Power box overview

5111197-01

User documentation ver 1.0

QR 6620957

1. Power box

The Control box has certain limitations such as number of safety zones and effect per safey zone.

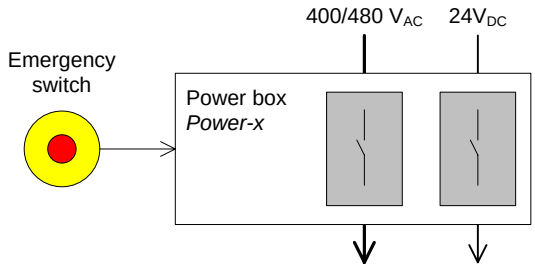
Power boxes provide safe power (3/4 according to EN 954-1, category depends on implementation) and are used for either adding more safety zones (parallel or embedded) to the system or provide more effect.

Types of Power boxes:

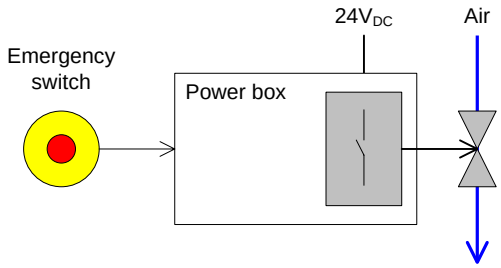
- Power-x
- Air-x
- Air

The Power-x version disconnects both 400/480 V_{AC} and 24V_{DC} while the Air-versions are intended for controlling the air supply valve of the safety zone.

Power box



Power-x version



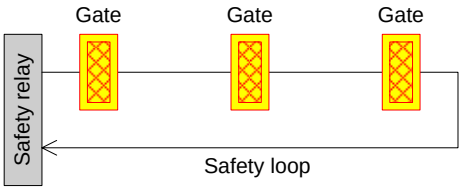
Air-x/Air versions

”-x” stands for ”extendable” and indicates that these versions can have the number of safety relays extended by the integrator.

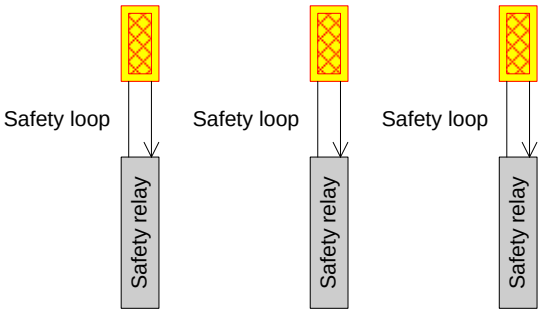
Additional safety relays are required for fulfilling safety category 4 when using multiple safety switches as safety category 4 demands short-circuit detection in the safety loop.

Note 1: The safety loop in the illustrations is in reality redundant consisting of double conductors.

Note 2: An emergency stop zone is advicably restricted to category 3 (EN 954-1).



Switches in series allowed in safety category 3



Category 4 demands short-circuit detection

Power box

1.1 Power box assortment overview

The Power box comes in different types and for different geographical areas.

Europe, Power bus 400V

5058140

Power-x

5058141

Air-x

5058150

Air

US, Power bus 480V

5059410

Power-x

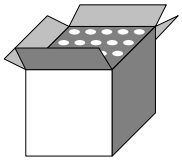
5059411

Air-x

5058150

Air

Miscellaneous



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Safety relay expansion kit

1.2 Field of application

Power boxes are used for:

- Creating parallel safety zones
- Creating embedded safety zones
- Electrical power supply expansion

The arrows in the pictures illustrate energy/power flow in general.

Creating a safety zone, parallel or embedded

A Power box can be used for creating a safety zone in parallel with other zones or to creating embedded safety zones inside other zones.

The difference between ”parallel” and ”embedded” refers to the power source. If the Power Box is powered by another box, it is considered embedded to this box.

In picture ”Creating a parallel safety zone”, the power box of Zone 2 is powered by an external power source, thus is independent of Zone 1's status. However, in picture ”Creating an embedded safety zone” the Power box is powered by the Control box. If the Control box is emergency stopped, the power supply to Zone 1.1 will stop.

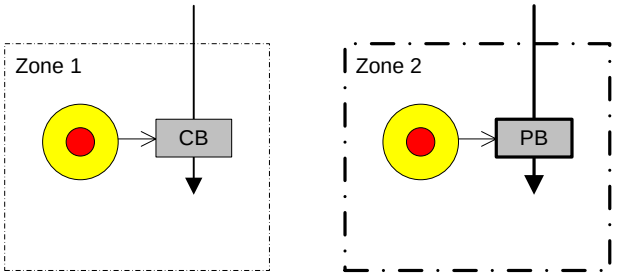
Electrical power supply expansion

A Power box, ”Power-x” can be used for providing additional safe power to a zone where the effect of the original box is not sufficient.

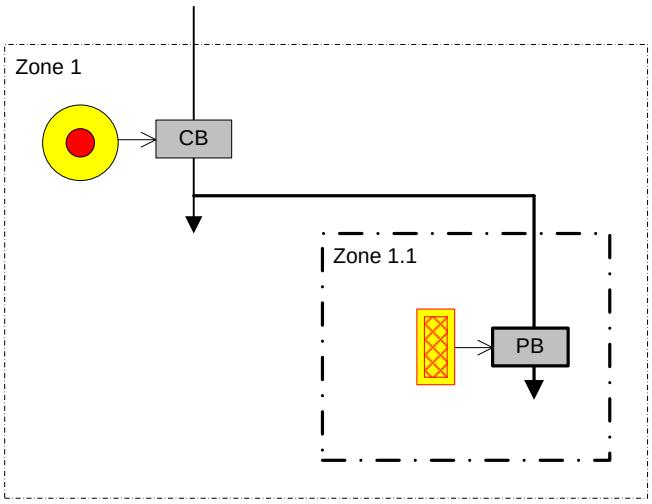
By powering the Power box externally and creating a Slave-relationship to the original box, another 16 A is provided the safety zone.

In picture ”Electrical power supply expansion” the Power box is used for adding a second Power bus of 16 A to Zone 1.

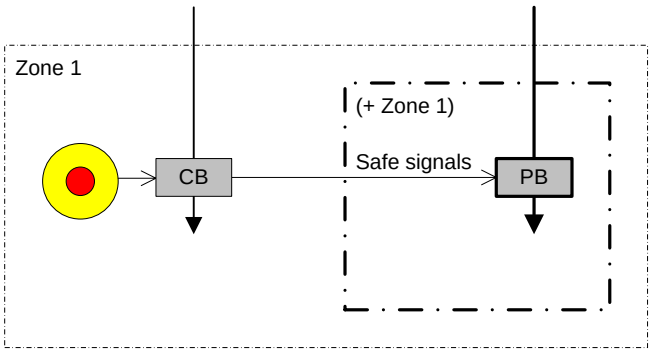
Up to four Power boxes can be assigned as slaves per zone.



Creating a parallel safety zone



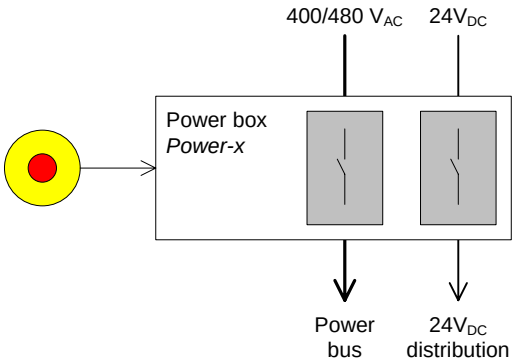
Creating an embedded safety zone



Electrical power supply expansion

2. Power-x version

The Power-x version provides safe distribution of Power bus and $24V_{DC}$.
The number of safety relays can be expanded from the default of 1 to 4 pcs.



Power-x version

2.1 Incoming power supply

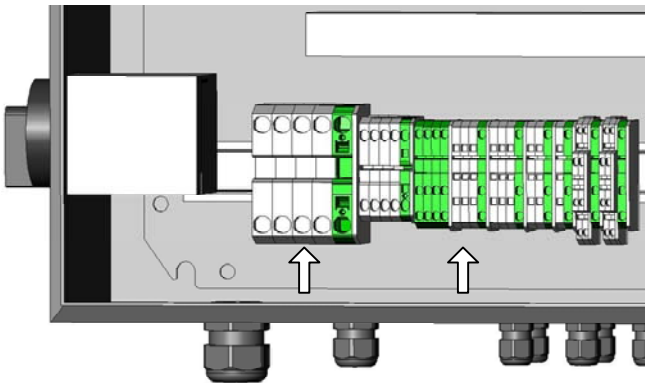
2.1.1 Power supply connection

V_{AC} power supply

Rated cable area connection: 16 mm2
Terminal group X301-1 connections:
Europe: L1/L2/L3 + N + PE
US: L1/L2/L3 + PE

$24V_{DC}$ power supply

Rated cable area connection: 2.5 mm^2
Terminal group: X301-3



Incoming power supply

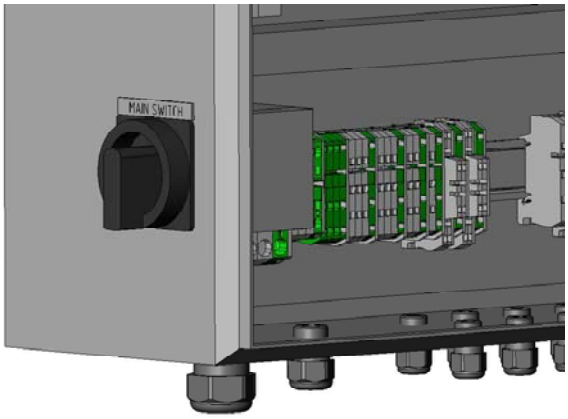
2.1.2 Main switch

The main switch disconnects the V_{AC} power supply to the box and can be locked with padlocks in off-position used as maintenance switch.

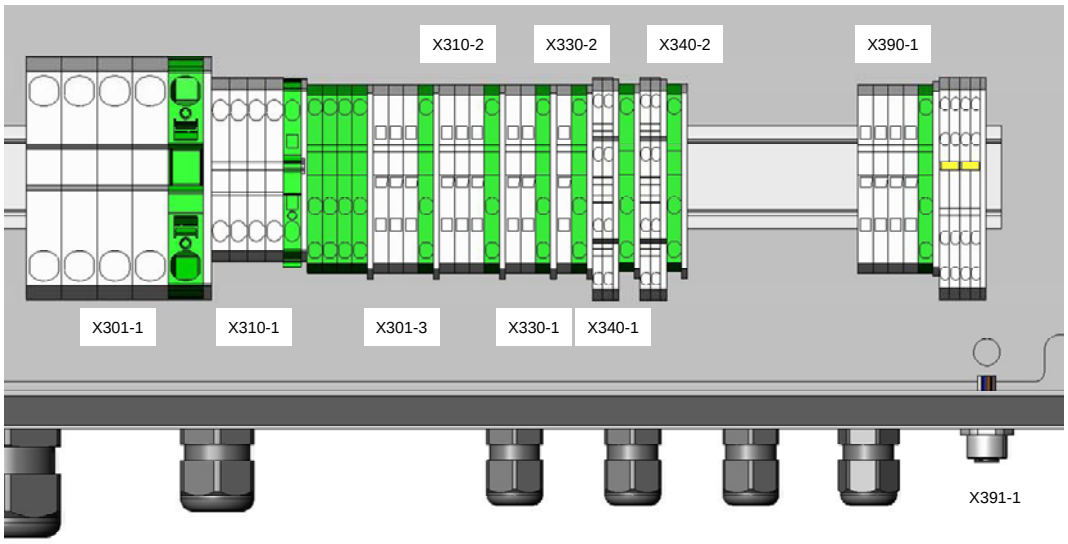
Important:

- $24V_{DC}$ power supply is not affected by Main switch.
- Load, i.e. motors, must be turned off before disconnection.

Rated uninterupted current: 25 A



Main switch



Interfaces

2.2 Power bus

The Power bus is used for powering AC-loads in the system, i.e. motors.

The Power bus cable is connected to terminals in the Power box and daisy-chained through the system's external loads.

The Power bus current is limited to 16 Ampere and safety protected to safety category 3 or 4 according to EN954-1 depending on implementation.

The safety system protecting the Power bus is also protecting the $24V_{DC}$ distribution.

Power bus voltage:

- Europe: 400 V_{AC}
- US: 480 V_{AC}

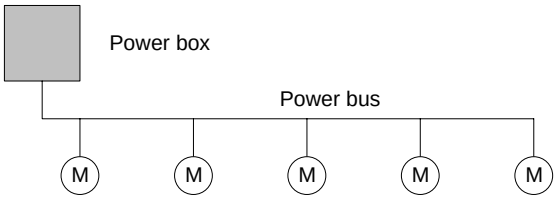
2.2.1 Power bus protection

The Power box is equipped with an advanced circuit breaker designed to protect power cables. In addition to the adjustable overload setting the circuit breaker has an adjustable short-circuit current setting in order to detect also low short-circuit currents occuring in systems with long Power bus cables (definition "long": distance>45 meters).

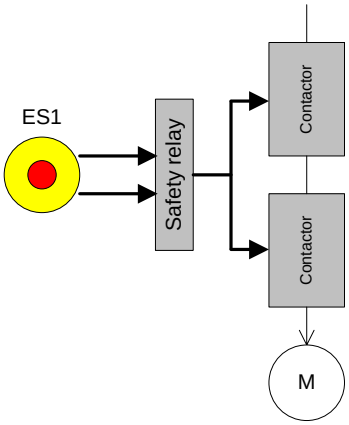
2.2.2 Power bus connection

Rated cable area connection: 4 mm^2

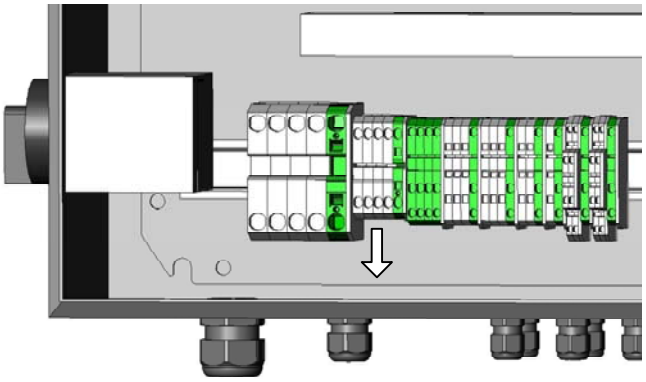
Terminal group X310-1 connections:
Europe: T1/T2/T3 + N + PE
US: T1/T2/T3 + PE



Power bus



Safety system category 3/4 according to EN954-1



Power bus terminal group

2.3 $24V_{DC}$-power distribution

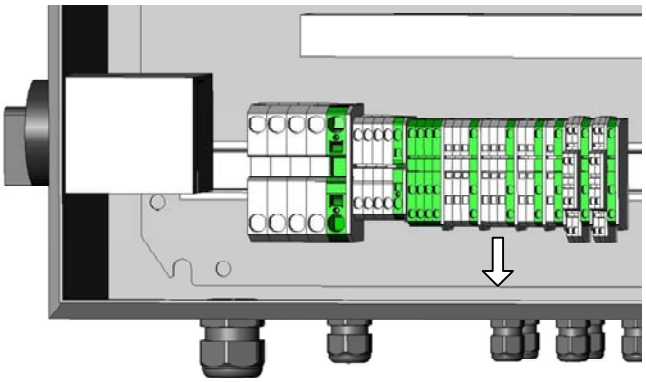
The 24VDC distribution current out from the Power box is protected and limited by a 4 A miniature circuit breaker.

It contains two power conductors of which one is safety protected to safety category 3 or 4, depending on implementation, according to EN 954-1 and the second provides continuous power independent of safety stop.

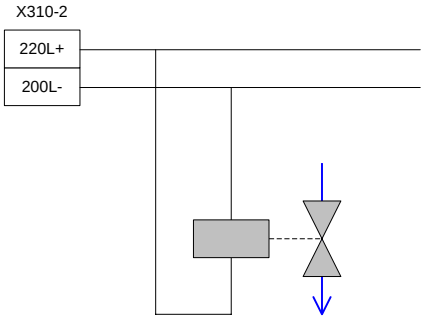
The safety system protecting the $24V_{DC}$ distribution is the same protecting the Power bus.

2.3.1 $24V_{DC}$-distribution connection

Rated cable area connection: 2.5 mm^2
Terminal group: X310-2



24VDC power distribution terminal group



Application: Powering air supply valve

2.4 Safety system

Signals used for communicating with the safety system:

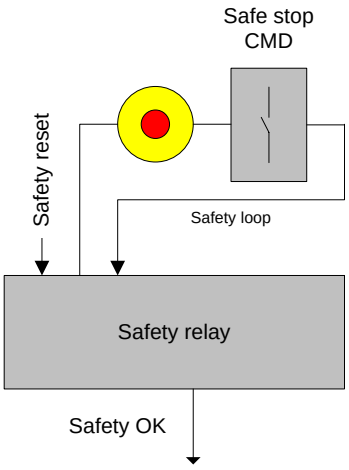
- Safety OK: Indicates safe status, that the system is in order and the safe power is activated.
- Safety reset : Resets safety system from outside the Power box.
- Safe stop CMD: Provides the functionality to safe stop by software.

Certain standards demand that the ”Stopped”-state of the machine should be safe. The output ”Safe stop CMD” breaks up the safety loop by means of a relay.

2.4.1 Safety inputs and outputs

The safety inputs/outputs are intended for communication between safety relays of the safety system.
Communication between relays are required when:

- Expanding the number of safety relays in the Power box in order to achieve safety category 4 of EN954-1 for multiple safety switches
- Adding Power boxes to a safety zone in order to increase incoming effect

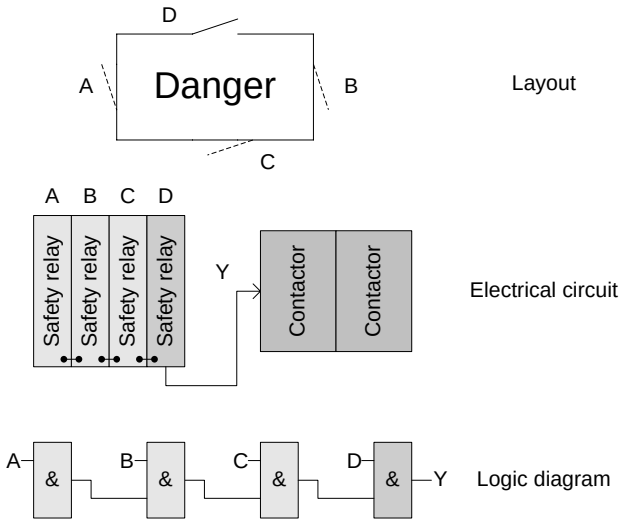


Safety relay communication

Multiple safety switches in safety category 4

In order to fulfill category 3 or 4 (EN 954-1) it is mandatory to detect short-circuits in the safety loop. This is only possible when using one safety relay per gate.

The safety system is by default equipped with one safety relay and has empty space for additionally three safety relays.
The inputs and outputs of the safety relays are used for creating a logical circuit.



Multiple safety switches in category 4

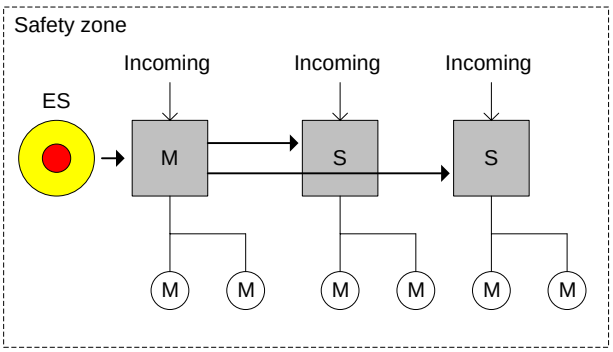
Increasing incoming effect for safety zone

Power boxes can be added to a safety zone in order to add incoming effect.

The safety outputs of the box to which the emergency/ safety switches are connected, are connected to the safety inputs of the added Power boxes, creating a Master-Slave relationship where the added Power boxes automatically follow the status of the Master box.

Note that the Master box can be either a Control box or Power box. Only Power boxes can be slaves.

The Master can send signals to up to three Power boxes.

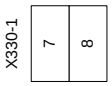


Adding effect to a safety zone

2.4.2 Safety relay connections

Safety outputs

Rated cable area connection: 2.5 mm^2
Terminal group: X330-1



Safety outputs

Safety input

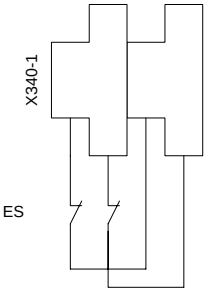
Rated cable area connection: 2.5 mm^2
Terminal group: X330-2

Safety input

Safety loop

Rated cable area connection: 1.5 mm^2
Terminal group: X340-1

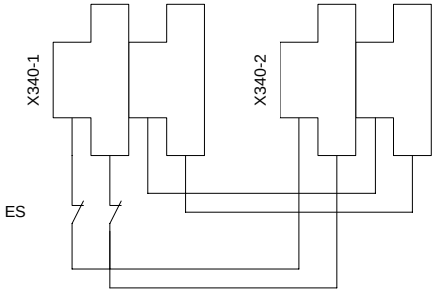
Lower storey is connected to lower storey. Upper storey is connected to upper storey.



Safety loop

Safe stop CMD

Rated cable area connection: 1.5 mm^2
Terminal group: X340-2



Safety loop with remote safe stop functionality

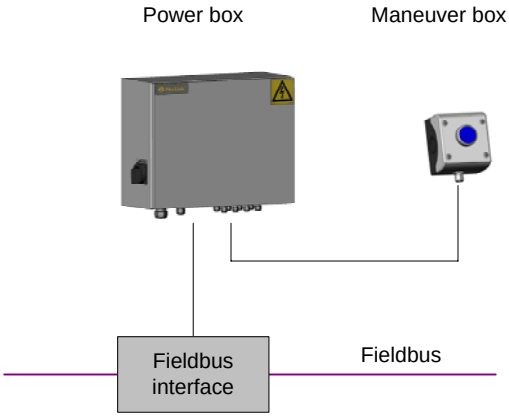
2.5 Communication

2.5.1 Fieldbus interface communication

Communication with Control box is performed by means of fieldbus. Signals: Safety OK, Safety reset and Safe stop CMD.

Fieldbus interface communication

Cross-section: Max. 2.5 mm^2 (with/without ferrule)
Terminal group: X390-1



Fieldbus interface and Maneuver box communication

2.5.2 Maneuver box communication

The Power box do not include any operator interface such as pushbuttons, lamp or displays, but includes an M12-connector for local reset through a local Maneuver box. Signals: Safety OK and Safety reset.

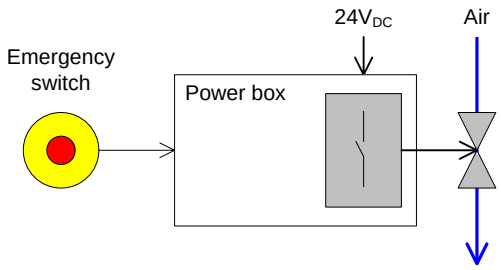
Maneuver unit connections

Type: M12, 4-pin, male, A-code
Connector: X391-1

3. Air-x version

The Air-x version provide safe distribution of $24V_{DC}$. The effect out is limited, intended for controlling an air supply valve of a safety zone.

The number of safety relays can be expanded from the default of 1 up to 4 pcs.



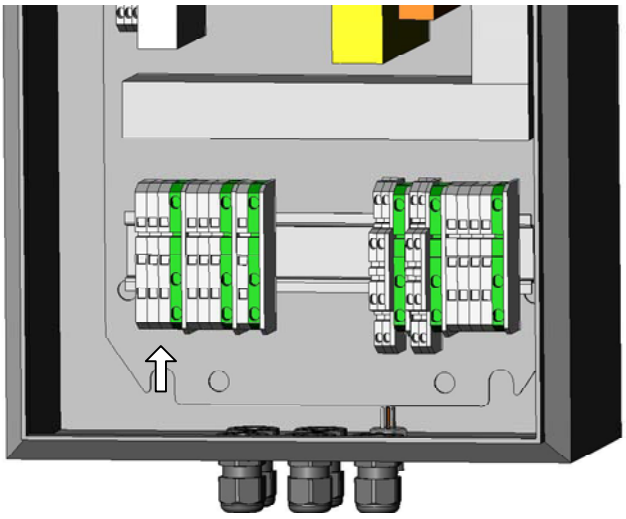
Air-x versions

3.1 Incoming power supply

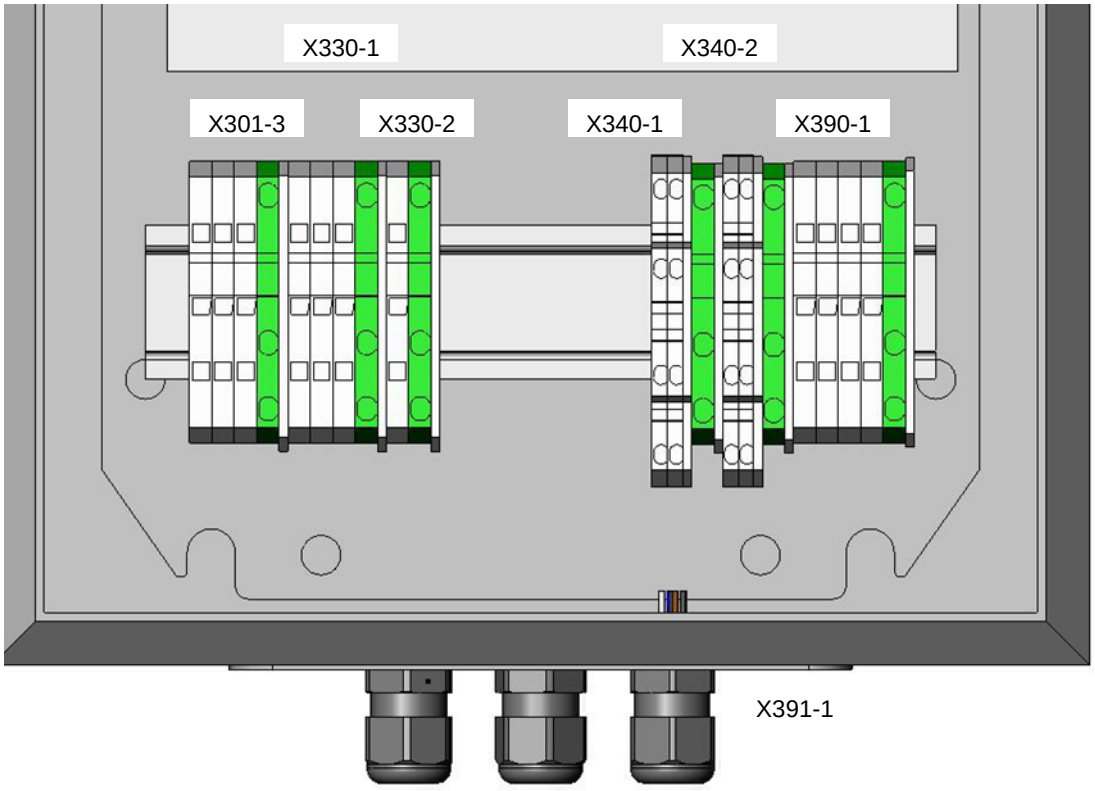
3.1.1 Power supply connection

$24V_{DC}$ power supply

Rated cable area connection: 2.5 mm^2
Terminal group: X301-3



Incoming power supply



Interfaces

3.2 Safety system

Signals used for communicating with the safety system:

- Safety OK: Indicates safe status, that the system is in order and the safe power is activated.
- Safety reset : Resets the safety system from outside the Power box.
- Safe stop CMD: Provides the functionality to safe stop from within the software.

Certain standards demand that the ”Stopped”-state of the machine should be safe. The output ”Safe stop CMD” breaks up the safety loop by means of a relay.

3.2.1 Safety inputs and outputs

Safety outputs are mainly intended for powering the air supply valve of the safety zone.

Additionally, the safety inputs/outputs are intended for communication between safety relays of the safety system.

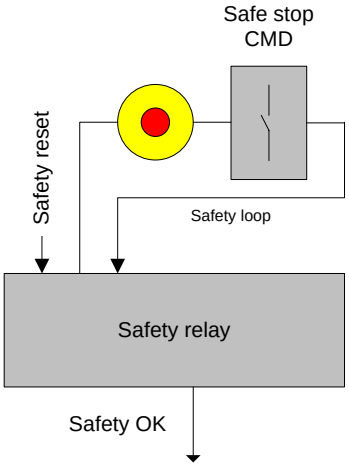
Communication between relays are required when:

- Expanding the number of safety relays in the Power box in order to achieve safety category 4 of EN954-1 for multiple safety switches

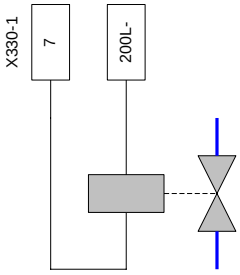
<u>Multiple safety switches in safety category 4</u>

In order to fulfill category 3 or 4 (EN 954-1) it is mandatory to detect short-circuits in the safety loop. This is only possible when using one safety relay per gate.

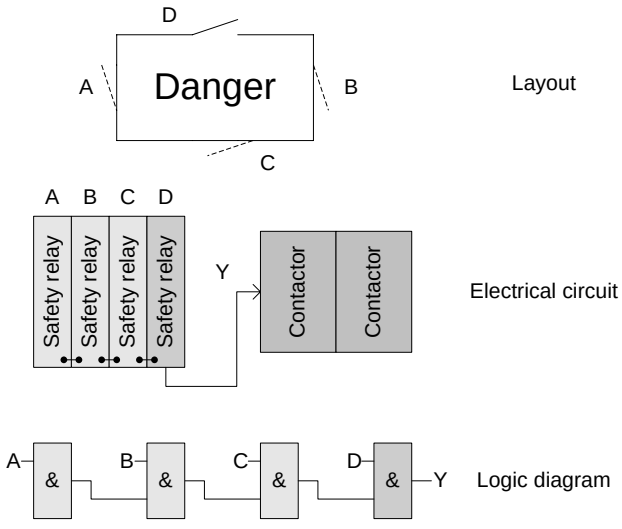
The safety system is by default equipped with one safety relay and has empty space for additionally three safety relays.
The inputs and outputs of the safety relays are used for creating a logical circuit.



Safety relay communication



Powering air supply valve

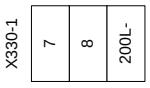


Multiple safety switches in category 4

3.2.2 Safety relay connections

Safety outputs

Rated cable area connection: 2.5 mm^2
Terminal group: X330-1



Safety outputs

Safety input

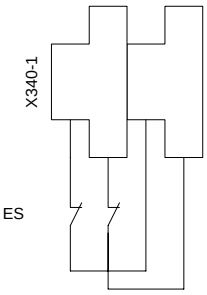
Rated cable area connection: 2.5 mm^2
Terminal group: X330-2

Safety input

Safety loop

Rated cable area connection: 1.5 mm^2
Terminal group: X340-1

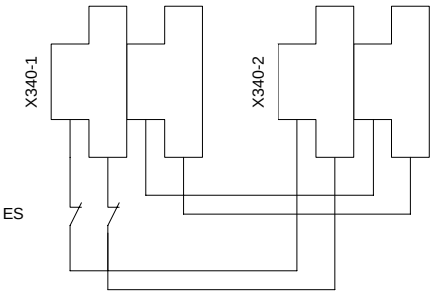
Lower storey is connected to lower storey. Upper storey is connected to upper storey.



Safety loop

Safe stop CMD

Rated cable area connection: 1.5 mm^2
Terminal group: X340-2



Safety loop with remote safe stop functionality

3.3 Communication

3.3.1 Fieldbus interface communication

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Fieldbus interface communication

Cross-section: Max. 2.5 mm^2 (with/without ferrule)
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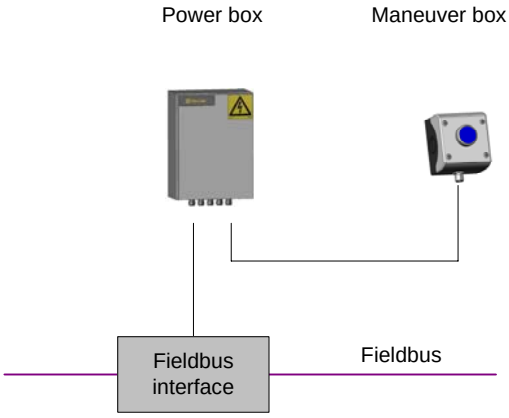


Fieldbus interface and Maneuver box communication

3.3.2 Maneuver box communication

The Power box do not include any operator interface such as pushbuttons, lamp or displays, but includes an M12-connector for local reset through a local Maneuver box. Signals: Safety OK and Safety reset.

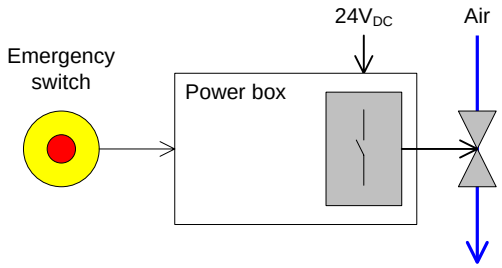
Maneuver unit connections

Type: M12, 4-pin, male, A-code
Connector: X391-1

4. Air version

The air version provide safe distribution of $24V_{DC}$. The effect out is limited, intended for controlling an air supply valve of a safety zone.

The box contains one safety relay and can not be expanded.



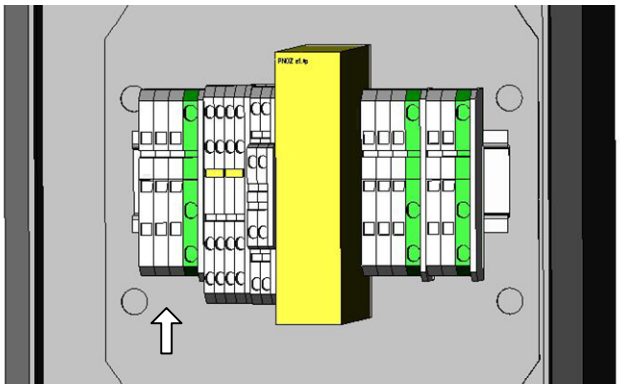
Air version

4.1 Incoming power supply

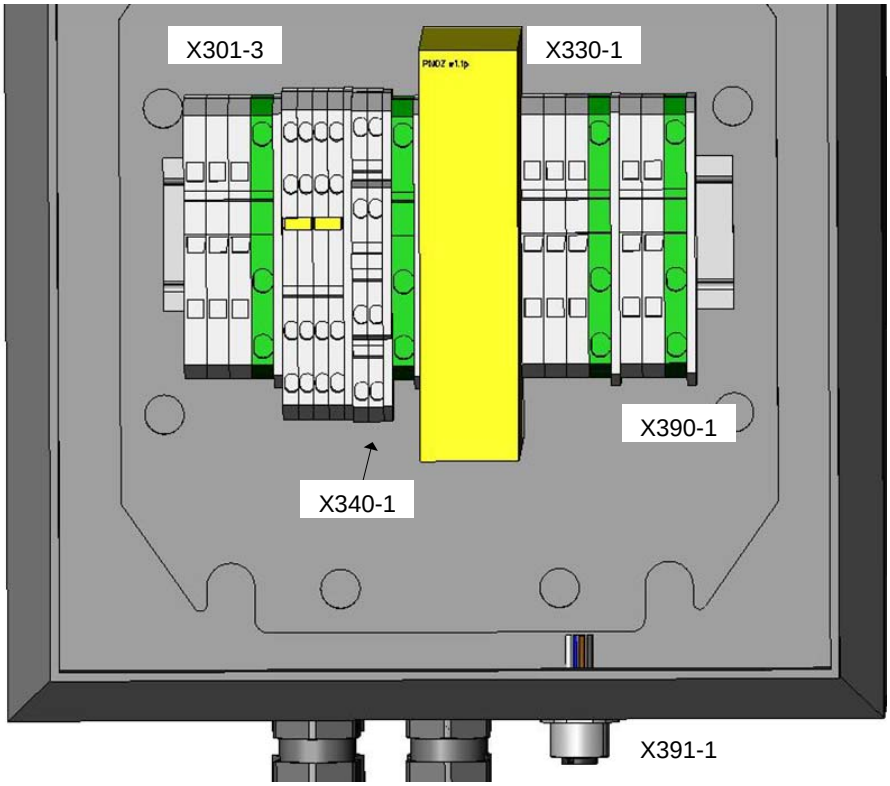
4.1.1 Power supply connection

<u>24V_{DC} power supply</u>

Rated cable area connection: 2.5 mm^2
Terminal group: X301-3



Incoming power supply



Interfaces

4.2 Safety system

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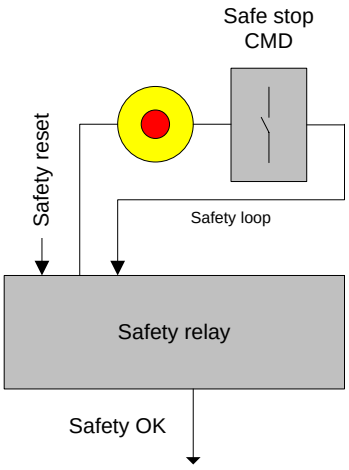
- Safe stop CMD: Provides the functionality to safe stop from within the software.

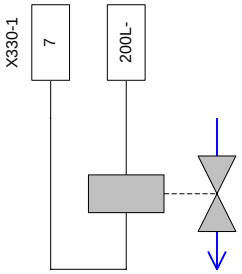
Certain standards demand that the ”Stopped”-state of the machine should be safe. The output ”Safe stop CMD” breaks up the safety loop by means of a relay.



Safety relay communication

4.2.1 Safety outputs

Safety outputs are intended for powering the air supply valve of the safety zone.



Application: Powering air supply valve

4.2.2 Safety relay connections

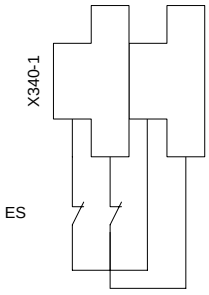
<u>Safety outputs</u>

Rated cable area connection: 2.5 mm^2
Terminal group: X330-1

<u>Safety loop</u>

Rated cable area connection: 1.5 mm^2
Terminal group: X340-1

Lower storey is connected to lower storey. Upper storey is connected to upper storey.



Safety loop

4.3 Communication

4.3.1 Control box communication

Communication with Control box is performed by means of fieldbus. Signals: Safety OK, Safety reset and Safe stop CMD.

Fieldbus interface communication

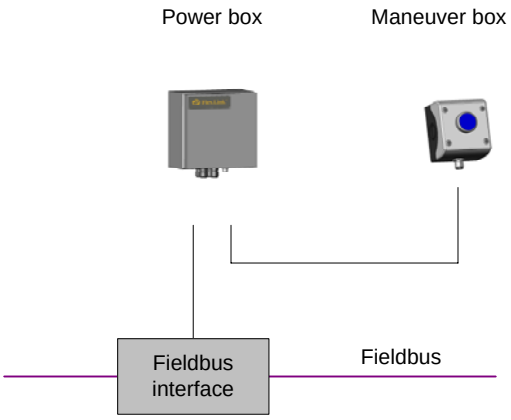
Cross-section: Max. 2.5 mm^2 (with/without ferrule)
Terminal group: X390-1

4.3.2 Maneuver box communication

The Power box does not include any operator interface such as pushbuttons, lamps or displays, but includes an M12-connector for local reset through a local Maneuver box. Signals: Safety OK and Safety rest.

Maneuver unit connections

Type: M12, 4-pin, male, A-code
Connector: X391-1



Fieldbus interface and Maneuver box communication

5. Safety zone engineering

5.1 Creating a parallel safety zone

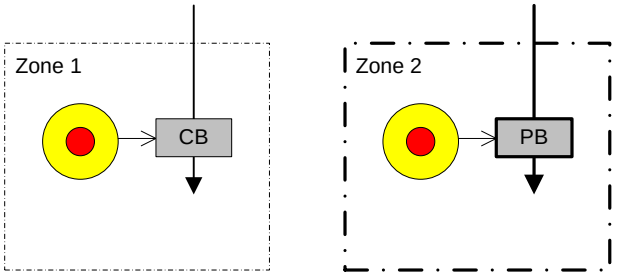
A Power box can be used for creating a safety zone in parallel with other zones.

In picture ”Creating a parallel safety zone”, the Power box of Zone 2 is powered by an external power source, thus is independent of Zone 1's status.

Instructions

Power Zone 2 by an external source. No connection between the safety systems of the two zones is necessary.

Note: Communication signals may be necessary.



Creating a parallel safety zone

5.2 Creating an embedded safety zone

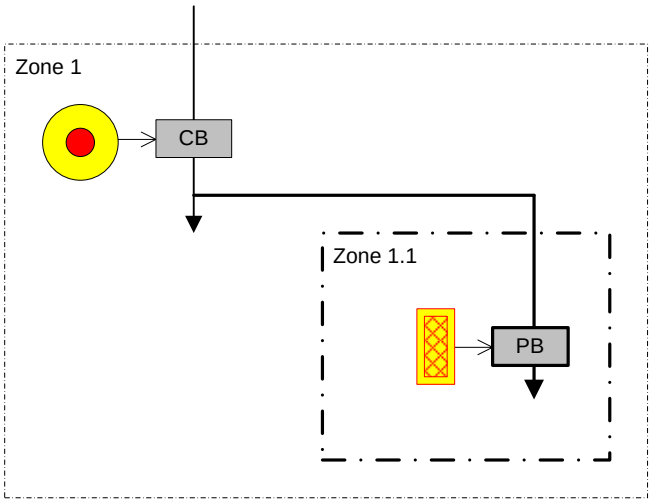
A Power box can be used for creating a safety zone in parallel with other zones.

In picture ”Creating an embedded safety zone” the Power box is powered by the Control box. If the Control box is emergency stopped, the power supply to Zone 1.1 will stop.

Instructions

The Power box must be powered by the Control box. No further safety connection is necessary.

Note: Communication signals may be necessary.



Creating an embedded safety zone

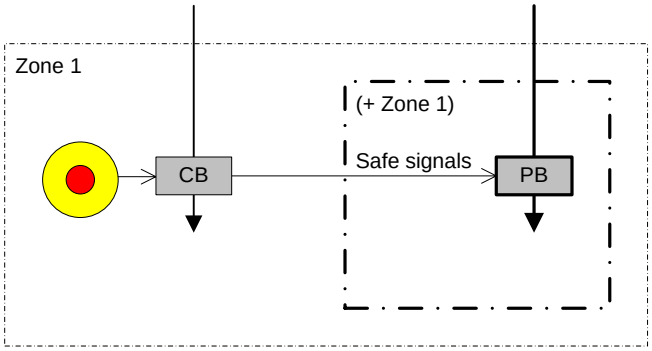
5.3 Expanding electrical power supply

Power-x can be used for providing additional safe power to a zone where the effect of the original box is not sufficient.

By powering the Power box externally and creating a Slave-relationship to the original box, another 16 A is provided the safety zone.

In picture ”Safety zone power supply expansion” the Power box is used for adding a second Power bus of 16 A to Zone 1.

Up to four Power boxes can be assigned as slaves per zone.

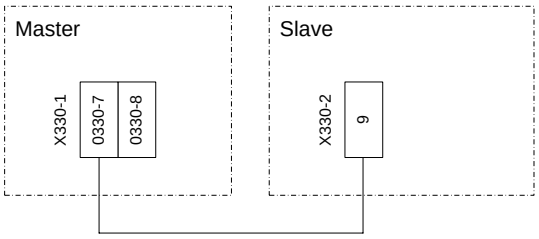


Safety zone power supply expansion

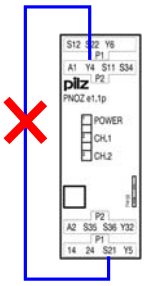
Instructions

1. Connect a safety output of the master box to the safety input of the slave box.
2. Slave: Remove the bridge between Y4 and S21 of safety relay.
3. Create a new bridge between S11 and S34.

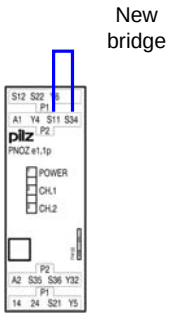
A relationship between master and slave is now established, where the slave box will automatically follow the status of the master. No individual reset of the slave is necessary.



1. Connecting the master output to the slave input



2. Remove bridge between Y4 and S21



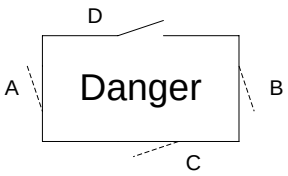
3. Create new bridge between S11 and S34

5.4 Multiple gates in safety category 4

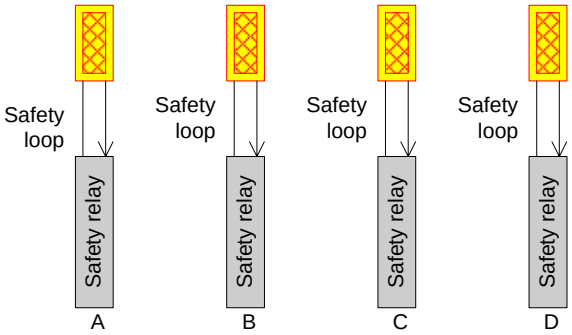
”-x” as in Power-x and Air-x stands for ”extendable” and indicates that these versions can have the number of safety relays extended by the integrator.

Additional safety relays are required for fulfilling safety category 4 when using multiple safety switches as safety category 4 demands short-circuit detection in the safety loop.

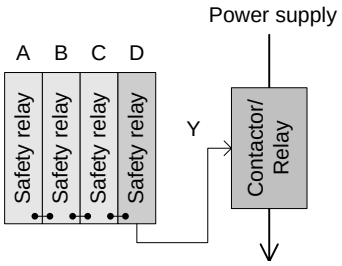
Up to four safety relays can be connected logically in series, where the last relay, the original, is controlling the power supply relay/contactor to the dangerous units.
All relays have their own safety loop with one gate connected.
Opening any gate will stop the power supply in a safe way (category 4, according to EN954-1).



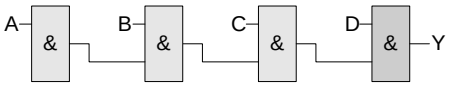
Application topview



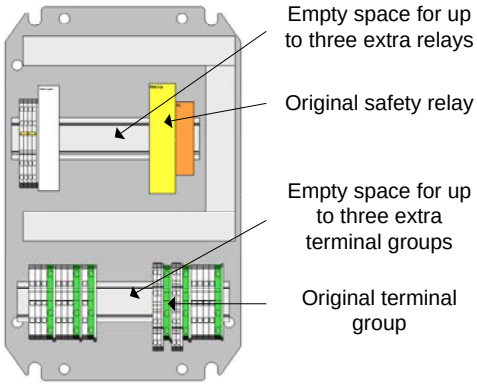
Category 4 individual safety relays



Electiral functional diagram



Safety relay logically connected in series

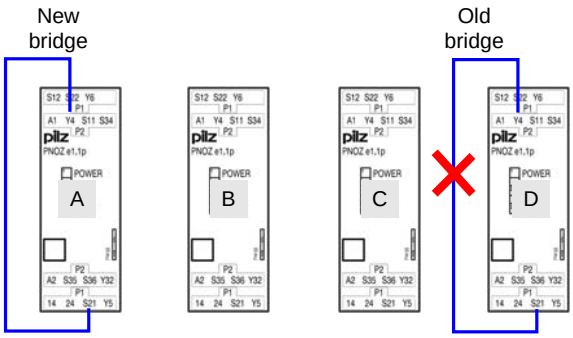


Dedicated empty space

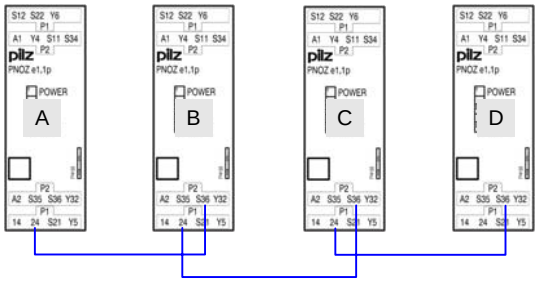
Instructions

The box originally contains one safety relay (in images called ”D”) and its corresponding terminal group for safety loop.
New relays called ”A”, ”B” and ”C” are added plus their terminal groups for safety loops.

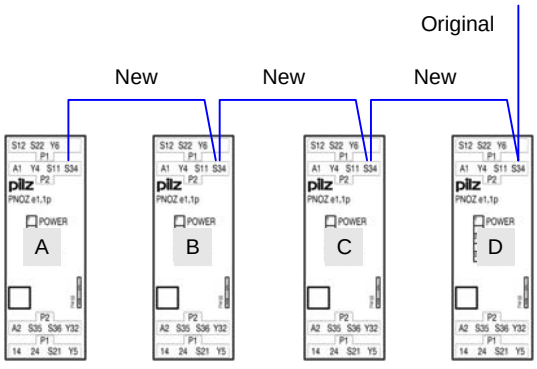
1. For D, remove the bridge between Y4 and S21. Create this bridge for the first relay, A.
2. Connect the safe output to the safe input of the next relay.
3. Bridge the reset signal between S34 of all safety relays.
4. Connect the safety loop of A, B and C to their terminal groups in the same way as D is. See electrical drawings for more information.



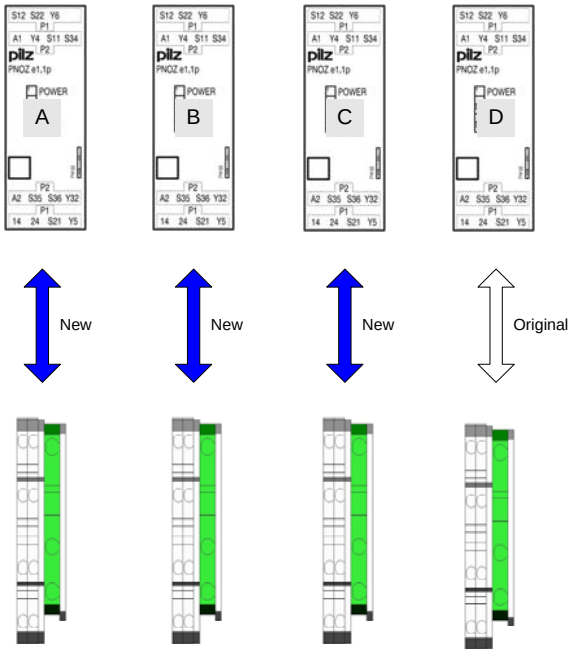
1. Remove the bridge of D and create it for A



2. Connect safe outputs to safe inputs



3. Bridge the reset signal to all relays



4. Connect the safety loop to their terminal groups