of 6 switching operations per minute and with no additional protection of the components connected to the safety outputs.

The use of additional protection for the components connected to the safety outputs significantly increases the life of the safety outputs.

Determining the Breaking Capacity According to EN 60947-5-1 (Table 4)

Utilization cat.	Start-up			Breaking			Total No. of Switching Ops.	Switching Ops. per minute for 1-1000 Switching Ops.	Switching Ops. per minute for 1001-6050 Switching Ops.	Minimum Duration of Switching Operation
	Current	Voltage	Cos φ	Current	Voltage	Cos φ				
AC-15	10 x Ie	Ue	0.3	Ie	Ue	0.3	6050	60	6	50 ms
Utilization cat.	**Start-up**			**Breaking**			**Total No. of Switching Ops.**	**Switching Ops. per minute for 1-1000 Switching Ops.**	**Switching Ops. per minute for 1001-6050 Switching Ops.**	**Minimum Duration of Switching Operation**
	Current	**Voltage**	**T 0.95**	**Current**	**Voltage**	**T 0.95**				
DC-13	Ie	Ue	50 ms	Ie	Ue	50 ms	6050	60	6	50 ms

Ie: Operational current measured.
Ue: Operational voltage measured.
Cos φ: Power factor.
T 0.95: Time taken to reach 95% of rated current.

Comments:

The maximum values for the breaking capacity of the safety outputs in the various utilization categories are not fixed and depend on the power factor and on the switching frequency. The test definition for the “breaking capacity” and “electrical life” tables in European standard EN 60947-5-1 uses different values for the power factor and the switching frequency.

The switching frequency of the safety outputs is higher in the “breaking capacity” table (60 switching operations per minute for the first 1000 switching operations) than in the “electrical life” table (6 switching operations per minute).

Consequently, the maximum breaking capacity values determined using the “breaking capacity” table are lower than those in the “electrical life” table.

AC Voltage and Current Ratings 50-60 HZ

Contact Rating Designation	Thermal Continuous Test Current, Amperes	Maximum Current, Amperes				Volt amperes	
		120 Volts		240 Volts			
		Make	Break	Make	Break	Make	Break
B300	5	30	3.00	15	1.50	3600	360
C300	2.5	15	1.50	7.5	0.75	1800	180

Operating Principle

Two-hand control stations are designed to protect personnel from hand injuries. They require machine operators to keep their hands clear of the hazardous motion area. The use of two-hand control is an individual protective measure, which can protect only one operator. Separate two-hand control units must be provided for each operator in a multiple-worker environment. Preventa™ XPSBA, XPSBC and XPSBF two-hand control safety relays, described below, comply with the requirements of European standard EN 574 for two-hand control systems.

The control units must be designed and implemented such that they cannot be activated involuntarily or easily rendered inoperative. Depending on the specific application, they must meet the requirements of the Type C standards pertaining to machinery.

To initiate a hazardous motion, both control units (two-hand push buttons) must be activated within an interval of ≤ 0.5 seconds (synchronous activation). If only one of the two push buttons is pressed during a hazardous operation, the control sequence is cancelled. Continuation of the hazardous operation is possible only if both push buttons are returned to their initial position and reactivated within a pre-determined time period. The feedback loop provides self-testing for contactors or relays with mechanically linked contacts designed to increase the number of output contacts or the current switching capacity.

The control sequence does not occur if:

- Both two-hand control push buttons are pressed during a time period greater than 0.5 seconds,
- A short-circuit is present in a push button contact,
- The feedback loop is not closed at start-up.

There must be enough distance between the control units and the hazardous area so that when only one control unit is released, the hazardous area cannot be reached before the hazardous motion stops or the cycle is completed.

XPSBA

This module is designed for use on lighter duty applications where a two-hand control function is desired, but where the safety category is B or 1 (per EN 954-1) and the two-hand control requirements meet Type III A (per EN 574). **This module is not to be used for applications, such as presses, which require a Type III C module or where the application is not a category B or 1.** For press applications, for applications in category 2, 3, or 4, or if application calls for a Type III C module, use XPSBC or XPSBF module.

XPSBC and XPSBF

These modules can be used on applications, such as presses, which require a Type III C module. The XPSBC and XPSBF can be used for a two-hand control application, including presses and similar equipment.

Technical Data

Type			XPSBA	XPSBC
Product designed for max. use in safety related parts of control systems (conforming to EN 954-1)			Category 1	Category 4
Power Supply				
voltage		V	24 Vac/dc, 115 Vac, 230 Vac	24 Vdc, 24 Vac, 115 Vac, 230 Vac
voltage limits			- 20 to + 20 % (24 Vdc), - 20 to + 10 % (24 Vac), - 15 to + 15 % (115 Vac), - 15 to + 10 % (230 Vac)	- 20 to + 10 % (24 Vdc), - 15 to + 10 % (24 Vac), - 15 to + 15 % (115 Vac), - 15 to + 10 % (230 Vac)
frequency		Hz	50/60	
Power Consumption		VA	< 20 (apparent power)	< 6
Module Fuse Protection			Internal, electronic	
Inputs			S1: 1 N.C. + N.O., S2: 1 N.C. + N.O.	
Two-hand Control Type conforming to EN 574			III A	III C
Synchronization Time (maximum)		s	0.5	
Control Unit Voltage				
24 Vdc version		Vdc	24	24
24 Vac, 115 Vac, 230 Vac version		Vdc	24	48
Minimum Voltage and Current U min/I min: 24 Vdc (20 °C) version U min/I min: 24 Vac/115 Vac/ 230 Vac (20 °C) version			Between terminals T11-T12, T11-T13 18 V/30 mA	Between terminals T11-T13, T21-T23 18 V/140 mA 30 V/50 mA
Calculation of Wiring Resistance RL (for XPSBC only) between terminals T11-T13, T21-T23 as a function of the internal supply voltage U int (terminals T13-T23)		Ω	–	RL max. = $\frac{\text{U int - U min.}}{\text{I min.}}$ Ue = true voltage applied to terminals A1-A2 U int = supply voltage Ue - 1 V (24 V version) (115 V, 230 V version) RL max must not exceed 50 Ω U int between 30.5 V and 35 V, with typical value = 35 V
Outputs				
voltage reference			Relay hard contacts	
number and type of safety circuits			1 N.O. (11-14)	2 N.O. (13-14, 23-24)
number and type of additional circuits			1 N.C. (11-12)	1 N.C. (31-32)
breaking capacity in AC-15		VA	C300: inrush 1800, maintained 180	
breaking capacity in DC-13			24 V/1.5 A - L/R = 50 ms	
maximum thermal current (Ithe)		A	5	2.5
output fuse production conforming to IEC 60947-5-1, VDE 0660 part 200		A	4 A or 6A fast acting	4 A
minimum current		mA	10	
minimum voltage		V	17	
Electrical Life			See page 156	
Response Time		ms	< 25	< 30
Rated Insulation Voltage (Ui)		V	300 (degree of pollution 2 conforming to IEC 60947-5-1, DIN VDE 0110 parts 1 and 2)	
Rated Impulse Withstand Voltage (Uimp)		kV	4 (over voltage category III, conforming to IEC 60947-1, DIN VDE 0110 parts 1 and 2)	
LED Display			2	3
Operating Temperature			+ 14 °F to + 130 °F (- 10 °C to + 55 °C)	
Storage Temperature			- 13 °F to + 185 °F (- 25 °C to + 85 °C)	
Degree of Protection conforming to IEC 60529				
Terminals			IP 20	
Enclosure			IP 40	
Connection	Type		Captive screw clamp terminals	
1-wire connection	without cable end		Solid or stranded wire: 26-14 AWG (0.14 - 2.5 mm²)	
	with cable end		Without bezel, stranded wire: 24-14 AWG (0.25 - 2.5 mm²)	
	with cable end		With bezel, stranded wire: 24-16 AWG (0.25 - 1.5 mm²)	
2-wire connection	without cable end		Solid or stranded wire: 26-20 AWG (0.14 - 0.75 mm²)	
	with cable end		Without bezel, stranded wire: 24-18 AWG (0.25 - 1.0 mm²)	
	with cable end		Double with bezel, stranded wire: 22-16 AWG (0.5 - 1.5 mm²)	
Recommended Terminal Clamp Torque			9.0 in.lbs. (0.8 Nm)	

Technical Data

Type			XPSBF1132	XPSBF1132P
Products designed for max. use in safety related parts of control systems (conforming to EN 954-1)			Category 4	
Power Supply				
voltage		V	24 Vdc	
voltage limits			- 20 to + 20%	
Power Consumption		W	< 3	
Module Fuse Protection			Internal, electronic	
Inputs			S1: 1 N.C. + N.O., S2: 1 N.C. + N.O.	
Two-hand Control Type conforming to EN 574			III C	
Synchronization time (maximum)		s	0.5	
Control Unit Voltage and Current			24 V/8 mA	
Output				
voltage reference			Relay hard contacts	
number and type of safety circuits			2 N.O. (13-14, 23-24)	
number and type of additional circuits			2 solid-state (type 24 V-20 mA)	
breaking capacity in AC-15		VA	C300: inrush 1800, maintained 180	
breaking capacity in DC-13			24 V/1,5 A - L/R = 50 ms	
maximum thermal current (Ithe)		A	6	
sum of maximum thermal current		A	10	
output fuse protection conforming to IEC 60947-5-1, VDE 0660 part 200		A	4 A or 6 A fast-acting	
minimum current		mA	10	
minimum voltage		V	17	
Electrical Life			See page 156	
Delays		ms	< 20	
Rated Insulation Voltage (Ui)		V	300 (degree of pollution 2 conforming to IEC 60947-5-1, DIN VDE 0110 parts 1 and 2)	
Rated Impulse with Stand Voltage (Uimp.)		kV	4 (over voltage category III, conforming to IEC 60947-1, DIN VDE 0110 parts 1 and 2)	
LED Display			3	
Operating Temperature Range			+ 14 °F to + 130 °F (- 10 °C to + 55 °C)	
Storage Temperature Range			- 13 °F to + 185 °F (- 25 °C to + 85 °C)	
Degree of Protection conforming to IEC 60529				
Terminals			IP 20	
Enclosure			IP 40	
Connection	Type		Captive screw clamp terminal	Captive screw clamp terminal, separate removable block
1-wire connection	Without cable end		Solid or stranded wire: 26-14 AWG (0.14 - 2.5 mm^2)	Solid or stranded wire: 24-14 AWG (0.2 - 2.5 mm^2)
	With cable end		Without bezel, stranded wire: 24-14 AWG (0.25 - 2.5 mm^2)	Without bezel, stranded wire: 24-14 AWG (0.25 - 2.5 mm^2)
	With cable end		With bezel, stranded wire: 24-16 AWG (0.25 - 1.5 mm^2)	With bezel, stranded wire: 24-14 AWG (0.25 - 2.5 mm^2)
2-wire connection	Without cable end		Solid or stranded wire: 26-20 AWG (0.14 - 0.75 mm^2)	Solid wire: 24-18 AWG (0.2 -1.0 mm^2) Stranded wire: 24-16 AWG (0.2 - 1.5 mm^2)
	With cable end		Without bezel, stranded wire: 24-18 AWG (0.25 - 1 mm^2)	Without bezel, stranded wire: 24-18 AWG (0.25 - 1.0 mm^2)
	With cable end		Double with bezel, stranded wire: 22-14 AWG (0.5 - 1.5 mm^2)	Double with bezel, stranded wire: 22-14 AWG (0.5 - 1.5 mm^2)
Recommended Terminal Clamp Torque			4.4 – 5.3 in.lbs (0.5 – 0.6 Nm)	

XPSBF1123P

XPSBC

XPSBA

Standard EN 574 defines the selection of two-hand control stations according to the control system category.

The following table details the three types of two-hand control conforming to EN 574. For each type, it lists the operating characteristics and minimum requirements.

Requirements of standard EN 574	Type I	Type II	Type III		
			A	B	C
Use of both hands (simultaneous action)					
Link between input and output signals					
Output signal inhibited					
Prevention of accidental operation					
Tamper-proof					
Output signal re-initialized					
Synchronous action (specified time limit)					
Use of proven components (Category 1 conforming to EN 954-1)			XPSBA		
Redundancy with partial error detection (Category 3 conforming to EN 954-1)				XPSBC XPSBF	
Redundancy + Self-monitoring (Category 4 conforming to EN 954-1)					XPSBC XPSBF

Meets the requirements of standard EN 574

Conforming to standard EN 954-1

Operating Principle

Preventa™ XPSBA conform to Category 1 of standard EN 954-1 and the XPSBC and XPSBF safety relays conform to Category 4 of standard EN 954-1.

They are used for monitoring two hand control stations.

The XPSBA and XPSBF modules have a compact 0.89"/22.5 mm wide enclosure.
The XPSBC modules are in a 1.77"/45mm wide enclosure.

The XPSBA has 1 N.O. and 1 N.C. outputs.
The XPSBC has 2 N.O. safety outputs and 1 N.C. output.
The XPSBF has 2 N.O. safety outputs.

The XPSBA and XPSBC modules have non-removable terminals are an integral part of the module.

The XPSBF has two type of terminals: one has non-removable terminal block mounting, which is an integral part of the module, the other has removable terminal blocks to reduce maintenance time and replacement.

The XPSBA has two LEDs and the XPSBC and XPSBF have three LEDs on the cover to provide status information for easier troubleshooting

Ordering Information

Type Conforming to Standard EN 574	Type of Connection Terminal Block	Number of Safety Circuits	Additional Outputs	Power Supply	Catalog Number	Weight oz (kg)
III A	Non-removable	1 N.O.	1 N.C.	24 Vac/dc	**XPSBA5120**	7.05 (0.200)
				115 Vac	**XPSBA3420**	7.05 (0.200)
				230 Vac	**XPSBA3720**	7.05 (0.200)
III C	Non-removable	2 N.O.	1 N.C.	24 Vdc	**XPSBC1110**	14.11 (0.400)
				24 Vac	**XPSBC3110**	14.11 (0.400)
				115 Vac	**XPSBC3410**	14.11 (0.400)
				230 Vac	**XPSBC3710**	14.11 (0.400)
		2 N.O.	2 solid-state	24 Vdc	**XPSBF1132**	6.20 (0.18)
	Removable	2 N.O.	2 solid-state	24 Vdc	**XPSBF1132P**	6.20 (0.18)

Preventa™ XPSBA safety relays are suitable for use in circuits through Category 1 per EN 954-1.
Preventa™ XPSBC and XPSBF safety relays are suitable for use in circuits through Category 4 per EN 954-1.

See page 258 for dimensions.

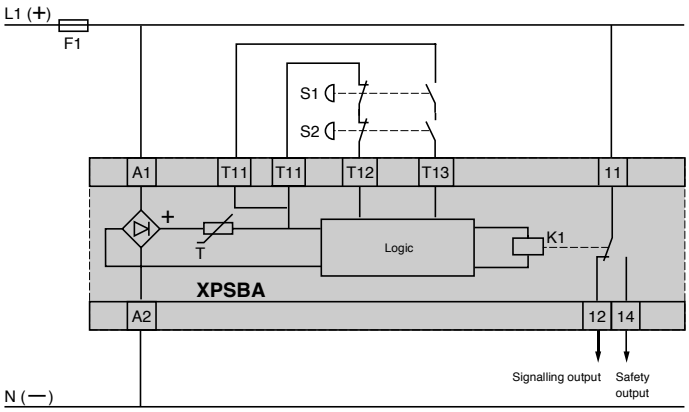
File E164353
CCN NKCR

File LR44087
Class 3211 03

Wiring and Functional Diagrams

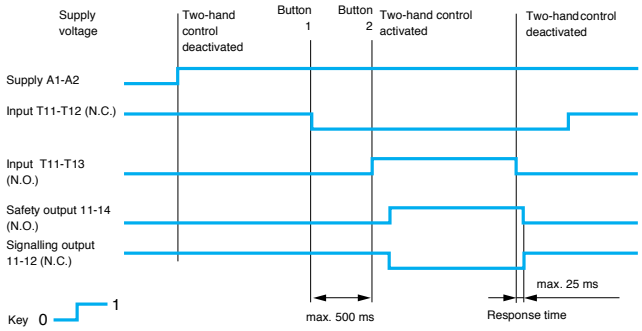
XPSBA

Module XPSBA with a two-hand control station
Type III A conforming to EN 574

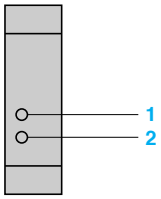


S1 and S2: push buttons.
Must not be used for applications (i.e.: presses) which require a type III C module (XPSBC/BF)

Functional diagram for module XPSBA



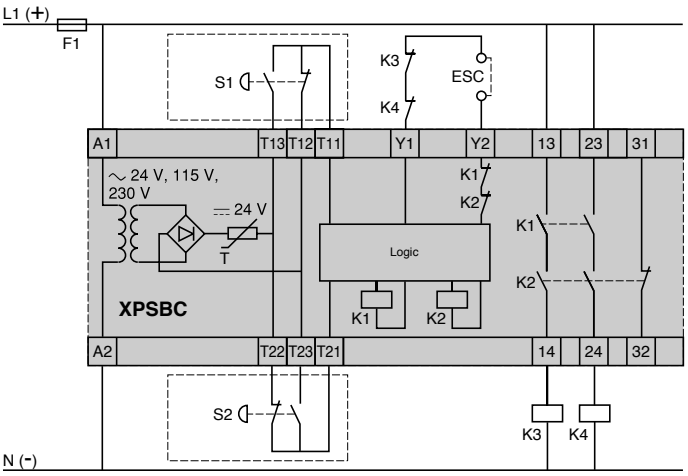
Key to LEDs



1) Supply voltage A1-A2
2) K1 state (N.O. safety output 11-14 closed)

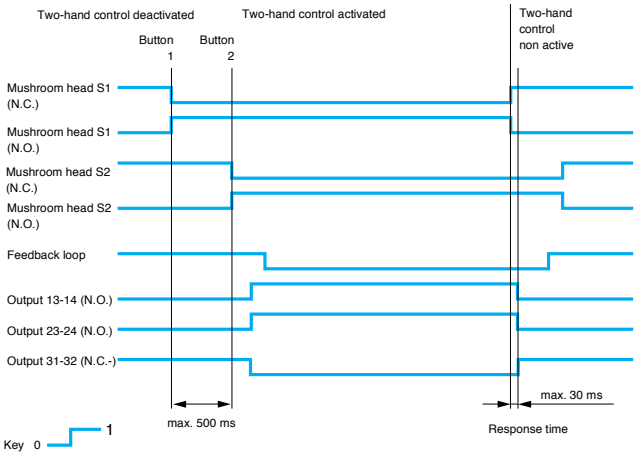
XPSBC

Module XPSBC with a two-hand control station
Type III C conforming to EN 574

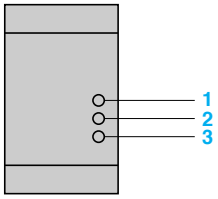


ESC: External start conditions. Y1-Y2: feedback loop.
Output (31-32) must not be used as a safety circuit.
It can be used for non-dangerous machine movements.

Functional diagram for module XPSBC



Key to LEDs

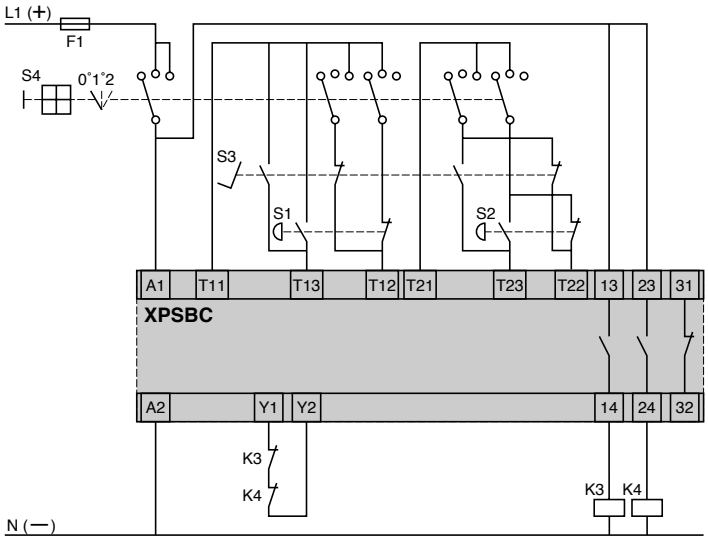


1) Supply voltage A1-A2, S1-S2 -- LED 1 indicates that buttons S1 and S2 are correctly connected
2) Feedback loop Y1-Y2
3) K1-K2 state (N.O. safety outputs closed)

Wiring Diagrams

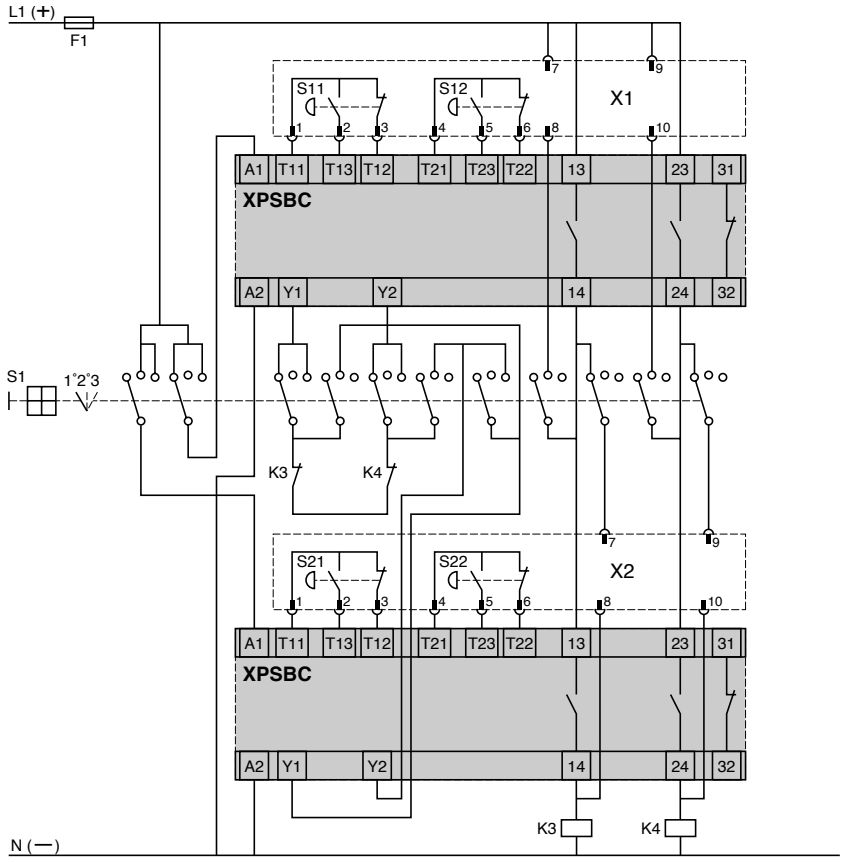
XPSBC

Module XPSBC with a two-hand control station and foot switch (must only be applied to suitable applications)



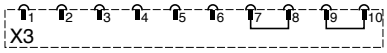
S4 selector switch:
0 = stop
1 = control station
2 = foot switch
S1-S2: two-hand control station push buttons
S3: foot switch

Modules XPSBC with 2 two-hand control stations



When operator 1 is absent:
replace terminal block X1 with X3 and physically remove the two-hand control station.

When operator 2 is absent:
replace terminal block X2 with X3 and physically remove the two-hand control station.

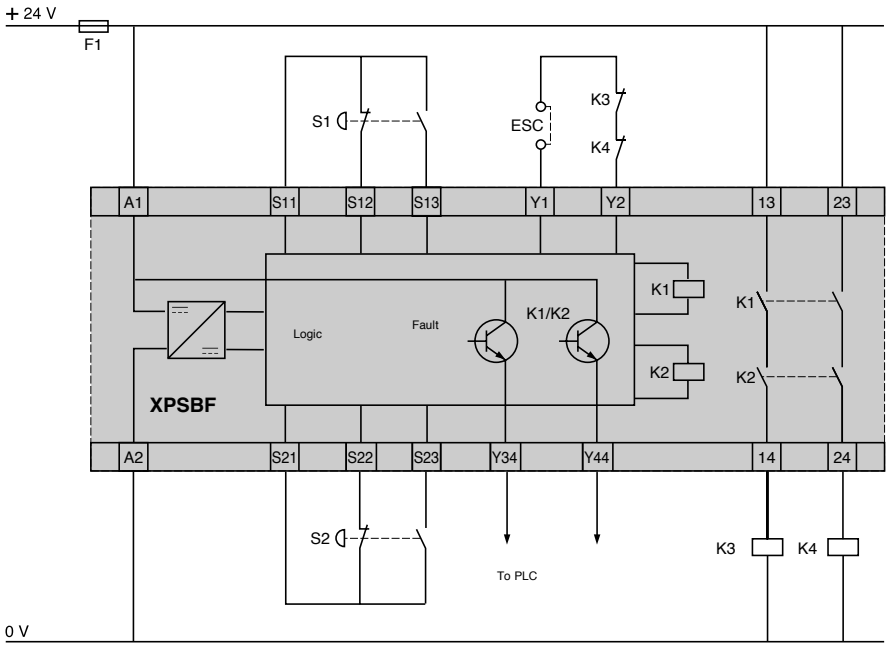


S1 selector switch:
1 = operator 1
2 = operator 2
3 = operator 1 and operator 2
S11-S12, S21-S22: two-hand control station push buttons

Wiring and Functional Diagrams

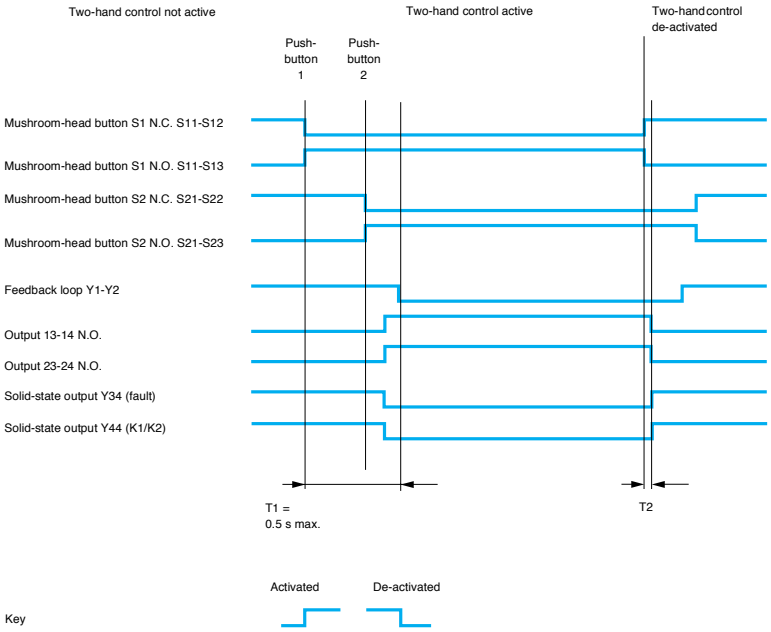
XPSBF

XPSBF module with a two-hand control unit

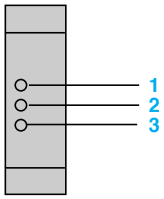


ESC: External start conditions. Y1-Y2: feedback loop

Functional diagram of XPSBF module



Keys to LEDs



1) A1-A2 supply voltage (fuse status)
2) Fault signalling
3) State of K1-K2 (N.O. safety outputs closed)