Preventa solutions for efficient machine safety

Safety chain solutions, Safety functions

Catalogue

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Function

Safety chain solutions

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
Function

Safety chain solutions

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
Function

Safety chain solutions

Emergency Stop with Embedded Safety PLC
Emergency Stop Push Button / PacDrive 3 Drive
Cat.4 PL e, SIL 3 / Stop Category 0

Related Products
- Switches, pushbuttons, emergency stop - Harmony XB4
- Switch mode Power supply - Phaseo ABL8
- Preventa Safety PLC TM5SLC (TM5SPS, SDIO, BC)
- Safety switches - Preventa XCS
- PacDrive 3
- Harmony XVB

Function
Safety-related stop function initiated by any stop or emergency stop command to halt the machine and to unlock the moveable guard that prevents the access to the hazardous area before the machine comes to a standstill. Emergency stop command is detected by using an emergency stop push button in positive actuation mode, which are then checked by the safety PLC allowing detection of the opening contacts. Actuation of the emergency stop or stop contacts initiates the functional stopping of the machine by cutting-off torque from the motor. As electric motors run down, a remanent voltage is produced in the windings of the motor due to residual magnetism. This voltage is measured so as to detect the stopped condition of the motor, providing the unlock signal for the electrically locked movable guard and for engaging brakes after the motor has come to a standstill. The continuity of the wiring between the motor windings and the inputs of the safety modules are also monitored to prevent a cable breakage or fault being seen as a stopped motor.

Typical applications
- Machine tools, robots, production test equipment, test benches
- Papermaking machines, textile production machines, calendars in the rubber industry
- Process lines in plastics, chemicals or metal production, rolling-mills
- Cement crushing machines, cement kilns, mixers, centrifuges, extrusion machines
- Drilling machines
- Conveyors, materials handling machines, hoisting equipment (cranes, gantries, etc.)
- Pumps, fans, etc.
Function

Guard Monitoring with Safety Module
Limit switch / 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 - Preventa XPSAC
- Safety switches - Preventa XCS
- Contactor - TeSys D
- Modular beacon and tower light - Harmony XVB

Function
Safety-related stop function initiated by the moveable guards designed to help protecting from the access to a hazardous zone. The opening of each guard is detected by using two limit switches in combination mode (positive mode + negative mode), which are checked by the safety module allowing detection of the opening or the removal of the protective guard.

Opening of any of these guards 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, textile, printing or similar machines where the access to the hazardous area is limited to maintenance interventions
Guard Monitoring with Safety Module
Coded Magnetic Switch -
Variable Speed Drive
Cat.4 PL e, SIL 3 / Stop Category 1

Function

Safety-related stop function initiated by a moveable guard that helps protecting from the access to the hazardous area.

Controlled stopping with power maintained to the actuator (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.

Opening of this guard is detected by a magnetic switch, which 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 safety module has elapsed, the safety delayed outputs are deactivated. The drive is then halted, by the “safe torque off” (STO) safety function integrated within it, which prevents the motor from restarting unintentionally.

The switching of the STO and LI3 input is monitored by the drive. The power stage is disabled if the time offset is exceeded. The motor can no longer generate torque and coasts down without braking.

The safety module also monitors the consistent actuation of the redundant coded magnetic switch contacts to detect possible failure, before restart of the machine movement is permitted.

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.

Related Products

- Switches, pushbuttons, emergency stop - Harmony XB4
- Safety Module - Preventa XPSAV
- Coded magnetic switches - Preventa XCSDM
- Variable speed drive - Altivar 32
- Modular beacon and tower lights - Harmony XVB
- Switch mode Power supply - Phaseo ABL8
Function

Safety chain solutions

Guard Monitoring with Safety Module
Guard switch with lock / Variable Speed Drive
Cat.3 PL d, SIL 2 / Stop Category 1

Related Products
- Switches, pushbuttons, emergency stop - Harmony XB4
- Emergency stop function - Harmony XALK
- Switch mode Power supply - Phaseo ABL8
- Safety Guard switches - Preventa XCSB, XCS
- Safety module - Preventa XPSATE
- Variable speed drive - Altivar 71
- Modular beacon and tower lights - Harmony XVB

Function
Safety-related stop function initiated by a moveable guard that helps protecting from the access to the hazardous area.
Controlled stopping with power maintained to the actuator (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. (*)
Opening of this guard is detected by a safety guard switch, which 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 safety module has elapsed, the safety delayed outputs are deactivated. The drive is then halted, by the “safe torque off” (STO) safety function integrated within it, which prevents the motor from restarting unintentionally.
The safety module also monitors the consistent actuation of the redundant guard switch contacts to detect possible failure, before restart of the machine movement is permitted.
(*) The function for stopping in an emergency is a protective measure which complements the safety functions for the safeguarding of hazardous zones according to EN/ISO 12100-2.

Typical applications
- Machines that use drives in their movements due to high speed and precision needed (i.e. stacker-crane used on automatic storage and retrieval systems), when the delayed initiation of the stopping in the event of a fault must not involve an unacceptably high residual risk
Guard Monitoring with Safety Module
Coded Magnetic Switch / Servo Drive
Cat.3 PL d, SIL 2 / Stop Category 1

Related Products
- Switches, pushbuttons, emergency stop - Harmony XB4
- Switch mode Power supply - Phaseo ABL8
- Coded magnetic system - Preventa XCSDM
- Safety Module - Preventa XPSAV
- Servo Drive - Lexium 32
- Modular beacon and tower lights - Harmony XVB

Function
Safety-related stop function initiated by any of the moveable guards that helps protecting from the access to the hazardous area.
Controlled stop with power available to the actuators (servo-drive) to achieve the stop (i.e. by controlled braking). Power is not interrupted until the stop is achieved (Safe Stop 1).
After activating the function, the servo motor is braked in a controlled manner, maintaining the power on the actuators. The power is then cut after the machine has come to a halt.
Opening of a guard is detected by a coded magnetic switch system that activates via the safety module the “Halt” function on the servo-drive; any active movement is decelerated via the adjusted ramp.
After the delay time monitored by the safety module has elapsed, the safety delayed outputs (stop category 1 in accordance with EN/IEC 60204-1) are deactivated. The servo-drive power stage is then disabled, via the “safe torque off” (STO) safety function integrated within it, which prevents the servo-motor from restarting unintentionally.
The switching of the two redundant STO inputs is monitored by the servo-drive. The power stage is disabled and an error message is generated if the time offset (< 1 sec) is exceeded. The servo-motor can no longer generate torque and coasts down without braking.
The safety module also monitors the consistent actuation of the magnetic switch contacts to detect possible failure, before restart of the machine movement is permitted.
Opening or removal of the protective guard is detected by means of the coded magnetic switch system, which are particularly usable for guards without accurate guidance and for use in difficult environments (dust, liquids, etc.).

Typical applications
- Packaging, printing, or similar machines that use servo-drives in their movements due to high speed and precision needed, on which non-braking stopping would result in an impermissibly long run-down of the hazardous tool movements
Guard Monitoring with 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 - Preventa XPSAF
- Safety Guard switches - Preventa XCSB, 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
Guard Monitoring with Safety Module
Coded Magnetic Switch / 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 - Preventa XPSDM
- Coded magnetic system - Preventa XCSDM
- Contactor - TeSys D
- Modular beacon and tower light - Harmony XVB

Function
Safety-related stop function initiated by any of the moveable guards that helps protecting from the access to the hazardous area.
The opening of each guard is detected by using magnetic switches, which are checked by the safety module by means of a combination of contacts (normally closed and normally open).
Opening of any of these guards causes the deactivation of the safety module outputs, which results in the switching-off of the motor power supply by means of the contactors K1 and K2 (stop category 0 according to EN/IEC 60204-1) to help prevent possible hazardous movements or states.
The main contactors are monitored by the safety module to detect contact welding by means of the mirror contacts.
The safety module also monitors the consistent actuation of the magnetic switch contacts to detect any failure, before restart of the machine movement is permitted.
Opening or removal of the protective guard is detected by means of the coded magnetic switches, which are particularly useful for guards without accurate guidance and for use in difficult environments (dust, liquids, etc.).

Typical applications
- Assembling, packaging or similar compacted machines with a short rundown time and where the access to the hazardous area is very frequent
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
Guard Monitoring with Safety Controller
Limit Switch / Contactor
Cat.4 PL e, SIL 3 / Stop Category 0

Function

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

The guard opening is detected by using a solenoid locked switch in combination with a limit switch in positive operating mode, which are checked by the safety module allowing detection of the opening or removal of the protective guard.

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

The motor can be also de-energized when the emergency stop device (S1) is actuated. (*)

The main contactors are monitored by the safety controller to detect for example contact welding, by means of the mirror contacts.

The safety controller also monitors the consistent actuation of the limit switch contacts to detect failure, before restart of the machine movement is permitted. (*)

(*) The function for stopping in an emergency is a protective measure which complements the safety functions for the safeguarding of hazardous zones according to EN/ISO 12100-2.

Typical applications

> Plastic injection, eccentric press or similar complex machines with 4 or more safety functions included, where a centralized safety controller would be required.

Related Products
- Switches, pushbuttons - Harmony XB4
- Emergency stop control station - Harmony XALK
- Two-Hand control station - Preventa XY2 SB
- Switch mode Power supply - Phaseo ABL8
- Logic controller - Modicon M258
- Guard interlock switch and safety switches - Preventa XCS
- Safety Controller - Preventa XPS MC
- Contactor - TeSys D
- Modular beacon and tower light - Harmony XVB
Guard Monitoring with Embedded Safety PLC
Guard Switch with lock/ PacDrive 3 Drive
Cat.4 PL e, SIL 3 / Stop Category 1

Function
Safety-related stop function initiated by a moveable guard that helps preventing access to the hazardous area.

Controlled stopping with power maintained to the actuator (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 or the emergency stop device is actuated. Opening of this guard is detected by limit switches, which 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, drive halts itself, by the “safe torque off” (STO) safety function integrated within it, which prevents the motor from restarting unintentionally. The switching of the STO and input is monitored by the drive. When the motor can no longer generate torque, the safety PLC is notified and it can provide the unlock signal for the electrically locked movable guard or engaging brakes.

The safety module also monitors the consistent actuation of the redundant limit switch contacts to detect possible failure, before restart of the machine movement is permitted.

Typical applications
> Machine tools, robots, production test equipment, test benches
> Papermaking machines, textile production machines, calendars in the rubber industry
> Process lines in plastics, chemicals or metal production, rolling-mills
> Cement crushing machines, cement kilns, mixers, centrifuges, extrusion machines
> Drilling machines
> Conveyors, materials handling machines, hoisting equipment (cranes, gantries, etc.)
> Pumps, fans, etc.
Guard Monitoring with Embedded Safety Servo Drive
Coded Magnetic Switch / Embedded Safety Servo Drive
Cat.4 PL e, SIL 3 / Stop Category 2

**Function**

Safety-related stop function realized by a moveable guard that helps protecting from the access to the hazardous area.

The hazardous movement is interrupted either if the stop button (S2) or the emergency stop device (S3) is actuated, which initiates the functional stopping of the servo-drive, i.e. by a deceleration ramp.

The Safe Stop 2 safety function is used to achieve a category 2 safe stop in accordance with EN/IEC 61800-5-2, where the servo motor is braked in a controlled manner, maintaining the power on the actuators.

The safety function SS2 (Safe Stop 2), integrated in the enhanced safety module (eSM) card, monitors the deceleration and the standstill position.

When the SS2 function is triggered, a deceleration of movement is monitored with the specified monitoring ramp up to standstill. The motor is then immobilized by the “safe operating stop” (SOS) function, which is used to monitor any deviation from the standstill position.

If the monitored deceleration ramp is violated or the monitored standstill position is not maintained, the drive is halted by the “safe torque off” (STO) function, which prevents the motor from restarting unintentionally.

The eSM card also monitors the consistent actuation of the redundant switch contacts from the magnetic switch to detect possible failure, before restart of the machine movement is permitted.

**Related Products**

- Switches, pushbuttons, emergency stop - Harmony XB4
- Guard switches - Preventa XCSLE
- Enhanced Safety Module (eSM) - Lexium 32M
- Servo drive - Lexium 32M
- Human machine interface - Magelis XBT GH
- Modular beacon and tower lights - Harmony XVB
- Switch mode Power supply - Phaseo ABL8

**Typical applications**

Packaging, printing, or similar machines that use servo-drives in their movements due to high speed and precision needed, on which non-braking stopping would result in an impermissibly long run-down of the hazardous tool movements.
Guard Monitoring with Well Tried Components
Limit Switch / Motor Starter
Cat.3 PL c, SIL 1 / Stop Category 0

Related Products
- Switches, pushbuttons, emergency stop - Harmony XB4
- Emergency stop function - Harmony XALK
- Switch mode Power supply - Phaseo ABL8
- Motor starter - TeSys U
- Safety Guard switches - Preventa XCS
- Modular beacon and tower lights - Harmony XVB

Function
Stop function initiated by a moveable protective guard. Opening of this guard is detected by a guard switch, which interrupts the control voltage of the motor starter (stop category 0 according to EN/IEC 60204-1) to help preventing possible hazardous movements.
The break contact of this guard switch interrupts the control circuit directly when the protective guard is not in the safe position.
The motor is also de-energized when either of the emergency stop devices (S1 or S2) are actuated. (*)
The safety function is fully dependent upon the reliability of the components.

(*) The function for stopping in an emergency is a protective measure which complements the safety functions for the safeguarding of hazardous zones according to EN/ISO 12100-2.

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
Enabling movement with Safety Controller
Two Hand Control Station / Contactor
Cat.4 PL e, SIL 3 / Stop Category 0

Related Products
- Switches, pushbuttons - Harmony XB4
- Emergency stop control station - Harmony XALK
- Two-Hand control station - Preventa XY2SB
- Switch mode Power supply - Phaseo ABL8
- Logic controller - Modicon M258
- Guard interlock switch - Preventa XCS
- Safety Controller - Preventa XPS MC
- Contactor - TeSys D
- Modular beacon and tower light - Harmony XV8

Function
Safety-related function to help control the location of the operator’s hands outside the hazardous area during a hazardous movement of the machine. To initiate a movement, both actuators (two-hand control pushbuttons S3 and S4) must be activated synchronously (within an interval less than 0.5 sec.) to energize the contactors (K1 and K2). When at least one of the two pushbuttons is released, the energization is cancelled and remains blocked until both pushbuttons are released and pressed again synchronously.

The logic device (Safety Controller) monitors operation of the actuators (pushbuttons). Faults in the actuating mechanism as well as the cable wiring are detected in S3/S4 by the use of two contacts employing a normally open (NO) and normally closed (NC) combination.

Faults in K1/K2 (with mirror contacts) are detected in the safety controller and lead to de-energization of the contactors (K1 and K2).

Typical applications
- Hydraulic, eccentric press or similar complex machines with 4 or more safety functions included, where a centralized safety controller would be required.
Function

Safety chain solutions

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

Related Products
- Switches, pushbuttons, emergency stop - Harmony XB4
- Switch mode Power supply - Phaseo ABL8
- Logic controller - Modicon M258
- Guard lock switch - Preventa XCSE
- Safety Module - Preventa XPS
- Contactor - TeSys D
- Modular beacon and tower lights - Harmony XVB

Function
Safety-related stop function initiated by any stop or emergency stop command to halt the machine and to unlock the moveable guard that prevents the access to the hazardous area before the machine comes to a standstill.
Guard opening is detected by using a solenoid locking guard switch in combination with a limit switch in positive actuation mode, which are then checked by the safety module allowing detection of the opening or removal of the protective guard.
Actuation of the emergency stop or stop contacts initiates the functional stopping of the machine by switching-off the motor power supply. As electric motors run down, a remanent voltage is produced in the windings of the motor due to residual magnetism.
This voltage is measured so as to detect the stopped condition of the motor, providing the unlock signal for the electrically locked movable guard and for engaging brakes after the motor has come to a standstill.
The continuity of the wiring between the motor windings and the inputs of the safety module is also monitored to prevent a cable breakage or fault being seen as a stopped motor. The main contactors are monitored by the safety modules by means of the mirror contacts to detect e.g. contact welding.
The safety modules also monitor the consistent actuation of the limit switch contacts to detect failure, before restart of the machine movement is permitted.

Typical applications
- On metal, wood work or similar high inertia machines with a long run-down of the hazardous tool movements, and where an electronically interlock guard is used to protect the hazardous area
### Function

Safety-related Speed monitoring function initiated by a safe command to control the machine and to unlock the moveable guard that prevents the access to the hazardous area before the machine comes to a safe speed.

Selector switch status change is detected by using a selector switch or standard PLC signal for change in operating mode, which are then checked by the safety PLC allowing detection of the change in operating mode of the machine.

Actuation of the selector switch or standard PLC signal initiates the control rampdown of the machine by drive controller. As electric motors run down, monitored by built in encoder, then speed will be continuously monitored. If at any time the speed of the motor exceeds the specified limit, SS1 or STO function is initiated for monitored stop or free whirling stop.

The continuity of the wiring between the motor windings and the inputs of the safety modules are also monitored to prevent a cable breakage or fault being seen as a stopped motor.

The safety modules also monitor the consistent actuation of the limit switch contacts to detect failure, before restart of the machine movement is permitted.

### Typical applications

- Machine tools, robots, production test equipment, test benches
- Papermaking machines, textile production machines, calendars in the rubber industry
- Process lines in plastics, chemicals or metal production, rolling-mills
- Cement crushing machines, cement kilns, mixers, centrifuges, extrusion machines
- Drilling machines
- Conveyors, materials handling machines, hoisting equipment (cranes, gantries, etc.)
- Pumps, fans, etc.

### Related Products

- Switches, pushbuttons, emergency stop - Harmony XB4
- Switch mode Power supply - Phaseo ABL8
- Preventa Safety PLC TM5SLC (TM5 Slices> SPS, SDIO, BC)
- Safety switches - Preventa XCS
- PacDrive 3
- Harmony XVB
**Function**

Safety-related stop function initiated by any stop or emergency stop command to halt the machine and to unlock the moveable guard that prevents the access to the hazardous area before the machine comes to a standstill.

Guard opening is detected by using a Coded magnetic switch, which are then checked by the safety PLC allowing detection of the opening or removal of the protective guard.

Actuation of the stop contacts initiates the functional stopping of the machine by control ramp down of the motor then monitor the motor position, for the stand still. If the position of the motor is violated the SS1 or STO will be initiated.

The continuity of the wiring between the motor windings and the inputs of the safety modules are also monitored to prevent a cable breakage or fault being seen as a stopped motor. The main contactors are monitored by the safety modules by means of the mirror contacts to detect e.g. contact welding.

The safety modules also monitor the consistent actuation of the coded magnetic switch contacts to detect failure, before restart of the machine movement is permitted.

**Typical applications**

- Machine tools, robots, production test equipment, test benches
- Papermaking machines, textile production machines, calendars in the rubber industry
- Process lines in plastics, chemicals or metal production, rolling-mills
- Cement crushing machines, cement kilns, mixers, centrifuges, extrusion machines
- Drilling machines
- Conveyors, materials handling machines, hoisting equipment (cranes, gantries, etc.)
- Pumps, fans, etc.

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**Related Products**

- Switches, pushbuttons, emergency stop - Harmony XB4
- Switch mode Power supply - Phaseo ABL8
- Preventa Safety PLC TM5SLC\(\bullet\) (TM5 Slices> SPS, SDIO, BC)
- Safety Switches - Preventa XCS
- PacDrive 3
- Harmony XVB
Function

Safety-related stop function initiated by any of the safety mats installed around the different potentially hazardous zones defined by the dangerous movement of the machine.

The hazardous movement is interrupted either if the emergency stop device (S1) or any of the safety mats (SM1 or SM2) is actuated.

Stepping on the safety mat deactivates the safety module outputs, which results in the switching-off of the motor power supply by means of the contactors K1 and K2 (stop category 0 in accordance with EN/IEC 60204-1) in order to prevent possible hazardous movements or states.

The safety mat provides a protection zone between machine operator and any dangerous movements and enables free access for the loading and unloading of the machine.

The safety module monitors the consistent actuation of the redundant safety mat contacts to detect possible failures.

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

The resetting of the function can be performed manually or automatically, depending on the configuration of the safety module, before renewed start-up of the machine movement. (*)

(*) The function for stopping in an emergency is a protective measure which complements the safety functions for the safeguarding of hazardous zones according to EN/ISO 12100-2.

Typical applications

> Machines which use a free and very frequent access to the hazardous area, where a high number of interventions are needed
**Perimeter Guarding with Safety Module**
Single Beam Light curtains / Contactor
Cat.3 PL c, SIL 1 / Stop Category 0

**Related Products**
- Switches, pushbutton, 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 - Preventa XPSCM
- Contactor - Tesys D
- Modular beacon and tower lights - Harmony XVB

**Function**
Safety-related stop function initiated by several single-beam photo-electric devices used as protective equipment (ESPE Type 2 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 photo-electric devices (B1...B4) are cyclically tested and monitored by the safety module to detect possible failures.

A muting function can be enabled by means of photo-electric sensors (A1, A2). It allows the light curtain’s detection function to be temporary inhibited without triggering the stop function. During the muting time interval, materials can be transported through the hazardous area and the muting indicator light (H1) indicates to the operator this temporary disabling of protection.

**Typical applications**
- Palletizing stations with automatic control system where pallets would pass frequently through the hazardous area
Function

Safety chain solutions

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
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.
Detailed description

Safety functions

Emergency stop

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

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
Detailed description

Safety functions
Guard monitoring

Guard monitoring

Guard 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.

Explanation of function

Guards without guard locking device

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

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 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
Detailed description

Safety functions
Enabling movement

Enabling movement

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.

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**

**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**

<table>
<thead>
<tr>
<th>Switch-on Sequence</th>
<th>State of Sensor 1</th>
<th>State of Sensor 2</th>
<th>Behavior</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>0</td>
<td>Error Message</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>1</td>
<td>Zero Speed Notification (2)</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>0</td>
<td>Error Message</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1</td>
<td>Zero Speed Notification (2)</td>
<td>0</td>
</tr>
</tbody>
</table>

(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 filters 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 12 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.
### Safety functions

**Speed monitoring**

#### Detailed description

**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 $v_2$ within the specified time $t_2$. Once the machine reaches the safe speed $v_2$, the function will monitor the speed to stay below the safe speed $v_2$.

In case of speed exceeding the specified speed during time $t_2$ and further, the safety function will initiate either SS1 or STO to stop the machine in the 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, the specified safe output will change its state.

**Safe direction**

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

#### Explanation of function

| 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 |

| Safety chain solution: |

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**Typical architecture**

*Safety-limited speed*  

*Safety maximum speed*  

*Safety direction*
Position monitoring

**Vertical position monitoring**

When the cabin is parked at a landing, with the doors open, some lifts automatically correct their level (isolevelling) in relation to the landing in order to compensate for any differences generated by modification of the load in the cabin.

During this operation, European standard EN-81 recommends that the presence of the cabin be checked within a zone of +/- 0.2 m around the landing (door unlocking zone), by means of a safety circuit which will cause the cabin to stop if it moves out of the specified zone.

The use of the safety module XPS EDA, which checks the presence of the cabin in the specified zone at two points, meets this requirement.

The module incorporates two safety outputs and two solid-state outputs for signaling functions. Four LEDs on the front face of the module provide visual indication of the status of the safety circuit.

The position of the cabin in relation to the landing is detected by two limit switches in the lift shaft. It is also possible to use non-contact sensors (magnetic sensors with reed contact).

When the cabin reaches the preset position and when it is within the permissible tolerances in relation to the landing, the two safety circuits in safety module XPS EDA close and allow isolevelling of the cabin with the doors open. Any change in one of the input signals (cabin outside the specified zone) or detection of a fault (break in the wiring, short-circuit, etc.) causes immediate opening of the safety outputs in the XPS EDA module and subsequent stopping of the cabin.

**Motion safety function:**

**Safe operating stop (SOS)**

The SOS function prevents the motor from deviating more than a defined amount from the stopped position. The drive provides energy to the motor to enable it to resist external forces. The Safe Operating Stop function is most commonly used in conjunction with the Safe Stop 2 function where the machine movement enters into zero speed the Safe Operating Stop is enabled.

**Typical architecture**

**Safety chain solution:**

- Position Monitoring with Embedded Safety PLC / Coded Magnetic Switch / PacDrive 3 Drive SS2 / Cat.4 PL e, SIL 3 / Stop Category 2
Safety functions
Perimeter guarding

**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 light curtains**

- 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

**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 mat applications**

- Perimeter Guarding with Safety Module / Safety Mat / Contactor / Cat.3 PL d, SIL 2 / Stop Category 0
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