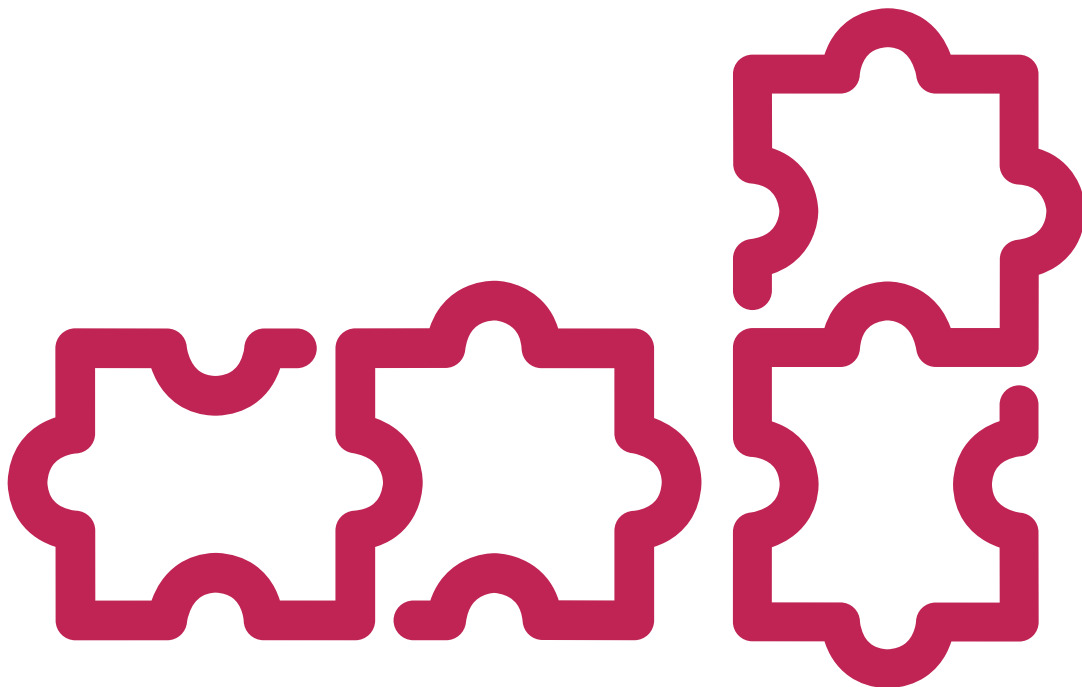


Preventa solutions for efficient machine safety

Safety Chain solutions, Safety functions

Catalogue

October 2019



How can you fit a 6000-page catalog in your pocket ?

Schneider Electric provides you with the complete set of industrial automation catalogs all on a handy USB key for PC or in an application for tablets



Digi-Cat, a handy USB key for PC



- > Convenient to carry
- > Always up-to-date
- > Environmentally friendly
- > Easy-to-share format



Contact your local representative to get your own Digi-Cat



e-Library, the app for tablets

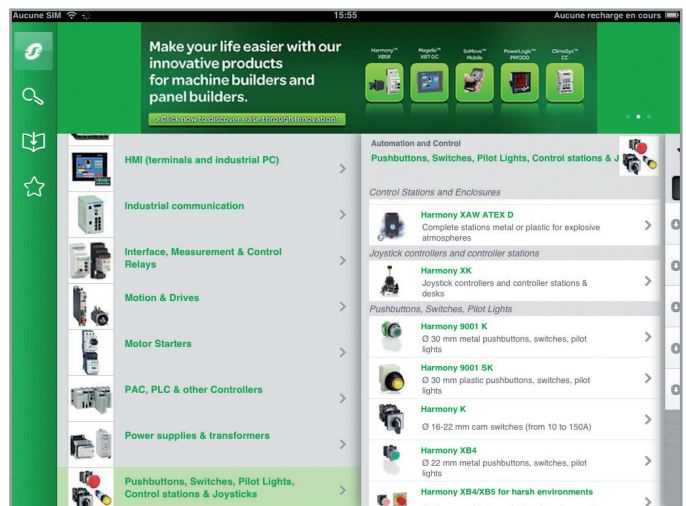
If you have an iPad®:

- > Go to the App Store and search for e-Library
- > or scan the QR code



If you have an Android tablet:

- > Go to the Google Play Store™ and search for eLibrary
- > or scan the QR code



General contents

Safety chain solutions, Safety functions




■ Safety chain solutions

Selection guide *page 2*

- Emergency stop *pages 3 to 4*
- Guard monitoring *page 5*
- Perimeter guarding *pages 6 to 7*

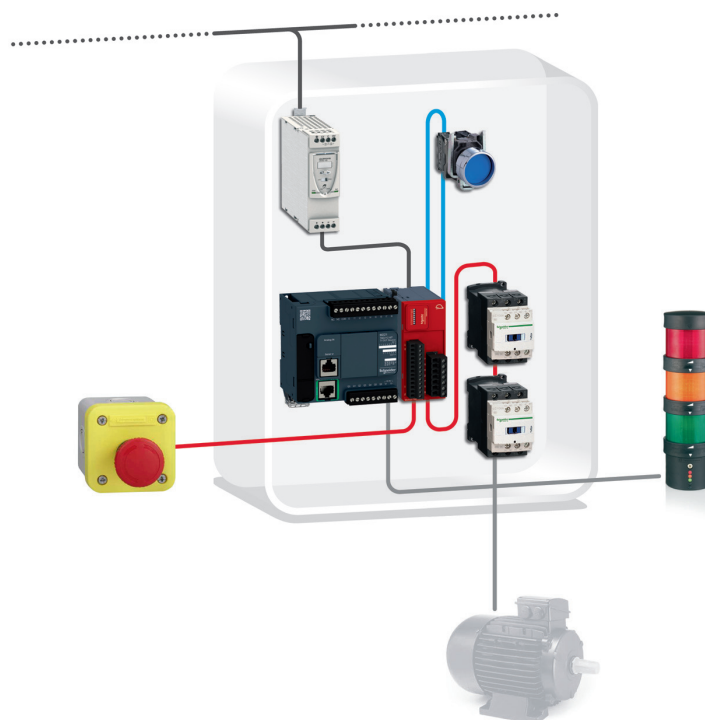
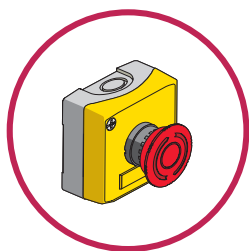
■ Safety functions with detailed description

- Emergency stop *page 9*
- Guard monitoring *pages 10 and 11*
- Enabling movement *page 12*
- Speed monitoring *pages 13 and 14*
- Perimeter guarding *page 15*

Function	Processing device	Input / Output	Cat. PL, SIL / Stop Cat. <i>see page</i>
Emergency Stop 	with Embedded Safety Module	Emergency Stop Pushbutton / Contactor	Cat.3 PL d, SIL 2 / Stop Category 0 <i>see page 3</i>
		Emergency Stop Pushbutton / Contactor	Cat.4 PL e, SIL 3 / Stop Category 0 <i>see page 4</i>
Guard Monitoring 	with Embedded Safety Module	Guard switch with lock / Contactor	Cat.4 PL e, SIL 3 / Stop Category 0 <i>see page 5</i>
Perimeter Guarding with Embedded Safety Module 	with Embedded Safety Module	Light curtain / Contactor	Cat.4 PL e, SIL 3 / Stop Category 0 <i>see page 6</i>
		Light curtain / Variable Speed Drive	Cat.3 PL d, SIL 2 / Stop Category 1 <i>see page 7</i>

Emergency Stop with Embedded Safety Module

Emergency Stop Pushbutton / Contactor
Cat.3 PL d, SIL 2 / Stop Category 0



Related Products

- Switches, pushbuttons, emergency stop - Harmony XB4
- Switch mode Power supply - Phaseo ABL8
- Safety Module - Modicon TM3SAC5R(G)
- Safety switches - Preventa XCS
- Contactor - TeSys D
- Modular beacon and tower light - Harmony XVB

Function

Safety-related stop function initiated by Emergency stop push button to minimize the consequences of possibly harmful event.

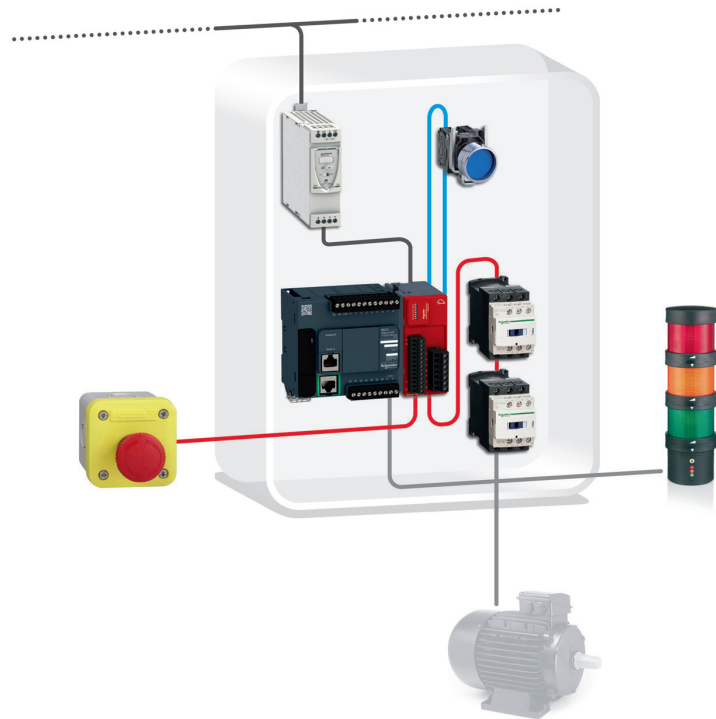
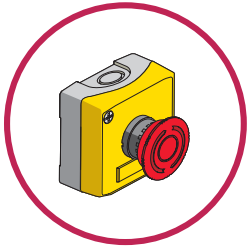
The pushing of emergency stop push button is detected from opening contacts, which are checked by the safety module.

Opening these contacts causes the deactivation of the safety module outputs (stop category 0 according to EN/IEC 60204-1), which results in a switch-off of the motor power supply to minimize hazard in case of emergency by means of the contactors (K1 and K2).

Typical applications

- > Machine-tools or similar machines with low inertia (no rundown time), where the access to the hazardous area is limited to maintenance interventions

Emergency Stop with Embedded Safety Module
Emergency Stop Pushbutton / Contactor
Cat.4 PL e, SIL 3 / Stop Category 0



Related Products

- Switches, pushbuttons, emergency stop - Harmony XB4
- Switch mode Power supply - Phaseo ABL8
- Safety Module - Modicon TM3SAF5R(G)
- Safety switches - Preventa XCS
- Contactor - TeSys D
- Modular beacon and tower light - Harmony XVB

Function

Safety-related stop function initiated by Emergency stop push button to minimize the consequences of possibly harmful event.

The pushing of emergency stop push button is detected from opening contacts, which are checked by the safety module.

Opening these contacts causes the deactivation of the safety module outputs (stop category 0 according to EN/IEC 60204-1), which results in a switch-off of the motor power supply to minimize hazard in case of emergency by means of the contactors (K1 and K2).

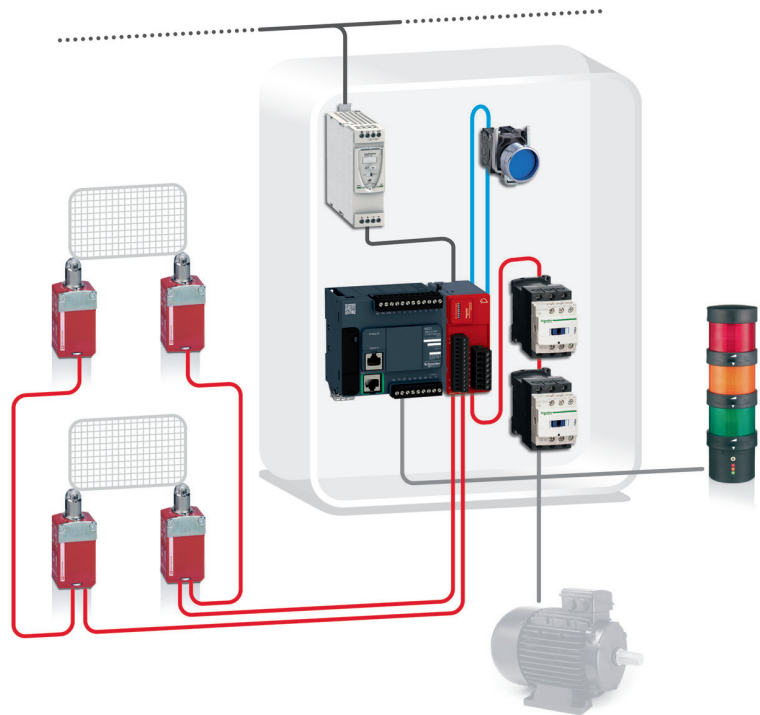
The main contactors are monitored by the safety module to detect e.g. contact welding, by means of their mirror contacts.

Typical applications

- > Machine-tools or similar machines with low inertia (no rundown time), where the access to the hazardous area is limited to maintenance interventions

Guard Monitoring with Embedded Safety Module

Guard switch with lock / Contactor
Cat.4 PL e, SIL 3 / Stop Category 0



Related Products

- Switches, pushbuttons, emergency stop - Harmony XB4
- Switch mode Power supply - Phaseo ABL8
- Safety Module - Modicon TM3SAF5R(G)
- Safety switches - Preventa XCS
- Contactor - TeSys D
- Modular beacon and tower light - Harmony XVB

Function

Safety-related stop function initiated by a moveable guard designed to help protecting from the access to a hazardous zone.

The opening of this guard is detected by using a guard switch, which is checked by the safety module allowing detection of the opening or the removal of the protective guard according to EN1088.

Opening of this guard causes the deactivation of the safety module outputs (stop category 0 according to EN/IEC 60204-1), which results in a switch-off of the motor power supply to prevent possible hazardous movements or states by means of the contactors (K1 and K2).

The main contactors are monitored by the safety module to detect e.g. contact welding, by means of their mirror contacts.

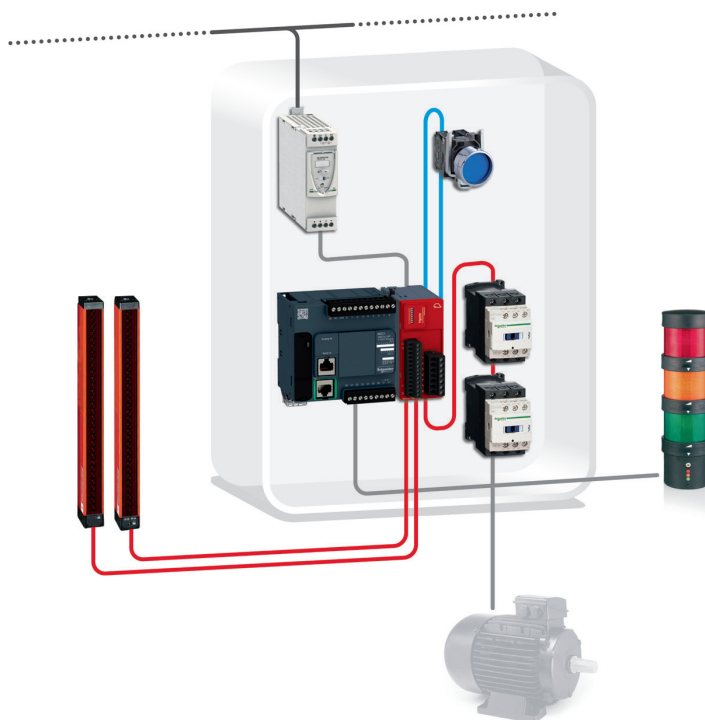
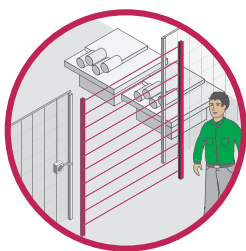
Typical applications

- > Assembling, machining centers or similar machines tools, where the access to the hazardous area is frequent or with long exposure time

Perimeter Guarding with Embedded Safety Module

Light curtain / Contactor

Cat.4 PL e, SIL 3 / Stop Category 0



Related Products

- Switches, pushbuttons, emergency stop - Harmony XB4
- Switch mode Power supply - Phaseo ABL8
- Safety light curtains, single-beam for body detections - Preventa XU2S
- Photo-electric sensors - OsiSense XU
- Safety Module - Modicon TM3SAFL5R(G)
- Contactor - Tesys D
- Modular beacon and tower lights - Harmony XVB

Function

Safety-related stop function initiated by safety light curtain (ESPE Type 4 according to EN/IEC 61496-1 and EN/IEC 61496-2).

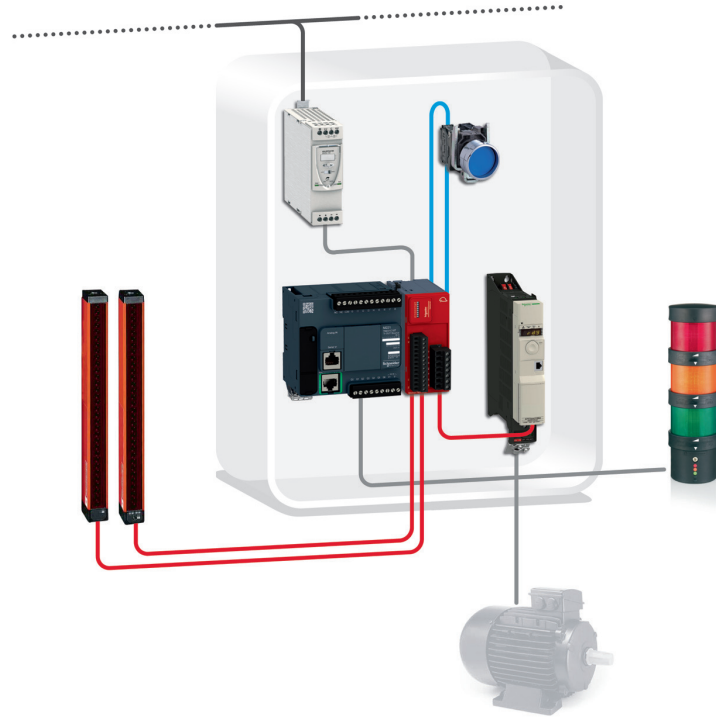
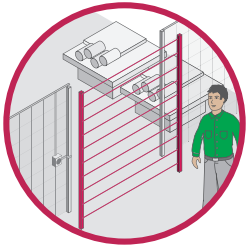
An interruption of the detection field causes the safety outputs to open. The deactivation of the safety outputs results in the switching-off of the motor power supply by means of the contactor (K1) to help to prevent possible hazardous movements or states.

The safety light curtain receivers and outputs are cyclically tested and monitored by the safety light curtain to detect possible failures.

Typical applications

- > Palletizing stations with automatic control system where pallets would pass frequently through the hazardous area

Perimeter Guarding with Embedded Safety Module
Light curtain / Variable Speed Drive
Cat.3 PL d, SIL 2 / Stop Category 1



Related Products

- Switches, pushbuttons, emergency stop - Harmony XB4
- Switch mode Power supply - Phaseo ABL8
- Safety Module - Modicon TM3SAK5R(G)
- Safety light curtains
- Variable speed drive - Altivar 32
- Modular beacon and tower lights - Harmony XVB

Function

Safety-related stop function initiated by a safety light curtain (ESPE Type 4 according to EN/IEC 61496-1 and EN/IEC 61496-2). Controlled stopping with power maintained to the drive to achieve stopping (i.e. braking), then cut-off of power when standstill is reached (Safe Stop 1). The hazardous movement is interrupted either if the stop button (S2) or the emergency stop device (S3) is actuated. An interruption of the detection field initiates the functional stopping of the drive, i.e. by a braking ramp (stop category 1 in accordance with EN/IEC 60204-1). After the delay time monitored by the drive has elapsed, the drive is halted, by the “safe torque off” (STO) safety function integrated within it, which prevents the motor from restarting unintentionally. The switching of the LI3 input is monitored by the drive. The power stage is disabled when the time offset is exceeded.

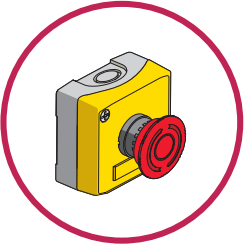
Typical applications

- > Machines that use drives in their movements due to high speed and precision needed (i.e. textile, wood-working or simple packaging machines), when the delayed initiation of the stopping in the event of a fault must not involve an unacceptably high residual risk



Emergency stop

Explanation of function



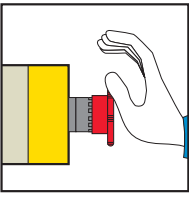
International standard EN/ISO 13850 (replaces standard EN 418) specifies the functional requirements and design principles of emergency stop devices.

Stop types:
Stop category 0 and/or stop category 1 and/or stop category 2 stop functions shall be provided as indicated by the risk assessment and the functional requirements of the machine:

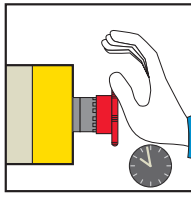
Stop Category 0:
Stopping by immediate removal of power to the machine actuators (i.e. an uncontrolled stop – stopping of machine motion by removing electrical power to the machine actuators)

Stop Category 1:
A controlled stop (stopping of machine motion with electrical power to the machine actuators maintained during the stopping process) with power available to the machine actuators to achieve the stop and then removal of power when the stop is achieved

Stop Category 2:
A controlled stop with power left available to the machine actuators



Stop category 0:
Emergency stop function



Stop category 1

For the Emergency stop function either Stop Category 0 or Stop Category 1 is chosen according to the risk assessment results.

It applies to all machines, whatever type of energy is used to control this function. When the emergency stop instruction ceases, the effect must be maintained until it is reset. Manual resetting must only be possible in the location where the instruction was given. Resetting must not start the machine, but simply enable the starting cycle.

Restarting of the machine must not be possible until the emergency stop has been reset.

Where required, facilities to connect protective devices and interlocks shall be provided. If such a protective device or interlock causes a stop of the machine, it may be necessary for that condition to be signalled to the logic of the control system. The reset of the stop function shall not initiate any hazardous situation.

Where more than one control station is provided, stop commands from any control station shall be effective when required by the risk assessment of the machine. In addition to the requirements for the emergency stop function has the following requirements:

- It shall override all other functions and operations in all modes
- Power to the machine actuators that can cause a hazardous situation(s) shall be either removed immediately (stop category 0) or shall be controlled in such a way to stop the hazardous motion as quickly as possible (stop category 1) without creating other hazards
- Reset shall not initiate a restart

The choice between these two stopping methods is determined by an evaluation of the machine-related risks.

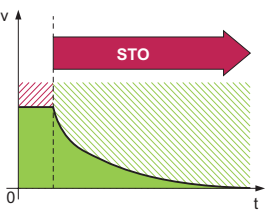
This function includes several sub-functions either Safe Torque off (stop category 0), Safe Stop 1 (stop category 1) or Safe Stop 2 (stop category 2) and is represented by the drawings opposite.

The operator interface may be:

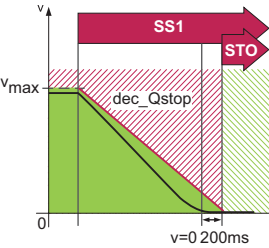
- Pushbutton equipped with a mushroom head
- Cable actuated switch
- Foot switch

Typical architecture

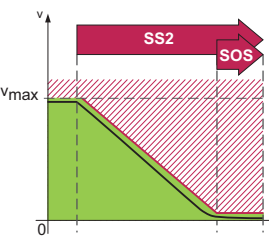
- Safety chain solution:**
- > Emergency Stop with Embedded Safety Module / Emergency Stop Pushbutton / Contactor / Cat.3 PL d, SIL2, Stop Category 0
 - > Emergency Stop with Embedded Safety Module / Emergency Stop Pushbutton / Contactor / Cat.4 PL e, SIL3, Stop Category 0
 - > Emergency Stop with Modular Safety Controller / Emergency Stop Pushbutton / Contactor / Cat.4 PL e, SIL3, Stop Category 0
 - > Emergency Stop with Embedded Safety PLC / Emergency Stop Pushbutton / PacDrive 3 drive STO / Cat.4 PL e, SIL3 / Stop Category 0



STO: Safe Torque Off

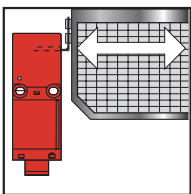


SS1: Safe Stop 1, STO: Safe Torque Off

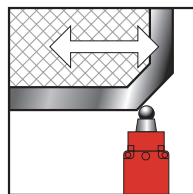


SS2: Safe Stop 2, SOS: Safe Operating Stop

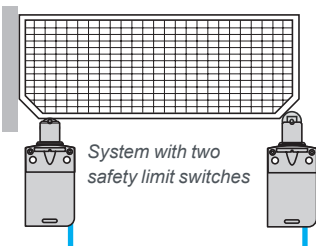
Guard monitoring



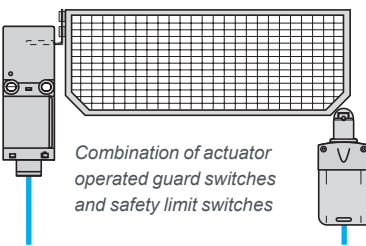
Guard without guard locking device



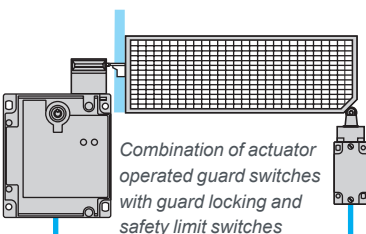
Guard with guard locking device



System with two safety limit switches



Combination of actuator operated guard switches and safety limit switches



Combination of actuator operated guard switches with guard locking and safety limit switches

Explanation of function

Guards without guard locking device

On a large number of potentially dangerous machines, the operator must be kept at a distance during operation, but needs to take action when the machine is stopped to position a part, remove a product or adjust a tool.

An effective means of protection is to install a guard which, according to the type of installation, will cut-off the power to the motor if an attempt is made to open it during the machine operating phase.

In all cases, it must not be possible to restart the machine until the guard is closed. Depending on the level of protection required, the system will comprise two conventional limit switches or a combination of protected, actuator operated guard switches to prevent tampering.

Guards with guard locking device

This type of guard is necessary for potentially dangerous machines with high inertia (long rundown time).

The guard is interlocked (by a solenoid for example); it cannot be opened until the machine has come to a complete standstill.

Typical architecture

Safety chain solution:

- > Guard Monitoring with Well Tried Components / Limit switch / Motor Starter / Cat.3 PL c, SIL 1 / Stop Category 0
- > Guard Monitoring with Safety Module / Limit switch / Contactor / Cat.3 PL d, SIL 2 / Stop Category 0
- > Guard Monitoring with Safety Module / Guard switch with lock / Contactor / Cat.4 PL e, SIL 3 / Stop Category 0
- > Guard Monitoring with Safety Module / Guard switch with lock / Variable speed drive / Cat.3 PL d, SIL 2 / Stop Category 1
- > Guard Monitoring with Embedded Safety Module / Guard switch with lock / Contactor / Cat.4 PL e, SIL 3 / Stop Category 0
- > Guard Monitoring with Safety Controller / Limit switch / Contactor / Cat.4 PL e, SIL 3 / Stop Category 0
- > Guard Monitoring with Modular Safety Controller / Guard switch with lock / Contactor / Cat.4 PL e, SIL 3 / Stop Category 0
- > Guard Monitoring with Embedded Safety PLC / Guard switch with lock / PacDrive 3 Drive SS1 / Cat.4 PL e, SIL 3 / Stop Category 1

Guard Monitoring

Explanation of function

Coded magnetic guard switch and system

A non-contact solution is often used on industrial machines fitted with a door or guards with imprecise guiding.

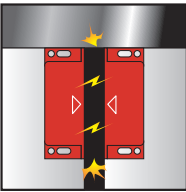
It is particularly suitable for machines subjected to frequent washing or splashing of liquids as well as small machines with a single guard for self-contained systems. Depending on the models used, the sensing distance will be between 5 and 10 mm. The reed contacts used for the coded magnetic switches cannot withstand short circuits and the switches always incorporate a resistor in series. Their operation can therefore only be guaranteed with the associated processing module. The Hall-effect self-contained systems with integral processing module do not require any further processing of the signal.

The illustrations opposite show the functions of coded magnetic guard switches and of a system.

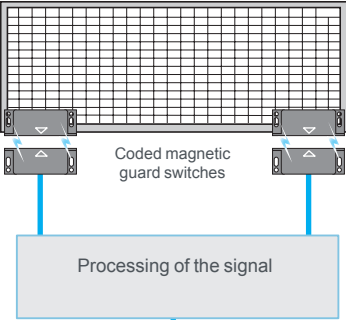
Typical architecture

Safety chain solution:

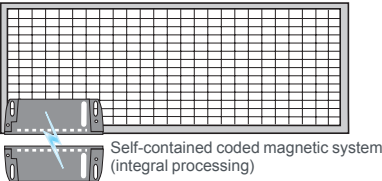
- > Guard Monitoring with Safety Module / Coded Magnetic switch / Contactor / Cat.4 PL e, SIL 3 / Stop Category 0
- > Guard Monitoring with Safety Module / Coded Magnetic switch / Variable speed drive / Cat.4 PL e, SIL 3 / Stop Category 1
- > Guard Monitoring with Safety Module / Coded Magnetic switch / Servos drive / Cat.4 PL e, SIL 3 / Stop Category 1
- > Guard Monitoring with Embedded Safety Servo Drive / Coded Magnetic switch / Embedded Safety Servo drive / Cat.4 PL e, SIL 3 / Stop Category 2



Coded magnetic guard switch

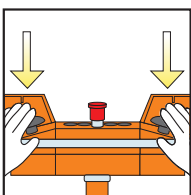
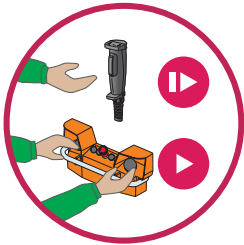


Functions of coded magnetic guard switches

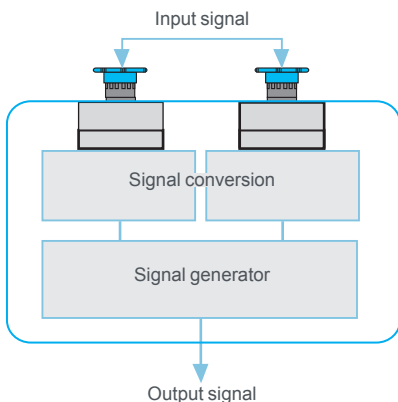


Functions of a coded magnetic guard switch system

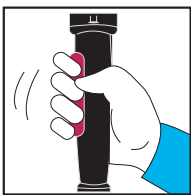
Enabling movement



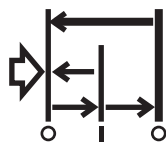
Two-hand control stations



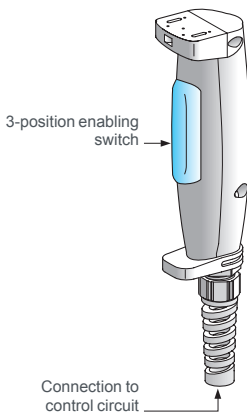
Functions of a two-hand control station



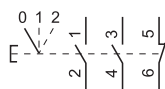
Enabling Switch



Marking identifying an enabling switch



Enabling switch XY2AU1:
2 enabling functions, 3 positions + 1 N/C



Explanation of function

Two-hand control stations

Standards ISO 13851 and EN 574 define this device. It requires simultaneous operation by both hands in order to start and maintain operation of a machine. It therefore provides protection exclusively for the person operating it.

A diagram representing the function is given opposite; it must meet the following requirements:

- > Concurrent, maintained operation of the two input controls for the same period of time
- > Synchronous operation; the delay between the two signals must not exceed 0.5 s
- > Prevention of accidental operation (mechanical guard)
- > Protection against tampering

Enabling switches, allow authorized personnel to carry out maintenance, adjustment or programming operations within hazardous zones of machines, provided certain conditions are met. These devices conform to standards EN/IEC 60947-5-8 and EN/IEC 60204-1. In effect, to gain access, these operations, often performed at reduced speed, must be selected by authorized personnel using selectors with key or equivalent.

Important note: the enabling switch alone must not lead to the actuation of any dangerous movements associated with the machine; a secondary, intentional, control action is required from the operator. All devices which conform to the standard must be identified by the marking scheme shown opposite.

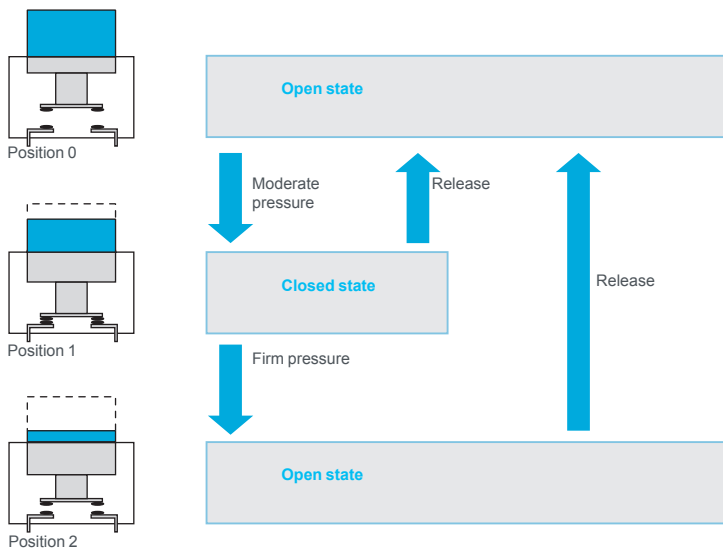
Enabling Switch

Operating principle

The three possible states are:

- > Position 0: contact open (control operator at rest)
- > Position 1: contact closed (control operator depressed to normal enabling position)
- > Position 2: contact open (control operator fully depressed)

When the switch is depressed in position 1, it must return to position 0 when released. The switch must change from position 1 to position 2 when pressed more firmly. When it is released from position 2 to position 0, the switching contact must not close.



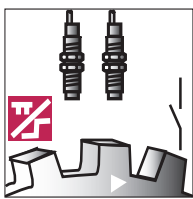
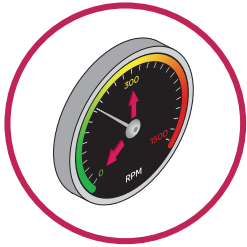
Operating principle of an enabling switch

Typical architecture

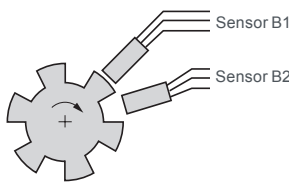
Safety chain solution:

- > Enable Machine Movement with Safety Controller / Two Hand Control Station / Contactor / Cat.4 PL e, SIL 3
- > Enable Machine Movement with Modular Safety Controller / Two Hand Control Station / Contactor / Cat.4 PL e, SIL 3

Speed monitoring



Speed monitoring

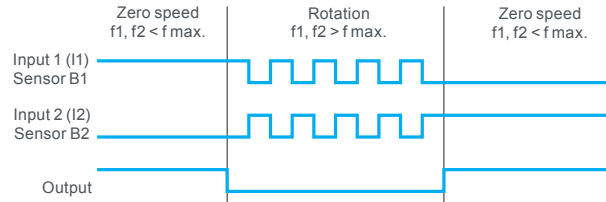


Sensor control

Explanation of function

Zero speed monitoring

Detection principle



The two sensors to be arranged that only one sensor is activated at any given time. If the inputs are in the low state, the zero speed signal will disappear after $t=1/f$ seconds and an open-circuit will be indicated. If the 2 inputs are in the high state, the zero speed signal will disappear after $t=1/f$ seconds and a short-circuit will be indicated. If the 2 inputs are in the high or low state after starting, no enabling will take place.

Sensor States and Behavior

Switch-on Sequence

State of Sensor 1	0	0 (1)	1
State of Sensor 2	0	1 (1)	1
Behavior	Error Message	Zero Speed	Notification (2)
Output	0	1	0

Operation

State of Sensor 1	0	0 (1)	1
State of Sensor 2	0	1 (1)	1
Behavior	Error Message	Zero Speed	Notification
Output	0	1	1

(1) If the state of the sensors is inverse (0/1, 1/0), the behavior is identical.
 (2) If the firmware version is earlier than 2.34 an error message (short circuit between inputs) appears instead of a notification. This error message must be acknowledged with the reset button.

Detection principle 2

Preventa safety modules XPSVNE for zero speed detection are used to detect the stop condition of electric motors. Their most common applications include: providing the unlock signal for electrically interlocked sliding or removable machine guards, controlling rotation direction signals for reversing motors and engaging locking brakes after a motor has come to a standstill.

As electric motors run down, a remanent voltage is produced in the windings of the motor due to residual magnetism. This voltage is proportional to the speed of the motor and, therefore, decreases as the motor comes to a standstill.

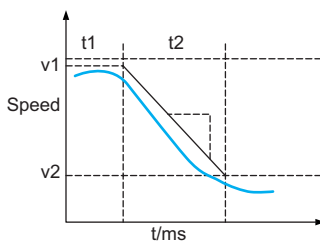
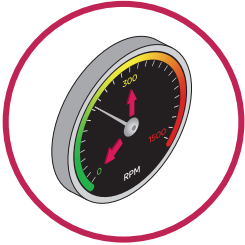
This remanent voltage is measured in a redundant manner so as to detect the stop condition of the motor. The cabling between the motor windings and the inputs of the XPSVNE module is also monitored to prevent a cabling breakage or fault being seen as a stopped motor.

A transformer should not be used to connect the motor to terminals Z1, Z2 and Z3 since there is no monitoring of the connection with the motor winding via the resistance monitoring.

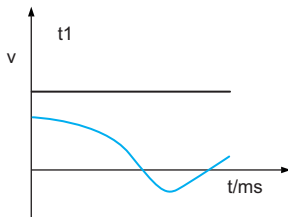
Modules XPSVNE are suitable for detecting the stop condition of all types of AC or DC motor driven machines which, when the motor runs down, produce a remanent voltage in the windings due to residual magnetism. These machines can be controlled by electronic devices, such as variable speed drives or DC injection brakes. The input lters for standard XPSVNE modules are designed for a frequency of up to 60 Hz.

For motors operating at a frequency higher than 60 Hz, which therefore produce a high frequency remanent voltage, special modules XPSVNE●●●●HS should be used. Modules XPSVNE have t2 potentiometers mounted on the front face of the module which allow independent adjustment of the switching threshold for each input circuit. This allows adjustment for different types of motors and application requirements. To aid diagnostics, modules XPSVNE have 4 LEDs and 2 solid-state outputs to provide information on the status of the zero speed detection circuit.

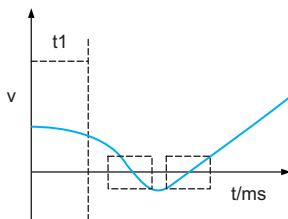
Speed monitoring



Safety-limited speed



Safe maximum speed



Safe direction

Explanation of function

Motion safety functions

Safety-limited speed

The SLS function prevents the motor from exceeding the specified speed limit.

When this function is initiated the machine starts to decelerate to the specified safe speed v_2 with in the specified time t_2 . Once the machine reaches the safe speed v_2 then the function will monitor the speed stays below safe speed v_2 .

In case of speed exceeding specified speed during time t_2 and further, safety function will initiate either SS1 or STO to stop the machine in minimum time.

Safe maximum speed

The SMS function provides a safe output signal to indicate whether the motor speed is below a specified limit.

This safety function is an optional function to set an upper limit parameter for continuous monitoring. If the speed of the machine exceeds the specified value then specified safe output will change its state.

Safe direction

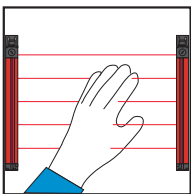
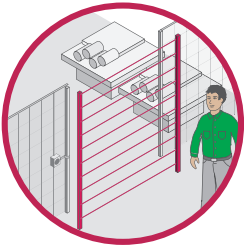
The SDI function prevents the motor shaft from moving in the unintended direction.

Typical architecture

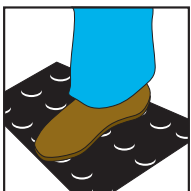
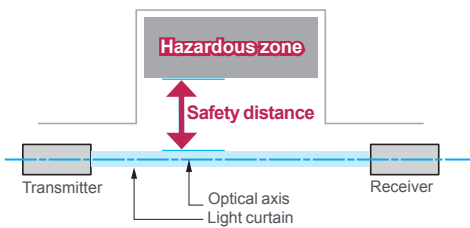
Safety chain solution:

- > Speed Monitoring with Safety Module / Remanent Voltage detection and limit switch and Guard switch with lock / Contactor / Cat.4 PL e, SIL 3 / Stop Category 0
- > Speed Monitoring with Modular Safety Controller / Safety Encoder / Contactor / Cat.4 PL e, SIL 3 / Stop Category 0
- > Speed Monitoring with Embedded Safety PLC / Selector Switch / PacDrive 3 Drive SLS / Cat.4 PL e, SIL 3 / Safe Limited Speed

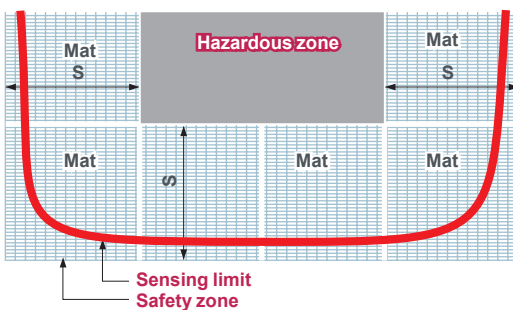
Perimeter guarding



Safety light curtain



Safety mat



Example of a safety mat application

Explanation of function

Safety light curtains

Safety light curtains are electro-sensitive systems (Electro-Sensitive Protective Equipment) designed to protect persons working in the vicinity of machinery, by stopping dangerous movements when a light beam is broken.

The absence of a door or guard reduces loading, inspection or tool changing times. This type of system, defined by standards EN/IEC 61496-1 and EN/IEC 61496-2, is frequently used with machines such as:

- presses
- machine tools
- assembly lines, etc.

The machine must be designed so that it is impossible to gain access to dangerous movements without breaking one or more of the light beams. In addition, the movement must be stopped whatever the entry speed of the operator into the hazardous zone.

The diagram opposite illustrates the operation of a light curtain.

Typical architecture

Safety chain solution:

- > Perimeter Guarding with Safety Module / Single beam Light Curtains / Contactor / Cat.3 PL c, SIL 1 / Stop Category 0
- > Perimeter Guarding with Embedded Safety Module / Light Curtain / Contactor / Cat.4 PL e, SIL 3 / Stop Category 0
- > Perimeter Guarding with Embedded Safety Module / Light Curtain / Variable Speed Drive / Cat. 3 PL d, SIL 2 / Stop Category 1
- > Perimeter Guarding with Modular Safety Controller / Light Curtain / Contactor / Cat.4 PL e, SIL 3 / Stop Category 0

Explanation of function

Safety mats

Safety mats are used to detect persons walking across or standing on the mat or objects falling onto the mat.

Standards EN 1760-1/ISO 13856 define their performance.

Any detection of an object on the mat initiates stopping of any dangerous machine movement.

Restarting can be controlled manually or automatically, depending on the configuration of the associated processing unit.

When pressure is applied, the mat distorts locally and the integrated sensors are short-circuited.

The special design of these sensors requires that the mat and the detection module be matched.

In general, several mats are used to cover the safety zone.

The safety distance **S**, defined by the standard, takes into account the speed at which a person can cross the safety zone to reach the hazardous zone.

Typical architecture

Safety chain solution:

- > Perimeter Guarding with Safety Module / Safety Mat / Contactor / Cat.3 PL d, SIL2 / Stop Category 0



More information on
<http://www.schneider-electric.com/machinesafety>

Schneider Electric Automation GmbH

Head Office
Schneiderplatz 1
97828 Marktheidenfeld
Germany

www.se.com

The information provided in this documentation contains general descriptions and/or technical characteristics of the performance of the products contained herein. This documentation is not intended as a substitute for and is not to be used for determining suitability or reliability of these products for specific user applications. It is the duty of any such user or integrator to perform the appropriate and complete risk analysis, evaluation and testing of the products with respect to the relevant specific application or use thereof. Neither Schneider Electric nor any of its affiliates or subsidiaries shall be responsible or liable for misuse of the information contained herein.

Design: Schneider Electric
Photos: Schneider Electric