



Building Automation

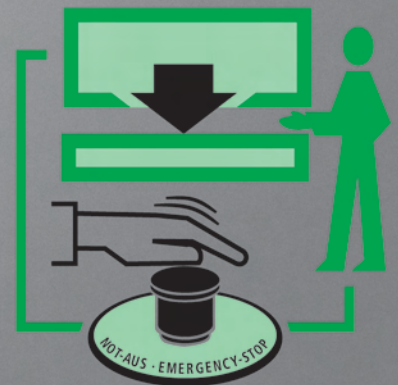
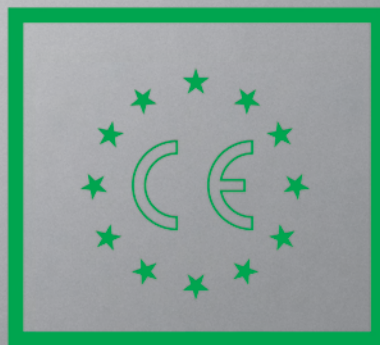
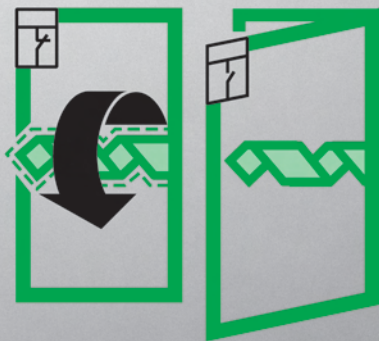
Industrial Automation

Systems

Technical Guide

Safety Applications

Ulrich Trapp



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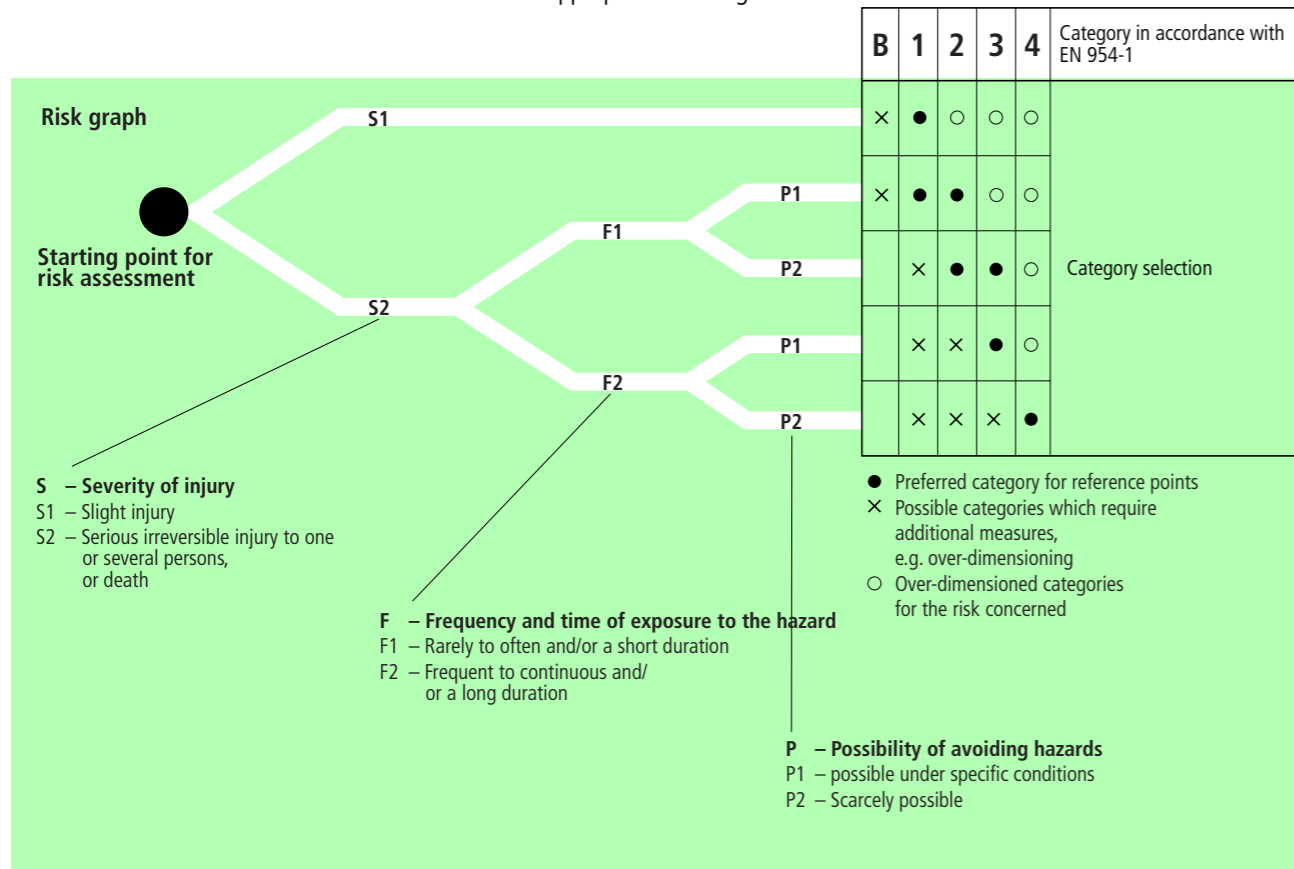
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Risk assessment in accordance with EN 1050 in conjunction with EN 954-1 for safety-related circuits

What happens if the protection fails?

- Estimate the risk with the help of the risk graph.

- Determine the required category.
- Select (from page 4 onwards) the circuit and appropriate controlgear.



Category	Requirements
B	Protective/control systems and components taking into account the operating and ambient temperatures.
1	Additional to "B": Well-tried components and principles that meet the safety requirements
2	Additional to "B": Checking of the safety function by the control system at suitable intervals
3	Additional to "B": Single fault safety and fault detection whenever practicable in accordance with the state of technology
4	Additional to "B": Single fault safety and fault detection or no hazard due to accumulation of faults

You will find further information on "EN 954-1" on page 89.

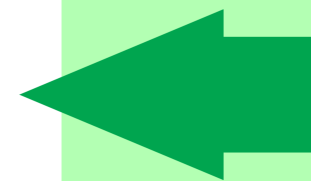
Please observe the "Important Note" on page II

Risk assessment is an important step on the path to safe and standards-compliant machinery. Even before the initial design phase potential hazards of all kinds must be identified.

Minimize risks, not only through design measures but also by making use of technical protective gear.

As soon as machine controls are provided with a safety function, EN 954-1 becomes particularly important.

Part of EN 954-1 deals with simplified risk assessment derived from EN 1050. Furthermore, the standard also provides 5 categories defining the ability of a control system to resist faults.



The opposite page "Risk assessment in accordance with EN 954-1" is a guide to selecting the required category and provides a link to the circuits detailed on page 4 to 77. Select the appropriate category via the risk graph and then find a suitable circuit from page 4 onwards.

Important note:
 The circuit categories shown from page 4 onwards describe the ability of control systems to resist faults. They are based on a Moeller interpretation of the standard EN 954-1. Changes are possible. The circuit diagrams from page 4 onwards are possible solutions in accordance with EN 60 204-1. They have been created by us to help you in your circuit designs, but cannot absolve you from the responsibility of undertaking your own tests, especially regarding their suitability for the intended application.

All the information provided, particularly with regard to environmental and mounting requirements, proper use and foreseeable misuse of machines must be examined in relation to the particular conditions of the individual case. In view of the large number of risk factors beyond our control we are unable to accept any liability for information provided in this guide and for its suitability for specific cases. Liability is expressly excluded insofar as we are not responsible for gross negligence.

The functions of the circuits represented are based on the use of the Moeller products mentioned. The sale of our products is subject to the "General Terms of Delivery for Products and Services of the Electrical Industry" as well as the "Moeller Additional Conditions".

Safety Specifications for Machines and Plants

This guide will help you in

- selecting and engineering safety-related protective devices
- selecting the correct circuit diagram right up to the correct switchgear
- carrying out a risk assessment of the machine control system
- compiling your collection of "compulsory" standard literature
- using the Machinery Directive and relevant standard

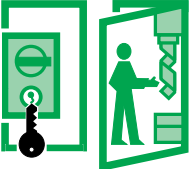




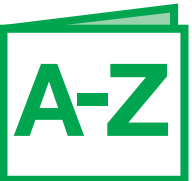
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 Frank Friederiszick
 Wolfgang Nitschky
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 Jürgen Volberg

Simple selection, engineering and application

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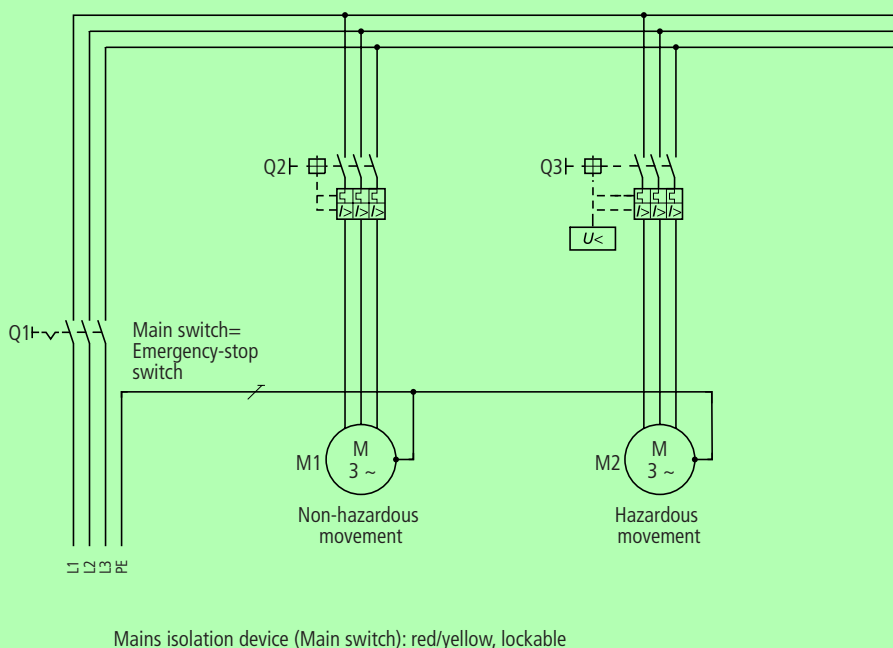
1. Emergency Stop

1.1 In the main circuit

Application:

- For simple drives in which the power disconnecting device (main switch) can be the emergency stop in an emergency situation (Emergency Stop).
- Where immediate disconnection of the power supply does not lead to hazardous conditions (uncontrolled stop – STOP category 0 in accordance with EN 60 204-1).
- Required when hazards to machine or user may occur.

B	1	2	3	4	Category according to EN 954-1
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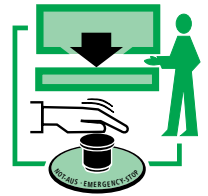
Power disconnecting device with Emergency-stop function

Requirements:

- Emergency stop main switch with red handle on yellow background, stayput function in OFF position.
- Switch disconnector features in accordance with EN 60 947-3, lockable in OFF position.
- Breaking capacity sufficient for the currents of all loads and current of the largest motor in the blocked state.
- Power disconnecting device (main switch) = device for an Emergency-stop in an emergency situation, only if the disconnection of all loads does not lead to hazardous conditions.
- Drives protected with undervoltage releases in order to prevent an automatic restart when the restart command is given. (see also "Preventing restarts" on page 30 to 33)

Features:

- The power supply to the entire system is switched off when the Emergency-stop switch is actuated.



The following safety standards apply to an "Emergency stop in the main circuit":		Page
EN 292	Safety of machinery – General principles for design	87
ISO 13 850/ EN 418	Safety of machinery – Emergency-stop device	94
EN 1037	Safety of machinery – Prevention of unexpected start-up	95
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947

Type	AC-3/400 V	Short-circuit protection device
PKZM0 +RH-PKZO	12.5 kW	No protective device required 16 A: 50 kA 20 A – 25 A from 16 kA/400 V: 50 A gL/gG

Special features: 3-pole motor-protective circuit-breaker with isolating features in accordance with EN 60 947-3, red-yellow door coupling handle, lockable in 0-position with up to 3 padlocks.

Power disconnecting device (main switch) with Emergency-stop function



Type	AC-3/400 V	Short-circuit protection device
T0-.../SVB	4 kW	20 A gL/gG
P1-.../SVB	7.5/13 kW	25/50 A gL/gG
P3-.../SVB	30/37 kW	80/100 A gL/gG

Special features: 3-/4-pole switch disconnecter in accordance with EN 60 947-3, red rotary handle, yellow locking collar, lockable in 0-position with up to 3 padlocks.

Power disconnecting device (main switch) with Emergency-stop function



Type	AC-23/400 V	Short-circuit protection device
P7-...+V-NZM7-SW	up to 250 A	NZM7-... up to NZM10-...
P10-...+V-NZM10-SW	up to 630 A	NZM10-... up to NZM14-...

Special features: 3-/4-pole switch disconnecter, red-yellow door coupling handle, lockable in 0-position with up to 3 padlocks.

Power disconnecting device (main switch) with Emergency-stop function



Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118.

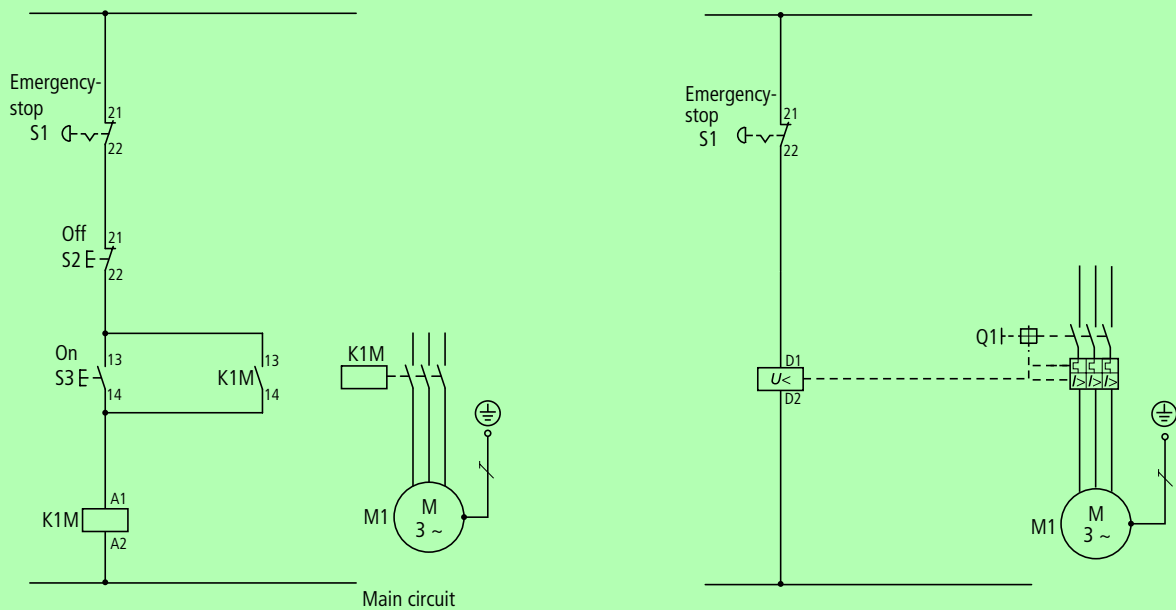
Emergency-Stop

1.2 In the control circuit – for simple drives

Application:

- For simple drives in which the motor contactor/motor-protective circuit-breaker is switched for operation.
- When the Emergency-stop actuator and the supply conductor are not exposed to any particular hazard.
- When immediate disconnection of the power supply does not lead to hazardous conditions (uncontrolled stop – STOP category 0 in accordance with EN 60 204-1).
- Required when hazards to machine or user may occur.

B	1	2	3	4	Category according to EN 954-1
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Emergency-stop with motor contactor switched for operation

Requirements:

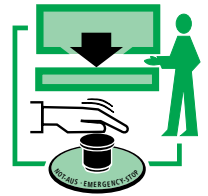
- Emergency-stop device with positive opening operation (EN 60 947-5-1 Appendix K) and function in accordance with ISO 13 850/EN 418.
- Provision of hardwired electro-mechanical components.
- The contactor/motor-protective circuit-breaker must be actuated for operation in order to detect faults.
- Supply conductor must be protected.
- Emergency-stop function must be tested regularly.
- Observe requirements of power supply and protective devices: Chapter 10.1.

Features:

- Design based on well-tried components and principles.
- Connection fault in switching device or non drop-out of K1M: causes loss of safety function.
- Open-circuit leads to immediate disconnection.

Function:

- The operation of the Emergency-stop actuator de-energizes K1M. K1M disconnects the power supply.
- The operation of the Emergency-stop actuator de-energizes the undervoltage release. The main contacts of Q1 are opened via the breaker mechanism.



The following safety standards apply to "Emergency-stop in the control circuit":		Page
EN 292	Safety of machinery – General principles for design	87
ISO 13 850/ EN 418	Safety of machinery – Emergency-stop device	94
EN 954-1	Safety of machinery – Safety-related parts of control systems	89
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947/ISO 13 850/EN 418

Type	AC-15/230 V	Short-circuit protection device
M22-PV	6 A	PKZM0-10, FAZ-B6
FAK	6 A	PKZM0-10, FAZ-B6
Q25(L)PV	4 A	FAZ-B6

Special features: tamper-proof in accordance with ISO 13 850/EN 418,
 ☉ positive opening operation in accordance with EN 60 947-5-1, red mushroom-head push-button, yellow button plate, degree of protection at least \geq IP 65, sealable shroud as accessory.

Emergency-stop actuators



Type	AC-3/400 V	Short-circuit protection device
DILEEM	3	PKZM0-0,25
up to	up to	up to
DILM820	450 kW	1200 A gL/gG for Type "1" coordination

Special features: finger proof and back-of-hand proof (from DILM185 with terminal shroud) in accordance with IEC 536.

Contactors



Type	AC-3/400 V	Short-circuit protection device
PKZM0	up to 12.5 kW	No protective device required 16 A: 50 kA 20 A – 25 A from 16 kA/400 V: 50 A gL/gG
PKZ2	up to 20 kW	No protective device required 25 A – 40 A from 30 kA/400 V: 160 A gL/gG

Special features: With undervoltage release without drop-out delay.
 Tripping not before $0.7 \times U_s$, and no later than $0.35 \times U_s$.

Motor-protective circuit-breaker



Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118

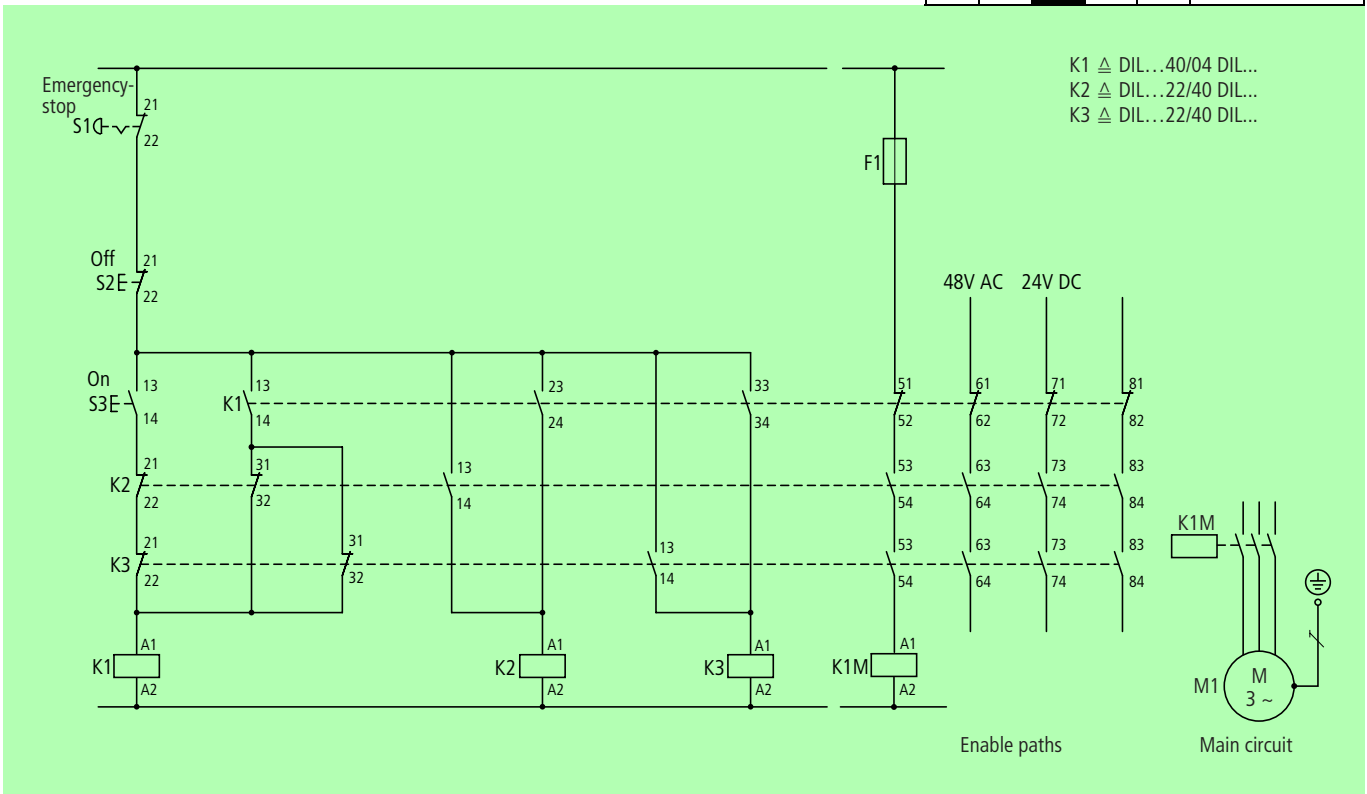
Emergency Stop

In the control circuit – for interrupting several control circuits

Application:

- For extensive control systems in which several circuits must be disconnected.
- When the Emergency-stop actuator and the supply conductor are not exposed to any particular hazard.
- When immediate disconnection of the power supply does not lead to hazardous conditions (uncontrolled stop – STOP category 0 in accordance with EN 60 204-1).
- Required when hazards to machine or user may occur.

B	1	2	3	4	Category according to EN 954-1
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Emergency-stop circuits with 4 enable paths

Requirements:

- Emergency-stop device with positive opening operation (EN 60 947-5-1 Appendix K) and function in accordance with ISO 13 850/EN 418.
- Contactors with positively driven contact elements.
- Provision of hardwired electro-mechanical components.
- The supply conductor to the Emergency-stop actuator must be protected.
- After enabling, hazardous movement must be switched on with a separate Start command.

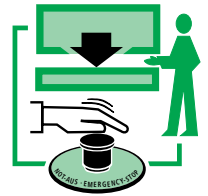
- Emergency-stop function must be tested regularly.
- Observe requirements of power supply and protective devices: Chapter 10.1.

Features:

- Design based on well-tried components and principles.
- Redundant and self-monitored command processing.
- Open-circuit and connection fault in the control cabinet are detected immediately or with the next start command.
- Connection fault in the Emergency-stop actuator or supply cable: Causes loss of safety function.

Function:

When the ON actuator S3 is operated, the break contacts K2 and K3/21-22 ensure that these contactor relays are in their rest position. K1 picks up and by means of its make contacts 23-24 and 33-34 energizes contactors K2 and K3, which are maintained by means of their contacts 13-14. K1 is further maintained by means of its make contact 13-14 until K2 and K3 have picked up and their break contacts have de-energized K1, thus enabling the circuits for the control voltage.



The following safety standards apply to "Emergency-stop in the control circuit":		Page
EN 292	Safety of machinery – General principles for design	87
ISO 13 850/ EN 418	Safety of machinery – Emergency-stop device	94
EN 954-1	Safety of machinery – Safety-related parts of control systems	89
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947/ISO 13 850/EN 418

Type	AC-15/230 V	Short-circuit protection device
M22-PV	6 A	PKZM0-10, FAZ-B6
FAK	6 A	PKZM0-10, FAZ-B6
Q25(L)PV	4 A	FAZ-B6

Special features: tamper-proof in accordance with ISO 13 850/EN 418,
 ☉ positive opening operation in accordance with EN 60 947-5-1, red mushroom-head push-button,
 yellow button plate, degree of protection at least \geq IP 65, sealable shroud as accessory.

Emergency-stop actuators



Type	AC-15/230 V	Short-circuit protection device
DILER(DC)	6 A	PKZM0-4
DILR(AC + DC)	6 A	PKZM0-4

Special features: positively driven contact elements (not with early-make contact and late-break contact),
 finger proof and back-of-hand proof in accordance with IEC 536.

Contactor relays



Type	AC-15/230 V	Short-circuit protection device
40(04)DILE	4 A	PKZM0-4
40(04)DIL	6 A	PKZM0-4

Special features: positively driven contact elements (not with early-make contact and late-break contact),
 finger proof and back-of-hand proof in accordance with IEC 536.

Auxiliary contact modules



Type	AC-3/400 V	Short-circuit protection device for 220/230 V auxiliary contacts
DIL00M up to DILM820/22	4 kW up to 450 kW	FAZ-C4

Special features: finger proof and back-of-hand proof (from DILM185 with terminal shroud) in accordance with IEC 536.

Contactors



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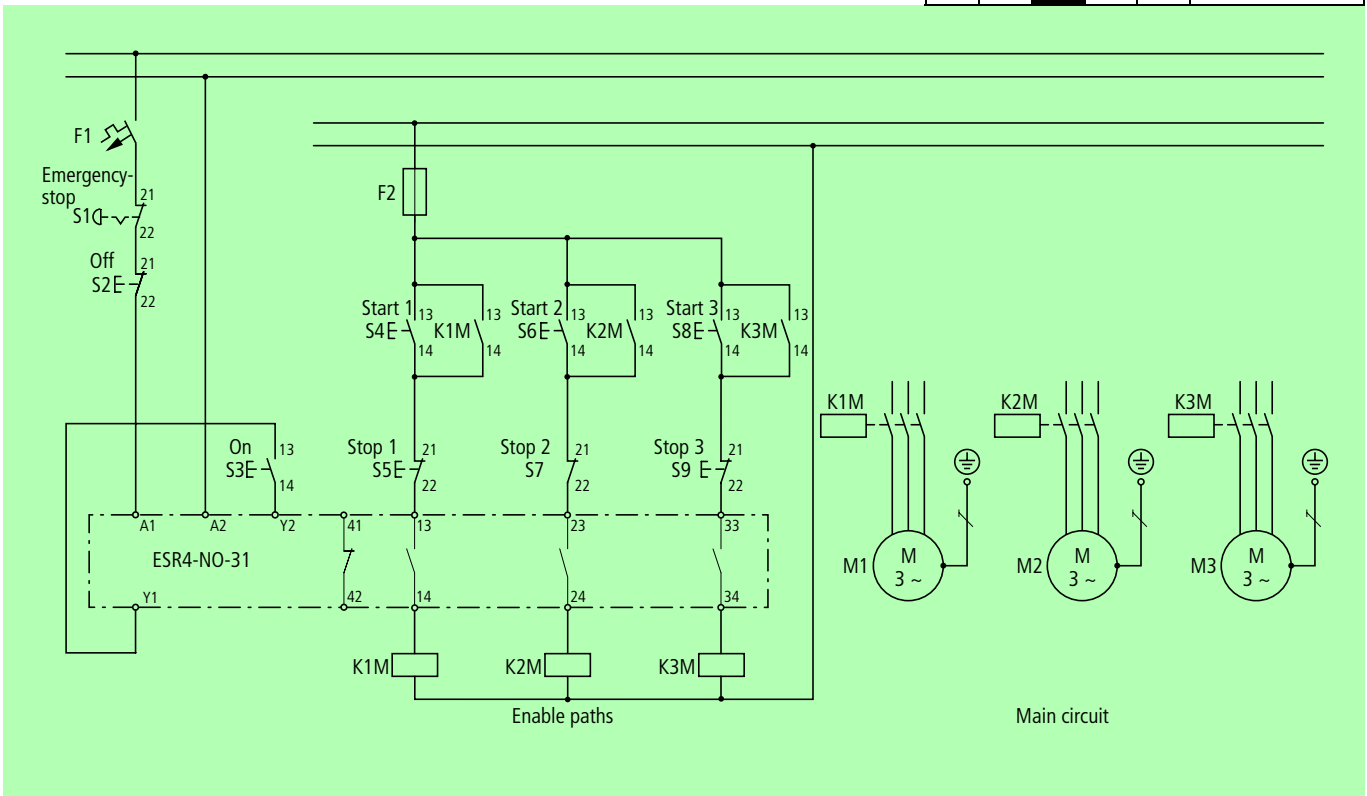
Emergency Stop

In the control circuit – for interrupting several control circuits

Application:

- For extensive control systems in which several circuits must be disconnected.
- When immediate disconnection of the power supply does not lead to hazardous conditions (uncontrolled stop – STOP category 0 in accordance with EN 60 204-1).
- Required when hazards to machine or user may occur.

B	1	2	3	4	Category according to EN 954-1
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Emergency stop with safety relays (single-channel)

Requirements:

- Emergency-stop device with positive opening operation (EN 60 947-5-1 Appendix K) and function in accordance with ISO 13 850/EN 418.
- Safety relays with positive opening operation contacts.
- Provision of hardwired electro-mechanical components.
- The Emergency-stop actuator may not be subjected to any sources of danger.
- The supply cable to the Emergency-stop actuator must be protected.

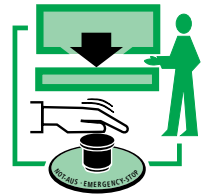
- After enabling, hazardous movement must be switched on with a separate "Start" command.
- The Emergency-stop function must be tested regularly.
- Observe requirements of power supply and protective devices: Chapter 10.1.

Features:

- Design based on well-tried components and principles.
- Redundant and self-monitored command processing.
- Connection fault in the Emergency-stop actuator for an emergency stop or in an incomer: Causes loss of safety function.

Function:

After the supply voltage is applied to the safety relay (connection A1-A2), the "Power" LED indicates the readiness to activate the enable path. When the ON actuator S3 is operated, the ESR-internal break contacts K1 and K2 ensure that the internal enable relays are in their rest position. The enable relays (K1 and K2) pick up and are maintained via their upstream make contacts. This state is indicated by the "K1, K2" LED. The signal path (connections 41-42) is opened and the three enable paths (connections 13-14, 23-24, 33-34) are closed. The contactors K1M, K2M and K3M can now be switched using their respective start commands S4, S6 and S8.



The following safety standards apply to "Emergency-stop in the control circuit"		Page
EN 292	Safety of machinery – General principles for design	87
ISO 13 850/ EN 418	Safety of machinery – Emergency-stop device	94
EN 954-1	Safety of machinery – Safety-related parts of control systems	89
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–
EN 61 810-1	Electro-mechanical switching relays	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947, ISO 13 850/EN 418, EN 61 810-1

Type	DC-13/24 V	Short-circuit protection device
M22-PV	6 A	PKZM0-10, FAZ-B6
FAK	6 A	PKZM0-10, FAZ-B6
Q25(L)PV	3 A	FAZ-B6

Special features: tamper-proof in accordance with ISO 13 850 /EN 418

☉ positive opening operation in accordance with EN 60 947-5-1, red mushroom-head push-button, yellow button plate, degree of protection at least \geq IP 65, sealable shroud as accessory.

Emergency-stop button



Type	Enable/signal contacts AC-15/230 V	Short-circuit protection device
ESR4-NO-31	6 A ¹⁾	6 A gG

Special features: positively driven contact elements, approved by the BG/EU design testing.

¹⁾ max. total current of all current paths = 12 A

Safety relay



Type	AC-3/400 V	Short-circuit protection device for 220/230 V auxiliary contacts
DIL00M/11 up to DILM820/22	4 kW up to 450 kW	FAZ-C4

Special features: finger proof and back-of-hand proof (from DILM185 with terminal shroud) in accordance with IEC 536.

Contactors



Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118.

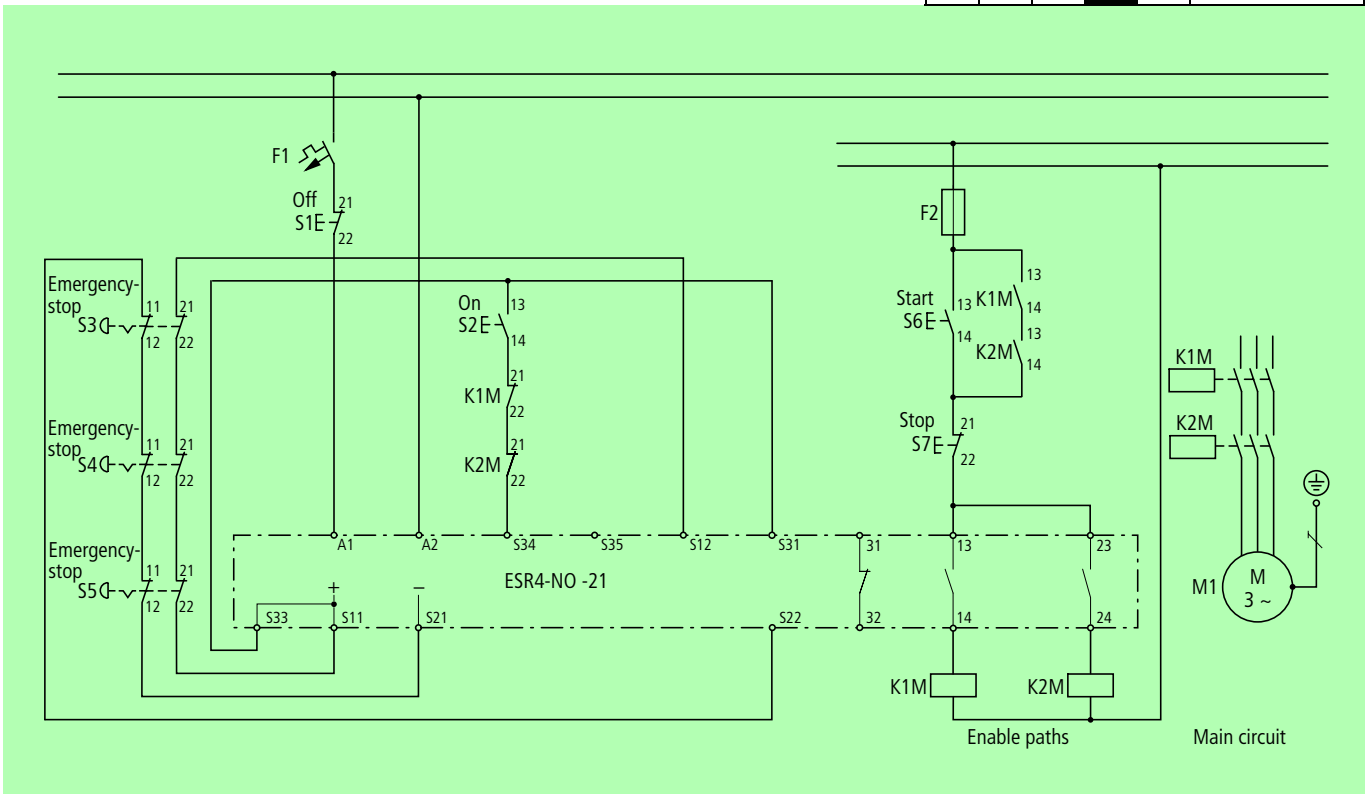
Emergency Stop

In the control circuit – for shut-down of several devices in an

Application:

- When the device has to be shut-down (Emergency-stop actuator) in an emergency and the incomer is subject to particular danger.
- When immediate disconnection of the power supply does not lead to hazardous conditions (uncontrolled stop – STOP category 0 in accordance with EN 60 204-1).
- Required when hazards to machine or user may occur.

B	1	2	3	4	Category according to EN 954-1
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Shut-down in an emergency with safety relays (two channel)

Requirements:

- Emergency-stop device with positive opening operation (EN 60 947-5-1 Appendix K) and function in accordance with ISO 13 850/EN 418.
- Safety relays with positive opening operation contacts.
- Provision of hardwired electro-mechanical components.
- After enabling, hazardous movement must be switched on with a separate Start command.
- The Emergency-stop function must be tested regularly.
- Observe requirements of power supply and protective devices: Chapter 10.1.

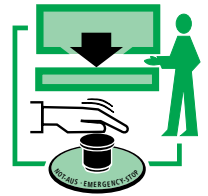
Features:

- Design based on well-tried components and principles.
- Redundant and self-monitored command processing
- Self-monitored actuated control circuit device.
- ON actuator monitoring
- Monitoring redundant contactor/safety valves via feedback circuit (see Page 81).

Function:

After the supply voltage is applied to the safety relay (connection A1-A2), the "Power" LED indicates the readiness to activate the enable path. When the ON actuator S2 is operated, the break contacts of the K1M, K2M feedback circuit ensure that the contactors are in their rest position. When this state is achieved, the safety relay is actuated by the falling edge of the control

logic on connection S34 (the ON-actuator must be pressed and released). The control logic monitors the ON-actuator and tests the rest position of the ESR-internal enable relays K1 and K2. The enable relays pick-up and are maintained via their upstream make contacts. This state is indicated by the "K1" as well as the "K2" LED. The signal path (connection 31-32) is opened. The contactors K1M, K2M can now be switched via the S6 start command.



The following safety standards apply to "Emergency-stop in the control circuit":		Page
EN 292	Safety of machinery – General principles for design	87
ISO 13 850/ EN 418	Safety of machinery – Emergency-stop device	94
EN 954-1	Safety of machinery – Safety-related parts of control systems	89
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–
EN 61 810-1	Electro-mechanical switching relays	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947, ISO 13 850/EN 418, EN 61 810-1

Type	DC-13/24 V	Short-circuit protection device
M22-PV	6 A	PKZM0-10, FAZ-B6
FAK	6 A	PKZM0-10, FAZ-B6
Q25(L)PV	3 A	FAZ-B6

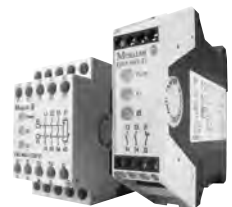
Emergency-stop button



Special features: tamper-proof in accordance with ISO 13 850/EN 418,
 ☉ positive opening operation in accordance with EN 60 947-5-1, red mushroom-head push-button, yellow button plate, degree of protection at least \geq IP 65, sealable shroud as accessory.

Type	Enable/signal contacts AC-15/230 V	Short-circuit protection device
ESR3-NO-31 (230V)	6 A ²⁾	6 A gG
ESR4-NO-21 ¹⁾	6 A ³⁾	6 A gG

Safety relay



Special features: positively driven contact elements, approved by the BG/EU design testing.

¹⁾ see circuit example

²⁾ max. total current of all current paths = 18 A

³⁾ max. total current of all current paths = 12 A

Type	AC-3/400 V	Short-circuit protection device for 220/230V auxiliary contact
DIL00M/11 up to DILM820/22	4 kW up to 450 kW	FAZ-C4

Contactors



Special features: finger proof and back-of-hand proof (from DILM185 with terminal shroud) in accordance with IEC 536.

Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118

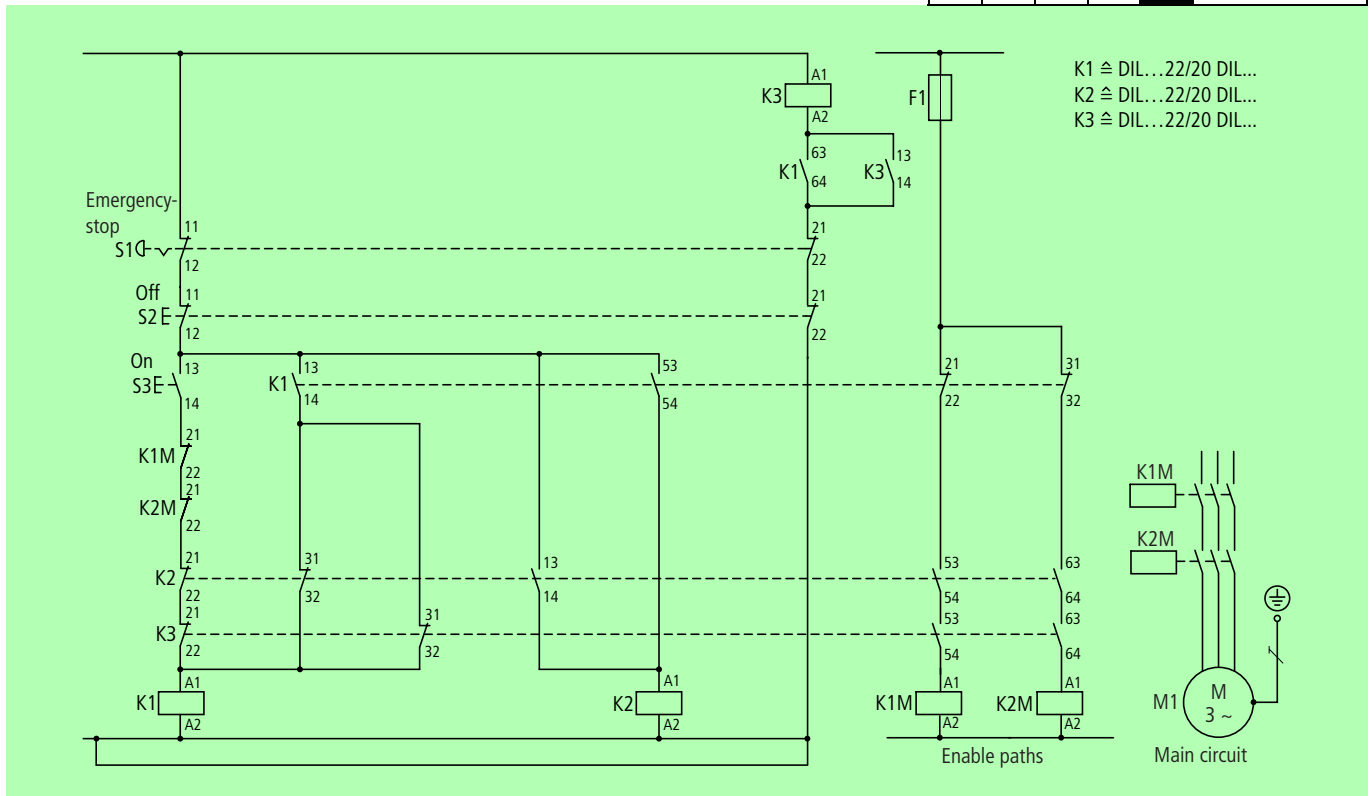
Emergency Stop

In the control circuit – monitoring of supply faults

Application:

- When the Emergency-stop actuator and the supply conductor are exposed to particular hazards.
- When immediate disconnection of the power supply does not lead to hazardous conditions (uncontrolled stop – STOP category 0 in accordance with EN 60 204-1).
- Required when hazards to machine or user may occur.

B	1	2	3	4	Category according to EN 954-1
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Emergency-stop with fault-monitored supply conductor

Requirements:

- Emergency-stop device with positive opening operation (EN 60 947-5-1) and function in accordance with ISO 13 850/EN 418.
- Contactors with positively driven contact elements.
- Provision of hardwired electro-mechanical components.
- Ensure correct mounting and assembly of switching devices during the installation and wiring.
- Observe the order of wiring in the circuit diagram from left to right and from top to bottom.
- Power supply from the left.
- The power supply must not be looped downstream to other circuits/components.

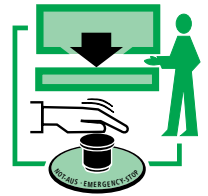
- Design the reference potential as a ring.
- Observe requirements of power supply and protective devices: Chapter 10.1.

Features:

- Design based on well-tried components and principles.
- Control circuits, supply cables and command processing redundant and self-monitored.
- Open-circuit and connection faults are detected immediately or with the next start command.
- Increasing the number of the enable paths or monitoring of redundant contactor relays via feedback circuit (see page 81).

Function:

When the ON actuator S3 is operated, the break contacts K2 and K3/21-22 ensure that these contactor relays are in their rest position. K1 picks up and by means of its make contacts 53-54 and 63-64 energizes contactors K2 and K3, which are maintained by means of their contacts 13-14. K1 is further maintained by means of its make contact 13-14 until K2 and K3 have picked up and their break contacts have de-energized K1, thus enabling the circuits for the control voltage.



The following safety standards apply to "Emergency-stop in the control circuit":		Page
EN 292	Safety of machinery – General principles for design	87
ISO 13 850/ EN 418	Safety of machinery – Emergency-stop device	94
EN 954-1	Safety of machinery – Safety-related parts of control systems	89
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947, ISO 13 850/EN 418

Type	AC-15/230 V	Short-circuit protection device
M22-PV	6 A	PKZM0-10, FAZ-B6
FAK	6 A	PKZM0-10, FAZ-B6
Q25(L)PV	4 A	FAZ-B6

Special features: tamper-proof in accordance with ISO 13 850/EN 418,
 ☉ positive opening operation in accordance with EN 60 947-5-1, red mushroom-head push-button,
 yellow button plate, degree of protection at least \geq IP 65, sealable shroud as accessory.

Emergency-stop actuators



Type	DC-15/230 V	Short-circuit protection device
DILER(DC)	6 A	PKZM0-4
DILR(AC+DC)	6 A	PKZM0-4

Special features: positively driven contact elements (not with early-make contact and late-break contact),
 finger proof and back-of-hand proof in accordance with IEC 536.

Contactor relays



Type	AC-15/230 V	Short-circuit protection device
40(04)DIL	6 A	PKZM 0-4

Special features: positively driven contact elements (not with early-make contact and late-break contact),
 finger proof and back-of-hand proof in accordance with IEC 536.

Auxiliary contact modules



Type	AC-3/400 V	Short-circuit protection device for 220/230 V auxiliary contacts
DIL00M/11 up to DILM820/22	4 kW up to 450 kW	FAZ-C4

Special features: finger proof and back-of-hand proof (from DILM185 with terminal shroud) in accordance with IEC 536.

Contactors



Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118.

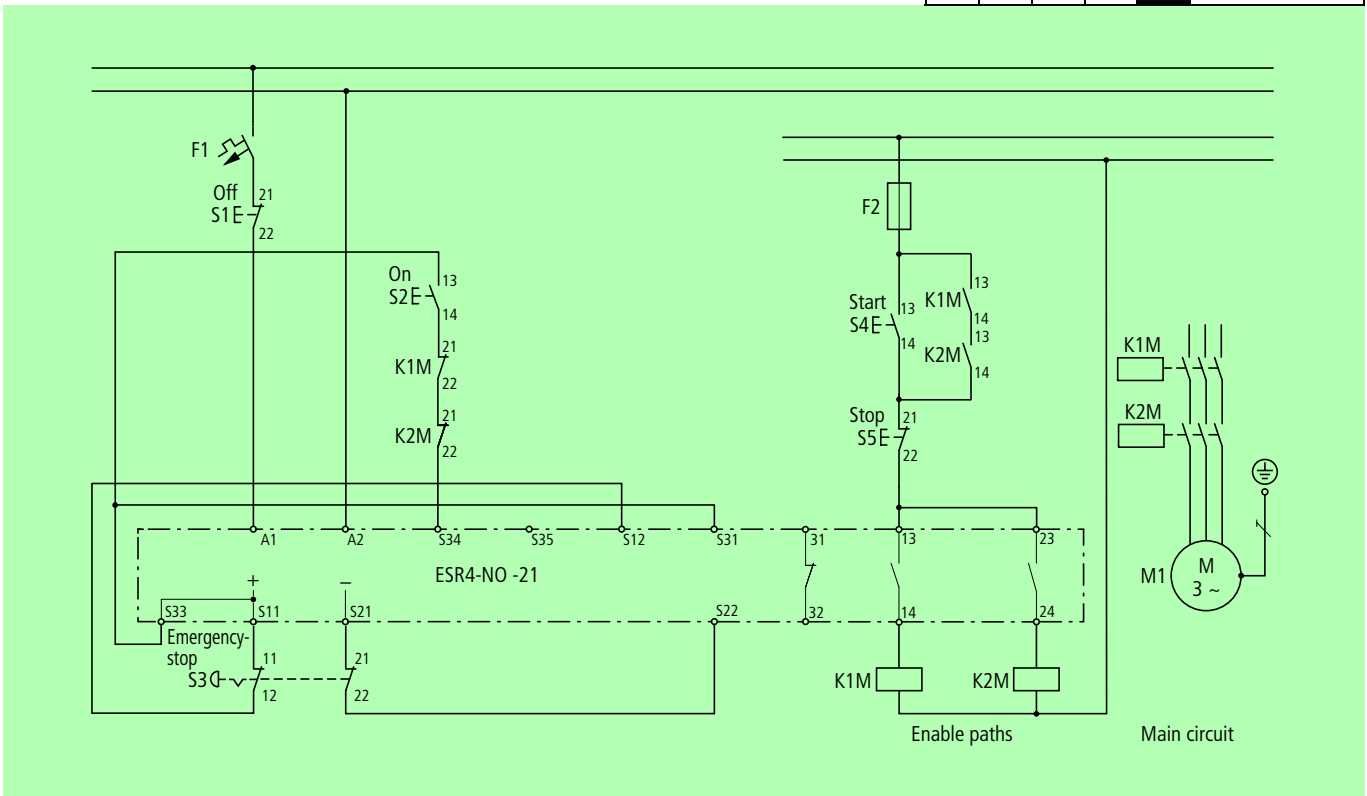
Emergency Stop

In the control circuit – monitoring of supply faults

Application:

- When the device has to be shut-down (Emergency-stop actuator) in an emergency and the incomer is subject to particular danger.
- When immediate disconnection of the power supply does not lead to hazardous conditions (uncontrolled stop – STOP category 0 in accordance with EN 60 204-1).
- Required when hazards to machine or user may occur.

B	1	2	3	4	Category according to EN 954-1
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Shut-down in emergency with safety relays (dual-channel, fault-monitored)

Requirements:

- Emergency-stop device with positive opening operation (EN 60 947-5-1 Appendix K) and function in accordance with ISO 13 850/EN 418.
- Safety relays with positive opening operation contacts.
- Contactors with positively driven contact elements.
- Provision of hardwired electro-mechanical components.
- After enabling, hazardous movement must be switched on with a separate Start command.
- Observe requirements of power supply and protective devices: Chapter 10.1.

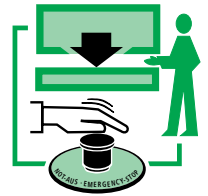
Features:

- Design based on well-tried components and principles.
- Control circuits, supply cables and command processing redundant and self-monitored.
- Open-circuit and connection faults are detected immediately or with the next start command.
- ON actuator monitoring
- Increasing the number of enable paths with an increase in the number of contacts is possible (e. g. with ESR4-NE-42, see Page 26).
- Monitoring of redundant contactor relays/safety valves via feedback circuit (see page 81).

Function:

After the supply voltage is applied to the

safety relay (connection A1-A2), the "Power" LED indicates the readiness to activate the enable path. When the ON actuator S2 is operated, the break contacts of the K1M, K2M feedback circuit ensure that the contactors are in their rest position. When this state is achieved, the safety relay is actuated by the falling edge of the control logic on connection S34 (the ON-actuator must be pressed and released). The control logic monitors the ON-actuator and tests the rest position of the ESR-internal enable relays K1 and K2. The enable relays pick-up and are maintained via their upstream make contacts. This state is indicated by the "K1" as well as the "K2" LED. The signal path (connection 31-32) is opened. The contactors K1M and K2M can now pick up via the S4 Start command via both of the enable relays (connection 13-14 and 23-24).



The following safety standards apply to "Emergency-stop) in the control circuit":		Page
EN 292	Safety of machinery – General principles for design	87
ISO 13 850/ EN 418	Safety of machinery – Emergency-stop device	94
EN 954-1	Safety of machinery – Safety-related parts of control systems	89
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–
EN 61 810-1	Electro-mechanical switching relays	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947, ISO 13 850/EN 418, EN 61 810-1

Type	DC-13/24 V	Short-circuit protection device
M22-PV	6 A	PKZM0-10, FAZ-B6
FAK	6 A	PKZM0-10, FAZ-B6
Q 25(L)PV	3 A	FAZ-B6

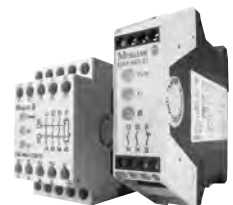
Emergency-stop button



Special features: tamper-proof in accordance with ISO 850/EN 213, 418⊕ positive opening operation in accordance with EN 60 947-5-1 Appendix K, red mushroom-head push-button, yellow button plate, degree of protection at least \geq IP 65, sealable shroud as accessory.

Type	Enable/signal contacts AC-15/230 V	Short-circuit protection device
ESR3-NO-31 (230V)	6 A ²⁾	6 A gG
ESR4-NO-21 ¹⁾	6 A ³⁾	6 A gG

Safety relay



Special features: positively driven contact elements, approved by the BG/EU design testing.

¹⁾ see circuit example

²⁾ max. total current of all current paths = 18 A

³⁾ max. total current of all current paths = 12 A

Type	AC-3/400 V	Short-circuit protection device for 220/230 V auxiliary contacts
DIL00M/11 up to DILM820/22	4 kW up to 450 kW	FAZ-C4

Contactors



Special features: finger proof and back-of-hand proof (from DILM185 with terminal shroud) in accordance with IEC 536.

Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118.

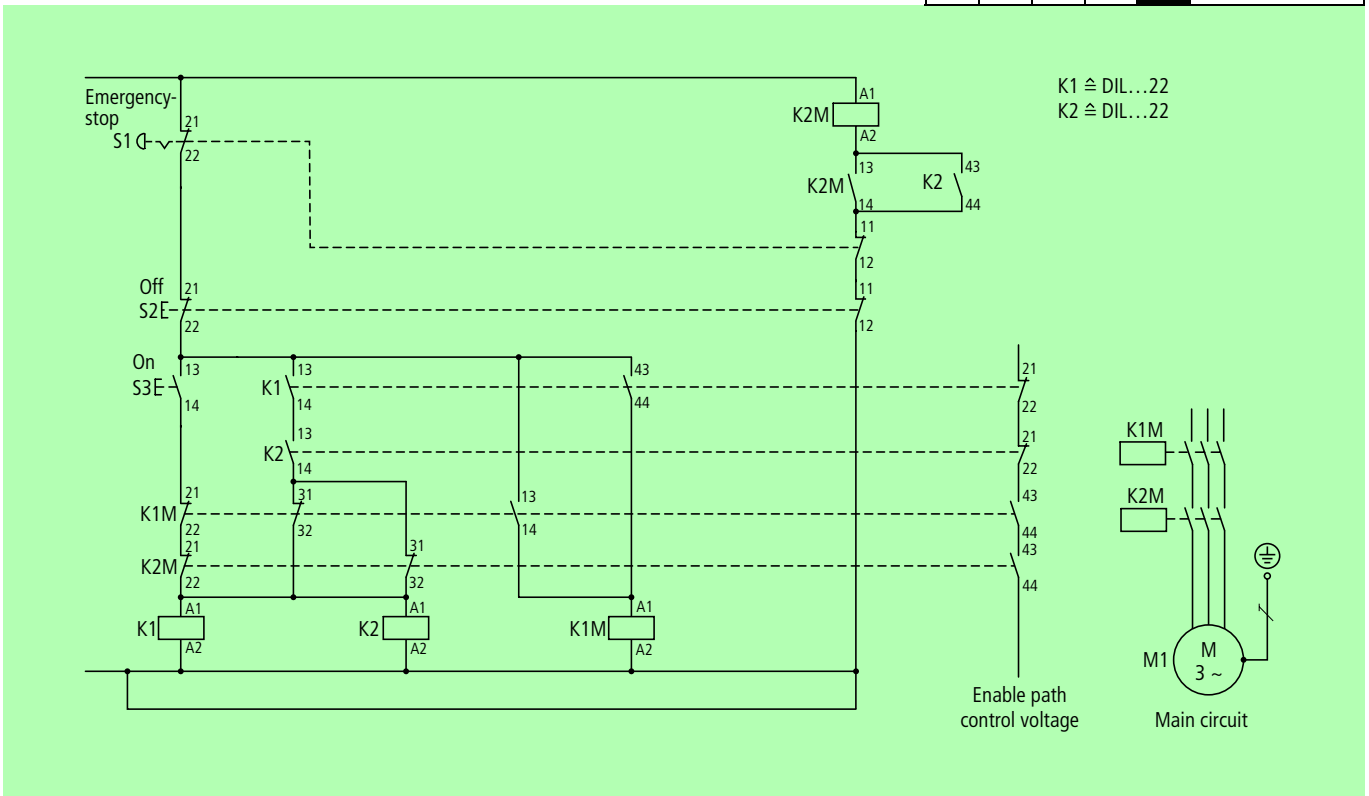
Emergency Stop

In the control circuit – redundant up to the power section

Application:

- Where redundancy up to the power section is required on the basis of a risk assessment.
- When the Emergency-stop actuator and the supply conductor are exposed to particular hazards.
- When immediate disconnection of the power supply does not lead to hazardous conditions (uncontrolled stop – STOP category 0 in accordance with EN 60 204-1).
- Required when hazards to machine or user may occur.

B	1	2	3	4	Category according to EN 954-1
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Emergency-stop circuit redundant and self-monitored up to the power section

Requirements:

- Emergency-stop device with positive opening operation (EN 60 947-5-1 Appendix K) and function in accordance with ISO 13 850/EN 418.
- Contactors with positively driven contact elements.
- Provision of hardwired electro-mechanical components.
- Ensure correct mounting and assembly of switching devices during the installation and wiring.
- Observe the order of wiring in the circuit diagram from left to right and from top to bottom.
- Power supply from the left.
- The power supply must not be looped downstream to other circuits/components.
- Design the reference potential as a ring.

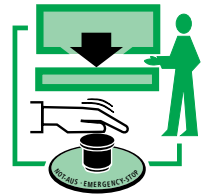
- Observe requirements of power supply and protective devices: Chapter 10.1.

Features:

- Redundant and self-monitoring command processing from the command input up to the power section.
- Design based on well-tried components and principles.
- Non drop-out of contactor relays detected reliably.
- Open-circuit and connection faults are detected immediately or with the next start command.

Function:

When the ON actuator S3 is operated, the break contacts K1M and K2M/21-22 ensure that these contactor relays are in the rest position. K1 and K2 pick up and by means of their make contacts 43-44 energize contactor relays K1M and K2M which thus enable the safety-related functions. K1M and K2M are maintained by means of their make contacts 13-14. Furthermore, K1 and K2 are maintained until K1M and K2M have picked up. If K1 or K2 do not drop out correctly, K1M or K2M are maintained and the fault is detected with the next start operation via S3.



The following safety standards apply to "Emergency-stop in the control circuit":		Page
EN 292	Safety of machinery – General principles for design	87
ISO 13 850/ EN 418	Safety of machinery – Emergency-stop device	94
EN 954-1	Safety of machinery – Safety-related parts of control systems	89
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947, ISO 13 850/EN 418

Type	AC-15/230 V	Short-circuit protection device
M22-PV	6 A	PKZM0-10, FAZ-B6
FAK	6 A	PKZM0-10, FAZ-B6
Q25(L)PV	4 A	FAZ-B6

Special features: tamper-proof in accordance with ISO 13 850/EN 418,
 ☉ positive opening operation in accordance with EN 60 947-5-1, red mushroom-head push-button, yellow button plate, degree of protection at least \geq IP 65, sealable shroud as accessory.

Emergency-stop actuators



Type	AC-15/230 V	Short-circuit protection device
DILR	6 A	PKZM0-4

Special features: positively driven contact elements (not with early-make contact and late-break contact), finger proof and back-of-hand proof in accordance with IEC 536.

Contactor relays



Type	AC-3/400 V	Short-circuit protection device for 220/230 V auxiliary contacts
DIL00M/22	4 kW	FAZ-C4

Special features: positively driven contact elements (not with early-make contact and late-break contact), finger proof and back-of-hand proof in accordance with IEC 536.

Contactors



Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118.

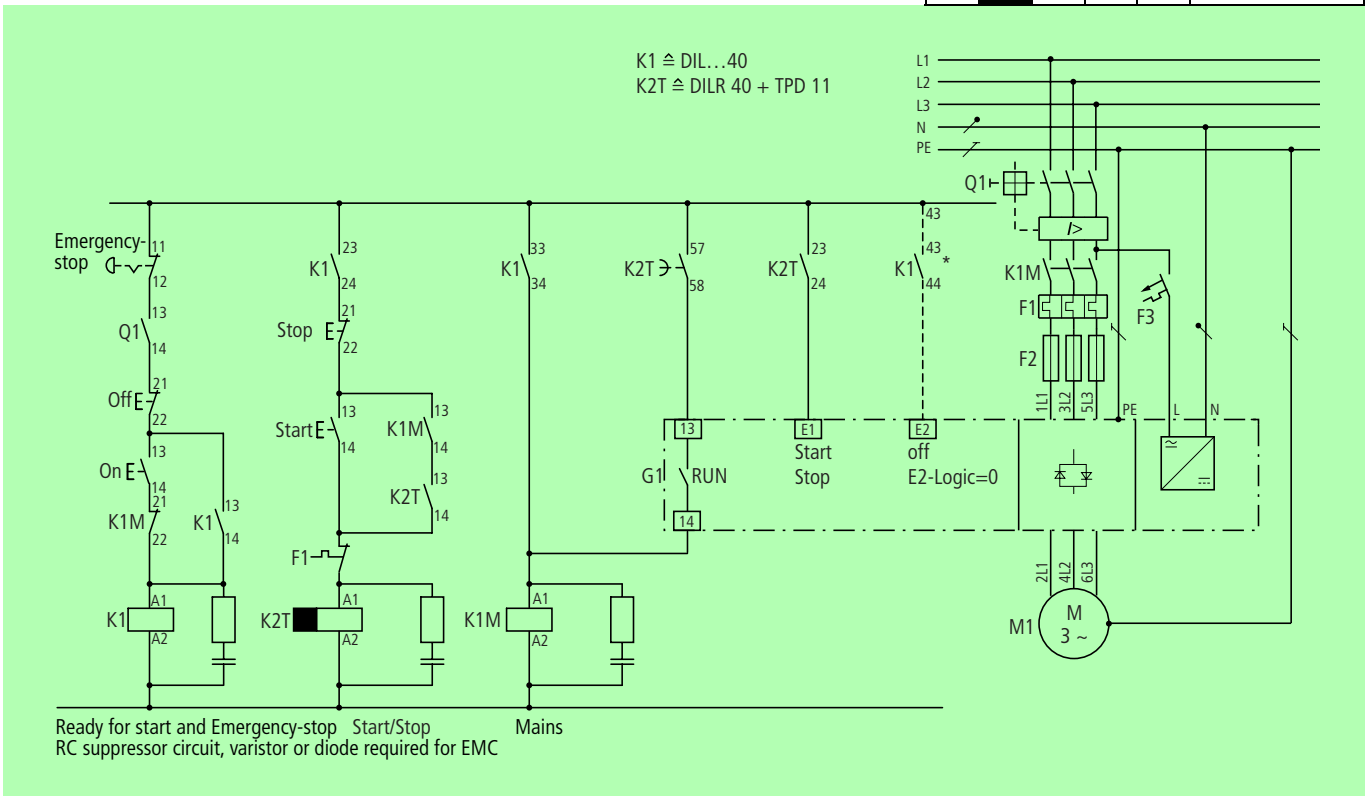
Emergency Stop

1.3 With electronically controlled drives (Soft starter)

Application:

- When uncontrolled coasting of the machine may cause hazardous conditions after the Emergency-stop: controlled stop (STOP category 1 in accordance with EN 60 204-1).
- Required if hazards to machines with electronically controlled drives may occur.

B	1	2	3	4	Category according to EN 954-1
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Emergency-stop with soft starter DM4

Requirements:

- Emergency-stop device with positive opening operation (EN 60 947-5-1 Appendix K) and function in accordance with ISO 13 850/EN 418.
- Provision of hardwired electro-mechanical components.
- Supply conductor to the Emergency-stop actuator must be protected.
- Separation of power supply via mains contactor.
- Delay time of the timing relay slightly longer than the stop time of the soft starter.
- Emergency-stop function must be tested regularly.

Features:

- When contact K1 (*) present: immediate disconnection of power supply (STOP category 0).
- When contact K1 (*) not present: Shut-down of the mains contactor at stand still (STOP category 1). Delayed disconnection via a programmed ramp.

Function:

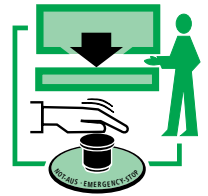
When the ON actuator is operated, K1 picks up and is maintained. K1 energizes the mains contactor K1M. The drive is "ready to start". When the START actuator is operated, K2T picks up and is maintained. K2T starts the drive via terminal E1. The contact G1 (Run state indicator: RUN) closes.

When the OFF actuator is operated, K2T drops out. The START command is removed from terminal E1. The drive decelerates to

ZERO on the ramp. The K1M mains contactor remains switched on and is switched off by pressing the OFF actuator.

When the **Emergency-stop actuator** is operated, K1 and K2T are disconnected. The drive decelerates to ZERO on the ramp. The mains contactor is switched off at stand still via the contact G1 (Run state indicator: RUN). The time delayed contacts of K2T monitor the shut down of the run state indicator of G1. The delay time of K2T must be longer than the Stop time setting.

If the E2 terminal is actuated via K1 (*), during an **Emergency-stop actuation**, the output of the soft starter is immediately inhibited and the run state indicator G1 is switched off. Mains contactor K1M immediately drops out. The drive runs out.



The following safety standards apply to "Emergency-stop in the control circuit":		Page
EN 292	Safety of machinery – General principles for design	87
ISO 13 850/ EN 418	Safety of machinery – Emergency-stop device	94
EN 954-1	Safety of machinery – Safety-related parts of control systems	89
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947, ISO 13 850/EN 418

Type	AC-15/230 V	Short-circuit protection device
M22-PV	6 A	PKZM0-6, FAZ-B6
FAK	6 A	PKZM0-6, FAZ-B6
Q25(L)PV	4 A	FAZ-B6

Special features: tamper-proof in accordance with ISO 13 850/EN 418,
 ☉ positive opening operation in accordance with EN 60 947-5-1, red mushroom-head push-button, yellow button plate, degree of protection at least \geq IP 65, sealable shroud as accessory.

Type	AC-15/230 V	Short-circuit protection device
DILER	6 A	PKZM0-4
DILR	6 A	PKZM0-4

Special features: positively driven contact elements (not with early-make contact and late-break contact), finger proof and back-of-hand proof in accordance with IEC 536.

Type	AC-15/230 V	Short-circuit protection device
TPD11DIL	4 A	PKZM0-2,4

Special features: adjustable time ranges, positively driven contact elements.

Type	AC-15/230 V	Short-circuit protection device
40(04)DILE	4 A	PKZM0-4
40(04)DIL	6 A	PKZM0-4

Special features: positively driven contact elements (not with early-make contact and late-break contact), finger proof and back-of-hand proof in accordance with IEC 536.

Type	AC-3/400 V	Short-circuit protection device for 220/230V auxiliary contact
DIL00M up to DILM820/22	4 kW up to 450 kW	FAZ-C4

Special features: finger proof and back-of-hand proof (from DILM185 with terminal shroud) in accordance with IEC 536.

Note: Circuits with STOP category 1 in accordance to EN 60 204-1 can be implemented with all Moeller DM4 soft starters.
 The function of terminal E2 must be programmed (see AWB 8250-1341 manual).

Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118.

Emergency-stop actuators



Contactor relays



Pneumatic timer module



Auxiliary contact modules



Contactors



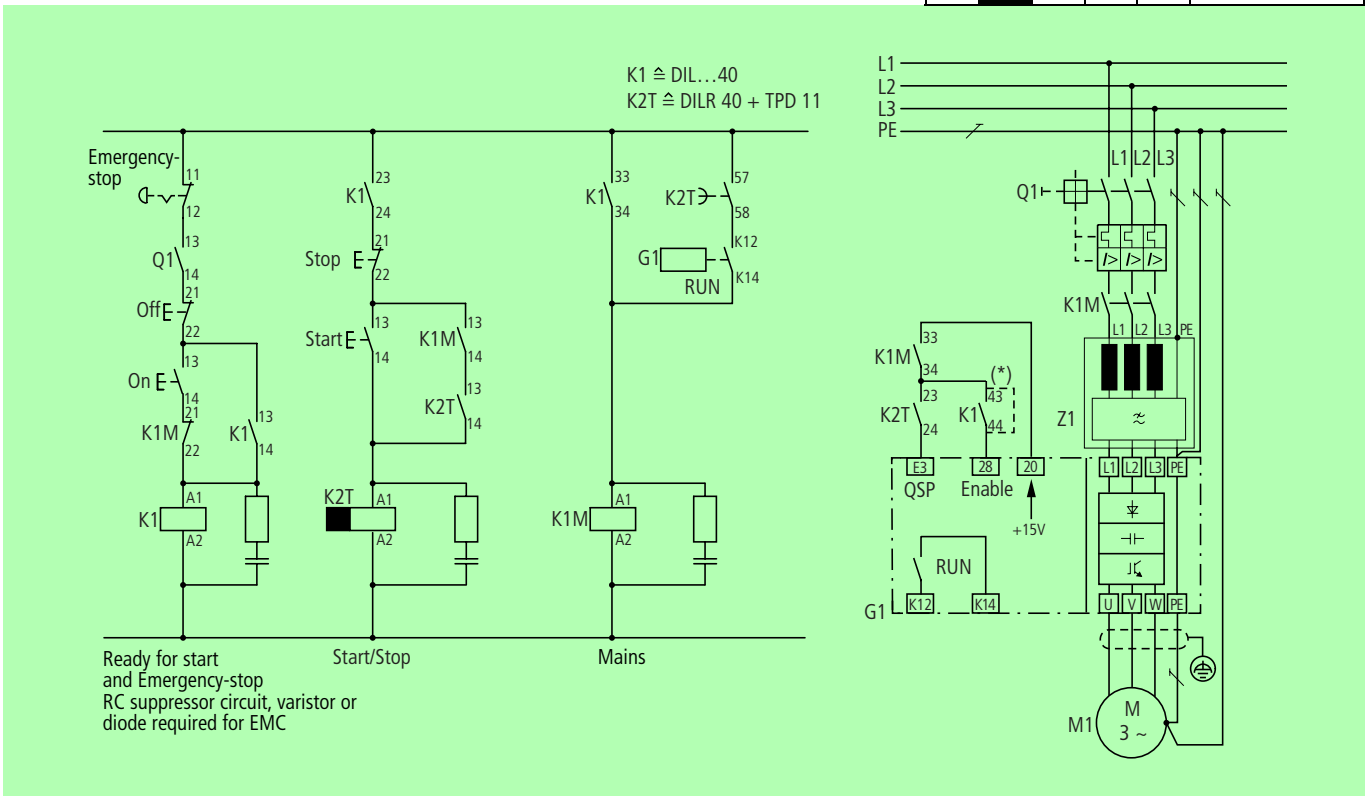
Emergency Stop

With electronically controlled drives (Frequency inverters)

Application:

- When uncontrolled coasting of the machine may cause hazardous conditions after the Emergency-stop: controlled stop (STOP category 1 in accordance with EN 60 204-1).
- Required if hazards to machines with electronically controlled drives may occur.

B	1	2	3	4	Category according to EN 954-1
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Emergency-stop with frequency inverter DF4

Requirements:

- Emergency-stop device with positive opening operation (EN 60 947-5-1 Appendix K) and function in accordance with ISO 13 850/EN 418.
- Provision of hardwired electro-mechanical components.
- Supply conductor to the Emergency-stop actuator must be protected.
- Separation of power supply via mains contactor.
- Delay time of the timing relay slightly longer than the stop time of the frequency inverter (QSP).
- Emergency-stop function must be tested regularly.

Features:

- If the bridge (*) across contact K1 is not present, immediate disconnection of power supply (STOP category 0).

- If the bridge (*) across contact K1 is present, disconnection of power supply on stand still (STOP category 1). Delayed disconnection via a programmed ramp.

Function:

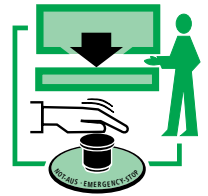
When the ON actuator is operated, K1 picks up and is maintained. K1 energizes the mains contactor K1M. The drive is "ready to start". When the START actuator is operated, K2T picks up and is maintained. K2T enables the drive via terminal E3. The drive starts when a speed setpoint value is applied. The contact G1 (Run state indicator: RUN) closes.

The drive stops when the speed setpoint value is set to zero or when the OFF actuator is pressed (K2T drops out, the START command on terminal E3 is removed). The K1M mains contactor remains switched on

and is switched off by pressing the OFF actuator.

When the **Emergency-stop actuator** is operated, K1 and K2T are disconnected. The drive decelerates to ZERO on the ramp. Requirement: The contact K1 on terminal 28 is bridged (*). The mains contactor is switched off at stand still via the contact G1 (run state indicator). The time delayed contacts of K2T monitor the shut down of the run state indicator of G1. The delay time of K2T must be longer than the Stop time setting.

If terminal 28 is actuated via K1 (*, no bridge), during an **Emergency-stop action**, the output of the frequency inverter is immediately inhibited and the run state indicator G1 switched off. Mains contactor K1M immediately drops out. The drive runs out.



The following safety standards apply to "Emergency-stop in the control circuit":		Page
EN 292	Safety of machinery – General principles for design	87
ISO 13 850/ EN 418	Safety of machinery – Emergency-stop device	94
EN 954-1	Safety of machinery – Safety-related parts of control systems	89
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947, ISO 13 850/EN 418

Type	AC-15/230 V	Short-circuit protection device
M22-PV	6 A	PKZM0-10, FAZ-B6
FAK	6 A	PKZM0-10, FAZ-B6
Q25(L)PV	4 A	FAZ-B6

Special features: tamper-proof in accordance with ISO 13 850/EN 418,
 ☉ positive opening operation in accordance with EN 60 947-5-1, red mushroom-head push-button, yellow button plate, degree of protection at least \geq IP 65, sealable shroud as accessory.

Type	AC-15/230 V	Short-circuit protection device
DILR	6 A	PKZM0-4

Special features: positively driven contact elements (not with early-make contact and late-break contact), finger proof and back-of-hand proof in accordance with IEC 536.

Type	AC-15/230 V	Short-circuit protection device
TPD11DIL	4 A	PKZM0-2,4

Special features: adjustable time ranges, positively driven contact elements.

Type	AC-15/230 V	Short-circuit protection device
40(04)DILE	4 A	PKZM0-4
40(04)DIL	6 A	PKZM0-4

Special features: positively driven contact elements (not with early-make contact and late-break contact), finger proof and back-of-hand proof in accordance with IEC 536.

Type	AC-3/400 V	Short-circuit protection device for 220/230V auxiliary contact
DIL00M up to DILM820/22	4 kW up to 450 kW	FAZ-C4

Special features: finger proof and back-of-hand proof (from DILM185 with terminal shroud) in accordance with IEC 536.

Note: Circuits with STOP category 1 in accordance to EN 60 204-1 can be implemented with the Moeller DF4 frequency inverter. A precondition is the respective parameter assignment of the control terminals (see manual AWB 823-1278).

- PNU007 = 2 (terminal configuration, E3 = QSP)
- PNU008 = 2 (relay, acoustic signal)

Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118.

Emergency-stop actuators



Contactor relays



Pneumatic timer module



Auxiliary contact modules



Contactors



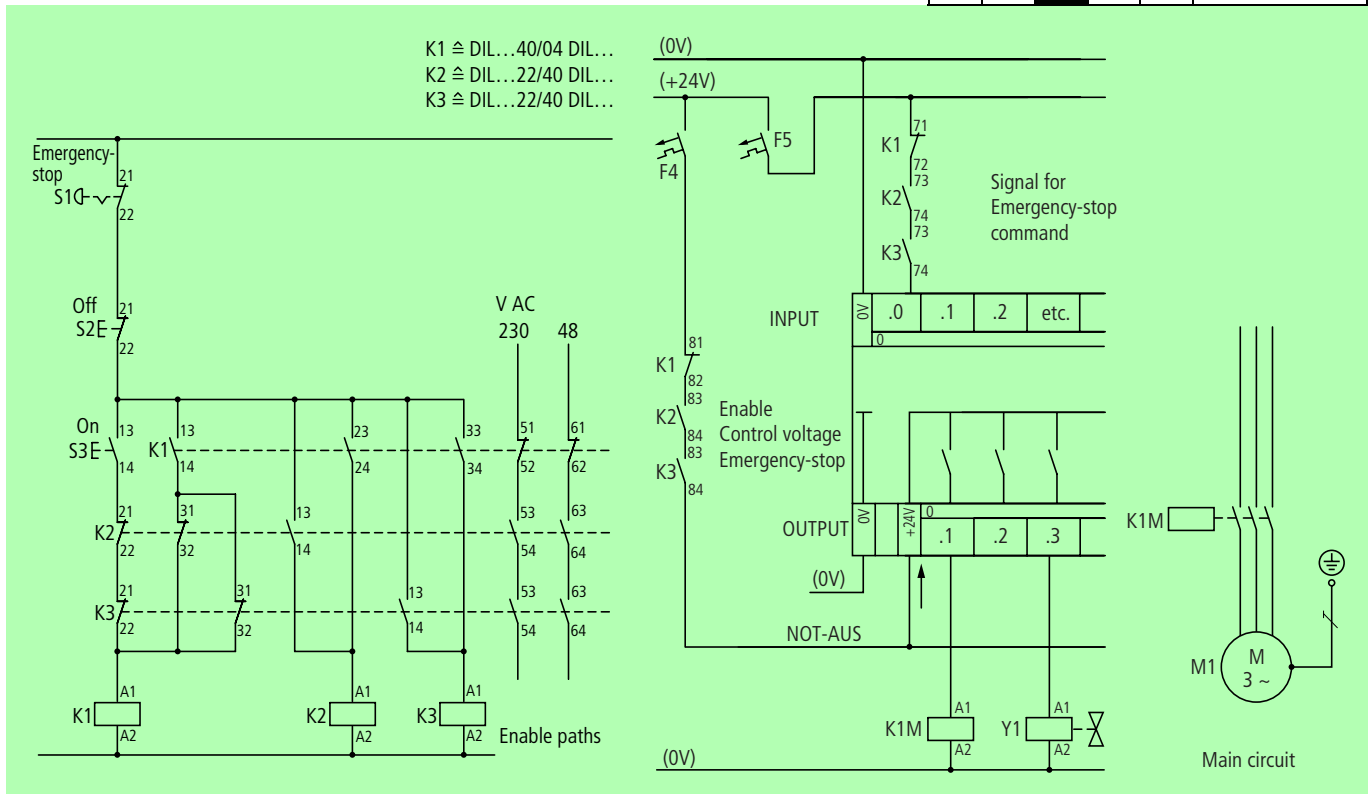
Emergency Stop

1.4 With programmable logic controllers

Application:

- For machines with electronic control systems which are not safety-related.
- When the Emergency-stop actuator and the supply conductor are not exposed to any particular hazard.
- When immediate disconnection of the power supply does not lead to hazardous conditions (uncontrolled stop – STOP category 0 in accordance with
- Required when hazards to machine or user may occur.

B	1	2	3	4	Category according to EN 954-1
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Emergency-stop with non safety-related PLC

Requirements:

Non safety-related electronic control systems must be connected as follows:

- PLC must have potentially isolated outputs.
- With an emergency-stop, the PLC output voltage for the hazardous movement must be disconnected. Furthermore, the disconnection must be signaled to the input side to indicate successful disconnection of the hazard. This is not required if the output signals do not control any hazardous movements.
- Emergency-stop device with positive opening operation (EN 60 947-5-1 Appendix K) and function in accordance with ISO 13 850/EN 418.
- Contactors with positively driven contact elements.
- Provision of hardwired electro-mechanical components.
- Supply conductor must be protected.

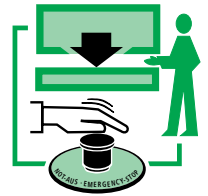
- Emergency-stop function must be tested regularly.
- Observe requirements of power supply and protective devices: Chapter 10.1.

Features:

- Design based on well-tried components and principles.
- Redundant and self-monitored command processing.
- Open-circuit and connection fault in the control cabinet are detected immediately or with the next start command.
- Connection fault in the Emergency-stop actuator or supply cable: causes loss of safety function.

Function:

When the ON actuator S3 is operated, the break contacts K2 and K3/21-22 ensure that these contactor relays are in their rest position. K1 picks up and by means of its make contacts 23-24 and 33-34 energizes contactors K2 and K3, which are maintained by means of their contacts 13-14. K1 is further maintained by means of its make contact 13-14 until K2 and K3 have picked up and their break contacts have de-energized K1, thus ensuring the enabling for the control circuits.



The following safety standards apply to "Emergency-stop in the control circuit":		Page
EN 292	Safety of machinery – General principles for design	87
ISO 13 850/ EN 418	Safety of machinery – Emergency-stop device	94
EN 954-1	Safety of machinery – Safety-related parts of control systems	89
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947, ISO 13 850/EN 418

Type	AC-15/230 V	Short-circuit protection device
M22-PV	6 A	PKZM0-10, FAZ-B6
FAK	6 A	PKZM0-10, FAZ-B6
Q25(L)PV	4 A	FAZ-B6

Emergency-stop actuators



Special features: tamper-proof in accordance with ISO 13 850/EN 418,
 ☉ positive opening operation in accordance with EN 60 947-5-1, red mushroom-head push-button, yellow button plate, degree of protection at least \geq IP 65, sealable shroud as accessory.

Type	AC-15/230 V	Short-circuit protection device
DILER(DC)	6 A	PKZM0-4
DILR(AC + DC)	6 A	PKZM0-4

Contactor relays



Special features: positively driven contact elements (not with early-make contact and late-break contact), finger proof and back-of-hand proof in accordance with IEC 536.

Type	AC-15/230 V	Short-circuit protection device
40(04)DILE	4 A	PKZM0-4
40(04)DIL	6 A	PKZM0-4

Auxiliary contact modules



Special features: positively driven contact elements (not with early-make contact and late-break contact), finger proof and back-of-hand proof in accordance with IEC 536.

Type	AC-3/400 V	Short-circuit protection device for 220/230V auxiliary contact
DIL00M up to DILM820/22	4 kW up to 450 kW	FAZ-C4

Contactors



Special features: finger-proof and back-of-hand proof (from DILM185 with terminal shroud) in accordance with IEC 536.

Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118.

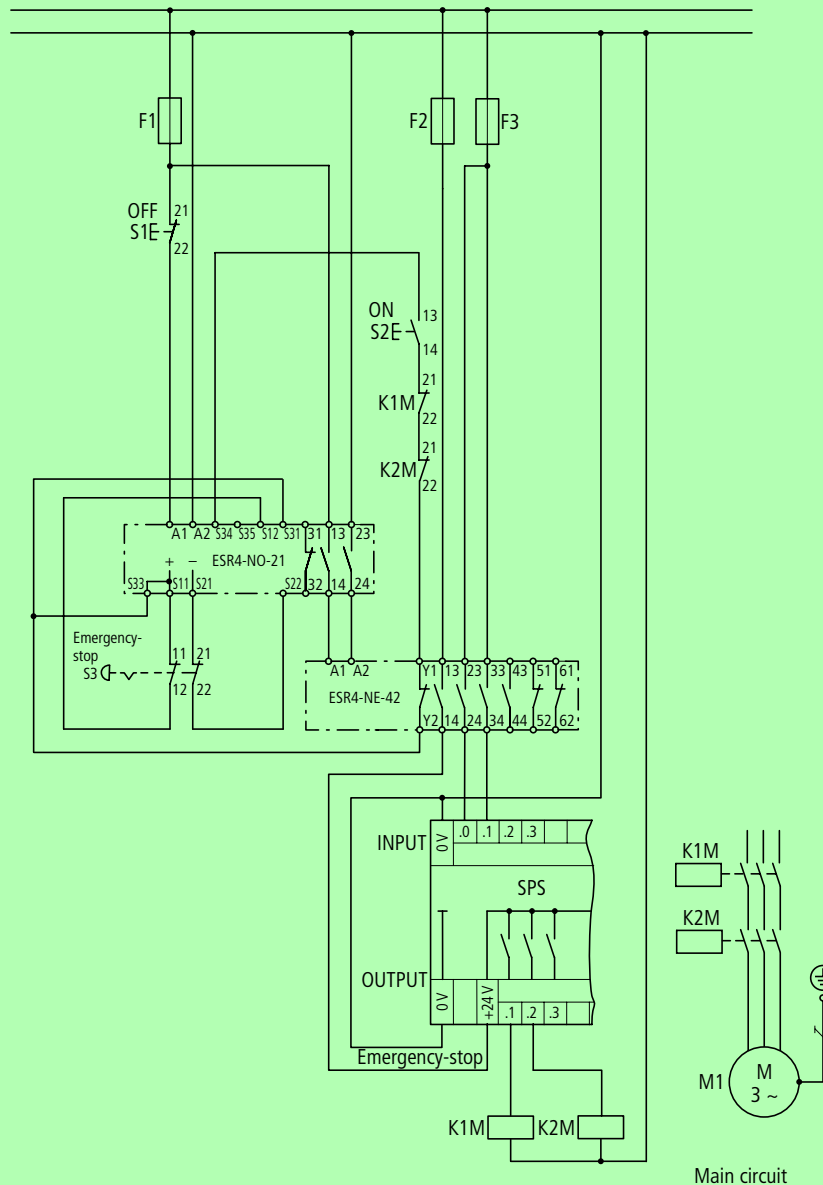
Emergency Stop

With programmable logic controllers

Application:

- For machines with electronic control systems which are not safety-related.
- When the device has to be shut-down (Emergency-stop actuator) in an emergency and the incomer is subject to particular danger.
- When immediate disconnection of the power supply does not lead to hazardous conditions (uncontrolled stop – STOP category 0 in accordance with EN 60 204-1).
- Required when hazards to machine or user may occur.

B	1	2	3	4	Category according to EN 954-1
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Emergency stop with safety relays, contact extension and non safety-related PLC

**Requirements:**

Non safety-related electronic control systems must be connected as follows:

- PLC's must have potentially isolated outputs.
- With an emergency-stop, the PLC output voltage for the hazardous movement must be disconnected. Furthermore, the disconnection must be signaled to the input side to indicate successful disconnection of the hazard. This is not required if the output signals do not control any hazardous movements.
- Emergency-stop actuator with positive opening operation (EN 60 947-5-1 Appendix K) and function in accordance with ISO 13 850/EN 418.
- Safety relays and contact extension with positively driven contact elements.
- Contactors with positively driven contact elements.
- Provision of hardwired electro-mechanical components.
- Observe requirements of power supply and protective devices: Chapter 10.1.

Features:

- Design based on well-tried components and principles.
- Control circuits, supply cables and command processing redundant and self-monitored.
- Open-circuit and connection faults are detected immediately or with the next start command.
- Monitoring of the contact extension via feedback path.
- ON actuator monitoring
- Monitoring of redundant contactor relays/safety valves via feedback circuit (see page 81).

Function:

After the supply voltage is applied to the safety relay (connection A1-A2), the "Power" LED indicates the readiness to activate the enable path. When the ON actuator S2 is operated, the break contacts K1M and K2M of the feedback circuit, as well as the feedback signal path of the contact extension (connection Y1-Y2), ensure that the contactors and the contact extension device are in their rest position. When this state is achieved, the safety relay is actuated by the falling edge of the control logic on connection S34 (the ON-actuator must be pressed and released). The control logic monitors the ON-actuator and tests the rest position of the ESR-internal enable relays K1 and K2. The enable relays K1 and K2 of the basic unit pick-up and are maintained via their upstream make contacts. This state is indicated by the "K1" as well as the "K2" LED. The signal path of the basic unit (connection 31-32) is opened. The supply voltage is applied to the contact extension (connection A1-A2) via both of the enable paths of the basic unit (connections 13-14 and 23-24). The enable relays K1 and K2 of the contact extension pick up. This state is indicated by the LEDs of the "K1" and "K2" contact extension. Both signal paths of the contact extension (connections 51-52 and 61-62) are opened. Voltage is applied to the potentially isolated outputs of the PLC via an enable path (connection 13-14) of the contact extension. With a shut-down with an emergency-stop, all outputs are shut down directly here, without any influence from the PLC. Further enable paths (here contact extension 23-24 and 33-34) are required with one annunciation per input, whereby the respective output is used to control a contactor.

Emergency Stop

With programmable logic controllers

The following safety standards apply to " (Emergency Stop) in the control circuit"		Page
EN 292	Safety of machinery – General principles for design	87
ISO 13 850/ EN 418	Safety of machinery – Emergency-stop device	94
EN 954-1	Safety of machinery – Safety-related parts of control systems	89
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–
EN 61 810-1	Electro-mechanical switching relays	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947/ISO 13 850/EN 418, EN 61 810-1

Type	DC-13/24 V	Short-circuit protection device
M22-PV	6 A	PKZM0-10, FAZ-B6
FAK	6 A	PKZM0-10, FAZ-B6
Q25(L)PV	3 A	FAZ-B6

Special features: tamper-proof in accordance with ISO 13 850/EN 418,
 ☉ positive opening operation in accordance with EN 60 947-5-1, red mushroom-head push-button, yellow button plate, degree of protection at least \geq IP 65, sealable shroud as accessory.

Emergency-stop button



Type	Enable/signal contacts AC-15/230 V	Short-circuit protection device
ESR4-NO-21 ¹⁾	6 A ²⁾	6 A gG
ESR4-NE-42 ¹⁾	6 A ²⁾	6 A gG

Special features: positively driven contact elements, approved by the BG/EU design testing.
¹⁾ see circuit example
²⁾ max. total current of all current paths = 12 A

Safety relay/
Contact extension



Type	AC-3/400 V	Short-circuit protection device for 220/230V auxiliary contact
DIL00M/11 up to DILM820/22	4 kW up to 450 kW	FAZ-C4

Special features: finger proof and back-of-hand proof (from DILM185 with terminal shroud) in accordance with IEC 536.

Contactors



Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118

Notes



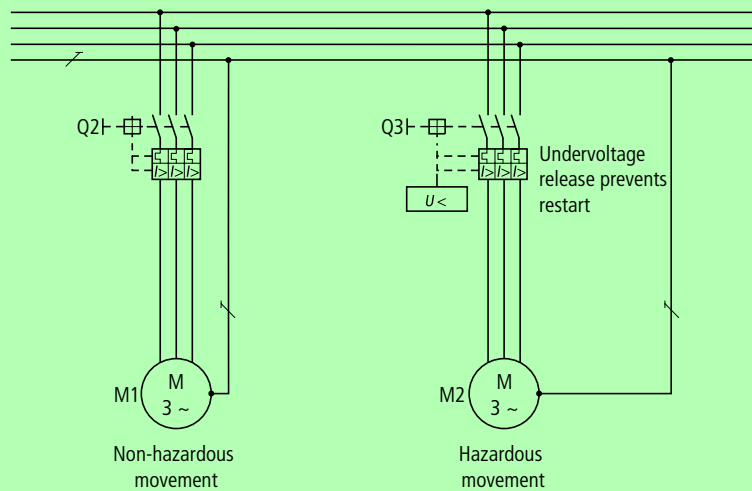
2. Preventing Restarts

2.1 With undervoltage releases

Application:

- When an automatic Restart causes hazardous conditions when the voltage is restored.
- When faulty behaviour of the electrical equipment occurs due to voltage failure.
- When transient voltage dips should not cause disconnection, use a delayed undervoltage release.

B	1	2	3	4	Category according to EN 954-1
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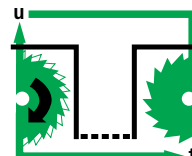
Undervoltage release prevents automatic restart of hazardous movements

Requirements:

- An off-delayed undervoltage release may be used if transient voltage drops do not cause any hazardous conditions.
- This method of operation must not impair the operation of the Stop function.
- The undervoltage release must comply with EN 60 947-2.

Features:

- The circuit-breaker fitted with an undervoltage release switches off the power supply in the event of a voltage failure.
- When the voltage is restored, the machine only starts with an intentional start command.
- Transient voltage drops do not cause disconnection with the off-delay undervoltage release.



The following safety standards apply to "Preventing restarts":		Page
EN 292	Safety of machinery – General principles for design	87
EN 1037	Safety of machinery – Prevention of unexpected start-up	95
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947

Type	AC-3/400 V	Short-circuit protection device
PKZM0	up to 12.5 kW	No protective device required 16 A: 50 kA 20 A – 25 A from 16 kA/400 V: 50 A gL/gG

Special features: With undervoltage release, tripping not before $0.7 \times U_s$, and no later than $0.35 \times U_s$.

Motor-protective circuit-breaker



Type	AC-3/400 V	Short-circuit protection device
PKZ2	up to 20 kW	No protective device required 25 A – 40 A from 30 kA/400 V: 160 A gL/gG

Special features: undervoltage release with and without 200 ms off delay, trip no earlier than $0.7 \times U_s$, and no later than $0.35 \times U_s$.

Motor-protective circuit-breaker



Type	AC-23 B / 400 V	Short-circuit protection device
NZM7	up to 250 A	NZM7-... up to NZM10-...
NZM10	up to 630 A	NZM10-... up to NZM14-...

Special features: undervoltage release with and without 0.2 to 4 second off delay, trip no earlier than $0.7 \times U_s$, and no later than $0.35 \times U_s$.

Switch disconnecter/ circuit-breaker



Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118.

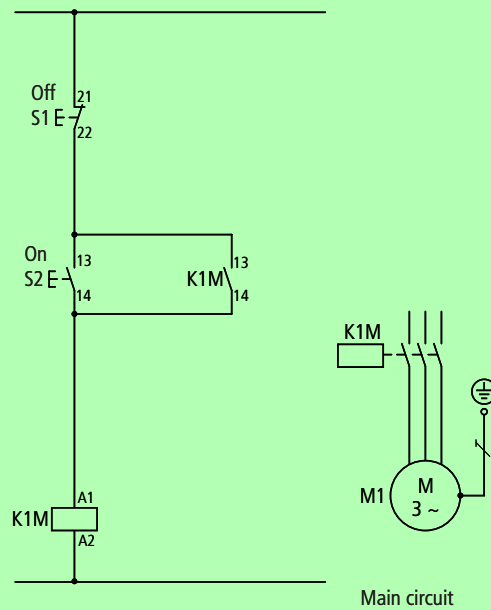
Preventing Restarts

2.2 With contactors

Application:

- When an automatic Restart causes hazardous conditions when the voltage is restored.
- When faulty behaviour of the electrical equipment occurs due to voltage failure.

B	1	2	3	4	Category according to EN 954-1
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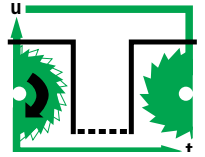
Self maintaining contactor preventing a restart when voltage is restored

Requirements:

- Contactors must have an operating voltage tolerance of between 85 % to 110 % of the control voltage in accordance with EN 60 947.
- Observe requirements of power supply and protective devices: Chapter 10.1.

Features:

- When the voltage is restored, the machine only starts with an intentional start command.
- Control voltage dips up to -15 % do not lead to disconnection.



For "Preventing Restarts":		Page
EN 292	Safety of machinery – General principles for design	87
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947

Type	AC-3/400 V	Short-circuit protection device
DILEEM	3 kW	PKZM0-0,25
up to DILM820	up to 450 kW	up to 1200 A gL/gG for Type "1" coordination

Special features: finger proof and back-of-hand proof (from DILM185 with terminal shroud) in accordance with IEC 536, voltage tolerance with AC drive: 80 % to 110 % U_s , DC drive: 85 % to 110 % U_s , DILM185 to DILM820: 70 % to 115 % U_s .

Contactors



Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118.

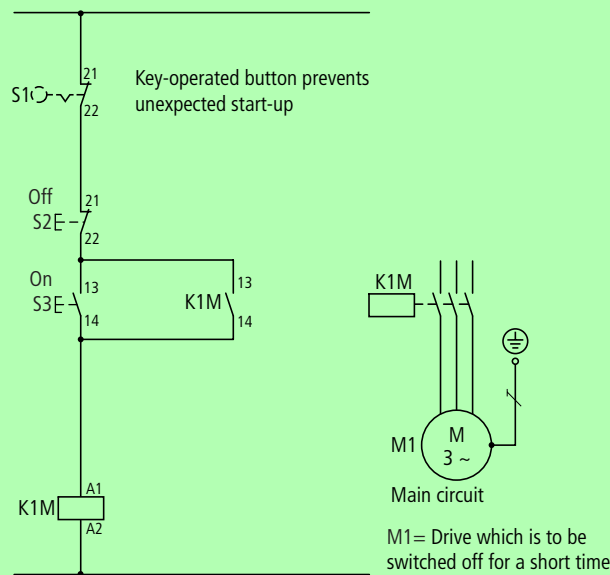
3. Preventing Unexpected Start-Up

3.1 For short machine related activities

Application:

- To switch off parts of the plant for work of a **minor nature and for a short duration.**
- Only for use with a low hazard potential.
- When switching on the machine unexpectedly may cause hazardous conditions.

B	1	2	3	4	Category according to EN 954-1
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Prevention of an unexpected start-up with a key switch

Requirements:

- In accordance with EN 60 204-1 can be utilized for:
 - Work without significant disassembly of the machinery
 - Adjustments which only require a relatively short time
 - Work on the electrical equipment if
 - there is no danger of electric shock or burning
 - disconnection cannot be influenced by the work which is being performed
 - the work involved is minimal.
- Switch with two switch positions: ON and OFF.
- Lockable in the OFF position.
- The contactor must be actuated for operation in order to detect faults.
- Observe requirements of power supply and protective devices: Chapter 10.1.

Features:

- Partial disconnection which is protected against restarts.



The following safety standards apply for "prevention of unexpected start-up":			Page
EN 292	Safety of machinery – General principles for design		87
EN 1037	Safety of machinery – Prevention of unexpected start-up		95
EN 60 204-1	Safety of machinery – Electrical equipment of machines		78
EN 60 947	Low-voltage switchgear		–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947

Type	AC-15/230 V	Short-circuit protection device
M22-WS	6 A	PKZM0-10, FAZ-B6

Special features: Key removable in 0 and I position,
 ⊕ positive opening operation in accordance with EN 60 947-5-1 Appendix K, degree of protection IP 66,
 standard lock mechanism or special individual lock mechanism or individual lock mechanisms not suitable for master key systems.

Key-operated actuator



Type	AC-3/400 V	Short-circuit protection device
DILEEM up to DILM820	3 kW up to 450 kW	PKZM0-0,25 up to 1200 A gL/gG for Type "1" coordination

Special features: finger proof and back-of-hand proof (from DILM185 with terminal shroud) in accordance with IEC 536.

Contactors



Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118.

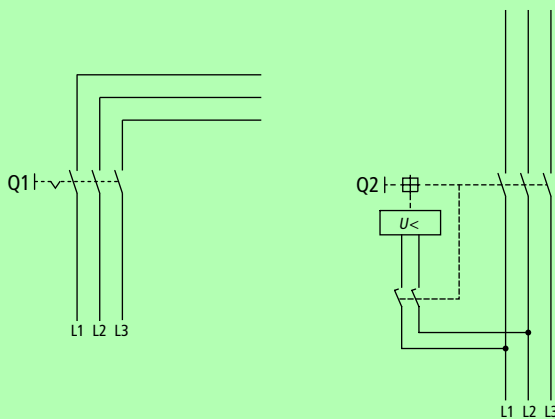
4. For Repair and Maintenance Safety

4.1 With power disconnecting device (main switch)

Application:

- A power disconnecting device (main switch) is compulsory for machines from 3 kW/16 A.
- For isolating the electrical installation.
- For prevention of unexpected start-ups.

B	1	2	3	4	Category according to EN 954-1
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Switch-disconnector and circuit-breaker as power disconnecting device (main switch)

Requirements:

- The power disconnecting device (main switch) must be one of the following types:
 - a) switch disconnector in accordance with EN 60 947-3 for utilization category AC-23B or
 - b) circuit-breaker in accordance with EN 60 947-2, suitable for isolation in accordance with EN 60 947-3, or
 - c) switch-disconnector with auxiliary contact for load disconnection before the main contacts open, or
 - d) plug and socket combination in accordance with EN 60 204-1 (5.3.2.d.) for machines with ratings not exceeding 3 kW/16 A.
- Switch with two switch positions: ON and OFF and intermediate position TRIPPED if required.
- Lockable in OFF position, e. g. via padlocks.
- Switch position indication which only shows the OFF position if the contacts are actually open in accordance with EN 60 947-3.
- Design in black and grey. If simultaneously for Emergency-Stop: Red.
- Breaking capacity sufficient for the currents of all loads and current of the largest motor in the blocked state.
- If in a multiple supply system the disconnection of only one power disconnecting device leads to hazardous conditions, the common disconnection via mechanical interlocks or undervoltage releases must be forced.
- The power disconnection device must be located between 0.6 to 1.9 m above the servicing level, preferably no more than 1.7 m.
- Special cabling requirements must be observed when tapping off upstream of the power disconnecting device, e. g. short-circuit-proof cabling, conductor colours, etc.

Features:

- One power disconnecting device (main switch): isolation of the entire system from the power supply.
- Multiple supply: isolation of particular circuits from the power supply, e. g. automatic, central disconnection.
- The following devices may remain switched on: lights, sockets, undervoltage releases, interlock circuits supplied externally, heating, program memory, ... (special marking of these circuits and equipment is necessary)
- Implements the first 2 of the 5 safety rules in accordance with VDE 0105:
 1. Isolate
 2. Protect against restart
 3. Verify isolation from supply
 4. Short-circuit and earth
 5. Shroud adjacent live parts.



The following safety standards apply to the "Power disconnecting device function" (main switch function):		Page
EN 292	Safety of machinery – General principles for design	87
EN 1037	Safety of machinery – Prevention of unexpected start-up	95
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947/EN 1037

Type	AC-3/400 V	Short-circuit protection device
PKZM0+H-PKZ0	12.5 kW	No protective device required 16 A: 50 kA 20 A – 25 A up to 16 kA/400 V: 50 A gL/gG

Special features: 3-pole motor-protective circuit-breaker with isolating features in accordance with EN 60 947-3, black door coupling handle, lockable in 0-position with up to 3 padlocks.

Power disconnecting device (main switch):



Type	AC-3/400 V	Short-circuit protection device
T0-.../SVB-SW	4 kW	20 A gL/gG
P1-.../SVB-SW	7.5/13 kW	25/50 A gL/gG
P3-.../SVB-SW	30/37 kW	80/100 A gL/gG

Special features: rotary handle lockable in 0-position with up to 3 padlocks, isolating characteristics in accordance with EN 60 947-3.



Type	AC-3/400 V	Short-circuit protection device
P7-...+V-NZM7-SW	up to 250 A	NZM7-... up to NZM10-...
P10-...+V-NZM10-SW	up to 630 A	NZM10-... up to NZM14-...

Special features: 3-/4-pole switch disconnecter with black door coupling handle, lockable in 0-position with up to 3 padlocks, with multiple supply interlocking by means of undervoltage release or mechanical interlock possible, isolating characteristics in accordance with EN 60 947-3.



Type	AC-3/400 V	Short-circuit protection device
NZM7-...+V-NZM7-SW	up to 250 A	NZM7-... up to NZM10-...
NZM10-...+V-NZM10-SW	up to 630 A	NZM10-... up to NZM14-...

Special features: 3-/4-pole switch disconnecter with black door coupling handle, lockable in 0-position with up to 3 padlocks, with multiple supply interlocking by means of undervoltage release or mechanical interlock possible, isolating characteristics in accordance with EN 60 947-3.



Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118.

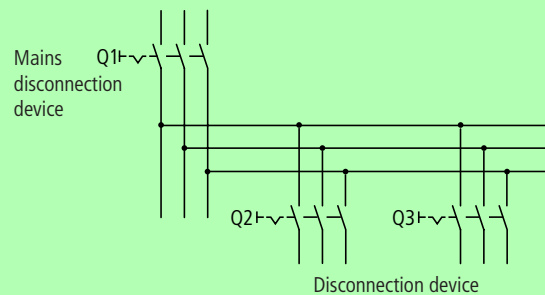
Repair and Maintenance Safety

4.2 With devices for isolation of the electrical equipment

Application:

- For work without the risk of an electric shock.
- For prevention of unexpected start-ups.
- When parts of the machine must remain functional.

B	1	2	3	4	Category according to EN 954-1
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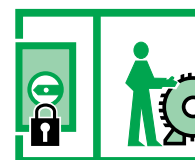
Devices for isolation allow a partial operation of the machinery

Requirements:

- The disconnecting device must be one of the following types:
 - a) switch disconnector in accordance with EN 60 947-3 for utilization category AC-23B or
 - b) circuit-breaker in accordance with EN 60 947-2, suitable for isolation in accordance with EN 60 947-3, or
 - c) switch-disconnector with auxiliary contact for load disconnection before the main contacts open, or
 - d) plug and socket combination in accordance with EN 60 204-1 (5.3.2.d.) for machines with ratings not exceeding 3 kW/16 A.
- Lockable in OFF position, e. g. via padlocks.
- Switch position indication which only shows the OFF position if the contacts are actually open in accordance with EN 60 947-3.
- Design in black and grey. If simultaneously for Emergency-Stop: Red.
- Switch with two switch positions: ON and OFF and intermediate position TRIPPED if required.

Features:

- Isolation of individual parts of the electrical equipment from the mains.
- Isolating characteristics allow unhindered work on the electrical and mechanical equipment as opposed to indirect shut-down with the aid of a contactor.
- Implements the first 2 of the 5 safety rules in accordance with VDE 0105:
 1. Isolation
 2. Protect against restart
 3. Verify isolation from supply
 4. Short-circuit and earth
 5. Shroud adjacent live parts



The following safety standards apply to the "Devices for isolation":		Page
EN 292	Safety of machinery – General principles for design	87
EN 1037	Safety of machinery – Prevention of unexpected start-up	95
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947/EN 60 204-1/EN 1037

Type	AC-3/400 V	Short-circuit protection device
PKZM0+H-PKZO	12.5 kW	No protective device required 16 A: 50 kA 20 A – 25 A up to 16 kA/400 V: 50 A gL/gG

Special features: 3-pole motor-protective circuit-breaker with isolating features in accordance with EN 60 947-3, black door coupling handle, lockable in 0-position with up to 3 padlocks.

Devices for isolation of the electrical equipment



Type	AC-3/400 V	Short-circuit protection device
T0-.../SVB-SW	4 kW	20 A gL/gG
P1-.../SVB-SW	7.5/13 kW	25/50 A gL/gG
P3-.../SVB-SW	30/37 kW	80/100 A gL/gG

Special features: rotary handle lockable in 0-position with up to 3 padlocks, isolating characteristics in accordance with EN 60 947-3.



Type	AC-3/400 V	Short-circuit protection device
P7-...+V-NZM7-SW	up to 250 A	NZM7-... up to NZM10-...
P10-...+V-NZM10-SW	up to 630 A	NZM10-... up to NZM14-...

Special features: 3 or 4-pole switch-disconnectors with black door coupling handle, lockable in 0-position with up to 3 padlocks, isolating characteristics in accordance with EN 60 947-3.



Type	AC-3/400 V	Short-circuit protection device
NZM7-...+V-NZM7-SW	up to 250 A	NZM7-... up to NZM10-...
NZM10-...+V-NZM10-SW	up to 630 A	NZM10-... up to NZM14-...

Special features: 3 or 4-pole circuit breakers or switch-disconnectors with black door coupling handle, lockable in 0-position with up to 3 padlocks, isolating characteristics in accordance with EN 60 947-3.



Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118.

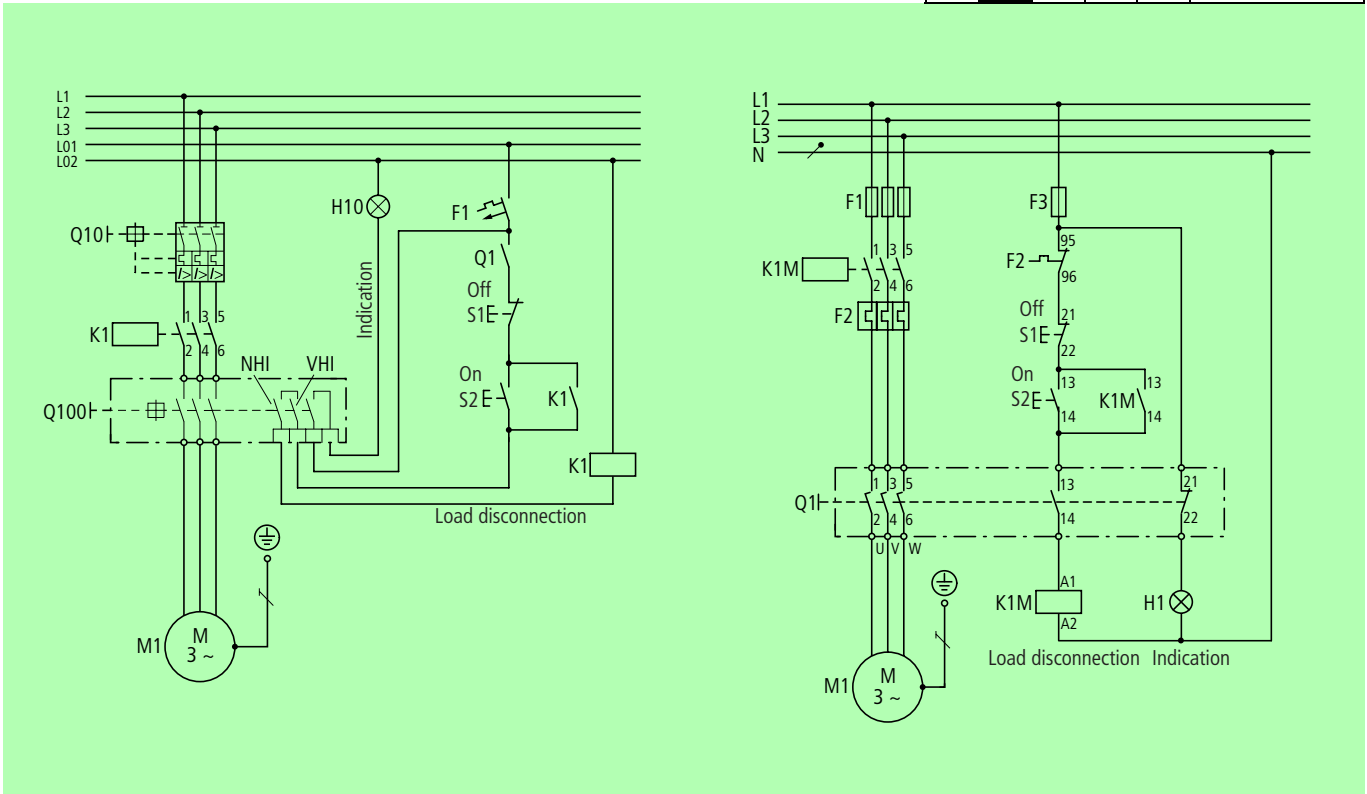
Repair and Maintenance Safety

4.3 With repair, maintenance and safety switch

Application:

- When switching on of the power supply during maintenance work may cause hazardous conditions.
- For isolating electrical systems or system sections from 3 kW upwards.
- For prevention of unexpected start-ups.

B	1	2	3	4	Category according to EN 954-1
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Startup prevention by means of safety switch

Requirements:

- The switch must fulfill one of the following conditions:
 - a) switch disconnector in accordance with EN 60 947-3 for utilization category AC-23B or
 - b) circuit-breaker in accordance with EN 60 947-2, suitable for isolation in accordance with EN 60 947-3, or
 - c) switch-disconnector with auxiliary contact for load disconnection before the main contacts open.
- Lockable in OFF position, e. g. via padlocks.
- Switch position indication which only shows the OFF position if the contacts are actually open in accordance with EN 60 947-3.
- Design in black and grey. If simultaneously for Emergency-Stop: Red.
- Unintentional or accidental operation not possible.
- Suitable for planned application, easily accessible location, easy to recognize and to use.
- Observe requirements of power supply and protective devices: Chapter 10.1.

Features:

- Isolation of the entire system from the power supply → Power disconnecting device (main switch).
- Isolation of individual sections of the system from the power supply → safety switch/ maintenance switch.
- Implements the first 2 of the 5 safety rules in accordance with VDE 0105:
 1. Isolate
 2. Protect against restart
 3. Verify isolation from supply
 4. Short-circuit and earth
 5. Shroud adjacent live parts.



The following safety standards apply to "Repair and maintenance switch function":		Page
EN 292	Safety of machinery – General principles for design	87
EN 1037	Safety of machinery – Prevention of unexpected start-up	95
EN 954-1	Safety of machinery – Safety-related parts of control systems	89
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947/EN 1037

Type	AC-3/400 V	Short-circuit protection device
P1-.../I2-SI/HI 11(-SW)	7.5/13 kW	25 A gL/gG/50 A gL/gG
P3-63/I4-SI/HI 11(-SW)	30 kW	80 A gL/gG
P3-100/I5-SI/HI 11(-SW)	37 kW	100 A gL/gG

Safety switch



Special features: in the housing, black or red-yellow rotary handle, lockable in 0-position with up to 3 padlocks, 3- or 6-pole, with or without load disconnection contact, degree of protection IP 55/65, isolating characteristics in accordance with EN 60 947-3.

Type	AC-3/400 V	Short-circuit protection device
P7-...+CI(-RT)-NZM7-...	up to 250 A	NZM7-... up to NZM10-...
P10-...+CI(-RT)-NZM10-...	up to 630 A	NZM10-... up to NZM14-...

Special features: in the housing, grey or red-yellow rotary handle, lockable in 0-position, with or without load disconnection contact, degree of protection IP 55, isolating characteristics in accordance with EN 60 947-3.

Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118.

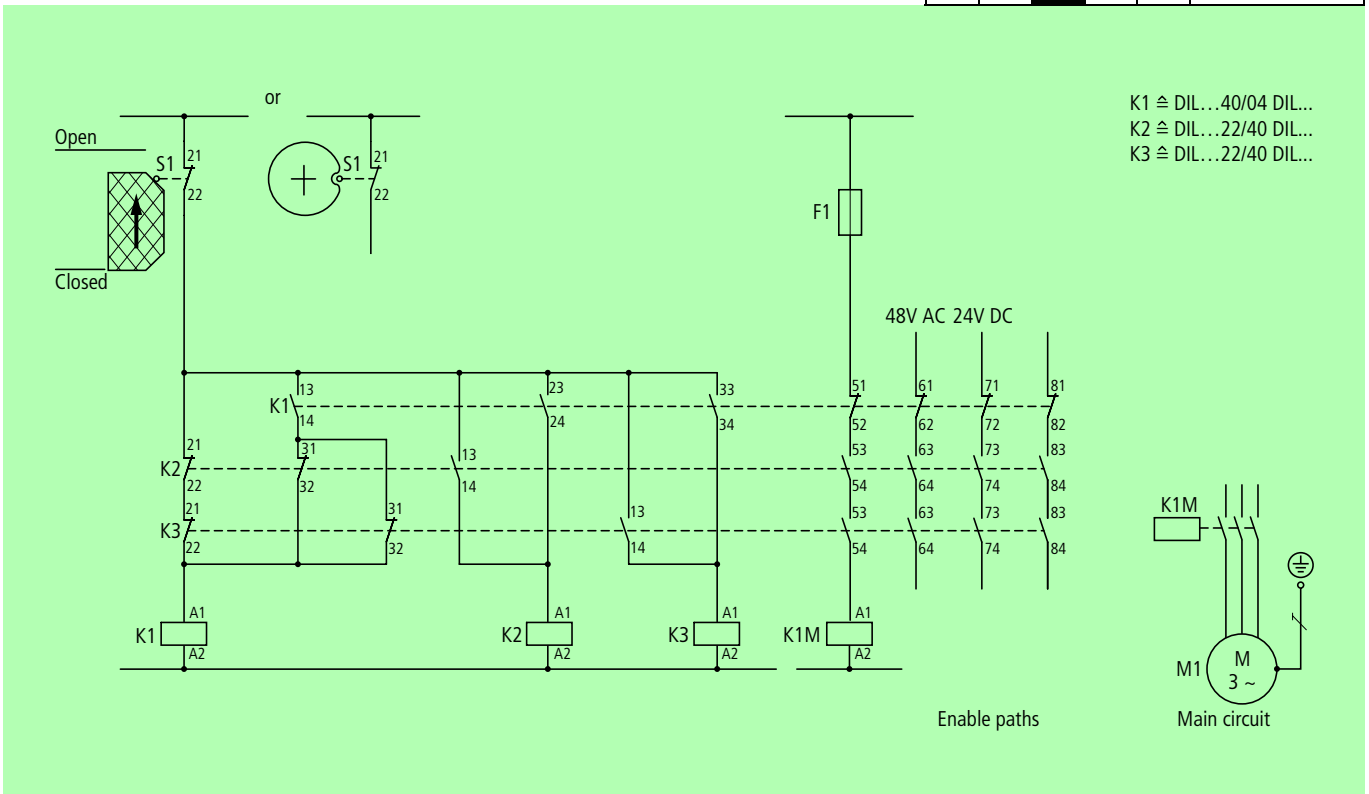
5. Monitoring Movable Guards

5.1 Without guard locking – protected supply conductor required

Application:

- When the position switch and the supply conductor are not exposed to any particular hazards.
- When occasional interventions in danger zones may be necessary.
- When the stopping time is less than the access time.
- Start condition: guard closed.

B	1	2	3	4	Category according to EN 954-1
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Interlocking device with 1 position switch, 1 break contact

Requirements:

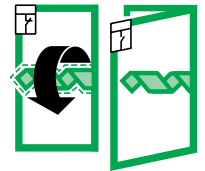
- Position switch with positive opening operation in accordance with EN 60 947-5-1 Appendix K and function in accordance with EN 1088.
- Contactors with positively driven contact elements.
- Provision of hardwired electromechanical components.
- Position switch and supply conductor must be protected against mechanical stress.
- The function of the circuit must be tested regularly.
- Observe requirements of power supply and protective devices: Chapter 10.1.

Features:

- Design based on well-tried components and principles.
- Redundant and self-monitored command processing.
- Open-circuit and connection fault in the control cabinet are detected immediately or with the next start command.
- Connection faults in the position switch or the supply conductor as well as mechanical failure of the position switch causes loss of safety function.

Function:

When the guard is being closed, the break contacts K2 and K3/21-22 ensure that these contactors are in the rest position. K1 picks up and by means of its make contacts 23-24 and 33-34 energizes contactors K2 and K3, which are maintained by means of their contacts 13-14. K1 is further maintained by means of its make contact 13-14 until K2 and K3 have picked up and their break contacts have de-energized K1, thus enabling the circuits for the control voltage.



The following safety standards apply to "Safety door monitoring without guard locking":		Page
EN 292	Safety of machinery – General principles for design	87
EN 1088	Safety of machinery – Interlock devices with or without retaining function	92
EN 954-1	Safety of machinery – Safety-related parts of control systems	89
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947/EN 1088

Type	AC-15/230 V	Short-circuit protection device
AT0	6 A	PKZM0-10, FAZ-B6
AT4	6 A	PKZM0-10, FAZ-B6

Position switch



Special features: ☉ positive opening in accordance with EN 60 947-5-1 Appendix K, protected against movement by means of a round hole fixing in direction of actuation, in accordance with EN 1088 section 4.2.1, degree of protection IP 65.

Type	AC-15/230 V	Short-circuit protection device
AT0-ZB	6 A	PKZM0-10, FAZ-B6
AT4/ZB	6 A	PKZM0-10, FAZ-B6
ATR/TS	6 A	PKZM0-10, FAZ-B6
ATR/TKG	6 A	PKZM0-10, FAZ-B6

Safety Position switch



Special features: with separate, triple coded actuating element, ☉ with positive opening operation in accordance with EN 60 947-5-1 Appendix K, in accordance with EN 1088 section 4.2.1, type-examined by the German Employers' Association and SUVA, degree of protection IP 65.

Type	AC-15/230 V	Short-circuit protection device
DILER.../...DILE (DC)	6 A	PKZM0-4
DILR.../...DIL (AC + DC)	6 A	PKZM0-4

Contactor relays



Special features: positively driven contact elements (not with early-make contact and late-break contact), finger proof and back-of-hand proof in accordance with IEC 536.

Type	AC-3/400 V	Short-circuit protection device for 220/230 V auxiliary contacts
DIL00M up to DILM820/22	4 kW up to 450 kW	FAZ-C4

Contactors



Special features: finger proof and back-of-hand proof (from DILM185 with terminal shroud) in accordance with IEC 536.

Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118.

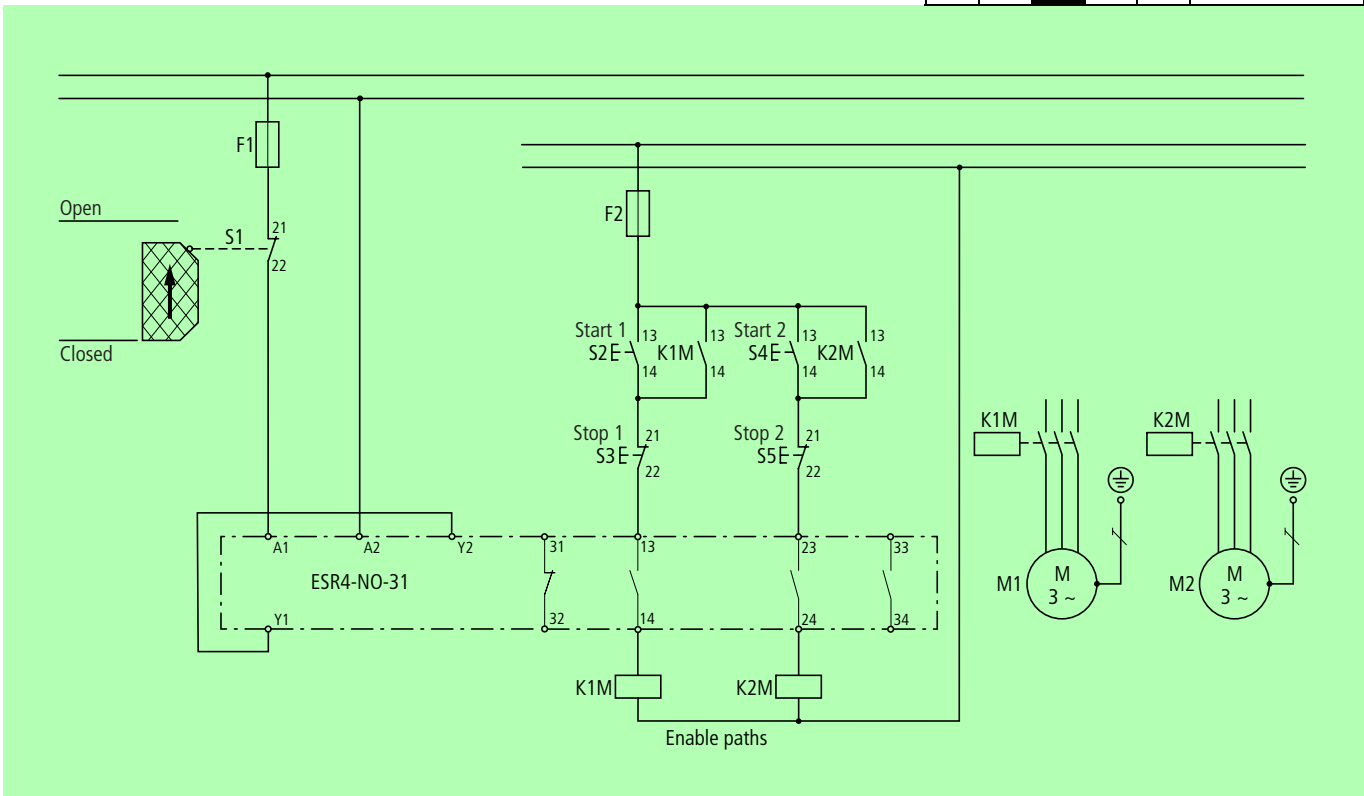
Monitoring Movable Guards

Without guard locking – protected supply conductor required

Application:

- When occasional interventions in danger zones may be necessary.
- When the stopping time is less than the access time.
- Start condition: guard closed.

B	1	2	3	4	Category according to EN 954-1
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Interlocking device with safety relay, 1 position switch, 1 break contact

Requirements:

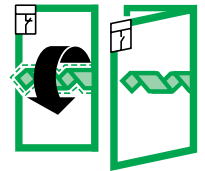
- Position switch with positive opening operation in accordance with EN 60 947-5-1 Appendix K and function in accordance with EN 1088.
- Safety relays with positive opening operation contacts.
- Provision of hardwired electromechanical components.
- Position switch and supply conductor must be protected against mechanical stress.
- Shutdown with a mobile protective mechanism must have its function tested regularly.
- Observe requirements of power supply and protective devices: Chapter 10.1.

Features:

- Design based on well-tried components and principles.
- Redundant and self-monitored command processing.
- Connection faults in the position switch or the supply conductor as well as mechanical failure of the position switch: Causes loss of safety function.

Function:

When the guard is closed and the supply voltage is thus applied to the safety relay (connection A1-A2), the ESR-internal break contact of the safety relays K1 and K2 ensure that the internal enable relays are in the rest position. The enable relays (K1 and K2) pick up and are maintained via their upstream make contacts. This state is indicated by the "K1, K2" LED. The signal path (connection 41-42) is opened. K1M can pick up via the first enable path (connection 13-14), K2M can pick up via the second enable path (connection 23-24) with the respective start commands S2 or S4.



The following safety standards apply to "Safety door monitoring without guard locking"		Page
EN 292	Safety of machinery – General principles for design	87
EN 1088	Safety of machinery – Interlock devices with or without retaining function	92
EN 954-1	Safety of machinery – Safety-related parts of control systems	89
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–
EN 61 810-1	Electromechanical switching relays	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947/EN 1088, EN 61 810-1

Type	DC-13/24 V	Short-circuit protection device
AT0	10 A	PKZM0-10, FAZ-B6
AT4	10 A	PKZM0-10, FAZ-B6

Special features: ☹ positive opening in accordance with EN 60 947-5-1 Appendix K, protected against movement by means of a round hole fixing in direction of actuation, in accordance with EN 1088 section 4.2.1, degree of protection IP 65

Type	DC-13/24 V	Short-circuit protection device
AT0-ZB	10 A	PKZM0-10, FAZ-B6

Special features: with separate, triple coded actuating element, ☹ with positive opening operation in accordance with EN 60 947-5-1 Appendix K, in accordance with EN 1088 section 4.2.1, type-examined by the German Employers' Association and SUVA, degree of protection IP 65.

Type	AC-15/230 V	Short-circuit protection device
ATR/TS	6 A	PKZM0-10, FAZ-B6
ATR/TKG	6 A	PKZM0-10, FAZ-B6

Special features: for direct fixing on the swiveling shrouds, ☹ with positive opening operation in accordance with EN 60 947-5-1 Appendix K, in accordance with EN 1088 section 4.2.1, type-examined by the German Employers' Association and SUVA, degree of protection IP 65.

Type	Enable/signal contacts AC-15/230 V	Short-circuit protection device
ESR4-NO-31	6 A ¹⁾	6 A gL

Special features: positively opening operation contacts, type-examined by the German Employers' Association/EU
¹⁾ max. total current of all current paths = 12 A

Type	AC-3/400 V	Short-circuit protection device for 220/230V auxiliary contact
DIL00M/11 up to DILM820/22	4 kW up to 450 kW	FAZ-C4

Special features: finger proof and back-of-hand proof (from DILM185 with terminal shroud) in accordance with IEC 536.

Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118.

Position switch



Safety Position switch



Safety door switch/Safety hinge switch



Safety relay



Contactors



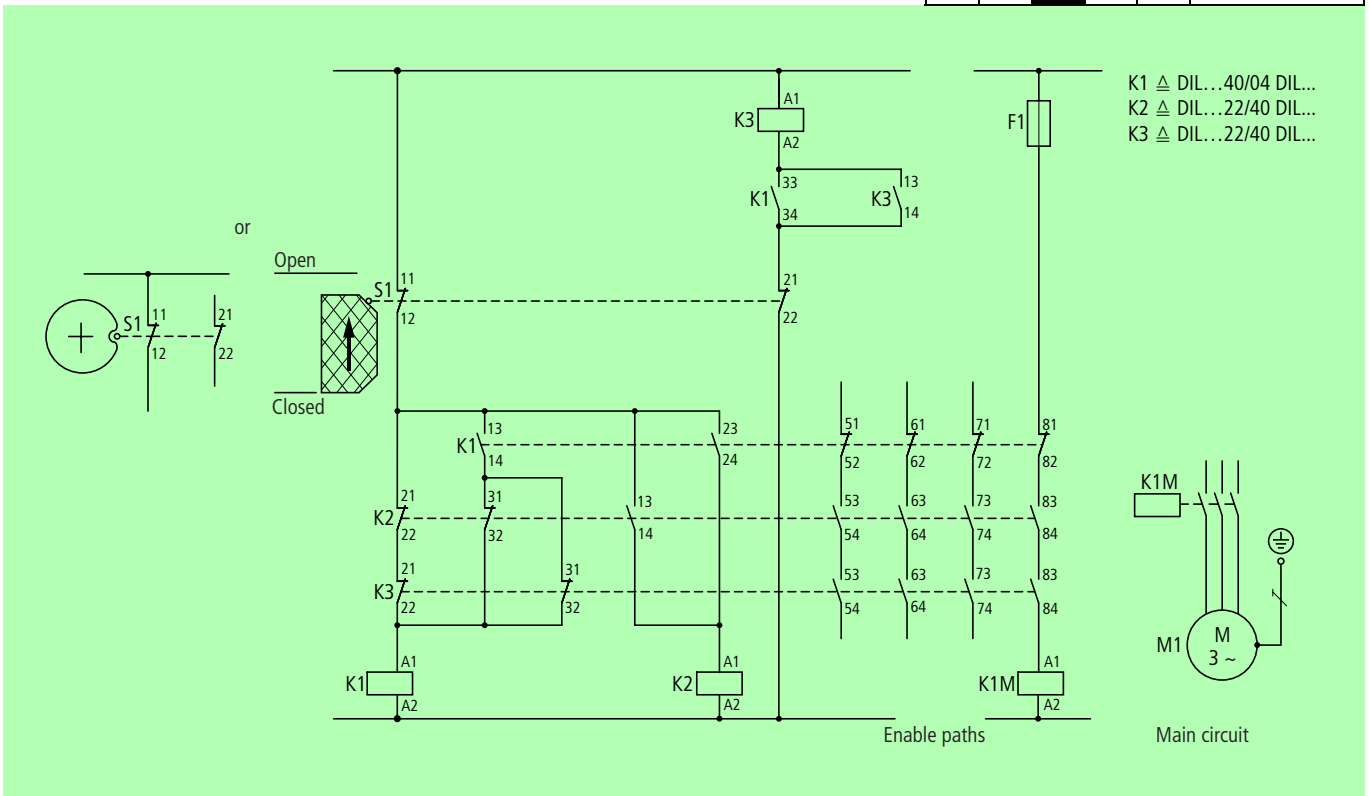
Monitoring Movable Guards

Without guard locking – fault monitoring of supply conductor

Application:

- When the position switch is not exposed to any particular hazards.
- When the supply conductor is exposed to particular hazards.
- When non-routine interventions in the danger zone may be necessary.
- When the stopping time is less than the access time.
- Start condition: guard closed.

B	1	2	3	4	Category according to EN 954-1
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Interlocking device with a position switch, 2 break contacts

Requirements:

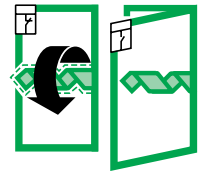
- Position switch with positive opening operation in accordance with EN 60 947-5-1 Appendix K and function in accordance with EN 1088.
- Contactors with positively driven contact elements.
- Provision of hardwired electromechanical components.
- Position switch must be protected against mechanical stress.
- Shutdown with a mobile protective mechanism must have its function tested regularly.
- Observe requirements of power supply and protective devices: Chapter 10.1.

Features:

- Design based on well-tried components and principles.
- Redundant and self-monitored command processing including supply conductor and position switch.
- Open-circuit and connection faults in the position switch, supply conductor and control panel are detected immediately or with the next start command.
- Mechanical failure of the position switch causes loss of safety function.

Function:

When the guard is being closed, the break contacts K2 and K3/21-22 ensure that these contactors are in the rest position. K1 picks up and by means of its make contacts 23-24 and 33-34 energizes contactors K2 and K3, which are maintained by means of their contacts 13-14. K1 is further maintained by means of its make contact 13-14 until K2 and K3 have picked up and their break contacts have de-energized K1, thus enabling the circuits for the control voltage.



The following safety standards apply to "Safety door monitoring without guard locking":		Page
EN 292	Safety of machinery – General principles for design	87
EN 1088	Safety of machinery – Interlock devices with or without retaining function	92
EN 954-1	Safety of machinery – Safety-related parts of control systems	89
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947/EN 1088

Type	AC-15/230 V	Short-circuit protection device
AT0-ZB	6 A	PKZM0-10, FAZ-B6
AT4/ZB	6 A	PKZM0-10, FAZ-B6

Special features: with separate, triple coded actuating element,
 ☉ with positive opening operation in accordance with EN 60 947-5-1 Appendix K, in accordance with EN 1088 section 4.2.1, type-examined by the German Employers' Association and SUVA, degree of protection IP 65.

Safety Position switch



Type	AC-15/230 V	Short-circuit protection device
ATR/TS	6 A	PKZM0-10, FAZ-B6
ATR/TKG	6 A	PKZM0-10, FAZ-B6
AT0	6 A	PKZM0-10, FAZ-B6

Special features: for direct fixing on the swiveling shrouds,
 ☉ with positive opening operation in accordance with EN 60 947-5-1 Appendix K, in accordance with EN 1088 section 4.2.1, type-examined by the German Employers' Association and SUVA, degree of protection IP 65.

Safety Position switch



Type	AC-15/230 V	Short-circuit protection device
DILER.../...DILE (DC)	6 A	PKZM0-4
DILR.../...DIL (AC+DC)	6 A	PKZM0-4

Special features: positively driven contact elements (not with early-make contact and late-break contact), finger proof and back-of-hand proof in accordance with IEC 536.

Contactor relays



Type	AC-3/400 V	Short-circuit protection device for 220/230 V auxiliary contacts
DIL00M up to DILM820/22	4 kW up to 450 kW	FAZ-C4

Special features: finger proof and back-of-hand proof (from DILM185 with terminal shroud) in accordance with IEC 536.

Contactors



Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118

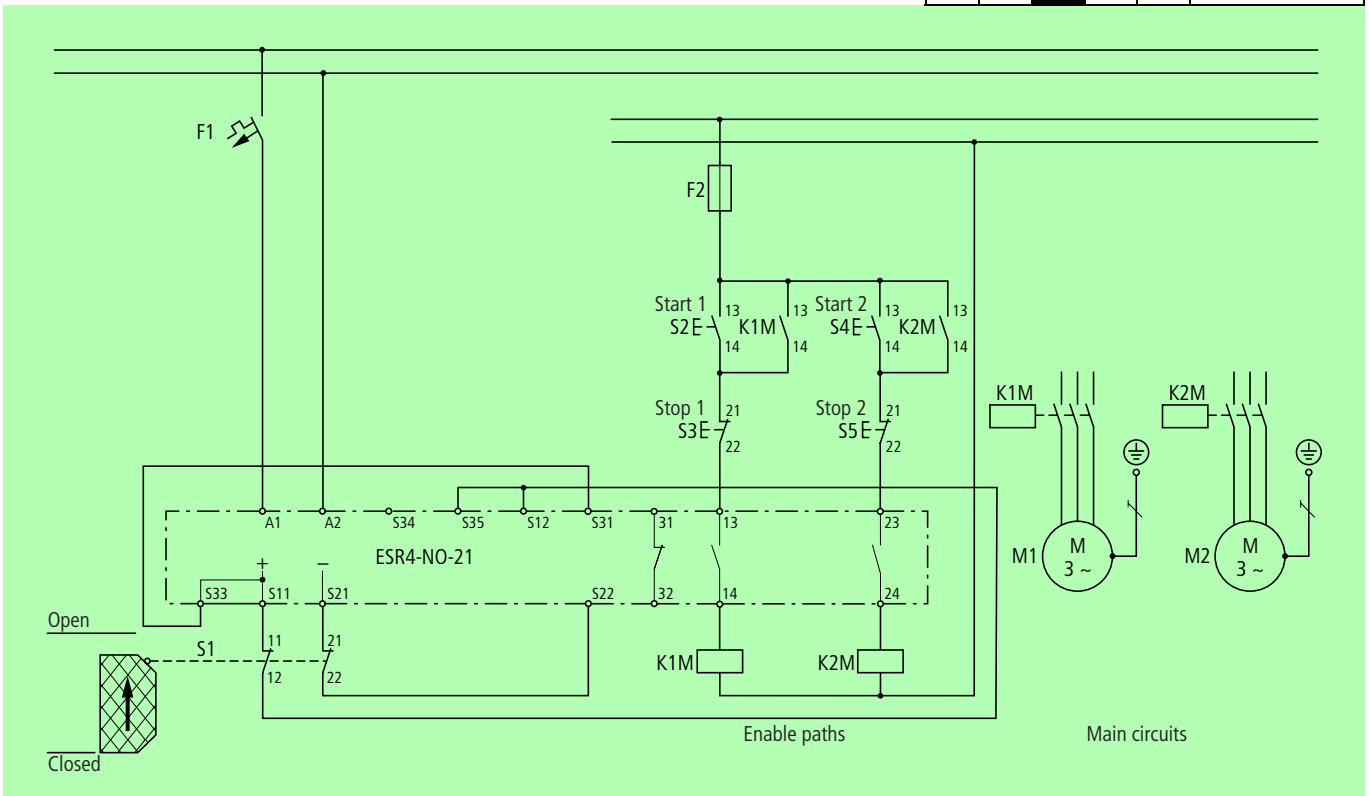
Monitoring Movable Guards

Without guard locking – fault monitoring of supply conductor

Application:

- When the supply conductor is exposed to particular hazards.
- When the stopping time is less than the access time.
- When non-routine interventions in the danger zone may be necessary.
- Start condition: guard closed.

B	1	2	3	4	Category according to EN 954-1
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Interlocking device with safety relay, 1 position switch, 2 break contacts

Requirements:

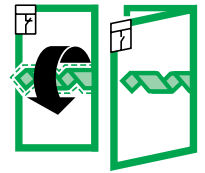
- Position switch with positive opening operation in accordance with EN 60 947-5-1 Appendix K and function in accordance with EN 1088.
- Safety relays with positive opening operation contacts.
- Provision of hardwired electromechanical components.
- Position switch must be protected against mechanical stress.
- Shutdown with a mobile protective mechanism must have its function tested regularly.
- Observe requirements of power supply and protective devices: Chapter 10.1.

Features:

- Design based on well-tried components and principles.
- Redundant and self-monitored command processing including supply conductor and position switch.
- Open-circuit and connection faults in the position switch, supply conductor and safety relay are detected immediately or with the next start command.
- Mechanical failure of the position switch causes loss of safety function.

Function:

After the supply voltage is applied to the safety relay (connection A1-A2), the "Power" LED indicates the readiness to activate the enable path. During closure of the protective mechanism, the control logic of the safety relay is activated by the rising edge (connection S35/wire bridge between S12 and S35 for automatic release of the enable path). The control logic monitors the ON-actuator and tests the rest position of the ESR-internal enable relays K1 and K2. The enable relays pick-up and are maintained via their upstream make contacts. This state is indicated by the "K1" and "K2" LEDs. The signal path (connection 31-32) is opened and the contactors K1M and K2M can now pick up via the two enable paths (connections 13-14 and 23-24) via the respective start commands S2 or S4.



The following safety standards apply to "Safety door monitoring without guard locking"		Page
EN 292	Safety of machinery – General principles for design	87
EN 1088	Safety of machinery – Interlock devices with or without retaining function	92
EN 954-1	Safety of machinery – Safety-related parts of control systems	89
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–
EN 61 810-1	Electromechanical switching relays	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947/EN 1088, EN 61 810-1

Type	DC-13/24 V	Short-circuit protection device
AT0	10 A	PKZM0-10, FAZ-B6

Special features: ☹ positive opening in accordance with EN 60 947-5-1 Appendix K, protected against movement by means of a round hole fixing in direction of actuation, in accordance with EN 1088 section 4.2.1, degree of protection IP 65.

Type	DC-13/24 V	Short-circuit protection device
AT0-ZB	10 A	PKZM0-10, FAZ-B6
AT4/ZB	10 A	PKZM0-10, FAZ-B6

Special features: with separate, triple coded actuating element, ☹ with positive opening operation in accordance with EN 60 947-5-1 Appendix K, in accordance with EN 1088 section 4.2.1, type-examined by the German Employers' Association and SUVA, degree of protection IP 65.

Type	DC-13/24 V	Short-circuit protection device
ATR/TS	10 A	PKZM0-10, FAZ-B6
ATR/TKG	10 A	PKZM0-10, FAZ-B6

Special features: for direct fixing on the swiveling shrouds, ☹ with positive opening operation in accordance with EN 60 947-5-1 Appendix K, in accordance with EN 1088 section 4.2.1, type-examined by the German Employers' Association and SUVA, degree of protection IP 65.

Type	Enable/signal contacts AC -15/230 V	Short-circuit protection device
ESR3-NO-31 (230V)	6 A ²⁾	6 A gG
ESR4-NO-21 ¹⁾	6 A ³⁾	6 A gG

Special features: positively driven contact elements, type-examined by the German Employers' Association and SUVA BG/EU design testing.

¹⁾ see circuit example

²⁾ max. total current of all current paths = 18 A

³⁾ max. total current of all current paths = 12 A

Type	AC-3/400 V	Short-circuit protection device for 220/230V auxiliary contact
DIL00M/11 up to DILM820/22	4 kW up to 450 kW	FAZ-C4

Special features: finger proof and back-of-hand proof (from DILM185 with terminal shroud) in accordance with IEC 536.

Position switch



Safety Position switch



Safety door switch/Safety hinge switch



Safety relay



Contactors



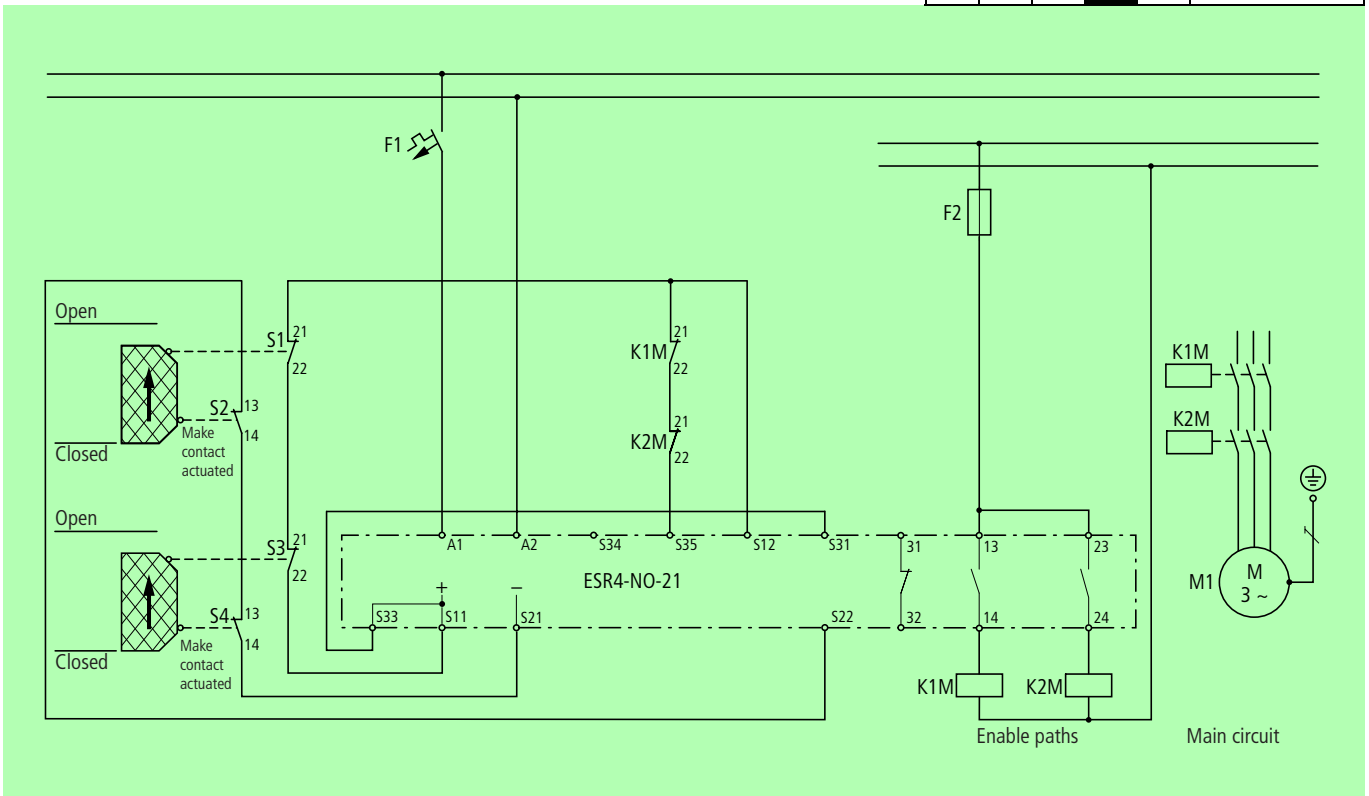
Monitoring Movable Guards

Without guard locking – several isolating protective mechanisms

Application:

- When the position switch and the supply conductor are exposed to particular hazards.
- When routine interventions in the danger zone may be necessary.
- When the stopping time is less than the access time.
- Start condition: all guards closed.

B	1	2	3	4	Category according to EN 954-1
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Interlock device with safety relay, with 2 isolating guards, with 2 positioning switches each (1 break, 1 make)

Requirements:

- Position switch with positive opening operation in accordance with EN 60 947-5-1 Appendix K and function in accordance with EN 1088.
- Safety relays with positive opening operation contacts.
- Provision of hardwired electromechanical components.
- Observe requirements of power supply and protective devices: Chapter 10.1.

Features:

- Design based on well-tried components and principles.
- Redundant command processing including supply conductor and position switch.
- The command processing including supply conductor and actuated position switch is self monitoring.

- Open-circuit and connection faults in the supply conductor and safety relay are detected immediately or with the next start command.
- An individual error does not lead to loss of the safety function.
- An accumulation of undetected errors can lead to a hazardous situation.
- Monitoring of redundant contactor relays/safety valves via feedback circuit (see page 81).

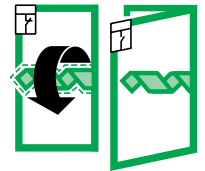
Function:

After the supply voltage is applied to the safety relay (connection A1-A2), the "Power" LED indicates the readiness to activate the enable path. When the last safety mechanism which was opened is closed, the break contacts of the K1M, K2M feedback circuit ensure that the contactors are in their rest position. If this state is

detected, the safety relay is actuated by the rising edge of the control logic (connection S35/connection between S12 and S35 for automatic start). The control logic first of all ensures the rest position of the ESR-internal enable relays K1 and K2. The enable relays pick-up and are maintained via their upstream make contacts. This state is indicated by the "K1" and "K2" LEDs. The signal path (connection 31-32) is opened and the contactors K1M and K2M can now pick up via the two enable paths (connections 13-14 and 23-24).

Caution!

The safety relay ESR4-NO-21 has the respective circuitry (i. e. respective assignment of the position switch) via simultaneous monitoring with $t_G = 0.5$ s. This assumes that the position switch S1 or S3 in channel 1 (connection S11-S12) closes before the respective position switch S2 or S4



in channel 2 (connection S21-S22). If channel 2 closes deactivated, i. e. $t_G = \infty$. before channel 1, simultaneous monitoring is

The following safety standards apply to "Safety door monitoring without guard locking"		
		Page
EN 292	Safety of machinery – General principles for design	87
EN 1088	Safety of machinery – Interlock devices with or without retaining function	92
EN 954-1	Safety of machinery – Safety-related parts of control systems	89
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–
EN 61 810-1	Electromechanical switching relays	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947/EN 1088, EN 61 810-1

Type	DC-13/24 V	Short-circuit protection device
AT0	10 A	6 A gL
AT4	10 A	6 A gL
ATR	10 A	6 A gL

Special features: ☉ positive opening in accordance with EN 60 947-5-1 Appendix K, protected against movement by means of a round hole fixing in direction of actuation, in accordance with EN 1088 section 4.2.1, degree of protection IP 65.

Position switch



Type	Enable/signal contacts AC -15/230 V	Short-circuit protection device
ESR3-NO-31 (230V)	6 A ²⁾	6 A gG
ESR4-NO-21 ¹⁾	6 A ³⁾	6 A gG

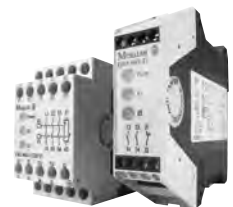
Special features: positively driven contact elements, type-examined by the German Employers' Association and SUVA.

¹⁾ see circuit example

²⁾ max. total current of all current paths = 18 A

³⁾ max. total current of all current paths = 12 A

Safety relay



Type	AC-3/400 V	Short-circuit protection device for 220/230V auxiliary contact
DIL00M/11 up to DILM820/22	4 kW up to 450 kW	FAZ-C4

Special features: finger proof and back-of-hand proof (from DILM185 with terminal shroud) in accordance with IEC 536.

Contactors



Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118

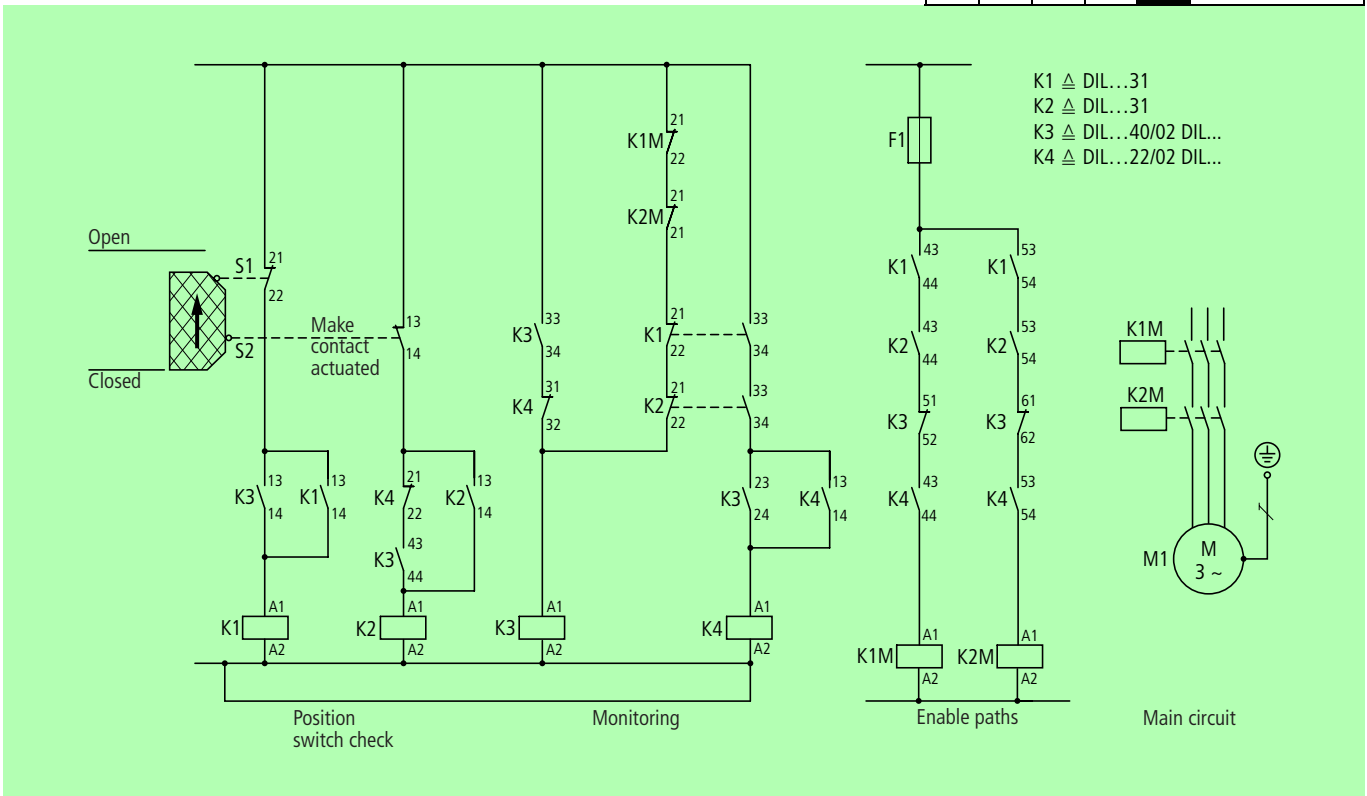
Monitoring Movable Guards

Without guard locking – fault monitoring of position switch and supply conductor

Application:

- When the position switch and the supply conductor are exposed to particular hazards.
- When routine interventions in the danger zone may be necessary.
- When the stopping time is less than the access time.
- Start condition: guard closed.

B	1	2	3	4	Category according to EN 954-1
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Interlock device with 2 position switches, 1 break contact and 1 make contact

Requirements:

- Position switch with positive opening operation in accordance with EN 60 947-5-1 Appendix K and function in accordance with EN 1088.
- Contactors with positively driven contact elements.
- Separately installed supply cables.
- Provision of hardwired electromechanical components.
- Ensure correct mounting and assembly of switching devices during the installation and wiring.
- Observe the order of wiring in the circuit diagram from left to right and from top to bottom.
- Power supply from the left.
- The power supply must not be looped downstream to other circuits/components.
- Design the reference potential as a ring.

- Observe requirements of power supply and protective devices: Chapter 10.1.

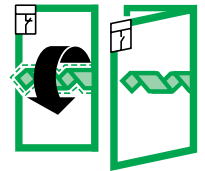
Features:

- Redundant and self-monitoring command processing including supply conductor and position switch.
- Protection in the event of a fault when switching device and supply conductor are used in rugged environments.
- Open-circuit and connection faults in the position switch, supply conductor and control cabinet are detected immediately or with the next start command.
- Increase of the enable paths or monitoring of redundant contactor relays via feedback circuit (see page 81).

Function:

When the safety guard is closed, the contactor K3 picks up via the break contacts 21-22 of K1 and K2 during switch on of the control voltage. K3 switches the contactors K1 and K2 on via its make contact 13-14 or 43-44. K1, K2 and K3 are self maintaining. The contactor K4 is switched on via the make contact 33-34 from K1 and K2 as well as from K3/23-24. K4 is maintained and disconnects contactor K3 via its break contact 31-32. The enable paths are thus closed.

By **opening** the safety guard, the contactors K1 and K2 are switched off via the make contacts S2/13-14 and via the break contacts S1/21-22, and the enable path is thus interrupted. Contactor K4 also drops out. K3 picks up via the break contact 21-22 of K1 and K2 and is self maintaining. The circuit monitoring is thus ready to start again.



The following safety standards apply to "Safety door monitoring without guard locking":		Page
EN 292	Safety of machinery – General principles for design	87
EN 1088	Safety of machinery – Interlock devices with or without retaining function	92
EN 954-1	Safety of machinery – Safety-related parts of control systems	89
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947/EN 1088

Type	AC-15/230 V	Short-circuit protection device
AT0	6 A	PKZM0-10, FAZ-B6
AT4	6 A	PKZM0-10, FAZ-B6

Special features: ☉ positive opening in accordance with EN 60 947-5-1 Appendix K, protected against movement by means of a round hole fixing in direction of actuation, in accordance with EN 1088 section 4.2.1, degree of protection IP 65.

Position switch



Type	AC-15/230 V	Short-circuit protection device
DILER(DC)	6 A	PKZM0-4
DILR(AC+DC)	6 A	PKZM0-4

Special features: positively driven contact elements (not with early-make contact and late-break contact), finger and back-of-hand proof in accordance with IEC 536.

Contactor relays



Type	AC-15/230 V	Short-circuit protection device
20(02)DIL	6 A	PKZM0-4

Special features: positively driven contact elements (not with early-make contact and late-break contact), finger and back-of-hand proof in accordance with IEC 536.

Auxiliary contact module



Type	AC-3/400 V	Short-circuit protection device for 220/230 V auxiliary contacts
DIL00M/11 up to DILM820/22	4 kW up to 450 kW	FAZ-C4

Special features: finger proof and back-of-hand proof (from DILM185 with terminal shroud) in accordance with IEC 536.

Contactors



Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales Office. The addresses of sales offices are given on page 118.

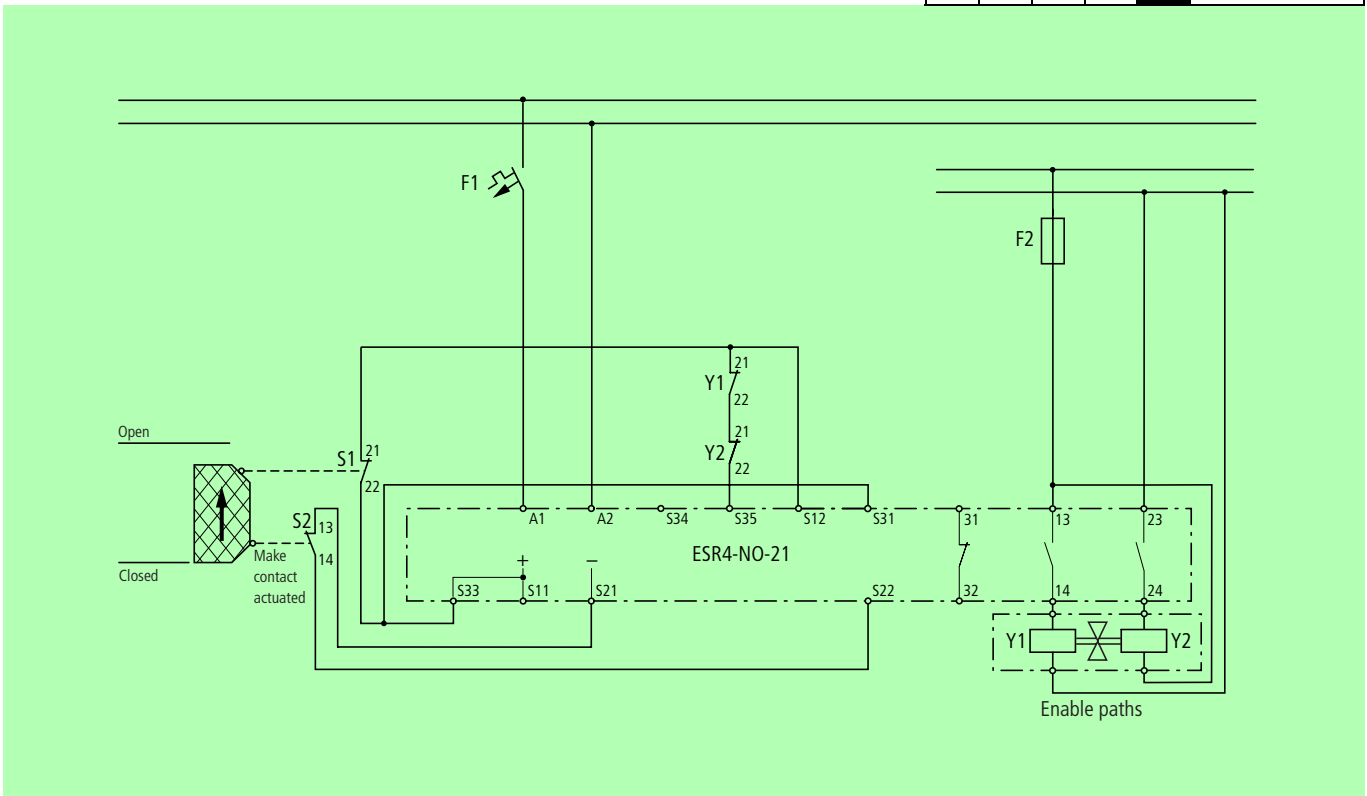
Monitoring Movable Guards

Without guard locking – fault monitoring of position switch and supply conductor

Application:

- When the position switch and the supply conductor are exposed to particular hazards.
- When routine interventions in the danger zone may be necessary.
- When the stopping time is less than the access time.
- Start condition: guard closed.

B	1	2	3	4	Category according to EN 954-1
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Interlock device with safety relay, 2 position switches, 1 break contact and 1 make contact

Requirements:

- Position switch with positive opening operation in accordance with EN 60 947-5-1 Appendix K and function in accordance with EN 1088.
- Safety relays with positive opening operation contacts.
- Separately installed supply cable.
- Provision of hardwired electromechanical components.
- Observe requirements of power supply and protective devices: Chapter 10.1.

Features:

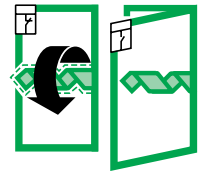
- Design based on well-tried components and principles.
- Redundant and self-monitoring command processing including supply conductor and position switch.
- Open-circuit and connection faults in the position switch, supply conductor and safety relay are detected immediately or with the next start command.
- Monitoring of redundant contactor relays/safety valves via feedback circuit (see page 81).

Function:

After the supply voltage is applied to the safety relay (connection A1-A2), the "Power" LED indicates the readiness to activate the enable path. When the safety guard is being closed, the break contact of the feedback circuit (Y1, Y2) ensures that the

safety valves Y1, Y2 are in the rest position. If this status is achieved, the safety relay (contact S35) is actuated by the rising edge of the control logic. The control logic monitors the ON-actuator and tests the rest position of the ESR-internal enable relays K1 and K2. The enable relays pick-up and are maintained via their upstream make contacts. This state is indicated by the "K1" as well as the "K2" LED. The signal path of the safety relay (connection 31-32) is opened and the safety valve Y1, Y2 opens via both of the enable paths (connections 13-14 and 23-24).

By **opening** the safety guard, the ESR internal enable relays K1 and K2 are switched off via both of the position switches (break contact S1/21-22 and make contact S2/13-14). The signal path (contact 31-32) closes and both enable paths (connections 13-14 and 23-24) open. The safety valve Y1,



Y2 closes and the safety relay is again ready to start via the closed break contact in the feedback circuit (Y1, Y2).

A short-circuit between both of the enable paths (connections 13-14 and 23-24) causes a shutdown by the short-circuit protection device, as a result of the design of the enable path (connection 23-24) when earthed. A short-circuit of this nature is conceivable outside the control panel due to e. g. damage to the supply conductor to safety valves Y1, Y2.

Caution!

The ESR4-NO-21 safety relay avails of the respective circuitry via monitoring of simultaneous action with $t_G = 0.5$ s. This assumes that the S1 position switch in channel 1 (connection S33-S12) closes before the S2 position switch in channel 2 (connection S21-S22). If S2 closes before S1, simultaneous monitoring is deactivated, i. e. $t_G = \infty$.

The following safety standards apply to "Safety door monitoring without guard locking"		Page
EN 292	Safety of machinery – General principles for design	87
EN 1088	Safety of machinery – Interlock devices	92
EN 954-1	Safety of machinery – Safety-related parts of control systems	89
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–
EN 61 810-1	Electromechanical switching relay	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947/EN 1088, EN 61 810-1

Type	AC-15/230 V	Short-circuit protection device
AT0	6 A	PKZM0-10, FAZ-B6
AT4	6 A	PKZM0-10, FAZ-B6
ATR	6 A	PKZM0-10, FAZ-B6

Special features: with separate, triple coded actuating element,

⊕ with positive opening operation in accordance with EN 60 947-5-1 Appendix K, in accordance with EN 1088 section 4.2.1, type-examined by the German Employers' Association and SUVA, degree of protection IP 65.

Type	Enable / signal contacts AC-15 at 230 V	Short-circuit protection device
ESR3-NO-31 (230V)	6 A ²⁾	6 A gG
ESR4-NO-21 ¹⁾	6 A ³⁾	6 A gG

Special features: positively driven contacts, type-examined by the German Employers' Association and SUVA .

¹⁾ see circuit example

²⁾ max. total current of all current paths = 18 A

³⁾ max. total current of all current paths = 12 A

Type	AC-3/400 V	Short-circuit protection device for auxiliary contacts 220/230V
DIL00M/11 up to DILM820/22	4 kW up to 450 kW	FAZ-C4

Special features: finger proof and back-of-hand proof (from DILM185 with terminal shroud) in accordance with IEC 536.

Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118.

Position switch



Safety relays



Contactors



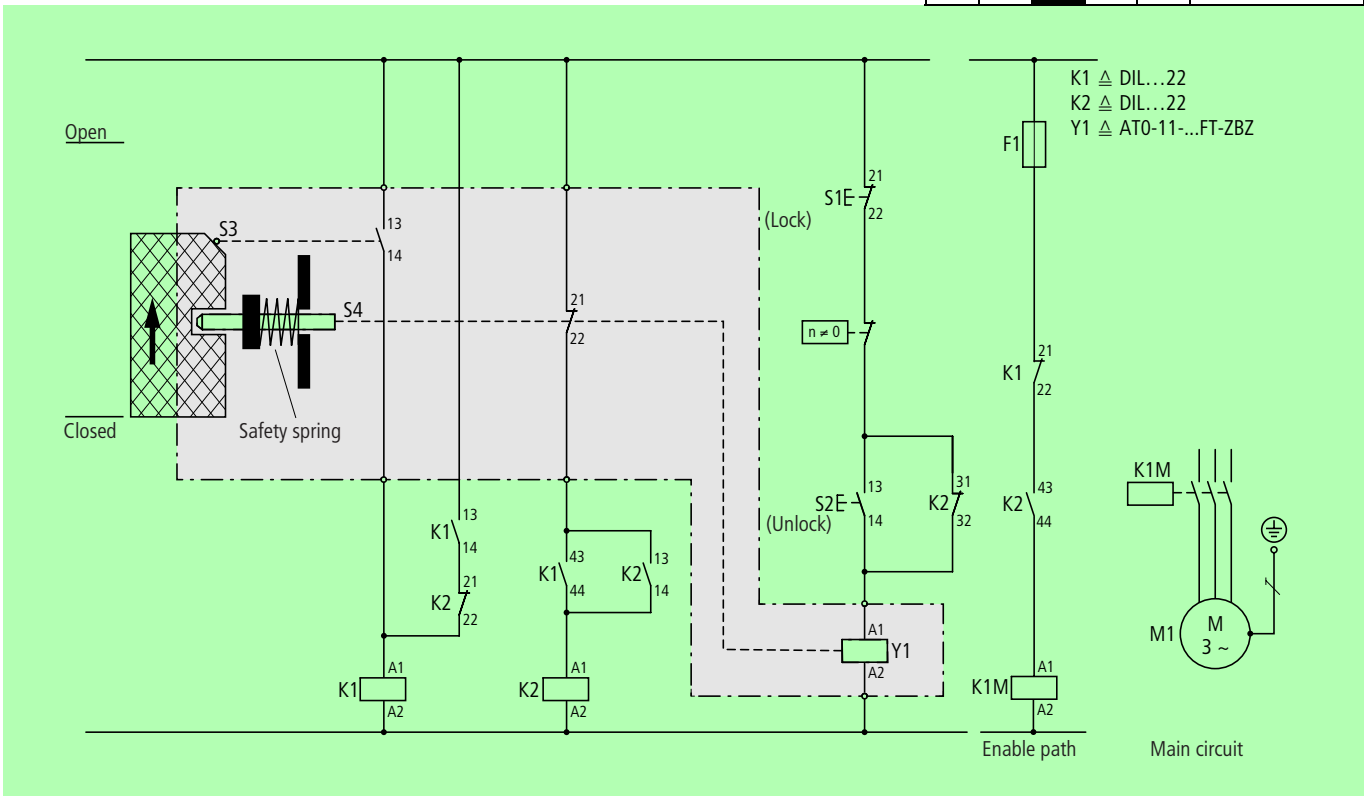
Monitoring Movable Guards

5.2 With guard locking – fault monitoring of supply conductor

Application:

- When the safety interlock is not exposed to any particular hazards.
- When the supply conductor is exposed to particular hazards.
- When non-routine interventions in the danger zone may be necessary.
- When the stopping time is greater than the access time.
- Start condition: opening and closing of guard and "Interlock" command.

B	1	2	3	4	Category according to EN 954-1
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Interlock device with safety interlock, 1 break contact and 1 make contact

Requirements:

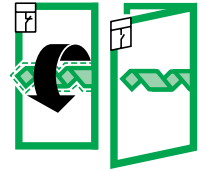
- Position switch with positive opening operation in accordance with EN 60 947-5-1 Appendix K and function in accordance with EN 1088.
- Safety interlock with guard locking must be protected against incorrect locking, i. e. the locking device cannot be locked when the guard is opened.
- Contactors with positively driven contact elements.
- Provision of hardwired electromechanical components.
- The mechanical locking function must be tested regularly.
- Observe requirements of power supply and protective devices, Chapter 10.1.

Features:

- Design based on well-tried components and principles.
- Redundant and self-monitored command processing incl. supply conductor and the mechanical function of the operating head.
- Open-circuit and connection faults in the safety interlock, supply conductor and control cabinet are detected immediately or with the next start command.
- Breakage or loosening or operating element from the guard causes the loss of the safety function.

Function:

When the control voltage is applied with the guard closed, Y1 (actuator magnet for the locking device and for break contact S4) picks up via the closed break contacts, unlocks the guard and opens the break contacts S4/21-22. When the guard is opened, contactor K1 picks up by means of the make contact S3/13-14 and is maintained by means of its make contact K1/13-14 and break contact K2/21-22. After the guard is closed (make contact S3/13-14 opens) this is interlocked by the opening of S1/21-22 (interlock) and the dropping out of Y1. At the same time K2 picks up by means of K1/43-44, is maintained via its make contact 13-14 and de-energizes or keeps K1 and Y1 de-energized. This closes the enable paths. At the beginning of the motor startup, the contact of the stop monitor opens. The guard cannot be unlocked until the motor has stopped.



The following safety standards apply to "Safety door monitoring without guard locking"		Page
EN 292	Safety of machinery – General principles for design	87
EN 1088	Safety of machinery – Interlock devices with or without retaining function	92
EN 954-1	Safety of machinery – Safety-related parts of control systems	89
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947/EN 1088

Type	AC-15/230 V	Short-circuit protection device
AT0-ZBZ	6 A	PKZM0-10, FAZ-B6

Special features: with separate, triple actuator element in 6 versions, locking force up to 2000 N, locking mechanism with spring or magnetic force, ☺ with positive opening operation in accordance with EN 60 947-5-1 Appendix K, in accordance EN 1088 section 4.2.2, type-examined by the German Employers' Association and SUVA, degree of protection IP 65.

Safety position interlock with mechanical securing function (guard locking)



Type	AC-15/230 V	Short-circuit protection device
DILER	6 A	PKZM0-4
DILR	6 A	PKZM0-4

Special features: positively driven contact elements (not with early-make contact and late-break contact), finger- and back-of-hand proof in accordance with IEC 536.

Contactor relays



Type	AC-3/400 V	Short-circuit protection device for auxiliary contacts 220/230 V
DIL00M up to DILM820/22	4 kW up to 450 kW	FAZ-C4

Special features: finger proof and back-of-hand proof (from DILM185 with terminal shroud) in accordance with IEC 536.

Contactors



Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118.

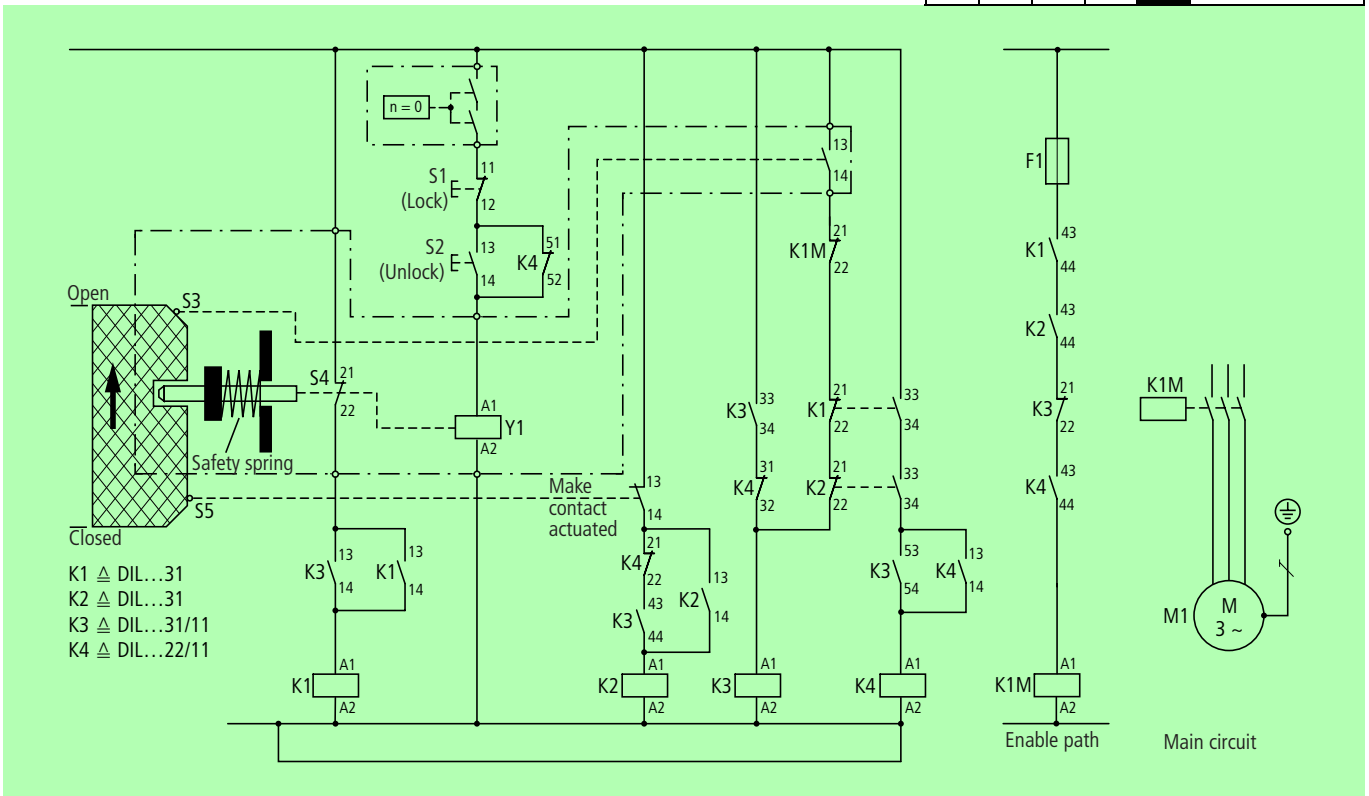
Monitoring Movable Guards

With guard locking – fault monitoring of position switch and supply conductor

Application:

- When the position/switch safety interlock and supply conductor are exposed to particular hazards.
- When routine interventions in the danger zone may be necessary.
- When the stopping time is greater than the access time.
- Start condition: opening and closing of guard and "Interlock" command.

B	1	2	3	4	Category according to EN 954-1
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Interlock device with guard locking (1 break contact and 1 make contact) and position switch (1 break contact)

Requirements:

- Safety interlock and position switch with positive opening operation in accordance with EN 60 947-5-1 Appendix K and function in accordance with EN 1088.
- Safety interlock with guard locking must be protected against incorrect locking, i. e. the locking device cannot be locked when the guard is opened.
- Contactors with positively driven contact elements.
- Provision of hardwired electromechanical components.
- Supply cables laid separately.
- The mechanical locking function must be tested regularly.
- Ensure correct mounting and assembly of switching devices during the installation and wiring.

- Observe the order of wiring in the circuit diagram from left to right and from top to bottom.
- Power supply from the left.
- The power supply must not be looped downstream to other circuits/components.
- Design the reference potential as a ring.
- Observe requirements of power supply and protective devices, Chapter 10.1.

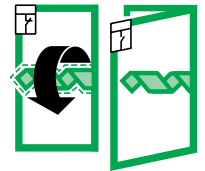
Features:

- All mechanical and electrical parts of the circuit are redundant and self-monitored.
- Protection in the event of a fault when switching device and supply conductor are used in rugged environments.
- Open-circuit and connection faults in the position switch, supply conductor and control cabinet are detected immediately or with the next start command.

- Increase of the enable paths or monitoring of redundant contactor relays via feedback circuit (see page 81).

Function:

When the control voltage is applied with the protective guard closed, Y1 (= actuator magnet for the locking device and for break contact S4) picks up via the closed break contacts and moves the locking devices from the locked position and opens S4/21-22. When the guard is opened, S3/13-14 closes. Contactor K3 picks up via S3/13-14 and the break contacts K1 and K2/21-22 and is maintained. Closing the protective door causes S5/13-14 to be actuated, and K2 picks up and is maintained. Actuating S1 (interlock) causes Y1 to drop out, the locking device moves to the locking position and S4 closes. At the same time K1 closes via S4/21-22 and K3/13-14 is maintained and energizes K4. K4 is again maintained and



disconnects contactor K3 via its break contact 31-32. This closes the enable paths. At the beginning of the motor startup, the contact of the stop monitor opens. The protective device cannot be unlocked until the motor has stopped.

The following safety standards apply to "Safety door monitoring with guard locking"		Page
EN 292	Safety of machinery – General principles for design	87
EN 1088	Safety of machinery – Interlock devices with or without retaining function	92
EN 954-1	Safety of machinery – Safety-related parts of control systems	89
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947/EN 1088

Type	AC-15/230 V	Short-circuit protection device
AT0-ZBZ	6 A	PKZM0-10, FAZ-B6

Special features: with separate, triple actuator element in 6 versions, locking force up to 2000 N, locking mechanism with spring or magnetic force, ☉ with positive opening operation in accordance with EN 60 947-5-1 Appendix K, in accordance EN 1088, type-examined by the German Employers' Association and SUVA, degree of protection IP 65.

Safety position interlock with mechanical securing function (guard locking)



Type	AC-15/230 V	Short-circuit protection device
AT0	6 A	PKZM0-10, FAZ-B6
AT4	6 A	PKZM0-10, FAZ-B6

Special features: ☉ positive opening in accordance with EN 60 947-5-1 Appendix K, protected against movement by means of a round hole fixing in direction of actuation, in accordance with EN 1088, degree of protection IP 65.

Position switch



Type	AC-15/230 V	Short-circuit protection device
DILER.../...DILE (DC)	6 A	PKZM0-4
DILR.../...DIL (AC+DC)	6 A	PKZM0-4

Special features: positively driven contact elements (not with early-make contact and late-break contact), finger- and back-of-hand proof in accordance with IEC536.

Contactor relays



Type	AC-3/400 V	Short-circuit protection device for 220/230 V auxiliary contacts
DIL00M/11 up to DILM820/22	4 kW up to 450 kW	FAZ-C4

Special features: finger proof and back-of-hand proof (from DILM185 with terminal shroud) in accordance with IEC 536.

Contactor



Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118.

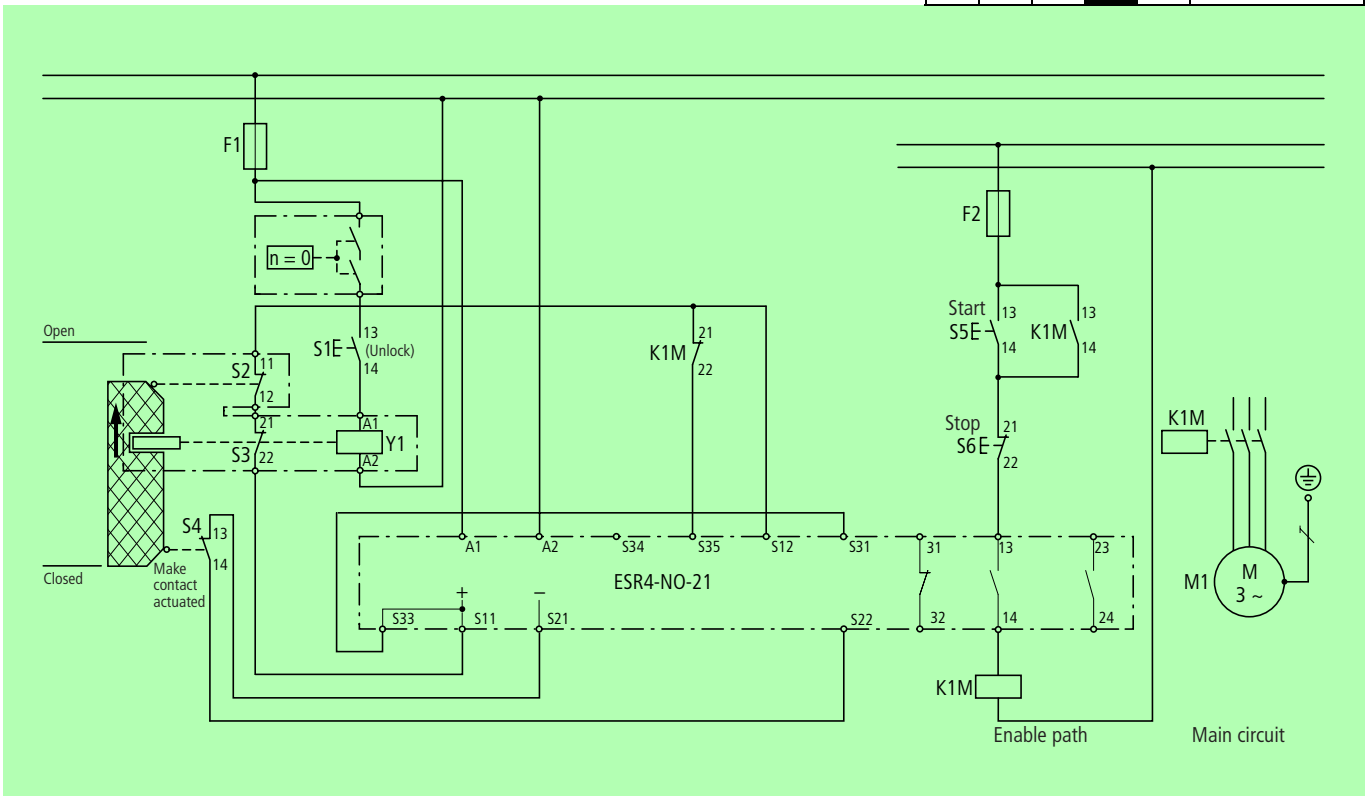
Monitoring Movable Guards

With guard locking – fault monitoring of position switch and supply conductor

Application:

- When the position/switch safety interlock and supply conductor are exposed to particular hazards.
- When routine interventions in the danger zone may be necessary.
- When the stopping time is greater than the access time.
- During opening of the safety guard, keep S1 (unlock) pressed.
- Start condition: guard closed.

B	1	2	3	4	Category according to EN 954-1
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Interlock device with safety relay, 1 safety position switch, 2 break contacts/1 position switch, 1 make contact

Requirements:

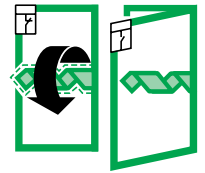
- Safety position switch and position switch with positive opening operation in accordance with EN 60 947-5-1 Appendix K and function in accordance with EN 1088.
- Safety interlock with guard locking must be protected against incorrect locking, i. e. the locking device cannot be locked when the guard is opened.
- Safety relays with positive opening operation contacts.
- Provision of hardwired electromechanical components.
- Observe requirements of power supply and protective devices: Chapter 10.1.
- All mechanical and electrical parts in the safety relevant section of the circuit are redundant and self-monitored.
- Open-circuit and connection faults in the safety position switch, position switch, supply conductor and safety relay are detected immediately or with the next start command.
- Monitoring of contactor relays via feedback circuit (see page 81).

Function:

After the supply voltage is applied to the safety relay (connection A1-A2), the "Power" LED indicates the readiness to activate the enable path. When the safety guard is closed, the break contact of the feedback circuit (K1M) ensures that the contactor K1M is in the rest position. If this state is achieved, the safety relay (contact S35) is actuated by the rising edge of the

control logic. The control logic monitors the ON-actuator and tests the rest position of the ESR-internal enable relays K1 and K2. The enable relays pick-up and are maintained via their upstream make contacts. This state is indicated by the "K1" as well as the "K2" LED. The signal path of the safety relay (connection 31-32) is opened and the contactor K1M can pick-up with the S5 "Start" command via the enable path (connection 13-14).

In order to **open** the safety guard, the "Stop" command S6 must first shutdown the hazardous motion. The S1 make contact (unlock) is actuated. In this manner, the stand still monitor ensures that there is no hazardous movements taking place. In this case, Y1 picks up (solenoid for the inhibitor and the S3 break contact), unlocks the safety guard and opens the S3 break contact. The safety relay drops out. The signal path



(contact 31-32) closes and the enable path (connections 13-14, 32-24) opens. The safety guard can only be opened when S1 (unlock) is being actuated. During opening of the safety guard, the S2 break contact of the safety position switch and the make contact S4 of the separate position switch open.

After **closing** of the safety guard and when S1 is not actuated (unlock), the signal path of the safety relay is opened automatically and the enable path is closed. The hazardous movement can be restarted.

The following safety standards apply to "Safety door monitoring with guard locking"		Page
EN 292	Safety of machinery – General principles for design	87
EN 1088	Safety of machinery – Interlock devices with or without retaining function	92
EN 954-1	Safety of machinery – Safety-related parts of control systems	89
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–
EN 61 810-1	Electromechanical switching relays	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947/EN 1088, EN 61 810-1

Type	AC-15/230 V	Short-circuit protection device
AT0-ZBZ	6 A	PKZM0-10, FAZ-B6

Special features: with separate, triple actuator element, locking force up to 2000 N, locking mechanism with spring or magnetic force, ☺ with positive opening operation in accordance with EN 60 947-5-1 Appendix K, in accordance EN 1088 section 4.2.1, type-examined by the German Employers' Association and SUVA (Swiss Accident Prevention Authority), degree of protection IP 65.

Safety Position switch



Type	Enable/signal contacts AC -15/230 V	Short-circuit protection device
ESR3-NO-31 (230V)	6 A ²⁾	6 A gG
ESR4-NO-21 ¹⁾	6 A ³⁾	6 A gG

Special features: positively driven contact elements, type-examined by the German Employers' Association and SUVA BG/EU design testing.

¹⁾ see circuit example

²⁾ max. total current of all current paths = 18 A

³⁾ max. total current of all current paths = 12 A

Safety relay



Type	AC-3/400 V	Short-circuit protection device for 220/230V auxiliary contact
DIL00M/11 up to DILM820/22	4 kW up to 450 kW	FAZ-C4

Special features: finger proof and back-of-hand proof (from DILM185 with terminal shroud) in accordance with IEC 536.

Contactors



Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118.

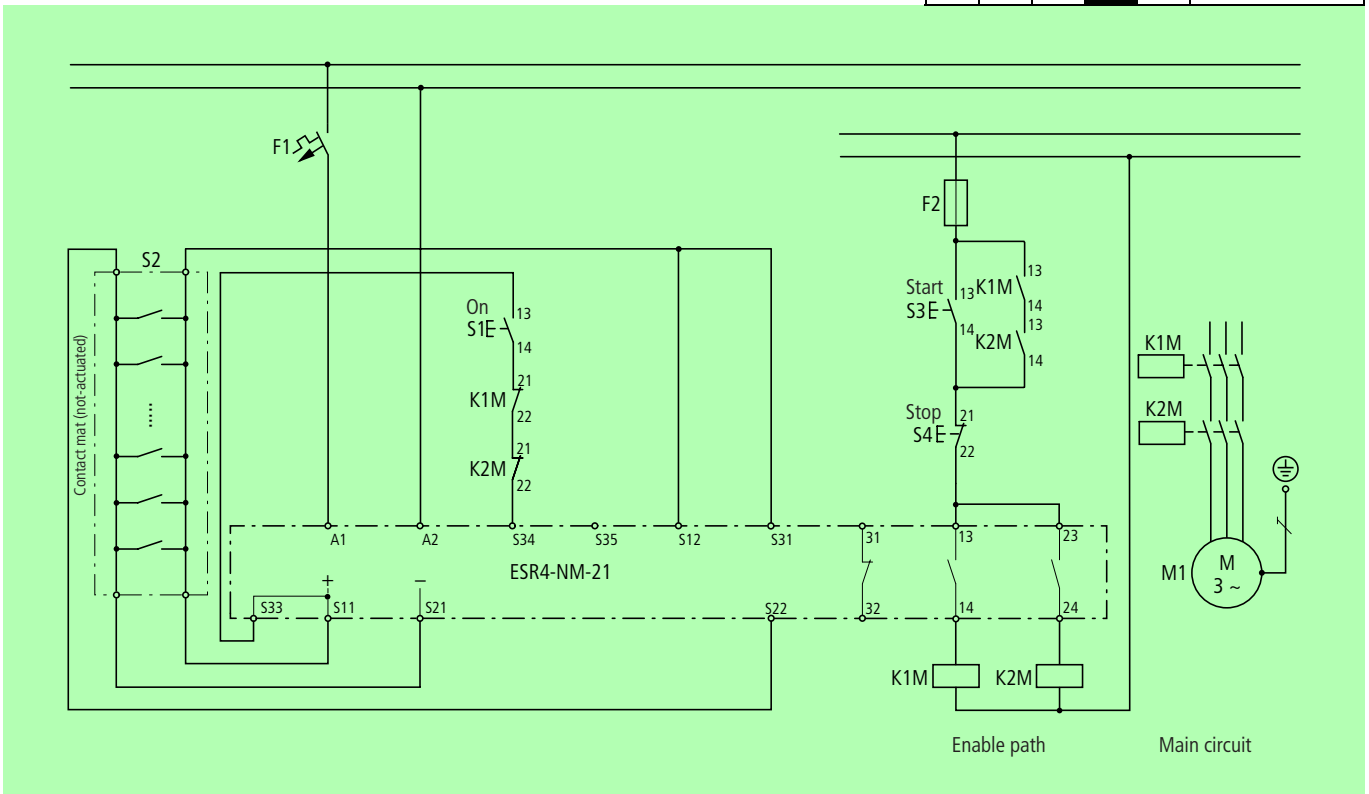
6. Monitoring Open Hazardous Zones

6.1 With contact mats

Application:

- With mechanically unprotected hazard areas.
- When the stopping time is less than the access time.
- Start condition: Contact mat unloaded.
- When the supply conductor is exposed to particular hazards.

B	1	2	3	4	Category according to EN 954-1
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Contact mat monitoring, 4-pole contact mat

Requirements:

- 4-pole contact mats
- Safety relays with positive opening operation contacts.
- Provision of hardwired electromechanical components.
- Observe requirements of power supply and protective devices: Chapter 10.1.

Features:

- Design based on well-tried components and principles.
- Redundant and self-monitored command processing.
- The control circuit device and incomer are redundant.
- Open-circuit and connection fault in the safety relay is detected immediately or with the next start command.

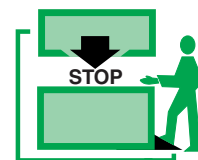
- Open-circuit and short-circuit in the contact mat and incomer are partially detected.
- An individual error does not lead to loss of the safety function.
- An accumulation of undetected errors can lead to a hazardous situation.
- Monitoring redundant contactor/safety valves via feedback circuit (see Page 81).

Function:

After the supply voltage is applied to the safety relay (connection A1-A2), the "Power" LED indicates the readiness to activate the enable path. When the ON actuator S1 is operated and the contact mat S2 is unloaded, the break contacts of the feedback circuit (K1M, K2M) ensure that the contactors are in their rest position. When this state is achieved, the safety relay is actuated by the falling edge of the control

logic on connection S34 (the ON-actuator must be pressed and released). The control logic monitors the ON-actuator and tests the rest position of the ESR-internal enable relays K1 and K2. These enable relays pick-up and are maintained via their upstream make contacts. This state is indicated by the "K1" as well as the "K2" LED. The signal path of the safety relay (connection 31-32) is opened and the contactors K1M and K2M can now pick up via the two enable paths (connections 13-14 and 23-24) via the start commands S3.

When the contact mat is walked on, an intended short-circuit is created via the internal make contact of S2. The shunted connection recognition of the safety relay (connection S11-S12 and S21-S22) activates immediate shut-down of the ESR-internal relays K1 and K2. The enable path opens and the signal path closes.



For the "monitoring of open hazardous zones with contact mats" the following safety standards apply		Page
EN 292	Safety of machinery – General principles for design	87
EN 1760-1	Safety of machinery – Pressure sensitive safety devices	–
EN 954-1	Safety of machinery – Safety-related parts of control systems	89
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–
EN 61 810-1	Electromechanical switching relays	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947/EN 61 810-1

Type	Enable/signal contacts AC -15/230 V	Short-circuit protection device
ESR4-NM-21	6 A ¹⁾	6 A gG

Special features: positively driven contact elements, approved by the BG/EU design testing.

¹⁾ max. total current of all current paths = 12 A

Safety relay



Type	AC-3/400 V	Short-circuit protection device for 220/230V auxiliary contact
DIL00M/11 up to DILM820/22	4 kW up to 450 kW	FAZ-C4

Special features: finger proof and back-of-hand proof (from DILM185 with terminal shroud) in accordance with IEC 536.

Contactors



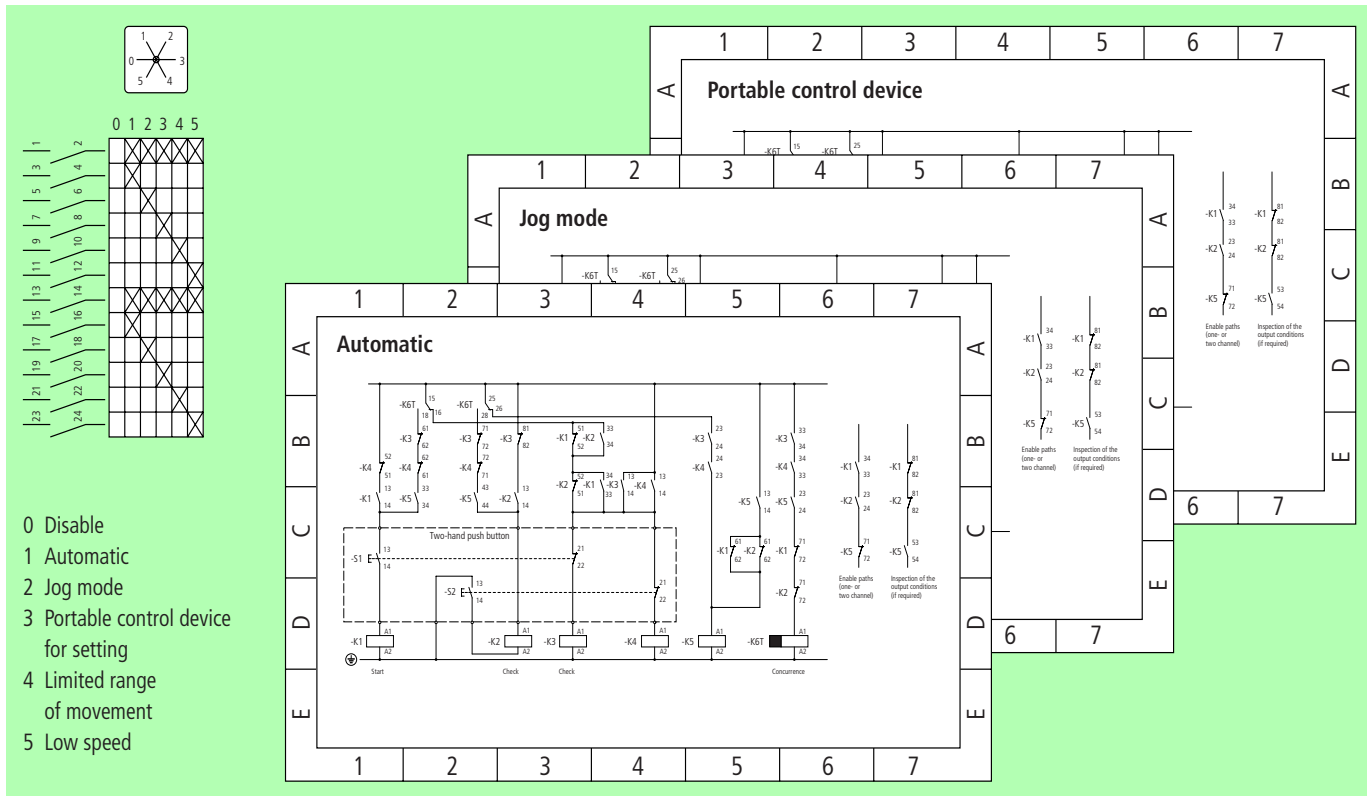
Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118.

7. Enable Setting

7.1 With operating mode selector switch

Application:

- Setting operation with guard opened.
 - On machine tools, as e. g.
 - presses
 - injection moulding machines
 - cutting machines
 - revolving stamping machines.



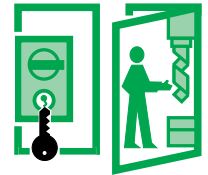
Possible operating modes during setting operation

Requirements:

- Operating mode selector switch must be lockable (EN 60 204-1).
- Operating mode selector switch with positively driven contacts without overlapping contacting.
- Additional measures for increasing the safety must be provided, e. g.:
 - Jog operation
 - Portable controller device for setting work
 - Restricted range of movement
 - Low speed

Function:

- The operating mode can be selected after unlocking via a key.
- This causes protective guards such as protective screens, light curtains etc. to be bypassed.
- This enables setting operation.
- "Measures for increasing the safety of setting operation" must be effective in accordance with the risks involved.



The following safety standards apply to "Enabling Setting":		Page
EN 292	Safety of machinery – General principles for design	87
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947

Type	AC-15/230 V	Short-circuit protection device
T0-.../SVA	4 A	20 A gL/gG
T3-.../SVA	6 A	25 A gL/gG

Special features: lockable in each switch position, only one operating mode selectable, suitable for the Moeller range of rotary switches, ☺ Positive opening operation in accordance with EN 60 947-5-1 Appendix K, standard or special lock mechanism or for master key systems, degree of protection IP 65.

Operating mode selectorkey switch with cylinder lock



Type	AC-15/230 V	Short-circuit protection device
T0-.../SVC	4 A	20 A gL/gG
T3-.../SVC	6 A	25 A gL/gG

Special features: lockable with padlocks in each switch position, only one operating mode selectable at a time, suitable for the Moeller range of rotary switches, ☺ positive opening operation in accordance with EN 60 947-5-1 Appendix K, degree of protection IP 65.

Operating mode selector switch with padlock



Type	AC-15/230 V	Short-circuit protection device
M22-WRS3	6 A	PKZM0-10,FAZ-B6

Special features: key can be removed in each switch position, 3 switch positions, suitable for the RMQ-Titan control circuit device range of Moeller, ☺ positive opening operation in accordance with EN 60 947-5-1 Appendix K, degree of protection IP 66, suitable for standard or special lock mechanism or for master key systems.

Key-operated actuator



Suitable circuits are very complex and cannot be presented in this manual. Contact your Moeller sales office for design and engineering advice.

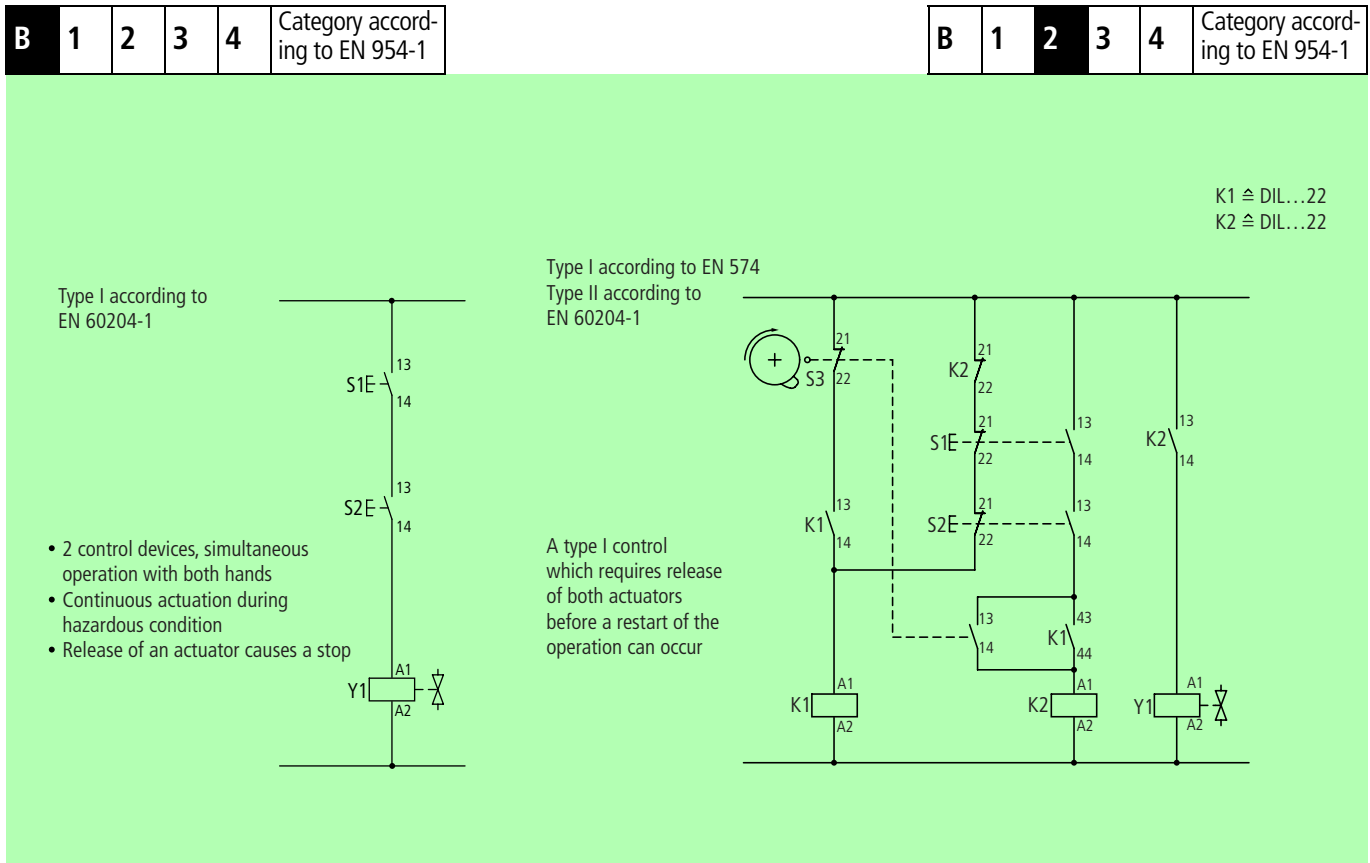
Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118.

8. Safe Operation

8.1 Two-hand control type I and II according to EN 60 204-1

Application:

- For hazardous machine movements: both hands outside the danger zone.
- For machines where there is a low risk of injury e. g. assembly devices with manual conveying.



Two-hand controls type I and type II in accordance with EN 60 204-1

Requirements:

- Operation with a standard two-hand control in accordance with EN 574.
- Locate the actuating devices so that unintentional starting or intentional single-handed operation is not possible.
- The circuit can be implemented at own risk.
- Observe requirements of power supply and protective devices: Chapter 10.1.

Features:

- Type I: Continuous, simultaneous actuation with both hands, release of either actuator causes STOP.
- Type II: As with type I, release of both actuators is additionally required before machine restart can be initiated.
- The requirements of EN 60 204-1 for two-hand controls are fulfilled by both these type I and type II circuits.
- Any further requirements of the standard amendment please refer to EN 574 (see page 96). Also required e. g., measures for the prevention of safety feature bypass and documentation stipulating error prevention.

Function:

Type I: Y1 only energized if S1 and S2 are actuated.

Typ II: K1 is only energized if K2 and consequently the machines drive has been disconnected.

K1 is maintained since S3 only interrupts for a short time before end of travel. K2 is then energized via S1, S2 and K1 and switches on the drive as long as the actuators are pressed. Before reaching the initial position, S3 opens briefly, K1 drops out and therefore, K2 and Y1 also. Both actuators must be released and pressed again in order to close K1 so that the machine is restarted. The make contact S3 prevents a blocking when the cam is in the actuating position.



The following safety standards apply to "Two-hand control":		Page
EN 292	Safety of machinery – General principles for design	87
EN 574	Safety for machinery – Two-hand control	96
EN 954-1	Safety of machinery – Safety-related parts of control systems	89
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947

Type	AC-15/230 V	Short-circuit protection device
FAK-SW	6 A	PKZM0-10, FAZ-B6

Special features: ☉ positive opening operation in accordance with EN 60 947-5-1 Appendix K, very rugged design, suitable for operation with gloves, degree of protection IP 67, IP 69K.

Foot and palm switches



Type	AC-15/230 V	Short-circuit protection device
AT0	6 A	PKZM0-10, FAZ-B6
AT4	6 A	PKZM0-10, FAZ-B6

Special features: ☉ positive opening in accordance with EN 60 947-5-1 Appendix K, protected against movement by means of a round hole fixing in direction of actuation, in accordance with EN 1088 section 4.2.1, degree of protection IP 65.

Position switch



Type	AC-15/230 V	Short-circuit protection device
DILER	6 A	PKZM0-4
DILR	6 A	PKZM0-4

Special features: positively driven contact elements (not with early-make contact and late-break contact), finger and back-of-hand proof in accordance with IEC 536.

Contact relays



Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118.

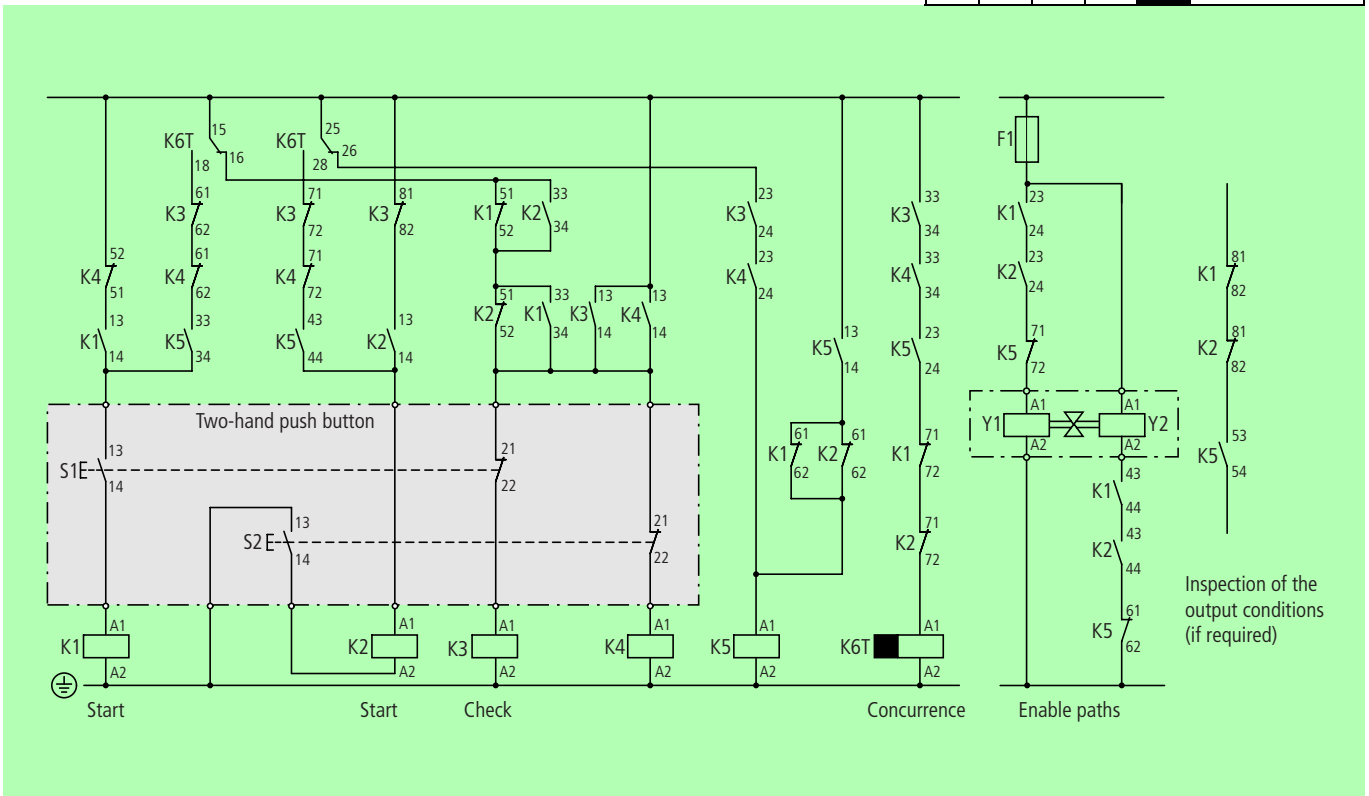
Safe Operation

8.2 Two-hand control in accordance with type III

Application:

- For hazardous machine movements: both hands outside the danger zone.
- For machines where there is a high risk of injury such as:
 - Presses with manual conveyance
 - Cutters with manual conveyance
- Stamping machines with manual conveyance

B	1	2	3	4	Category according to EN 954-1
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Type 3 two-hand control in accordance with EN 60 204-1 and Type III C in accordance with EN 574

Requirements:

- Operation with a standard two-hand control in accordance with EN 574.
- Locate the actuating devices so that unintentional starting or intentional single-handed operation is not possible.
- Circuits must be type-examined in accordance with EC regulations. The above circuit is type-examined by the German Employers Association, Board for Iron and Metal III.
- Positively opening actuating devices in accordance with EN 60 947-5-1 Appendix K.
- The two-channel design must also apply to the operating elements (sensors/actuators) of the safety control.
- Observe requirements of power supply and protective devices: Chapter 10.1.

Features:

- As type II (page 66), both buttons must also be operated within max. 0.5 seconds of each other. If this time is exceeded, both buttons must be released.
- Circuit is redundant and self-monitored.
- A single fault in the control system does not cause the loss of the safety function.
- Individual faults are detected before executing the next function.
- The safety functions are retained in the event of an error.
- Open-circuit and connection faults and failure of operating equipment inside and outside the control system are detected and cause safe operation.

Function:

The devices K3, K4, K5, K6T are energized when the power supply is switched on. Actuating S1 and S2 causes K3 and K4 to drop out and K1 and K2 to pick up. The enable circuit is active after K5 drops out. If only one actuator is operated and the second actuator is not actuated within 0.5 seconds, K6T drops out and deactivates the second actuator. A restart is only possible after both actuating elements have been released.

Connection faults between the make contacts of S1 and S2 are detected by connecting the make contact S2 to the earthed potential.

The same principle applies for the circuit arrangement of the safety valves Y1, Y2.



The following safety standards apply to "Two-hand control":		Page
EN 292	Safety of machinery – General principles for design	87
EN 574	Safety for machinery – Two-hand control	96
EN 954-1	Safety of machinery – Safety-related parts of control systems	89
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947

Type	AC-15/230 V	Short-circuit protection device
M22-DP...	6 A	PKZM0-10, FAZ-B6

Special features: ☉ positive opening operation in accordance with EN 60 947-5-1 Appendix K, abrasion resistant symbols, suitable for operation with gloves, degree of protection IP 66.

Mushroom actuators



Type	AC-15/230 V	Short-circuit protection device
FAK	6 A	PKZM0-10, FAZ-B6

Special features: ☉ positive opening operation in accordance with EN 60 947-5-1 Appendix K, very rugged design, suitable for operation with gloves, degree of protection IP 67, IP 69K.

Foot and palm switches



Type	AC-15/230 V	Short-circuit protection device
DILR.../...DIL	6 A	PKZM0-4

Special features: positively driven contact elements (not with early-make and late-break contact), finger and back-of-hand proof in accordance with IEC 536.

Contactor relays



Type	AC-3/400 V	Short-circuit protection device for 220/230 V auxiliary contacts
DIL00M/11 up to DILM820/22	4 kW up to 450 kW	FAZ-C4

Special features: finger proof and back-of-hand proof (from DILM185 with terminal shroud) in accordance with IEC 536.

Contactors



Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118.

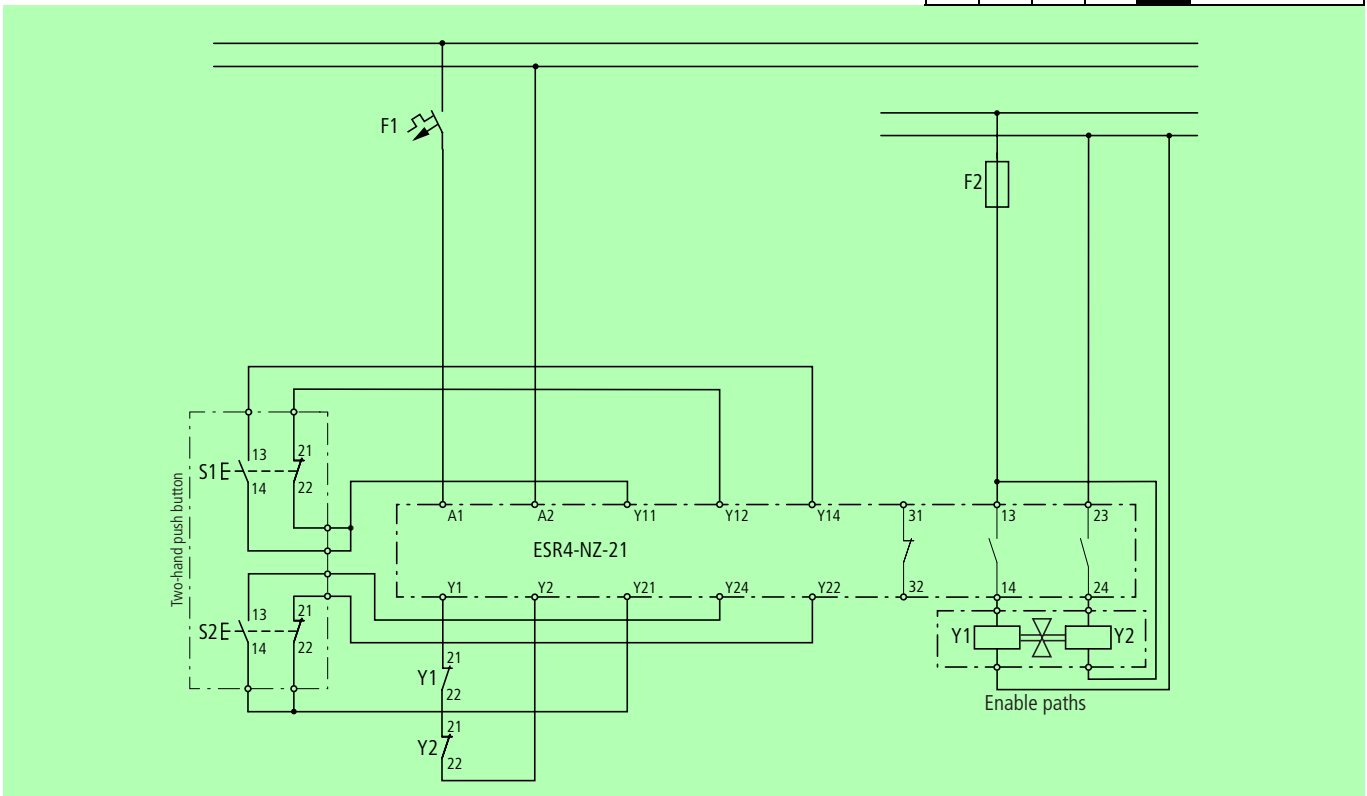
Safe Operation

Two-hand control in accordance with type III

Application:

- For hazardous machine movements: both hands outside the danger zone.
- For machines where there is a high risk of injury such as:
 - Presses with manual conveyance
 - Cutters with manual conveyance
- Stamping machines with manual conveyance

B	1	2	3	4	Category according to EN 954-1
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Type III two-hand control in accordance with EN 60 204-1 and Type III C in accordance with EN 574, with safety relays.

Requirements:

- Operation with a standard two-hand control in accordance with EN 574.
- Locate the actuating devices so that unintentional starting or intentional single-handed operation is not possible.
- The safety relays must be EU-prototype tested: ESR4-NZ-21 is prototype tested.
- Positively opening actuating devices in accordance with EN 60 947-5-1 Appendix K.
- The two-channel design must also apply to the operating elements (sensors/actuators) of the safety control.
- Observe requirements of power supply and protective devices: Chapter 10.1.

Features:

- Design based on well-tried components and principles.

- Control circuits, supply cables and command processing are redundant and self-monitored.
- Both actuators must be pressed within a max. of 0.5 seconds. Release of both actuators is required if this time is exceeded, before restart can occur.
- If any one of both actuators is released during a hazardous movement, the safety relay is immediately de-energized and the enable paths open (uncontrolled stopping - STOP - category 0 according to EN 60 204-1).
- Open-circuit and connection faults in the control circuit device, supply conductor and safety relay are detected immediately or with the next start command.
- Monitoring of redundant contactor relays/safety valves via feedback circuit (see page 81).

Function:

After the supply voltage is applied to the safety relay (connection A1-A2), the "Power" LED indicates the readiness to activate the enable path. When the two-hand control keys are actuated (S1 and S2 simultaneously within a max. of 0.5 seconds), the break contact of the feedback circuit (Y1 and Y2) ensures the normal position of the safety valve Y1, Y2. If this state is assured, the LED "K1" (Channel 1) and the LED "K2" (Channel 2) indicate that a synchronous actuation of the two-hand control keys has occurred. The signal path of the safety relay (connection 31-32) is opened and the safety valve Y1, Y2 can open via both of the enable paths (connections 13-14 and 23-24).

A short-circuit between both of the enable paths (connections 13-14 and 23-24) causes a shutdown by the short-circuit protection



device, as a result of the design of the enable path (connection 23-24) when earthed. A short-circuit of this nature is conceivable outside the control panel due to e. g. damage to the supply conductor to safety valves Y1, Y2.

The following safety standards apply to "Two-hand control"		Page
EN 292	Safety of machinery – General principles for design	87
EN 574	Safety for machinery – Two-hand control	96
EN 954-1	Safety of machinery – Safety-related parts of control systems	89
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–
EN 61 810-1	Electromechanical switching relays	–

Note also the explanation in chapter 11

Safety-related switching devices in accordance with EN 60 947, EN 61 810-1

Type	DC-13/24 V	Short-circuit protection device
M22-DP...	6 A	PKZM0-10, FAZ-B6

Special features: ☺ positive opening operation in accordance with EN 60 947-5-1 Appendix K, abrasion resistant symbols, suitable for operation with gloves, degree of protection IP 66.

Mushroom actuators



Type	DC-13/24 V	Short-circuit protection device
FAK	6 A	PKZM0-10, FAZ-B6

Special features: ☺ positive opening operation in accordance with EN 60 947-5-1 Appendix K, very rugged design, suitable for operation with gloves, degree of protection IP 65, IP 69K.

Foot and palm switch



Type	Enable/signal contacts AC -15/230 V	Short-circuit protection device
ESR4-NZ-21	6 A ¹⁾	6 A gG

Special features: positively driven contacts, approved by the BG/EU design testing.

¹⁾ max. total current of all current paths = 12 A

Safety relay



Type	AC-3/400 V	Short-circuit protection device for 220/230V auxiliary contact
DIL00M/11 up to DILM820/22	4 kW up to 450 kW	FAZ-C4

Special features: finger proof and back-of-hand proof (from DILM185 with terminal shroud) in accordance with IEC 536.

Contactors



Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118.

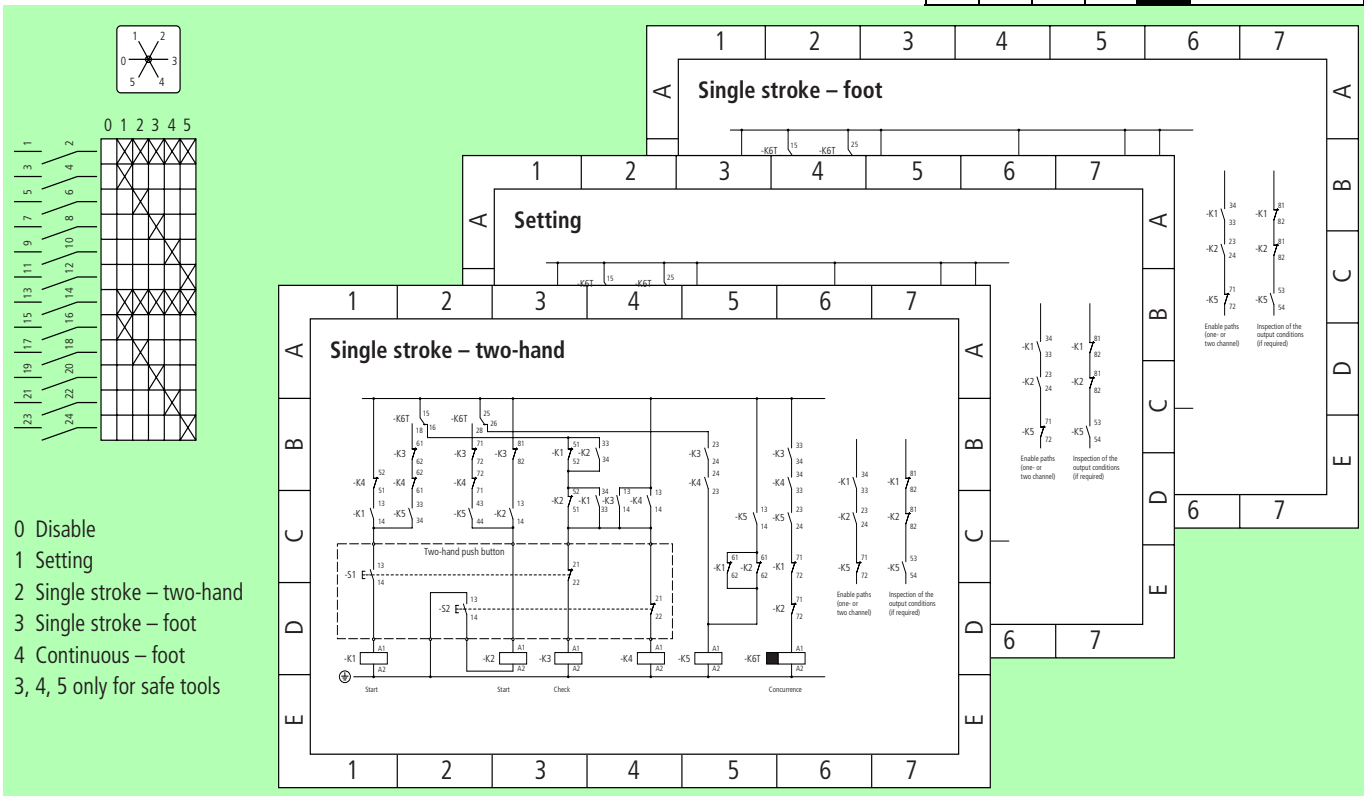
Safe Operation

8.3 Press safety control system

Application:

- Protection of the operator when working on machine tools for forming and cutting.
- All safety-relevant, electrical control functions are implemented, such as:
 - Two-hand control
 - Operating mode selection
 - etc.

B	1	2	3	4	Category according to EN 954-1
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Press-safety control system

Requirements:

- Engineering design and construction by Moeller in accordance with the approved prototype tested documentation.

Features of "Contactor Circuit Design Concept"

- Circuit concept for designing safety control systems with contactor wiring.
- Designed from self-contained function blocks.
- Using standard circuits, the concept allows the possibility of individually designed control systems for a wide range of press designs, sizes and functions (mechanical or hydraulic).
- Only standard switching devices are required for stocking spares.
- Moeller has a type-examination (certificate) for this circuit concept from the German Employers' Association, Board for Iron and Metal III.



The following safety standards apply to "Safe operation" of machines:		Page
EN 292	Safety of machinery – General principles for design	87
EN 574	Safety for machinery – Two-hand control	96
EN 954-1	Safety of machinery – Safety-related parts of control systems	89
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 947	Low-voltage switchgear	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 947

Type	AC-15/230 V	Short-circuit protection device
M22-DP...	6 A	PKZM0-10, FAZ-B6

Special features: ☉ positive opening operation in accordance with EN 60 947-5-1 Appendix K, abrasion resistant symbols, suitable for operation with gloves, degree of protection IP 66.

Mushroom actuators



Type	AC-15/230 V	Short-circuit protection device
T0-.../SVA	4 A	20 A gL/gG
T3-.../SVA	6 A	25 A gL/gG

Special features: lockable in each switch position, only one operating mode selectable, suitable for the Moeller range of rotary switches, ☉ positive opening operation in accordance with EN 60 947-5-1 Appendix K, standard or special lock mechanism or for master key systems, degree of protection IP 65.

Operating mode selector switch with cylinder lock



Type	AC-3/400 V	Short-circuit protection device
DILR.../...DIL	6 A	PKZM0-4

Special features: positively driven contact elements (not with early-make and late-break contact), finger and back-of-hand proof in accordance with IEC 536.

Contactor relays



Suitable circuits are very complex and cannot be presented in this manual. Contact your Moeller sales office for design and engineering support.

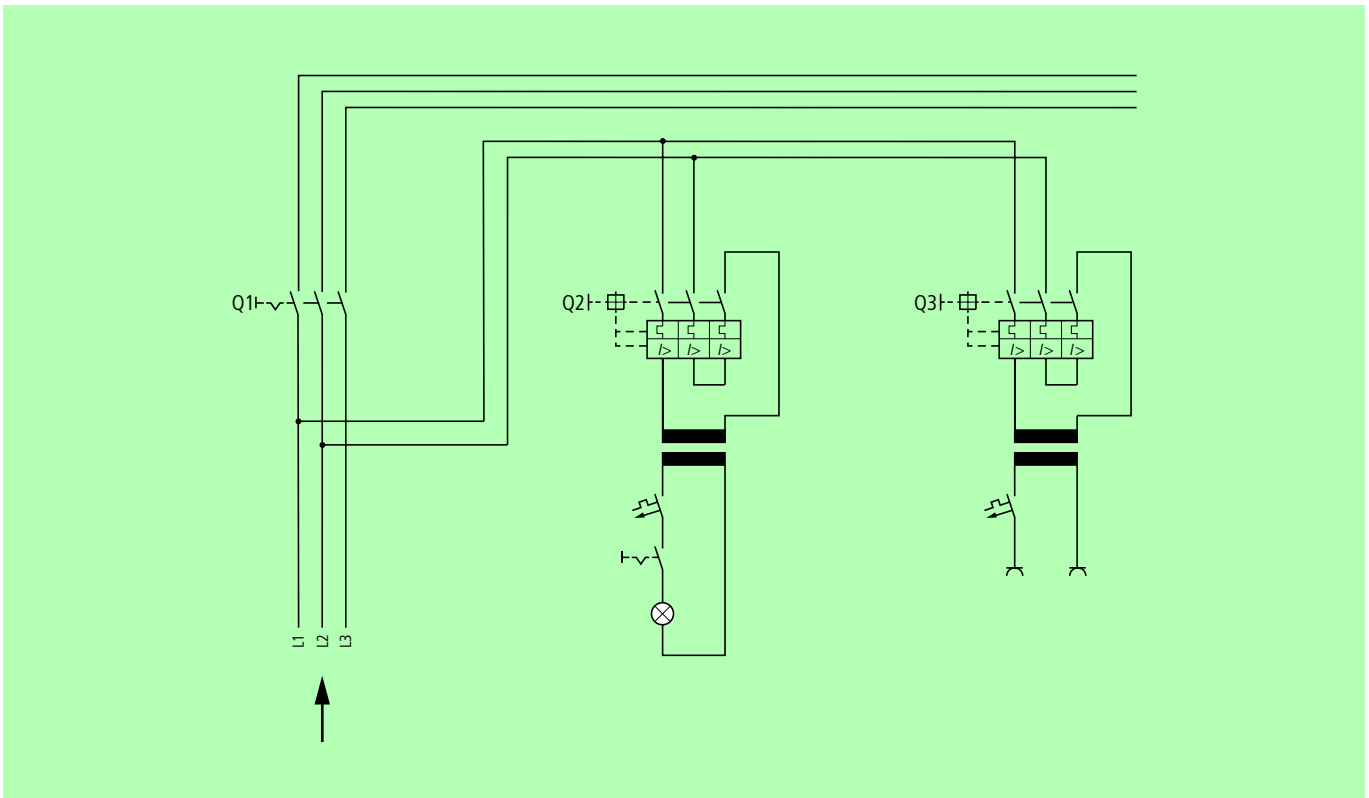
Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118.

9. Protection Against Electrical Shock

9.1 Electrical isolation

Application:

- Photoelectric circuits for maintenance work in control panels.
- Power supply for machines used with maintenance work in control panels.
- Protection against indirect contact, i. e. in the event of insulation failures.



Protection by electrical separation

Requirements:

- Isolating transformer in accordance with EN 60 742.
- Safely insulated windings (reinforced or double isolation).
- Circuit downstream of the isolating transformer must remain unearthed.
- Normally only for one load.
- Secondary voltage not more than 250 V.
- Observe special cabling requirements when tapping upstream of the main switch, e. g. short-circuit proof cabling, conductor colours, etc.

Features:

- Protection against electric shock with simultaneous contact with a conductive part and an earthed component.
- Protection against electric shock with simultaneous contact of the earth potential and conductive components which are live due to an insulation fault.
- Simultaneous contact of both conductors causes electric shock.



The following safety standards apply to "Protection by electrical isolation":		Page
EN 292	Safety of machinery – General principles for design	87
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 742	Isolating transformers and safety transformers Requirements	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 742, IEC 60 989, EN 60 947

Type	Rated output	Primary short-circuit protection device
STI0,06 to STI4,0	0.06 kVA to 4.0 kVA	PKZM0-0,4 at 400 V to PKZM2/ZM16 at 400 V (Settings see Main catalogue)

Special features: isolating transformers: 12, 24, 42, 110, 230 V secondary, rated output from 0.06 – 4.0 kVA, double or reinforced insulation, additional tapplings primary $\pm 5\%$, voltage drop from rated voltage: max. 5 %.

Single-phase control/isolating and safety transformers



Type	Rated continuous current I_u	Short-circuit protection device
PKZM0	0.16 to 25 A	No protective device required 16 A: 50 kA 20 A – 25 A from 16 kA/400 V: 50 A gL/gG
PKZ2	0.6 to 40 A	No protective device required 25 A – 40 A from 30 kA/400 V: 160 A gL/gG

Special features: for primary protection of transformer, fast-acting short-circuit release with inrush current up to $14 \times I_u$.

Motor-protective circuit-breaker



Type	Rated operational current I_n	Tripping current of fast-acting release
FAZ-B...	6 – 63 A	$3 - 5 \times I_n$
FAZ-C...	0.5 – 63 A	$5 - 10 \times I_n$
FAZ-D...	6 – 40 A	$10 - 20 \times I_n$
FAZ-R...	6 – 50 A	$2 - 3 \times I_n$
FAZ-S...	1 – 16 A	$13 - 17 \times I_n$

Special features: for secondary protection of cables and devices, release from $3 \times I_n$ within 0.2 sec.

Miniature circuit-breaker



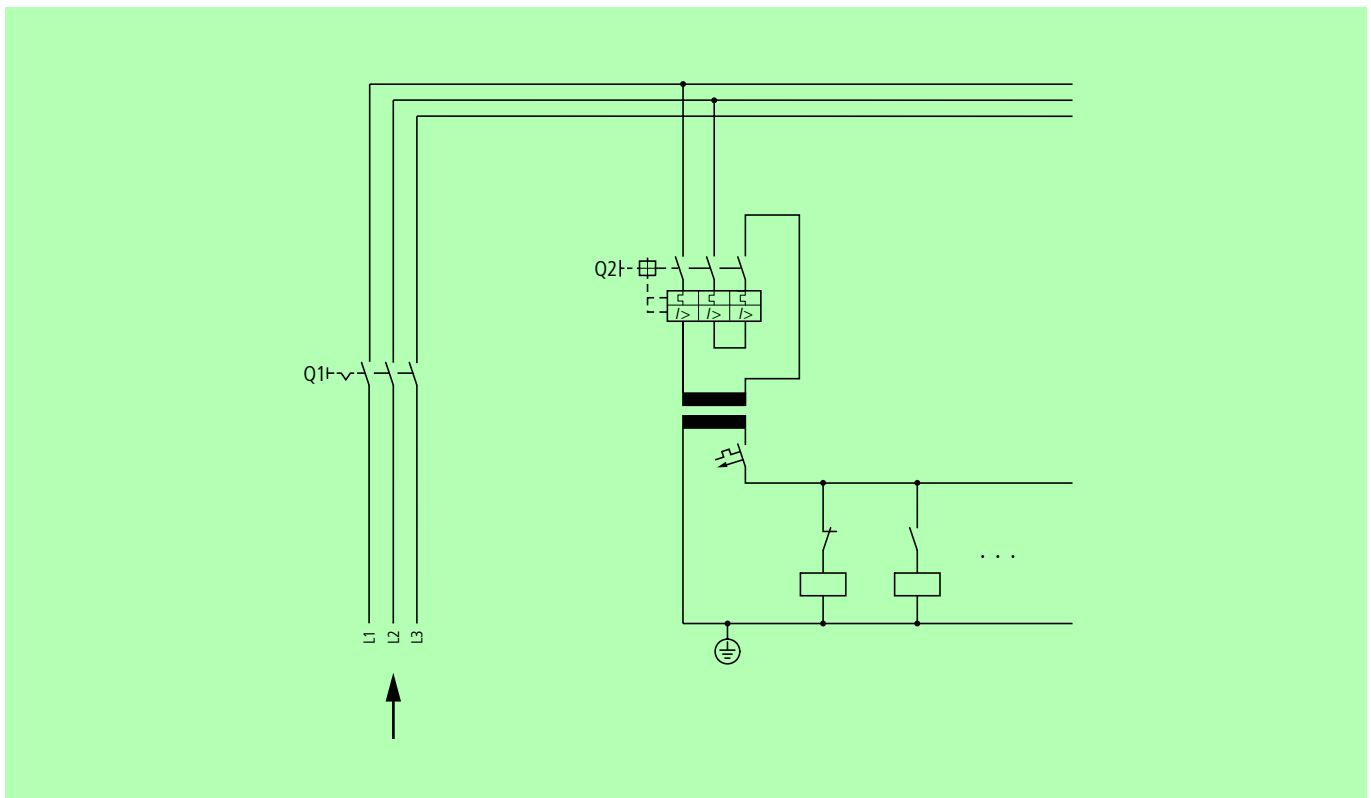
Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118.

Protection Against Electric Shock

9.2 Protective Extra Low Voltage (PELV)

Application:

- Protection against direct and indirect contact.



Protective Extra Low Voltage (PELV)

Requirements:

- Safety transformer in accordance with EN 60 742.
- Safely insulated windings (reinforced or double isolation).
- Circuit downstream of safety transformer must remain earthed.
- Secondary voltage with AC not more than 50 V (on machines no more than 24 V).

Features:

- Protection against electric shock with simultaneous contact with a conductive part and an earthed component.
- Protection against electric shock with simultaneous contact of the earth potential and conductive components which are live due to an insulation fault.
- Protection against electric shock on simultaneous contact of both conductors.



The following safety standards apply to "Protective extra low voltage":		Page
EN 292	Safety of machinery – General principles for design	87
EN 60 204-1	Safety of machinery – Electrical equipment of machines	78
EN 60 742	Isolating transformers and safety transformers Requirements	–

Note also the explanations in chapter 11

Safety-related switching devices in accordance with EN 60 742

Type	Rated output	Primary short-circuit protection device
STI0,06 to STI4,0	0.06 kVA to 4.0 kVA	PKZM0-0,4 at 400 V to PKZ2/ZM16 at 400 V (Settings see Main catalogue)

Special features: safety transformers: 12, 24, 42 V secondary, rated output from 0.06 – 4.0 kVA, double or reinforced insulation, additional tapplings primary $\pm 5\%$, voltage drop from rated voltage: max. 5 %.

Single-phase control/isolating and safety transformers



Type	Rated continuous current I_u	Short-circuit protection device
PKZM0	0.16 to 25 A	No protective device required 16 A: 50 kA 20 A – 25 A from 16 kA/400 V: 50 A gL/gG
PKZ2	0.6 to 40 A	No protective device required 25 A – 40 A from 30 kA/400 V: 160 A gL/gG

Special features: for primary protection of transformer, adjustable release range (inrush current can be taken into account).

Motor-protective circuit-breaker



Type	Rated operational current I_n	Tripping current of fast-acting release
FAZ-B...	6 to 63 A	3 to $5 \times I_n$
FAZ-C...	0.5 to 63 A	5 to $10 \times I_n$
FAZ-D...	6 to 40 A	10 to $20 \times I_n$
FAZ-R...	6 to 50 A	2 to $3 \times I_n$
FAZ-S...	1 to 16 A	13 to $17 \times I_n$

Special features: for secondary protection of cables and devices, release from $3 \times I_n$ within 0.2 sec.

Miniature circuit-breaker



Refer to Moeller's Main Catalogue for further information and ordering details for the products listed or contact your nearest sales office. The addresses of sales offices are given on page 118.

10. Safety-Related Engineering In Accordance with EN 60 204-1 (1997)

10.1 Power supply and protective devices

The reliability of the protective function does not depend solely on the selected devices and the circuit. Other interrelationships should be taken into account.

Weld-free design

Welded contacts make the opening of circuits and the elimination of hazards impossible.

A weld-free design is not required for main circuits.

If the switching device is to be used as a safety device, risk evaluation may however require over-dimensioning or a redundant

design (see "Feedback circuit" in the following).

Try to ensure in the event of overcurrent or short-circuit, that the protective device is tripped before the contacts of the switching device weld.

The protective device should of course be capable of withstanding the starting of motors or the energizing of transformers.

Correct control circuit design

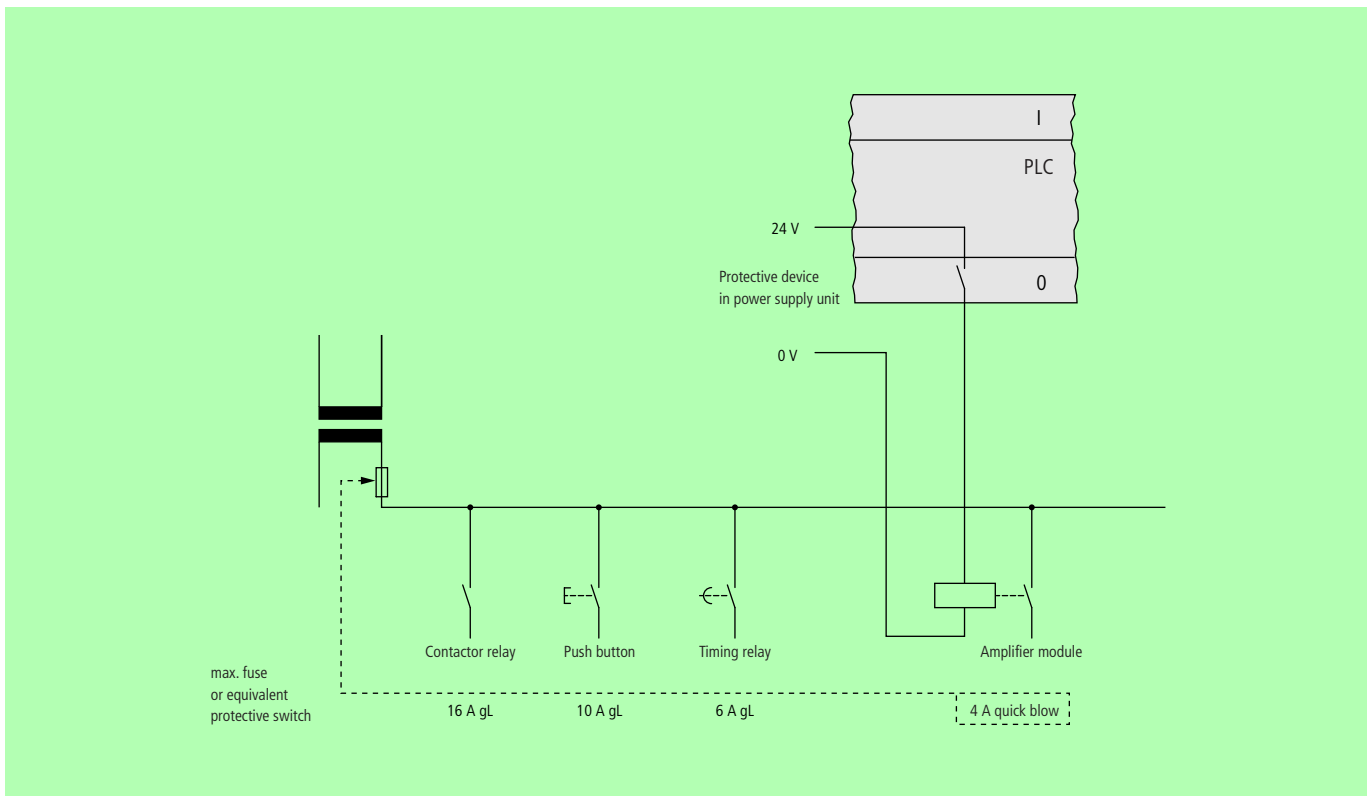
A short-circuit in the control circuit may cause uncontrolled states, which in the worst case may involve the failure of the safety function.

Either

- contacts can weld or
- the short-circuit current does not cause tripping of the short-circuit protective device.

In both cases the selection of the appropriate short-circuit protective device and the transformer is very important.

EN 60 204-1 requires weld-free design in section 7.2.10: "When selecting these protective devices, consideration shall be given to the protection of control switching devices in case of overcurrent, e. g. against welding of the control switching device contacts." Select therefore the lowest value of the maximum permissible overcurrent protective device specified for the switching devices used.



Note:

Devices with positive opening operation ☺ can have two specifications for the maximum permissible protective device.

A) If positive opening operation is required: protective device in accordance with EN 60 947-5-1 Appendix K.

The switching device must be able to activate the short-circuit itself and then allow positive opening operation.

B) If positive opening operation is not required: protective device in accordance with EN 60 947-5-1.

The short-circuit current should flow via the closed contacts. The contacts should then be able to open and close.

Ensure that the prospective short-circuit current in your control circuits does not exceed 1000 A. Switching devices in accordance with EN 60 947-5-1 are protected against welding up to this maximum value by means of the protective devices specified.

The prospective short-circuit current can be limited as follows:

Use of transformers

The use of transformers for the supply of control circuits is required for almost all machines.

Except for the following: machines with a single motor starter and a maximum of two external control devices. According to 9.1.1, these should be Start/Stop pushbuttons or locking devices.

Protective device and cable length/cross-section

The protective device should respond quickly in the event of a short-circuit. The short-circuit current must be switched off by the quick acting release within 0.2 s.

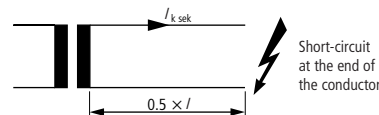
1. Determine therefore the short-circuit current value considering the following factors.

- Transformer
- Cable length
- Cable cross-section

2. Then select a short-circuit protective device with a maximum tripping value smaller than the short-circuit current value.

Use the following equation for the calculation:

1. Calculation of the secondary short-circuit current



$$I_{k \text{ sek}} = \frac{U_{n \text{ sek}}}{(r \times l) + (U_{n \text{ sek}}^2 \times u_k / P_n)}$$

STI control transformer

$I_{k \text{ sek}}$ = Secondary short-circuit current in A

$U_{n \text{ sek}}$ = Rated secondary voltage of the transformer in V

u_k = Short-circuit voltage of the transformer in %

S_n = Rated power (rating) of the transformer in kVA

l = Cable length of secondary circuit in km

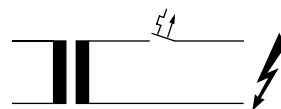
r = Resistance per unit length of the single core cable in Ω/km

$r = 29.24 \Omega/\text{km}$ for $0.75 \text{ mm}^2 \text{ Cu}$

$r = 21.93 \Omega/\text{km}$ for $1.0 \text{ mm}^2 \text{ Cu}$

$r = 14.62 \Omega/\text{km}$ for $1.5 \text{ mm}^2 \text{ Cu}$

2. Determination of the short-circuit device



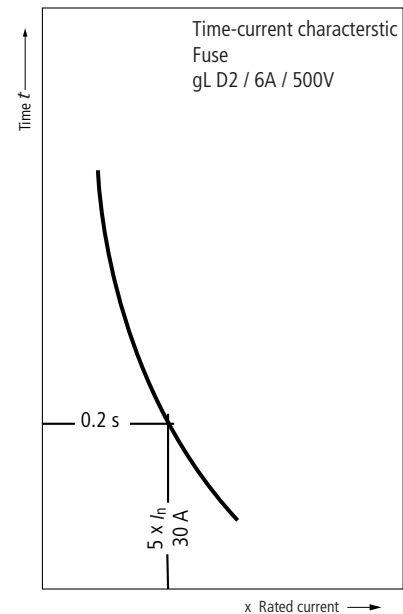
Requirement: $I_{k \text{ sek}} \geq I_{\text{max. tripping values}}$

- Tripping values of miniature circuit-breaker for 0.2 seconds.

Type	Charac-teristics	tripping current for quick-acting release
FAZ	R	$2 - 3 \times I_n$
FAZ	B	$3 - 5 \times I_n$
FAZ	C	$5 - 10 \times I_n$
FAZ	D	$10 - 20 \times I_n$
FAZ	S	$13 - 17 \times I_n$

- Fuse

Find the disconnection current at 0.2 seconds on the time-current characteristic curve for the fuse concerned.



For example, Time-current curve of a 6 A fuse

Safety-Related Engineering In Accordance With EN 60 204-1 (1997)

10.2 Long control conductors

Connecting contactors by means of long multiple control cables

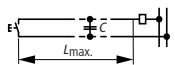
The capacitance of long control conductors in AC circuits may impede contactors from dropping out in response to an Emergency stop command. This is particularly the case of:

- high control voltages (e. g. 500 V)
- low contactor sealing currents
- contactors with very low drop-out voltages U_a
(IEC/EN 60 947-4-1:
10 % < U_a < 75 %
Moeller contactors:
40 % < U_a < 60 %)

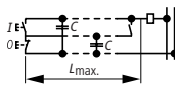
The control conductor therefore must not exceed a maximum length l_{max} for a given control voltage and contactor size, otherwise the capacitance of the control conductors will prevent the contactor from switching off due to the sealing current present.

Maximum line length l_{max}

The actual conductor capacitance C must be less than C_{max} in order to ensure trouble-free switching of a contactor. With continuous contacts the capacitance to be calculated is C , and $2 \times C$ with pulse contacts. In the latter case, the maximum length of the control conductor l_{max} is therefore only half the length as for continuous contacts.



Continuous contact



Pulsed contact

Using a guide value for the specific cable capacity of 0.3 $\mu\text{F}/\text{km}$ for a 2-core control cable, the maximum permissible control cable length at 50 Hz is:

Continuous contact

$$l_{max} = 1,7 \cdot 10^6 \frac{P_H}{U_c^2} [\text{m}]$$

Pulsed contact

$$l_{max} = 0,85 \cdot 10^6 \frac{P_H}{U_c^2} [\text{m}]$$

P_H = Rated sealing power in W

U_c = Rated sealing power in V

The conductor length must be reduced by approx. 50 % if the total switching time of the contactor exceeds 1×10^6 switching operations.

The table below shows the maximum single control conductor lengths for Moeller contactors. Rated operating voltage: 230 V, 50 Hz, max. $1.1 \times U_c$.

Total switching time: max. 1.0×10^6 switching operations.

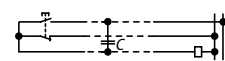
At 60 Hz, the specified conductor lengths are reduced by 20 %. At 110 V they can be four times longer.

Contactor type	Max. permissible control conductor length for	
	Continuous contact [m]	Pulsed contact [m]
DILE	161	80
DILR, DIL00(A)M	298	149
DIL0(A)M	351	175
S-PKZ2	456	228
DIL1(A)M	491	245
DIL2(A)M	562	281
ESR	2.800	1.400

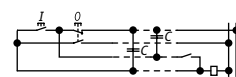
Remedy

If during the engineering phase or during commissioning it is determined that the contactors do not drop out due to the long control conductor lengths involved, use the following methods to solve the problem:

- Use a larger contactor (higher sealing power)
- Reduce the control voltage (allow for voltage drop)
- Use a DC actuated contactor
- The coil is shorted by means of an additional break contact for continuous contact or a make contactor for pulsed contact. An additional conductor is required for this. The disconnection times of the contactor will increase considerably.



Continuous contact



Pulsed contact

- Connect a resistor to the contactor coil in parallel. The resistance is determined using the following equation:

$$R = \frac{1000}{C} [\Omega]$$

C = Conductor capacitance in μF

The rating of the resistor is as follows:

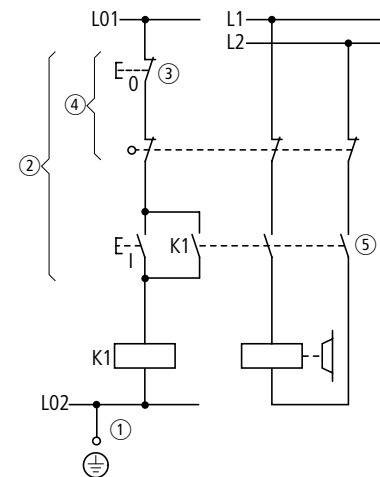
$$P = \frac{U_c^2}{R} [\text{W}]$$

Remember that the resistor will contribute to the total heat dissipation of the circuit.

10.3 Circuit design

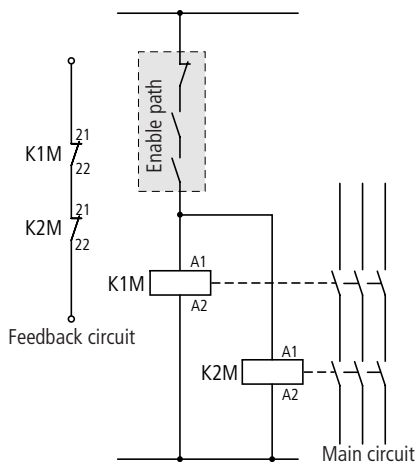
Use proven circuit designs and components.

- ① Earth the control current circuit.
- ② Connect all switch functions to the unearthed side.
- ③ Disconnect by de-energizing to ensure fail-safe operation.
- ④ Use switches with positively opening contacts (do not confuse this with positively driven operation).
- ⑤ Connect all live cables to the control device.



Feedback circuit

Insert a break contact for each of the subsequent contactors or at the location of the "feedback circuit" for additional enable paths or for monitoring redundant contactors. If higher capacity contactors are used, 2 break contacts (placed to the left and right of the contactor) should be used (symmetry). If one of the contactors welds, the circuit remains in the rest state with the next ON command until the fault is rectified. See circuits on page 14, 52 and 58.



Feedback circuit, monitoring external contactors

Provide redundancy

Redundancy means that more components than required for normal operation are provided. A typical form of redundancy is the double provision of contactor relays in the Emergency-stop combination, as shown on page 8.

If one of the devices fails because it is not energized or is blocked, the other device

establishes a safe condition and the fault is detected.

This, however, can only be carried out with positively driven contacts on the contactors.

Ensure diversity

This concerns the design of control circuits using different function principles or with different types of components. These are, for example, the combination of make and break contacts as described on page 52, which are operated by protective devices.

Carry out function tests

The control system should carry out the function tests automatically in the best case. Many functions cannot be tested automatically. For example, an Emergency-stop actuator is only actuated in the event of an emergency. Carry out individual function tests at appropriate intervals.

10.4 Use of equipment

Arrange devices effectively

Refer to the requirements of EN 1088, page 92, concerning the arrangement of position switches.

Usually no programmable electronic equipment is to be used for safety-related functions

EN 60 204-1 specifies the following in section 11.3:

"Programmable electronic equipment shall not be used for category 0 emergency stop functions.

For category 1 emergency stop functions and all other safety-related stop functions, the use of hardwired electromechanical components is preferred."

The reliability of an individual channel of the PLC or MMI is currently not sufficient for safety-oriented tasks. If a PLC should carry out safety-oriented tasks, it must offer almost the same reliability as hardwired electromechanical components. Therefore implement hybrid designs, i. e. control functions by the PLC, safety functions by conventional switching devices.

Consider foreseeable misuse

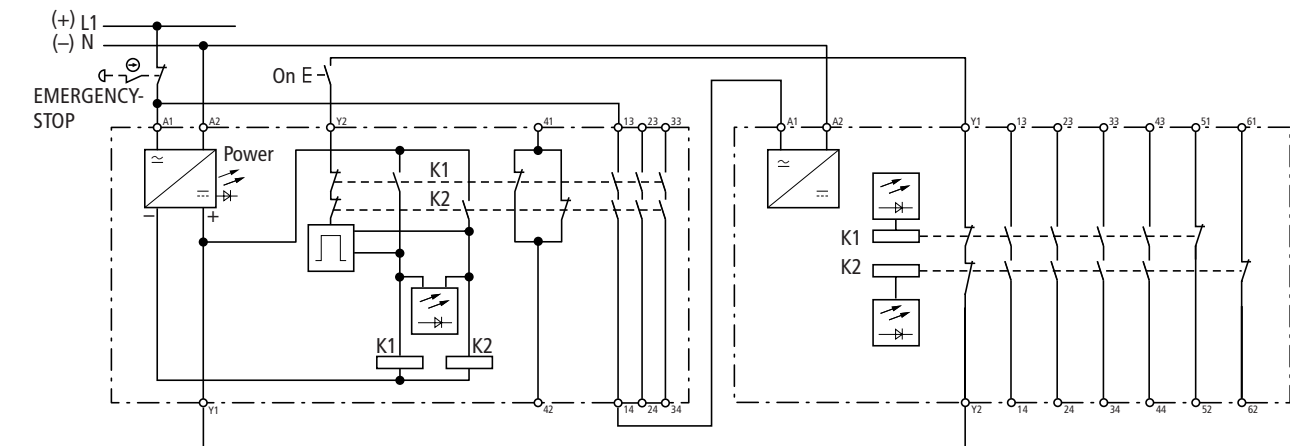
Machines are reset for operation as soon as possible after malfunctions. Hazardous situations occur in many cases.

For example:

Packages, pallets or machine parts jam inside a paletting machine. After an Emergency-stop the machine should restart. The operator therefore goes to the danger zone and tries to rectify the fault. For this situation, the drive may possibly have to start in the opposite direction.

If this is only possible by manually operating the contactors, there is high risk of danger. The wrong drive may be started or the wrong rotation direction may be selected.

The points specified in the standards alone are not sufficient for these considerations. More foresighted planning in cooperation between machine designers and electrical engineers is required.



Feedback circuit, safety relay with contact extension

11. Regulations, Directives, EN Standards

11.1 Overview

Measures are e. g.:

- Consideration of the environmental conditions with the placement of control panels, operating elements and indication elements.
- Extended functions with the setting mode:
 - Jog operation for the operation of drives
 - with additional selection of the direction of rotation
 - Start-up function with incorrect start position
- Marker function for continued unhindered operation after stop.
- Display of the stored actual situation.
- Errors should be recognizable from a safe location: Extended display functions.
- From a safe location, it must be possible to simultaneously observe the critical machine movements and the indicating instruments while being able to operate the control elements.
- After reset of an action in an emergency (Emergency-stop command), the machine may not restart automatically. The start command must occur via a separate pushbutton.

Safety also by Bus

The current revision of EN 60 204-1 now allows the transmission of safety-relevant signals via a Bus system. The safety standard must be identical with the conventional hardwired devices. This clears the way, for the future use of Bus-capable switching devices such as Emergency-stop actuators and safety position switches. These devices are also suitable for automatic diagnosis.

The way towards "safe machinery"

Your machine must be demonstrably safe, i. e. it must perform its functions without causing injury or damage to health. As a rule you are permitted to provide self-certification and to refer to the "responsible authorities" in special cases. This should also be certified externally by affixing the CE mark.

A useful "schedule" is shown in the flow diagram on the right. Further relevant details are described in the following.

Hazard detected, hazard excluded

A risk assessment must be made for the entire machine as well as for its associated parts. If the conclusion is reached that a circuit or component failure in protective devices may cause danger, then additional measures must be taken to avoid the risks in the event of a fault. This procedure must be executed carefully and documented in every case.

Implementing the EC Machinery Directive Measures

Create a factory standard

- Identify the relevant directives
- Research the standards

Prepare technical documentation

- List the basic requirements
- Identify the hazards
- Describe solutions
- Assess risk
- Establishing test criteria

Integrate the safety concept

- Design solutions
- Protective devices
 - in accordance with standards
 - prototype testing
 - other procedures
- Warning of residual hazards

Create test reports

Prepare operating instructions

- Basic safety chapter
- Special danger notes
- Translate operating instructions

Create a declaration of conformity

Attach the CE mark



Create a factory standard

- Identify the relevant directives
- Research the standards

The European safety concept

To date there are 17 different directives with compulsory marking requirements and a large and rapidly growing number of EN standards (harmonized European standards). Their aim and purpose is to assist the free movement of goods within the European Union on the basis that each member state will have similar requirements for ensuring that minimum safety levels for users are met.

EU Directives = National Legislation

EU directives are a type of superordinate directive. The directives must be implemented by all member states into national legislation.

Example: With the ninth decree, the Machinery Directive became part of the Device Safety Regulations in Germany.

The EU directives are primarily there to ensure a standard and binding legal framework.

However, only the basic requirements are specified without technical details so as not to impair technological developments.

The European standards

The European standards (EN standards) are implemented into the national standards of each member state within the European Union.

National standards with contents not complying with EN standards are withdrawn.

This applies to DIN/VDE standards as well as to work safety standards VBG..., ZH... etc. (in Germany).

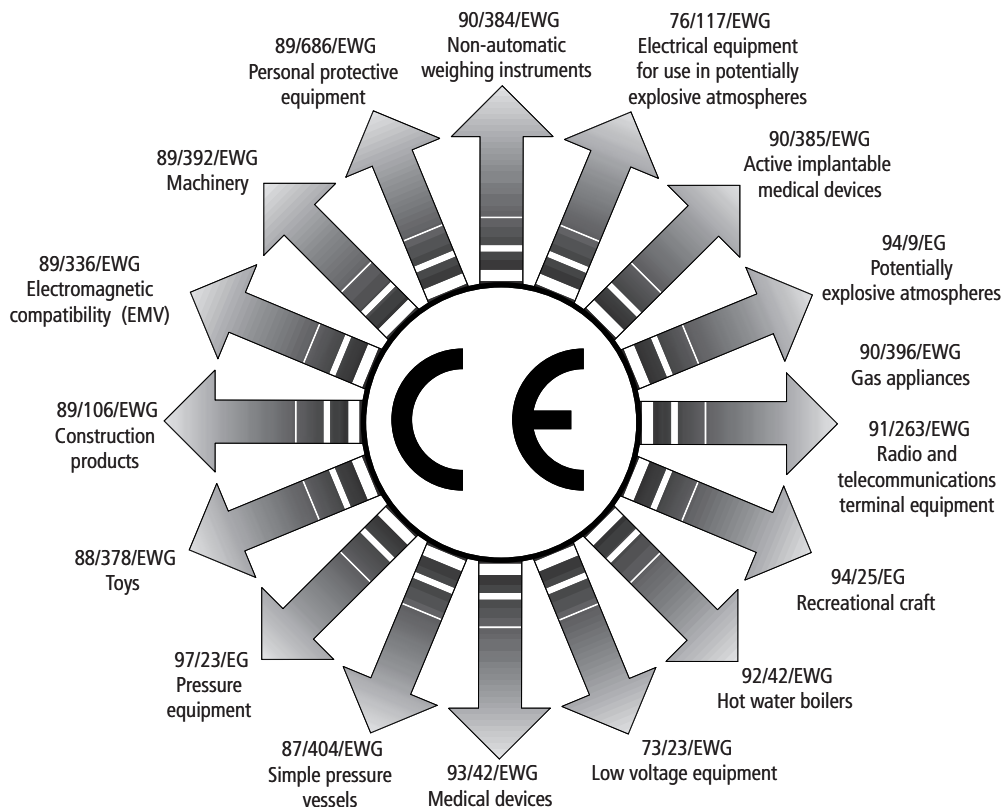
By complying with the EN standards, it is "assumed" that the requirements of the directives are fulfilled. These EN standards are listed in the "Report of the commission in the scope of the execution of the guideline". Available from the Bundes-Anzeiger, Cologne in Germany (as well as from the relevant national authorities)

Can EN draft standards be used?

Only the valid (white paper) EN standards are to be used.

As long as there are no EN standards for a particular field, or only drafts, then the national standards can and should be used.

In practice, the draft standards (prEN..) published in the EC Official Journal are used by the responsible authority as the basis for conformity assessment.



Regulations, Directives, EN Standards

11.2 Important directives for machines

Machinery Directive

Since the beginning of 1995, CE marking has been made obligatory for compliance with the Machinery Directive 89/392/EEC and stipulates the general requirements placed on the safety of machines and the health of the user/operator.

What is a “machine”?

Quotation of the Machine Directive:

In accordance with this directive, a machine means an assembly of linked parts or components, at least one of which moves, with the appropriate actuators, control and power circuits, etc., joined together for a specific application, in particular for the processing, treatment, moving or packaging of a material.

The directive defines a machine for example as follows:

- Industrial machines
- Shelf handling devices
- Fork lift trucks
- Further categories are described from page 98 onwards.

However, the Machinery Directive only contains basic requirements whilst there are many different types of machines available. The question therefore arises: “How can I prove that my machine is safe?”

The EN standards consequently stipulate requirements that can be tested and are therefore certifiable for this purpose.

The EN “Safety for Machines” standards are divided into three main groups:

- Type A: defines requirements which apply to all machine types and are basic safety requirements
- Type B: are group standards that deal with design aspects such as distances, surface temperatures, ... or functional aspects such as Emergency-stop, two-hand control, ... These aspects apply to different machine groups.
- Type C: are “product standards” that stipulate specific requirements placed on individual machine types. The type C standard enables the safety of the machines to be tested and certified.

Many type B standards and most of the type C standards are still in draft form. This fact together with the fact that compliance with standards is mandatory explains the uncertainty amongst machine manufacturers regarding this subject. Up-to-date information on type C standards is given on page 98.

The safety requirements stipulated in the Machinery Directive and in EN standards depend on the risk of accident involved.

Most type C standards take into account the specific risks of the machine type concerned. The degree of safety required therefore tends to depend on the particular standard concerned.

Preparing technical documentation

- List the basic requirements
- Identify the hazards
- Describe solutions
- Assess risk
- Establish test criteria

The machine engineer must evaluate the risk by means of a hazard analysis, implement measures to minimize risks, carry out tests and record results, if a relevant type C standard does not exist.

The type B standards EN 1050 and EN 954-1 (see page 88, 89) will help the engineer in the assessment and reduction of risks.

Integrating the safety concept

- Design solutions
- Protective devices
 - in accordance with standards
 - prototype testing
 - other procedures
- Warning of residual hazards

The protective measures to be taken must have the objective of excluding the risk of accidents during the machine lifetime in all operating situations.

CEN safety standards Hierarchical structure

Type A standards

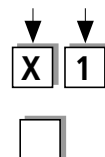
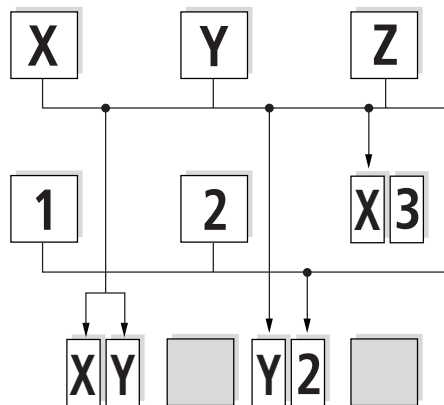
Basic safety standards

Type B standards

Group or machine family standards

Type C standards

Specific safety standards or product standards



Reference to basic safety standards or group standards

Specific product group requirements



Issuing a declaration of conformity

The manufacturer must prepare a declaration of conformity for each machine in which the relevant EN standards are mentioned and the conformity of the machine is declared.

If compliance with these standards is ensured, it can be assumed that the requirements of the Machinery Directive are also fulfilled.

Annex II of the Machinery Directive stipulates three different declarations of conformity:

1. Annex II A for machines and hazardous machinery in accordance with Annex IV
2. Annex II B for components, machines to be mounted and control systems
3. Annex II C for safety components

Samples of declarations of conformity are shown on page 112.

A list of the machines and safety components in accordance with Annex IV is shown on page 110.

In addition to the declaration of conformity, the manufacturer must document all relevant hazards/risks and counter measures with test results.

This documentation is not written for customers but must be presented to a "responsible authority" if this is requested on justifiable grounds.

Prepare operating instructions

- Basic safety chapter
- Special danger notes
- Translate operating instructions

The operating instructions with the description of "intended use" and "warnings" are important for the user.

The completed risk evaluation is of use here: "Warning of residual hazards that cannot be excluded".

Low-Voltage Directive

From 1997, the Low-Voltage Directive 73/23/EEC requires the mandatory CE marking of electrical equipment.

The fulfillment of safety objectives is meant to ensure protection from hazards caused by electrical current in low-voltage devices. Important basic requirements in the form of safety objectives are described in Annex I of the directive.

Low-voltage devices include electrical switching devices, conductors, cables, wires and installation components with a voltage range of 50 – 1000 V AC and 75 – 1500 V DC.

EMC Directive

The marking of products compliant with the EMC Directive 89/336/EEC has been compulsory since 1996.

The EMC Directive stipulates two basic requirements placed on the **electromagnetic compatibility** of devices:

- EN 50 081 – Emitted interference, i. e. the highest value of electromagnetic interference emitted by devices (emission).
- EN 50 082 – Interference immunity, i. e. the appropriate immunity of devices to electromagnetic interference.

Different requirements are placed on industrial applications on the one hand and home, business, trade, light industry, small companies, offices and laboratories on the other.

Provision of the CE mark

CE marking

The manufacturer and the authorized agent in the EU (licensee/contract partner) must declare the conformity of products with the safety requirements of the relevant directives and EN standards. This is documented by the issuing of an EU declaration of conformity.

The manufacturer takes full responsibility for the affixing of the CE marking after prototype testing.

The CE mark is a compulsory condition of sale since from the date of compulsory CE marking onwards,

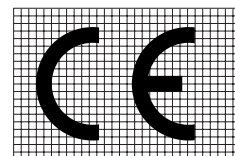
products/components/devices/systems may not be sold without the CE mark.

The CE marking should be considered like a passport within the European single market. It must not, however, be confused with a quality mark or seal since it is only intended as an administrative marking. The CE marking mainly is designed for the competent body. It indicates to purchasers and end users that it can be "assumed" that the product meets the requirements of the directive or the applicable legislation.

The CE marking must be carried out before putting the product onto the market, i. e. before selling and commissioning. Putting into circulation as defined by the directive applies to any transfer of technical devices, products or other goods to others. Importation into the EU is also considered as putting into circulation, and so import goods must also be provided with the CE marking if they are required to comply with a directive. Technical equipment includes working equipment that is ready for use, devices, tools and machines. Working equipment is ready for use when it can be used for the intended purpose. No other parts are required.

Putting into circulation, and thus CE marking, applies to the following machines:

- new machines produced for the first time in the EU
- existing machines which must be retrofitted and/or modified
- all machines (new ones and existing machines) which are imported from a non-EU country and which are sold and/or used in the EU.
- new or modified machines which are provided free of charge.



Old machines

Information on machines put into circulation on the market and commissioned before 01.01.95 is provided on page 111.

Regulations, Directives, EN Standards

11.3 EN ... machine safety standards

Type B safety group standards

deal with design aspects such as distance, surface temperatures,... or functional aspects such as, for example, Emergency-stop, two-hand operation,... These standards apply to different machine groups.

If no Type C product standard exists for the machine, or if significant hazards of the machine are not dealt with, Type B group standards should provide guidance.

Ordering addresses for EN standards on page 115.
Information on the Internet at:
www.VDMA.ORG/NAM

Topic	Standard
General	
Basic concepts, general principles for design	
Basic terminology, methodology	EN 292-1
Technical principles and specifications	EN 292-2
Safety of machinery; risk assessment	EN 1050
Electrical equipment of machines	
General requirements	EN 60 204-1
Safety-related parts of control systems	
General principles for design	EN 954-1
Reduction of risks to health from hazardous substances emitted by machinery	
Principles and specifications for machinery manufacturers	EN 626-1
Method of creating test procedures	EN 626-2
Protective devices	
Interlocking devices associated with guards	
Principles for design and selection	EN 1088
Contact-free operating guards	EN 61 496-1
General requirements for the design and construction of guards (fixed, movable)	EN 953
The positioning of protective equipment in respect of approach speeds to parts of the human body	EN 999
Distances, surface temperatures	
Minimum gaps to avoid crushing of parts of the human body	EN 394
Safety distances to prevent danger zones being reached by the lower limbs	EN 811
Safety distances to prevent danger zones being reached by the upper limbs	EN 294
Temperatures of touchable surfaces – Ergonomic data to establish temperature limit values for hot surfaces	EN 563

Topic	Standard
Displays, actuators, signals	
Ergonomic requirements for the design of displays and control actuators	
Human interactions with displays and control actuators	N 894-1
Displays	EN 894-2
Actuators	prEN 894-3
Visible, acoustic and touchable signals	EN 61 310-1
Designation regulations	EN 61 310-2
System of auditory and visual danger and non-danger signals	EN 981
Persons	
Human body weight	
Principle for determining the dimensions required for openings for whole body access into machinery	EN 547-1
Human body dimensions	EN 547-2
Human body dimensions	EN 547-3
Human physical performance	
Terms and definitions	prEN 1005-1
Emergency-stop, two-hand control, isolating and dissipating power	
Emergency-stop equipment, functional aspects, principles for design	ISO 13 850 EN 418
Two-hand control devices – Functional aspects – Principles for design	EN 574
Prevention of unexpected start-up	EN 1037



The contents of Standards

have been laid out and structured on the following pages for practical use.

Please refer to the standard concerned directly for binding or detailed information.

The Order

of the standards described is based on the "Implementing the machinery directive" flow chart on page 82.

More than 100 standards of type A and B will be included in the Machine Directive.

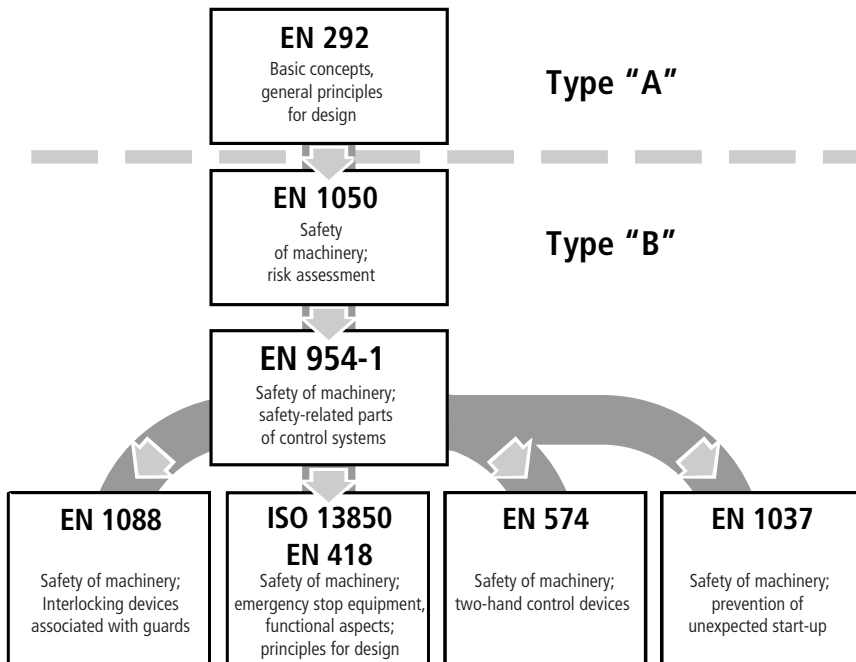
EN 292

Safety of machinery

Basic concepts, general principles for design

Part 1: Basic terminology, methodology

Part 2: Technical principles and specifications



Purpose:

Which fundamental and practical methods can be used as a basis for the design of machines of all types in order to achieve compliance with European legislation?

This information will provide guidance if there is no product standard for your machine. This type A standard is the basis for the type B and C standards.

Target group:

Machine builders and type B and C standard makers and creators of factory standards.

Essential points in brief:

In order to prevent injury and damage to health construct your machine in 4 stages.

1. Risk reduction by design

The most important measure for the prevention of hazards is the selection of appropriate design features, such as

- no sharp corners and edges
- ensuring minimum safety distances from hazards
- reducing forces, speeds and masses to safe values
- designing components below the strain limits concerned
- using intrinsically safe designs like protective extra low voltage, non-toxic liquids in hydraulic system etc.
- mechanical restraint devices shall be given preference over solutions dependent on power when the transfer of movement is involved.

Ensure ergonomic features such as sufficient lighting and ergonomic operation.

Regulations, Directives, EN Standards

EN ... machine safety standards

- Exclude hazardous behaviour of the machinery such as unexpected startups or uncontrolled speed changes by means of safe control system design
- Fault detection by means of redundant design
- Minimize the work required in the danger zone through
 - reliability of machine functions - this reduces the frequency of the interventions required
 - no manual loading and unloading of the machinery
 - service locations outside the danger zone

Take into account all "phases of the working life" of the machine:

Construction, transport and commissioning, operation and implementation, decommissioning, dismantling and, when necessary disposal.

Assess the risk of injury. EN 1050 and EN 954-1 will provide guidance with regard to the safety-related parts of the control system.

2. Risk reduction by means of technical safeguards

Technical protection measures must be applied if it is not possible to reduce the potential hazards by means of appropriate design features.

Case A:

If access to the danger zone is not necessary during operation, close this area off by means of mechanical covers. EN 953 describes the requirements placed on "guards".

Case B:

Ensure the following measures if the user must work in the danger zone:

- Movable guard with monitoring feature
- Contact-free operating guards
- Two-hand control

The safeguards should remain functional when possible during servicing and setting operations. If this is not possible, a lockable operating mode selector switch must be used. This should enable an operating mode of "reduced risk" such as creep speed to be selected manually.

Carry out a risk assessment.

3. Warning of residual risks

If you were not able to remove all hazards satisfactorily by means of design measures or technical safeguards. Warn the user directly by means of clear indications in the operating instructions at the location of danger!

4. Additional precautions

In the event of emergency one or several Emergency-stop devices must be provided. This is not necessary for

- Portable handheld or manually operated machines
- Machines where the risk is not reduced by an Emergency-stop.

Means of isolating or reducing the power supply are required for safety and repair work.

For example, use lockable main switches with an isolating function.

Furthermore:

- Provide connection possibilities for transport with lifting gear.
- Ensure that all work such as operation, maintenance etc. can be carried out on the floor or on non-slip platforms.
- Ensure static and dynamic stability.

EN 1050

Safety of machinery

Risk assessment

Purpose:

To gather and combine knowledge of design, application, hazards and accidents for risk assessment.

Target group:

Machine builders and Type C standard makers.

Essential points in brief:

Appropriate safety measures must be taken to ensure that your machinery or system can be considered as safe and reliable. The risk assessment and the danger analysis show you whether the safety measures are necessary, and to what extent.

The following two types of protection always apply:

- Protection of individuals, such as by means of two-hand controls
- Protection of working areas that protect each person, such as by means of guards.

The European standard EN 1050 "Safety of machinery – risk assessment" enables you to estimate the safety or the risk to be expected in several steps.

Step 1: Hazard analysis

Defining the limits of the machine.

- Which functions are to be fulfilled by the machine and which not? Proper usage and foreseeable faults and misuse.
- Who should use the machine and who not? Qualification and experience of the personnel in all areas from development to maintenance.



Identify the hazards.

- Which kind of hazards are present on the machine? Use the table EN 1050, Annex A as a check list . This table indicates possible electrical, mechanical, chemical and physical dangers.

Assess the ambient and operating conditions of the machine.

- Which events can cause damage? Manual material supply or removal, service, maintenance, human behavior, influence by persons that are not operating personnel, failure of safety-related components.

Step 2: Risk assessment

Assess the entire risk taking into account all the following factors:

- Probability of injury and damage to health
- Frequency and exposure time to the hazard
- Highest foreseeable severity of injury
- Possible avoidance of the safety measures taken
- Reliability of the safety functions
- Possible behavior of the machine and system in all operating modes
- Human factors: risk awareness, training, time pressure
- Combination and interrelationship of hazardous situations (complexity).

Step 3: Risk reduction

Observe the requirements for risk reduction in accordance with EN 292:

- Removal of identified hazards
- Unauthorized personnel should not have access to the machine.
- Use of safeguards
- Reduce the degree of damage by the limitation to safe values.

Step 4: Risk evaluation

Has the required safety been achieved?

- Have hazards been removed/reduced?
- Do the technical protective measures offer sufficient protection and can they be used in practice?
- Is the category selected in accordance with EN 954-1 correct?
- Are instructions for the intended use clearly formulated and understandable?
- Are safe working procedures described properly?
- Is the user informed of the necessity of the personal protective equipment?
- Is the user warned sufficiently of residual risks?

The certification of the hazard analysis is a check that all significant hazards have been identified and appropriate precautions have been taken, such as the selection of the suitable category in accordance with EN 954-1. Furthermore, the protective measures and the objectives achieved must

be documented. In simple applications, the type B or C standards are sufficient for the documentation.

EN 954-1

Safety of machinery

Safety-related parts of control systems

Part 1: General principles for design

Purpose:

Parts of the control system should perform safety-related tasks. Define the degree of the resistance to faults in relation to the risk of injury. Check whether the control system fulfills the requirements and document this.

Target group:

Machine builders and Type C standard makers.

Essential points in brief:

Document which parts of the control system are to perform safety-related tasks and which not. You will know which contribution to risk reduction the control system will have by means of hazard analysis and risk assessment (EN 292 and EN 1050).

A movable protective door, for example, should be monitored with position switches.

In this way you can ensure that no hazardous machine movements are possible when the door is open.

The following list shows other possible documentation:

No.	Type of hazard in accordance with EN 1050	No. according to EN 1050	Localization	Solution
1	Squeezing	1.31	With working process xy	Maximize distance
2	Shearing	1.32	Machine part front	Protection measure 5
3	Shearing	1.32	Conveyance of the...	Modify part xy...
4	Cut and cut off	1.33	No hazard since...	-/-

Regulations Directives, EN Standards

EN ... machine safety standards

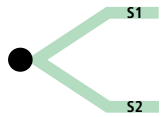
Risk Assessment

The risk assessment evaluates the risks if a part of a control system fails.

For example:

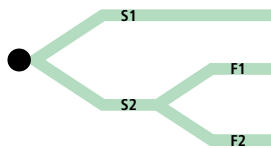
Let us assume that a fault occurs and operation with the door open is still possible.

- How high is the potential risk of injury?



Starting point of the risk assessment

If the consequences of the accident are mainly reversible such as, for example, bruises or cuts without complications, select S1. Irreversible injuries such as the loss of limbs or even death should be assigned to S2.



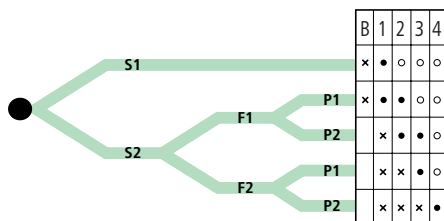
Starting point of the risk assessment

If the frequency of exposure is seldom and/or the duration is short select F1.

For long and frequent exposure select F2.

A typical case for F2 is the intervention between tools at regular intervals in order to remove or insert workpieces during cyclical operation. If access is necessary from time to time, select F1.

At the end there is the question: "Which possibilities for accident prevention exist?"



Starting point of the risk assessment

An accident can primarily be avoided if the hazard can be identified.

Observe the following points:

- Can the hazard be identified directly on the basis of its physical characteristics or only by means of technical equipment such as displays?
- Does the hazard occur suddenly, quickly and unexpectedly or slowly and visibly?
- Can accidents be prevented by means of escape or intervention of third parties?
- Is the machinery operated by an unskilled or qualified person?
- Is the operation supervised or not?
- What practical experience is available with regard to safety during the process?

Is there a realistic chance of preventing the accident or reducing the consequences considerably?

Only in this case should you select P1.

If the hazard can hardly be prevented, select P2.

This procedure is not mathematically exact, it is rather more qualitatively correct. It is a method of assessment which provides sufficient accuracy in most cases with few requirements. It should be considered as part of the risk assessment in accordance with EN 1050 and not as a substitute.

Category

Define how reliable the safety-related parts of the control system should be in the event of a fault.

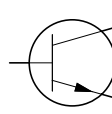
Observe the following principle:

The more that risk reduction depends on the safety-related parts of the control system, the higher the resistance to faults must be.

The categories laid down by EN 954-1 are provided as assessment criteria. The category is defined in respect of the risk concerned and describes the resistance of the control system to faults.

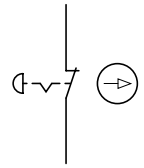
Category B (basic category)

The safety-related parts of the control system shall, as a minimum, be designed in accordance with the current state of the art. They shall withstand the influences which are to be expected.



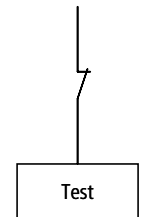
Category 1

The safety-related parts of the control system must be designed and constructed using well-tried components and safety principles. A well-tried safety principle is, for example, the use of position switches with positively opening contacts. Normally, category 1 cannot be implemented with electronic components.



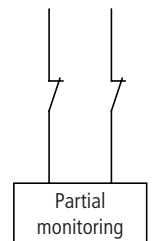
Category 2

The safety functions of the safety-related parts of a control system must be checked at suitable intervals. The check can be performed automatically or manually and at least with each startup. The check can also be carried out periodically during operation as determined by the risk analysis. A hazardous situation may occur on the machine between the checks.



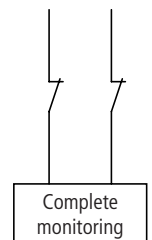
Category 3

A single fault in a safety-related part of the control system does not cause loss of the safety function. An accumulation of undetected faults may cause a hazardous situation on the machine, since not all faults must be detected. An example of this is the use of a redundant circuit without self monitoring.



Category 4

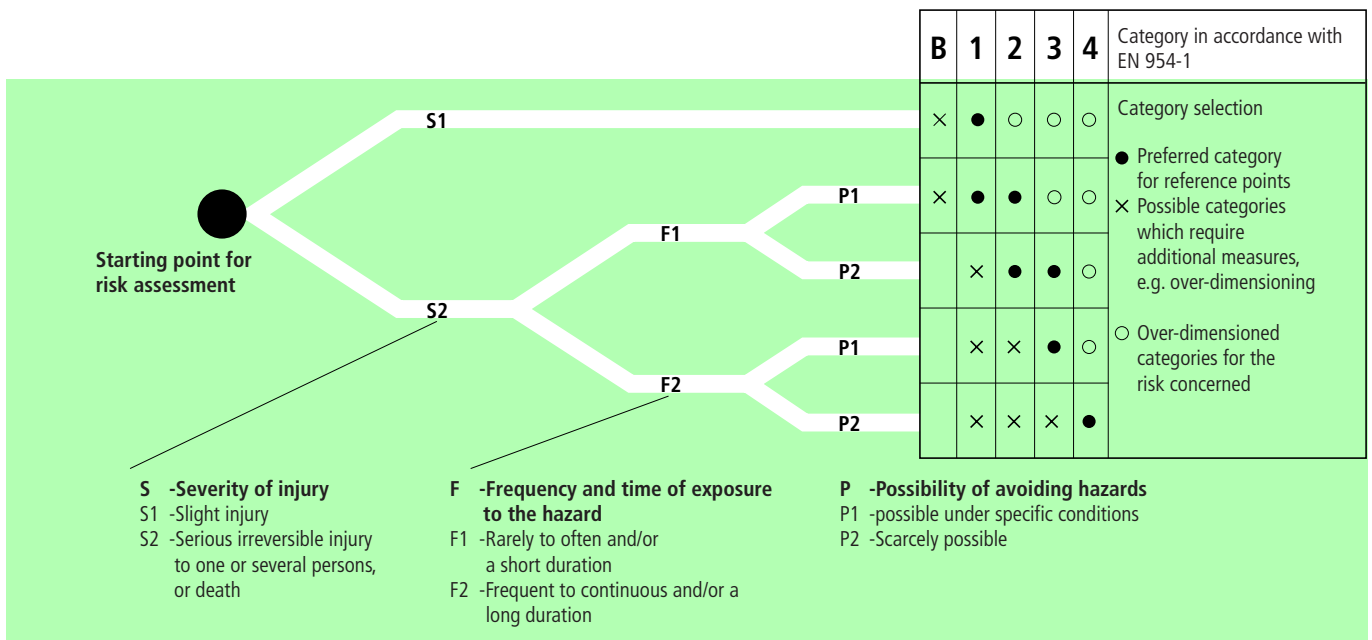
A single fault in a safety-related part of the control system does not cause the loss of the safety function. This fault must be detected immediately or before the next potential danger, e. g. when closing the door before a restart of the machine. If this is not possible, the accumulation of faults must not lead to the loss of the safety function.





Category in accordance with EN 954-1

Category of the safety-related parts of the control system	Requirements	Behaviour of the control system
B	<ul style="list-style-type: none"> State-of-the-art control system Components must withstand the influences which are to be expected 	<ul style="list-style-type: none"> Failure of the safety function possible Some faults remain undetected
1	<ul style="list-style-type: none"> Requirements of B must be fulfilled Use of well-tried components and safety principles 	<ul style="list-style-type: none"> Higher reliability of the safety function, but failure of the safety function still possible
2	<ul style="list-style-type: none"> Requirements of B must be fulfilled Testing the safety function at suitable intervals 	<ul style="list-style-type: none"> 1 fault is detected by the check 1 fault can lead to the loss of the safety function between the tests
3	<ul style="list-style-type: none"> Requirements of B must be fulfilled 1 individual error does not lead to loss of the safety function. Fault should be detected if possible 	<ul style="list-style-type: none"> If 1 fault occurs, the safety function is always maintained (single fault safety) Some, but not all faults are detected Failure of the safety function with several faults
4	<ul style="list-style-type: none"> Requirements of B must be fulfilled 1 fault does not cause the loss of the safety function (self monitoring) The fault is detected, the machine can no longer be operated Safety function is retained with several faults 	<ul style="list-style-type: none"> Each fault occurring for the first time is detected The safety function is always retained (no failure)



Category	Requirements
B	Protective/control systems and components taking into account the operating and ambient temperatures.
1	Additional to "B": Well-tried components and principles that meet the safety requirements
2	Additional to "B": Checking of the safety function by the control system at suitable intervals
3	Additional to "B": Single fault safety and fault detection whenever practicable in accordance with the state of the art technology
4	Additional to "B": Single fault safety and fault detection or no hazard due to accumulation of faults

Regulations, Directives, EN Standards

EN ... machine safety standards

Faults and Fault Exclusion

A fault is a device state characterized by its inability to perform a required function.

There are many types of faults that may theoretically occur. In practice, however, some faults can be excluded.

The following faults have been assumed for assigning categories to the circuits in this guide:

- Contactors do not pick up or do not drop out
- Open-circuit on each terminal location and in supply lines outside the control panel
- Short-circuit between adjacent terminal locations and in supply lines outside the control cabinet
- Changed location of position switches or faulty operation
- With position switches/guard locking devices with separate actuating element:
 - Connection of actuator to door loose
 - Faulty position of actuating element due to inaccurate door guidance.

Error avoidance:

- Remove the auxiliary contact modules from the contactors
- Faulty Emergency-stop actuator
- Short-circuit within the contactor circuit in the control cabinet.

Reason:

Protected installation in the control cabinet, well-tried design.

Further faults can be excluded depending on the ambient conditions, thus obtaining a higher category with few additional requirements.

Take into account the following fault criteria:

- If other components fail as a result of a fault, the first fault and all resulting faults must be considered as a single fault.
- Faults with the same cause are considered as a single fault.
- The simultaneous occurrence of two separate faults is not taken into account.

Creating safety measures

Select the required safety measures shown on the pages 4 to 77. Integrate these measures into your application.

Validation: Does the solution fulfill the safety requirements?

Draw up a validation plan as to which analyses and tests you wish, to determine the compliance of the solution with the requirements.

Check in each case, if

- All safety-related output signals are generated in a correct and logical fashion by the input signals
- The behaviour in the event of a fault complies with the defined categories.
- Depending on the complexity of the control system and the sequences involved, a theoretical test of the circuit diagrams is sufficient. Otherwise carry out a practical test with fault simulation.
- The control system and the devices are dimensioned sufficiently for all operating modes and ambient conditions.

Create a validation report once the tests and analyses have been completed.

The report should contain at least:

- All items to be tested
- The personnel responsible for the test
- Test devices (incl. details of the calibration) and simulation instruments
- The performed tests
- The detected problems and their solutions
- The results.

File the documented results in an understandable form.

User information

Inform the user about the correct usage, the power ratings and the performance limits of the safety-related parts.

Instruct the user how to obtain the rated power values of the safety-related parts, especially if the fault exclusion measures taken by you require special maintenance work.

EN 1088

Safety of machinery

Interlocking devices associated with guards

Principles for design and selection

Purpose:

How should the movable protective devices be monitored?

This standard describes principles for the selection and design of the interlocking devices and their connection to the guards (→ EN 953) and the control system (→ EN 954-1).

Target group:

Machine builders and Type C standard makers.

Essential points in brief:

This standard describes basic concepts and general design principles for interlocking devices and guards.

Select and design the interlocking device for your application so that the basic EU safety requirements are fulfilled.

Important **selection criteria** for an appropriate interlocking device in special applications are for example:

- The application conditions and the intended use
- Hazards that may occur on the machine
- The severity of possible injury
- The probability of a failure of the interlocking device
- The stop/access time
- The time for which a person is exposed to the hazard

Some of these criteria have already been considered in EN 292, EN 1050 and EN 954-1.

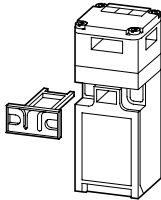
Designs with and without guard locking are provided.



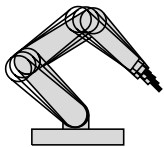
Interlocking Devices With and Without Guard Locking

An interlocking device **without** guard locking is a mechanical or electrical device which only allows the operation of a machine if the protection door is closed (e. g. safety position switch with separate actuator).

Actuating element



This protection measure prevents hazardous machine functions if the guard is not closed. If the guard is opened during operation, this initiates a Halt command, comparable with the Stop command (ISO 13 850/EN 418, Emergency-stop devices). The machine is switched to the ready for operation status by closing the guard. The start signal (Start), however, must be initiated separately.

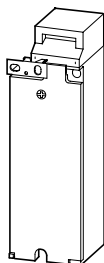


- Door open
- Voltage off
- No danger

Interlocking device without guard locking for the protection of persons

An interlocking device with guard locking is a mechanical or electrical device which allows the operation of a machine only if the protection door is closed and secured (e. g. safety position switch with separate actuators and guard locking).

Actuating element



Hazardous machine functions are protected by means of a closed guard with a locking mechanism. The guard remains closed until the risk of injury by the hazardous machine function and movement is excluded (monitoring is carried out by means, for example, of a zero speed relay).

The machine is switched to the ready for operation status by closing and locking the guard. The start signal (Start), however, must be switched on separately.



- Stop command
- Wait time
- Machine stops
- Guard open
- No danger

Interlocking device with guard locking for the protection of persons.

Which design must be used and when?

Stopping time > access time → interlocking device with guard locking

Stopping time < access time → interlocking without guard locking

Example:

An operator opens the guard door of a rotary machine and thus switches off the drive power.

He now reaches into the danger zone to remove a workpiece.

The hazardous movement must be terminated before the operator has reached these machine parts.

Otherwise an interlocking device with guard locking must be provided.

The stopping time of the machine can easily be determined.

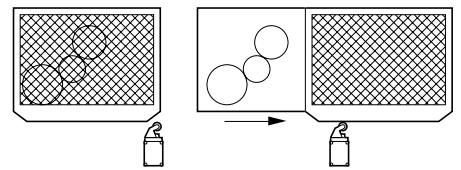
The access time depends on the parameters distance, approach speed and machine specific conditions such as the type of accessibility.

These times can be calculated using EN 999 "The positioning of protective devices in respect of approach speeds of parts of the human body".

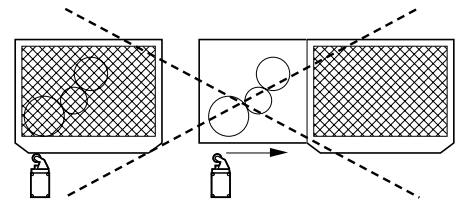
Operation type of mechanical position switches

Always viewed with opened protection door.

- A position switch: must be actuated with positive operation.



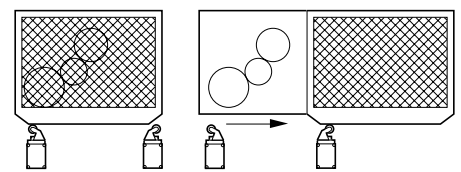
Correct



Incorrect

- Two position switches: One must be operated positively and one may be operated via a return spring.

→ Prevent faults with the same cause.



Arrangement and fixing of position switches

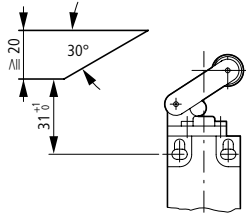
Position switches and actuators must be protected against change of position:

- Only use fixing elements that are reliable and which can only be undone with a tool.
- Protected against self-loosening
- Use oblong holes only for initial setting.
- Ensure mechanical restraint by means of bolts, pins, mechanical stops etc.
- Do not use the switch as a mechanical stop.

Regulations, Directives, EN Standards

EN ... machine safety standards

- Observe the paths specified by the switch manufacturer.



- Ensure that the switch is protected so that external influences cannot cause any damage.
- Fit the switch so that it is accessible for maintenance and function testing.
- When the guard door is opened, the disconnection must be made before a hazardous condition occurs.

Bypassing the safety function should be made more difficult by separate switch actuators (safety position switches).

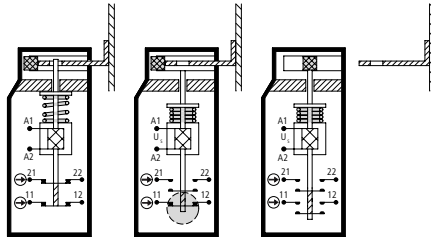
- The switch must be fitted with a cover.
- The actuator should be fitted as a captive part.

Requirements for position switches

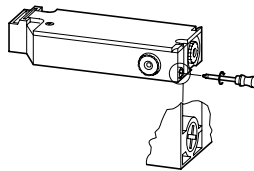
- Break contacts must have ⊖ positive operation in accordance with IEC/EN 60 947-5-1 Appendix K.
- Enclosed devices must have at least ≧ IP 54.

Guard locking devices must

- Be form-fit by means of two rigid parts,
- Assume the locked position by means of spring force and must be unlocked by means of energy,



- have a manual auxiliary unlocking function which can only be operated by means of a tool (only for spring-force locked devices),



- Be totally in the locked position before the machine movement is enabled,
- Withstand the forces expected.

ISO 13 850/EN 418

Safety of machinery

Emergency-stop equipment, functional aspects

Principles for design

Purpose:

Functional requirements placed on the Emergency-stop equipment.

Target group:

Machine builders and Type C standard makers.

Essential points in brief:

The Emergency-stop function should prevent or reduce arising or existing hazards to personnel and damage to machines or on the working material. Hazards may, for example, be functional irregularities, malfunctions of the machine, unacceptable properties in the processed material and human errors.

Emergency stop is required

The Machinery Directive stipulates the mandatory use of Emergency-stop devices for each machine with the following exceptions:

- Machines on which Emergency-stop devices do not reduce the risk.
- Hand-held and manually operated machines.

Emergency-stop is a supporting measure and not a substitute for missing protection measures!

Emergency-stop devices must be provided on all operating panels and other working stations in accordance with EN 60 204-1.

Emergency-stop operation

The Emergency-stop function is activated by a single manual operation of a person. It must always be available and functional (→ EN 954-1). The particular operating mode is not important.

Design the Emergency-stop devices in such a way that the user is not forced to consider the consequences of operating the device. This prevents delays up to the point of activating the device when the system is disconnected.

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Regulations, Directives, EN Standards

EN ... machine safety standards

Main switches in accordance with EN 60 204-1 section 5.3 fulfill these requirements.



Determine the arrangement and number of such devices according to

- The design of the machine
- The necessity of the presence of persons in the danger zone
- The risk assessment carried out in accordance with EN 1050.

Also observe "Devices for switching off for prevention of unexpected startup", section 5.4 of EN 60 204-1.

Devices for the dissipation

of stored energy or its retention are, for example, brakes for movable parts, circuits for discharging capacitors, valves for pressure tanks.

Dissipation devices must be provided if stored energy can cause hazardous conditions.

Ensure that the energy dissipation or retention

- Occur at the same time as energy isolation
- Do not cause hazardous conditions by themselves,
- Are described in the operating instructions,
- Can be checked for efficiency by the user (e. g. manometer).

Further measures

If the isolation/dissipation of energy is not appropriate for all operations, you can apply the following measures:

- Prevention of accidentally generated start command (example: control circuit device with flush operating surface)
- Accidentally generated start commands may not cause an unexpected startup. STOP shall override START function. (Examples: latched Emergency-stop actuator, key-operated actuator, opened movable protection door)



- Automatic stop before a hazardous situation can be caused. (Example: A drive is stopped only by means of the drive controls = Stop category in accordance with EN 60 204-1. A stop monitoring device causes the disconnection by means of an auxiliary contactor when starting an uncontrolled movement.)

Warning: These measures are not a substitute for energy isolation and dissipation. They may only be used after a thorough risk assessment.

EN 574

Safety of machinery

Two-hand controls

Functional aspects

Principles for design

Purpose:

The two-hand control is a safety device. A design in compliance with the standard prevents access to the danger zones during hazardous processes.

Target group:

Machine builders, manufacturers of two-hand controls and type C standard makers.

Essential points in brief:

The standard specifies requirements and instructions for the design and the selection of two-hand controls. The appropriate type C standard and the risk assessment (→ EN 292/EN 1050) will determine which machines require the use of two-hand controls.

The suitable two-hand control

Select the type and design of the two-hand control, depending on

- The hazard concerned
- The risk assessment
- The state of the application technology
- Further influences such as prevention of accidental operation or safety feature bypassing.



No simple bypassing of the protection function or accidental actuation

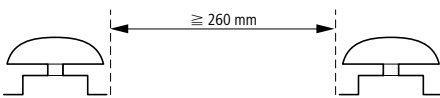
Arrange the operating elements of the two-hand control so that the protection function cannot be bypassed easily. The possibility of accidental operation should also be reduced to a minimum.

The types of bypassing to be considered depend on

- The design of the two-hand control,
- The actuation conditions
- The type and location of mounting,
- The specified safety distances

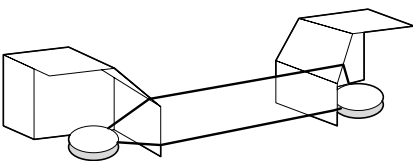
The standard shows some special procedures on how to prevent bypassing and accidental operation. The following examples are possible for different types of bypassing:

- Operation with one hand
 - Inside distance between the operating elements min. ≥ 260 mm



- Operation with hand and elbow of the same arm
 - Inside distance between the operating elements min. ≥ 550 mm (max. ≤ 600 mm)
 - Operating elements with different operation directions

- Operation with forearm and elbow
 - Use of covers or collars



- Operation with one hand and any part of the body
 - Operating elements on horizontal area min. ≥ 1100 mm above servicing level
- Operation by blocking an operating element
 - Use type II or type III

These measures may not be compatible with ergonomic requirements. Make a careful decision here and take into account the "Safety first" principle!

The standard provides for 3 types in accordance with the minimum safety requirements:

Requirements	Types				
	I	II	III		
			A	B	C
Use of both hands	●	●	●	●	●
Output signal only if both signals are present	●	●	●	●	●
Release of one or both operating elements terminates the output signal	●	●	●	●	●
Prevent accidental actuation when possible	●	●	●	●	●
No simple bypass of the protection function possible	●	●	●	●	●
New output signal only after release of both operating elements		●	●	●	●
Output signal only after synchronous actuation within max. 0.5 seconds			●	●	●
Complies with category 1 in accordance with EN 954-1	●		●		
Complies with category 3 in accordance with EN 954-1		●		●	
Complies with category 4 in accordance with EN 954-1					●

What else must be observed?

Ensure the functioning in all operating and ambient conditions. Accidental START signals must not be generated in particular by impact, shock, falling etc. Provide two differently functioning operating elements on hand-held machines, preferably with a locking device. Portable two-hand controls in separate housings should be stable and secured against changes in their location. Protect the supply lines from damage.

Calculate the safety distance between two-hand controls and danger zone by means of the following points:

- Hand-arm speed rate (EN 999)
- Design and arrangement of the two-hand control
- Response time of the two-hand control
- Stop time: time between the termination of the output signal and the ending of the hazard
- Usage in accordance with EN 292-1
- The relevant type C standards

Tests and information for use

Do the two-hand controls meet the requirements specified in the risk assessment? This must be evaluated by the theoretical assessment and the practical test. Table 2 of the EN 574 contains detailed information.

Provide information for the installation, operation and service preferably in the official language of the designer/operator.

Mark the two-hand control with at least the type and the standard concerned.

Example:

EN 574: Type III B

Further requirements apply to independent two-hand controls

Regulations, Directives, EN Standards

11.4 Machine-related product standards

Product standard contain safety requirements placed on specific machine types

→ Find the product standard for your machine in the following table or in the Internet at www.VDMA.ORG/NAM for the product standard applicable to your machine.

→ Order this product standard. (Ordering address: see page 114)

(The following table is only an extract due to the large number of type C standards available. Valid as of: July 1999)

The meaning of the type C standards:

First of all, compliance with the product standard must be ensured for the machine type concerned.

The product standard normally refers to the relevant group standard (type B).

If the type C standard contains additional requirements, the type C standard applies.

– If there is no product standards (type C) for the machine

or

– If significant hazards of the machine are not covered in this standard,

the definitions of the requirements of the type B group standards will offer guidance.

You will find information about the group standards on page 86.

If the product standard is in draft form, the national regulations still apply.

In practice, however, prEN... draft standards are also used for assessing conformity.

Hazard analysis

The safety requirements stipulated in the Machinery Directive and in EN standards depend on the risk of accident involved.

Most type C standards take into account the specific risks of the machine type concerned. The degree of safety required therefore tends to depend on the particular standard concerned.

The machine designer must assess the degree of the risk by means of a hazard analysis and implement measures to minimize risks, check and document them in each case, especially if no type C standard is available.



Machine type	C standard
Woodworking machines	
General requirements	prEN 691
Planing machines	EN 859 EN 860 EN 861
Band saw machines	EN 1807
Circular saw machines	EN 1870
Spindle moulding machines	EN 848-1
Top spindle moulder machines	EN 848-2
Combined machines	EN 940
Tenon cutting machines	EN 1218-1
Machine tools	
Mechanical presses	EN 692
Hydraulic presses	prEN 693
Press brake	prEN 12 417
Grinding machines	EN ISO 6103
Turning machines	EN 1550
Machining centres	prEN 12 417
Electrical discharge machines	in preparation
Sawing machines	in preparation
Small NC turning machines and centers	prEN 12 415
Rubber and plastic processing machines	
Injection moulding machines	EN 201
Moulding and injection moulding presses	EN 289
Extruders and extrusion systems	EN 1114
Mills	EN 1417
Blow moulding machines	EN 422
Size reduction machines	prEN 12 012-1
Blade granulators	prEN 12 012-2
Strand pelletisers	prEN 12 012-3
Internal mixers	prEN 12 013-1
Calender	prEN 12 301
Reaction casting machine	EN 1612
Hot forming machines	EN 12 409

Machine type	C standard
Packaging machines	
General requirements	prEN 415-1
For form-rigid packaging	prEN 415-2
Form, fill and seal machines	prEN 415-3
Palletizers	EN 415-4
Wrapping machines	in preparation (EN 415-5)
For securing the pallets	in preparation (EN 415-6)
Collective packing machines	in preparation (EN 415-7)
Food processing machinery	
Safety requirements	prEN 1672-1
Hygiene requirements	EN 1672-2
Dough mixers	prEN 453
Planetary mixers	prEN 454
Stikken baking ovens	prEN 1673
Dough and pastry breaks	prEN 1674
Automatic dividers	prEN 12 042
Butcher machines	
Slicing machines	EN 1974
Vegetable cutting machines	EN 1678
Cooking oil/grease production machines	in preparation
Machines for the production of noodles	in preparation
Intermediate provers	prEN 12 043
Moulders	prEN 12 041
Passing machines	prEN 12 331

Regulations, Directives, EN Standards

Machine-related product standards

Machine type	C standard	Machine type	C standard
Thermoprocessing technology		Printing and paper machines	
General safety requirements	EN 746-1	Printing and paper converting machines	prEN 1010
Combustion and fuel handling systems	EN 746-2	Paper preparation machines	prEN 1034
Hot dip galvanizing thermoprocessing equipment	prEN 746-4	Tannery machines	
Salt bath thermoprocessing equipment	prEN 746-5	Reciprocating roller machines	EN 972
Liquid phase treatment thermoprocessing equipment	prEN 746-6	Cutting and separation machines	in preparation
Vacuum thermoprocessing equipment	prEN 746-7	Machines with moving plates	EN 1035
Quenching equipment	prEN 746-8	Spraying and plush machines	in preparation
Underground mining machines		Drying conveyor	in preparation
Mobile extracting machines	prEN 1552	Rotating casks and similar machines	in preparation
Mobile machines and rail locomotives	prEN 1889-1	Footwear and leather machines	
Hydraulic powered roof supports	prEN 1804-1	Punching and perforating machines	in preparation
Mining ventilation machines	prEN 1872	Roughing, scouring, polishing and trimming machines	EN 930
Building and building material machines		Shoe forming machines	EN 1845
Earth-moving machines	EN 474 EN ISO 3457	Lasting and needle machines	EN 931
Piling and drawing equipment	EN 996	Modular footwear repairing machines	in preparation
Drill rigs	EN 791	Leather and footwear presses	in preparation
Tunnel boring machines	EN 815 prEN 12 111	Foundry machines	
Road construction machines	EN 500	Metal casting machine	EN 869
Preparation, transport, installation of concrete	in preparation	Moulding and core making machines, foundry ladles, spinning machines	EN 710
Preparation of cement, lime, gypsum	prEN 1009	Foundry and casting machines	prEN 1247
Preparation of concrete and chalky sandstone products	in preparation	Abrasive blasting machines	prEN 1248
Extraction and processing of natural stone	in preparation		
Preparation of ceramics	in preparation		
Preparation of glass	in preparation		
Demolition machines	in preparation		
Preparation of concrete and mortar	prEN 12 151		
Conveying, spraying and distributing machines for concrete and mortar	prEN 12 001		



Machine type	C standard
Textile machines	
Textile machines	EN ISO 11 111
Dry-cleaning machines	EN ISO 8230
Laundry and ironing machines	EN ISO 10 472
Compressors	
Compressors and vacuum pumps	EN 1012-1
Vacuum pumps	EN 1012-2
Pumps and pump units for liquids	EN 809
Surface treatment equipment	
Atomizing and spraying equipment for coating materials	EN 1953
Surface cleaning and preparatory treatment of industrial products	in preparation
Coating and colour mixture equipment	in preparation
Coating equipment	in preparation
Dryers, ovens, vapour escape equipment	prEN 1539
High pressure cleaners	prEN 1829
Industrial centrifuges	
Centrifuges	EN 12 547
Industrial robots	
Safety	EN 775
Sewing machines	
Electrical equipment for industrial machines	EN 60 204-3-1
Safety, devices for domestic use	EN 60 335-2-28
Elevators/lifting devices	
Elevators	EN 81-1 EN 81-2
Elevators for small goods	prEN 81-3
Escalators and passenger conveyors	EN 115
Building elevators	in preparation
Mobile and movable jacks	prEN 1494
Vehicle lifts	EN 1493

Machine type	C standard
Continuous mechanical handling equipment	
Common safety requirements	prEN 616
Continuous mechanical handling equipment for parts and bulk material	prEN 617 to 620
Industrial trucks	
Electrical equipment	EN 1175
Unmanned industrial trucks	EN 1525
Shelf handling devices	
Safety	EN 528
Cranes	
Safety	EN 12 077-2
Agricultural and forestry machines	
General requirements	EN 1553
Combine harvester and field chopper	EN 632
Silo stationary unloaders	EN 703
Collective presses	EN 704
Silo stationary unloaders for round silos	prEN 1374
Lasers and laser related equipment	
Laser machining	EN 12 626
Min. requirements placed on documentation	EN 31 252
Mechanical interfaces	EN 31 253
Heat pumps, refrigerating plant (not for Machine directive)	
Heat pumps, requirements	prEN 255-8
Refrigerating plants and heat pumps Safety requirements	EN 378-1

12. Appendix

12.1 Definitions

Access time (time for the access to the danger zone) (EN 1088)

The required time for access to the dangerous machine parts after the initiation of the stop command by the interlock, calculated on the basis of the speed of approach for which the value can be selected for each individual case, taking into account the parameters in EN 999 "Safety of machinery - The positioning of protective equipment in respect of approach speeds of parts of the human body."

Actuator (operating element) (EN 60 204-1)

The part of the operating system on which an external actuating force is applied.

NOTE 1: The actuator may take the form of a handle, knob, push-button, roller, plunger etc. (IEV 441-15-22).

NOTE 2: There are many actuating means which do not require an external actuating force but only an action.

NOTE 3: See also machine actuator, EN 60 204-1, 3.36.

Actuator, operating element

Mechanical element of a safety position switch or a safety interlocking device which initiates the switching operation. Due to their design, the position switches and actuators are coded so that manipulation with simple tools (screwdriver, piece of wire) is not possible.

Auxiliary contact (EN 60 947-1/IEV 441-15-10)

A contact which is included in an auxiliary circuit and is mechanically operated by the switching device.

Auxiliary switch (EN 60 947-1/IEV 441-15-11)

Switch containing one or more control or auxiliary contacts and which is mechanically operated by a switching device. Auxiliary switches can be retrofitted in modular systems of contactors, circuit-breakers and motor-protective circuit-breakers, or they are a fixed component of a switching device, e. g. contactor relay. They are designated according to whether they

1. Making contact as a break contact, make-contact, changeover contact or fleeting contact;

2. Function as normal, early, late, drive or trip indicator switches.

Auxiliary circuit (EN 60 947-1/IEV 441-15-04)

All the conductive parts of a switching device or system which are intended to be included in a circuit other than the main circuit and the control circuits of the device.

Back-of-hand proof

A switching device is considered as back-of-hand proof if its conductive parts cannot be touched with a ball with a diameter of 50 mm.

Back-up protection (EN 60 947-1)

Installation of two overcurrent protective devices in series, whereby the protective device installed on the supply side, protects the downstream safety device and prevents excessive stress or destruction of the device, in the event of a short-circuit.

In the engineering design phase, consider that in selectively protected system parts, the upstream overcurrent protective device disconnects a short-circuit within the shortest possible time, if the switching capacity of the switching device closer to the source of the fault is exceeded. The selection is carried out by comparing the characteristic curves of the switching devices involved with the short-circuit current to be expected.

Category → (Control) Category

CE marking

(Communauté Européenne, European Community)

Marking that indicates the conformity of the marked product with the relevant European regulations and thus approval for the whole of Europe. The ruling directives are: the Machinery Directive (compulsory since 1995), the EMC Directive (from 1996) and the Low-voltage Directive (from 1997). The CE marking is not to be considered as a quality marking but as a "passport" for the free movement of goods within the European single market.



Conditional rated short-circuit current (EN 60 947-1/IEV 441-17-20)

The short-circuit current which a switching device (e. g. contactor) protected by a short-circuit protective device (e. g. motor-protective circuit-breaker) can satisfactorily withstand during the operating time.

Contact, direct (EN 60 204-1)

Contact with live parts by persons or domestic animals (IEV 826-03-05).

Contact, indirect (EN 60 204-1)

Contact with components of electrical devices by persons or domestic animals, which become live under fault conditions (IEV 826-03-06).

Contactors

Contactors which are suitable for the connection of loads in main circuits. Generally, the contactor is equipped with 3 main current paths and can be additionally equipped with further auxiliary contacts (make contact, break contact) to actuate auxiliary circuits. Contactors are classified according to their load switching capacity: motor switching capacity AC-3 and AC-4, active load switching capacity AC-1 and conventional thermal current I_{th} .

Contactors relay (EN 60 947-1/IEV 441-14-35)

Contactors for use as an auxiliary switch.

(Control) Category (EN 954-1)

A classification of the safety-related parts of a control system in respect of its resistance to faults and its subsequent behaviour in the fault condition, and which is achieved by the structural arrangement of the parts and/or by their reliability.

Control circuit device

Manually operated control devices for controlling, signaling, interlocking etc. of switching devices, e. g. pushbuttons, rotary switches.

Control circuit (of a machine) (EN 60 204-1)

Circuit used for the operational control of the machine and for protection of the power circuits.

Coordination type

Status of a switchgear assembly (motor starter) during and after the test with the conditional rated short-circuit-current.

Type 1 coordination:

- No hazard to persons and systems.
- No immediate operational readiness is necessary.
- Damage to the starter permissible.

Type 2 coordination:

- No hazard to persons and systems.
- Starter is suitable for further operation.
- No damage to the starter except slight welding of the switch contacts if these can be separated easily without significant deformation.
→ Rated short-circuit current, conditional.

Current, prospective (EN 60 947-1/IEV 441-17-01)

Current which would flow in a circuit if all poles of the switching device or the fuse would be replaced by conductors of negligible impedance.

Current/time characteristic curve

Graphical representation of the relationship between the overcurrent flowing through an overcurrent release or a fuse, and the time required until it trips. The curve is represented in a double-logarithmic matrix with the time on the vertical axis and the multiple of the current setting and the rated current on the horizontal axis (standard representation).

Danger zone (EN 292-1)

Any zone within and/or around machinery in which a person is exposed to risk of injury or damage to health.

Note: The hazard generating the risk envisaged in this definition:

- Is either permanently present during the intended use of the machine (motion of hazardous moving elements, electric arcing during a welding phase etc.)
- Or may appear unexpectedly (unintended/unexpected startup etc.).

Degree of protection

The degree of protection of an electrical device or an enclosure provides information on the range of:

- Protection against contact: protection of persons against contact of dangerous parts
- Protection against foreign bodies: protection of the operating device against the ingress of solid foreign bodies
- Protection against water: protection of the operating device against the ingress of water.
The degree of protection provided by an enclosure is indicated by the IP code (international protection) and two numbers. The first number indicates the degree of protection against contact and the ingress of foreign bodies, and the second number indicates the degree of protection against water.

Design of a machine (EN 292-1)

A series of actions including:

a) The study of the machine itself, taking into account all phases of its "life":

1. Construction
2. Transport and commissioning
 - Assembly and installation
 - Setting
3. Use
 - Setting, teaching/programming or process changeover
 - Operation
 - Cleaning
 - Fault finding
 - Maintenance

4. Decommissioning, dismantling and, as far as safety is concerned, disposal

b) The drafting of the instructions relating to the above-mentioned phases of the "life" of the machine (except construction), dealt with in 5.5 of EN 292-2.

Device (EN 60 204-1)

A unit of an electrical system which is intended to carry but not utilize electric energy.

Early-make contact

Make contact, mainly used as an auxiliary contact which closes before the main contacts of the device.

Emergency-stop device (EN 418)

Arrangement of components to avert arising or to reduce existing hazards to persons, damage to machinery or to work in progress. The function of an emergency stop device does not have to consist of the disconnection of the power supply of the driving machine in every case. In order to avert hazards, it may be useful to maintain individual current circuits in operation, e. g. to activate electromagnetic clamping devices or certain safety routines, e. g. braking or reversal.

Emergency-stop switching device

→ Emergency-stop

Enforced contact separation (EN 60 947-5-1)

Enforced contact separation is ensured by means of a connection between operating element and switching element, causing the force executed on the operating element (without flexible parts) to be transferred to the switching element.

Failure (EN 954-1)

The termination of the ability of a device to perform a required function.

NOTE 1: After a failure the device has a fault.
NOTE 2: "Failure" is an event, as distinguished from a "fault" which is a state.
NOTE 3: This concept as defined here does not apply to items consisting of software only.

Fault (EN 954-1)

The state of an item characterized by inability to perform a required function, excluding the inability during preventative maintenance or other planned actions, or due to lack of external resources.

Note: A fault is often the result of a failure of the item itself, but may exist without prior failure.

Appendix

Definitions

Feedback circuit

The feedback circuit is used to monitor downstream, redundant contactors with positively opening contacts. Break contacts of both contactors are connected in series in the feedback circuit of the safety circuit. If a main or enable contact welds, reactivation of a safety circuit is not possible. The safety circuit can only be switched in when the feedback loop is closed.

Finger proof

A switching device is to be considered as finger proof if its live parts cannot be touched when actuating the operating elements. This also applies when operating adjacent switching devices. The finger proof area of a push-actuated operating device is a circular area with a minimum radius of 30 mm around the actuator concerned at right angles to the direction of operation. Within this area, hazardous parts should be fitted at least 80 mm below the level of the actuating area.

Foot and palm switches

Robust auxiliary switch with a very large actuator element that can be operated by hand or foot.

Guard (EN 292-1)

Part of a machine specifically used to provide protection by means of a physical barrier. Depending on its construction, a guard may be called casing, cover, screen, door, enclosing guard etc.

• Fixed guard

a guard kept in place (i. e. closed):

- either permanently (i. e. by welding etc.)
- or by means of fasteners (screws, nuts, etc.), making removal/opening impossible without using tools.

• Movable guards

Guard generally connected by mechanical means (e. g. hinges or slides) to the machine frame or an adjacent fixed element and which can be opened without the use of tools.

• Interlocking guard (Δ EN 1088)

Guard associated with an interlocking device so that:

– the hazardous machine functions “covered” by the guard cannot operate until the guard is closed.

– if the guard is opened while hazardous machine functions are operating, a stop instruction is given

– when the guard is closed, the hazardous machine functions “covered” by the guard can operate, but the closure of the guard does not by itself initiate their operation.

• Control guard

Guard associated with an interlocking device (with or without guard locking) so that:

– the hazardous machine functions “covered” by the guard do not operate until the guard is closed

– closing the guard initiates operation of the hazardous machine function

Hazard (EN 292-1, EN 1050)

A source of a possible injury or damage to health.

Hazardous machine functions (EN 292-1)

Any function of a machine which generates a hazard when operating.

Hazardous situation (EN 292-1)

Any situation in which a person is exposed to a hazard or to hazards.

Industrial machine (EN 60 204-1)

A power-driven machine used to shape or form material by cutting, impact, pressure, electrical, thermal or optical techniques, lamination, or a combination of these processes or associated machines or equipment used in conjunction with these industrial machines to transfer raw material, work in progress, or tooling (including, fixtures); assemble/disassemble; spray or coat; inspect or test; or package. The associated electrical equipment including the logic controller(s) and associated software or logic together with the actuators and sensors are considered as part of the industrial machine.

Information for use (EN 292-1)

Safety measures consisting of communication elements such as texts, words, characters, signals, symbols or diagrams which are used individually or combined in order to convey information to the user. The information is written for industrial and/or non-industrial users.

Inherent stability

Property of a switching device that switches off at specified voltages at a current expected in the event of a short-circuit (the prospective short-circuit current) at any level (greater than 100 kA), without being affected in its function (conducting current, tripping in the event of an overload).

Inherent stability is normally obtained by damping components in the switching device which reduce a short-circuit current so that it can be switched off by the contact system. With circuit-breakers and motor-protective circuit-breakers for small rated operating currents, this is caused by the resistance in the bimetal trip and in the winding of the short-circuit release. Larger switching devices obtain this effect by the fast and wide opening of the contacts, leading quickly to an arc resistance which also limits the current. Inherent stability mainly applies to switching devices with small rated currents due to the increasing mass inertia of the contact system of large circuit-breakers.

Intended use of a machine (EN 292-1)

The use for which the machine is suited according to the information provided by the manufacturer or which is deemed usual according to its design, construction and function.

Intended use also involves the compliance with the technical instructions laid down notably in the instruction manual, taking into account reasonably foreseeable misuse:

Note: With regard to foreseeable misuse, the following behaviour should be particularly taken into account in the risk assessment:

- The foreseeable incorrect behaviour resulting from normal carelessness, but not resulting from deliberate misuse of the machine.
- The reflex behaviour of a person in case of malfunction, incident, failure, etc., during use of the machine.

- The behaviour resulting from taking the “line of least resistance” in carrying out a task.
- For some machines (especially machines for non-professional use), the foreseeable behaviour of certain persons, such as children or the disabled.

Interlock

The interlock of a locking device with retainer, mechanically prevents that the locking system returns to the locked position when the safety guard is open.

Interlock (locking) (EN 292-1, Δ EN 1088)

A mechanical, electrical or other device which prevent the operation of a machine element under specified conditions (normally as long as a guard is not closed).

Interlocking guard with guard locking (EN 1088)

Guard associated with an interlocking device and a guard locking device so that:

- The hazardous machine functions “covered” by the guard cannot operate until the guard is closed,
- If the guard is opened while hazardous machine functions are operating, a Halt command is initiated,
- When the guard is closed, the hazardous machine functions “covered” by the guard can operate, but the closure of the guard does not initiate their operation.

Interlocking guard with guard locking (EN 1088)

Guard associated with an interlocking device and a guard locking device so that:

- The hazardous machine function “covered” by the guard cannot operate until the guard is closed and locked,
- The guard remains closed and locked until the risk of injury from the hazardous machine functions has passed,
- When the guard is closed and locked, the hazardous machine functions “covered” by the guard can operate, but the closure and locking of the guard does not initiate their operation.

Isolating (VDE 0100 Part 200)

Disconnection of the entire system, a part of the system or a device from all conductors which are not earthed.

Isolation and dissipation of energy (EN 1037)

Procedure which consists of the following four steps:

- a) Isolating (switch off, disconnection) the machine (or defined parts) from all supply sources.
- b) Locking (or securing in another way) of all isolating devices in the “isolated position” if required (e. g. with large machines or plants).
- c) Dissipating or retaining any stored energy which can cause a hazard.

Note: Energy as c) can be stored, for example, in:

- mechanical parts which continue to move due to mass inertia;
- mechanical parts which can move under gravity;
- capacitors, accumulators;
- pressurized media;
- springs.

d) Ensure by means of safe operation that the above measures as per a), b) and c) have the required effect.

Isolation function (EN 60 947)

The function of switching devices whose switching contacts, when opened, achieve the required isolation for isolating circuits. The entire system or part of the system can thus be disconnected from the supply to ensure safety, e. g. during maintenance work.

Key-operated push-button (EN 60 947-5-1)

Push-button which can only be operated with the key inserted.

Late-break contact

Break contact, mainly with auxiliary switch function, which opens with a delay when compared to the main contacts of the basic unit.

Limit switch → Position switch

Load disconnection

1. Circuit measure to prevent dangerous overloads or reduce power/current peaks by disconnecting secondary loads. The load is disconnected by, for example, the trip electronics of a circuit-breaker in order to prevent an expected overcurrent trip. The load disconnection contact switches off the operating voltage of a contactor which isolates the load from the circuit.
2. Early disconnection and late connection of loads for reducing of the contact load of isolating switches. The load connection is carried out by the assigned contactor control since disconnectors do not always provide the total load switching capacity.

Locking capability (EN 60 204-1)

Precondition for the functioning of a switching device as a main switch. The switching device must be lockable in the OFF position, e. g. by the attachment of at least one padlock.

Low-voltage switchgear

Switching devices for circuit up to 1000 V AC or 1500 V DC.

Machinery (EN 292-1)

An assembly of linked parts or components, at least one of which moves, with the appropriate actuators, control and power circuits, etc., joined together for a specific application, in particular for the processing, treatment, moving or packaging of a material. The term machinery also covers an assembly of machines which, in order to achieve one and the same end, are arranged and controlled so that they function as an integral whole.

Main circuit (EN 60 204-1)

A circuit for supplying power to the devices used for the production process and the control transformers.

Main switch

→ Power disconnecting device

Maintenance switch

Safety switch for the isolating of electrical drives during maintenance work.

Appendix

Definitions

Modular system

Modular concept of switching devices which allows required functions to be added or retrofitted depending on the application, e. g. control switches, voltage releases, handles, enclosures.

Monitoring, automatic (EN 292-1)

A back-up safety function which ensures that a safety measure is initiated if the ability of a component or an element to perform its function is diminished, or if the process conditions are changed in such a way that hazards are generated.

There are two categories of automatic monitoring:

- “Continuous” automatic monitoring whereby a safety measure is initiated when a failure occurs;
- “Discontinuous” automatic monitoring, whereby a safety measure is initiated during the following machine cycle, if a failure has occurred.

Muting (EN 954-1)

A temporary automatic suspension of a safety function by safety-related parts of the control system.

Operating voltage tolerance

Term for the operating reliability of a magnetic drive in terms of the limit values of the applied actuating voltage.

A contactor has a satisfactory operating voltage tolerance if it is switched by the smallest permissible actuating voltage (pick-up voltage = seal-in voltage). A relatively low voltage is required for disconnection, so that no accidental switch conditions occur in the event of voltage failures. The drop-out voltage, however, may not be too low as with long control cables, it is possible that the sealing current can flow even after opening the control contact, due to the capacitance in the conductors, and the drop off is at least delayed.

Person, instructed (EN 60 204-1)

individual adequately advised or supervised by a skilled person, to enable that individual to avoid hazards in the event of faulty behaviour, and who is trained, if required, as well as instructed on the required protection devices and measures.

Position switch

(EN 60 947-5-1/IEV 441-14-49)

Auxiliary switch which is actuated by a moving part of the machine if this part has reached a specified position.

Position switches are divided into the following type according to their operation:

- Mechanical position switches
Actuation by means of direct contact or over-travelling of the drive head by a part of the machine. Safety position switches with separate actuators are used for the position monitoring of working machines.
- Proximity switches
Non-contact actuation into the monitored area. These are inductive, capacitive and optical devices depending on their method of operation.

Position switch with safety function (IEV 441-14-50)

Position switch having positive opening operation.

Positive opening operation (EN 60 947-1/IEV 441-16-11)

Opening operation that ensures that all the main contacts are in the open position when the actuator is in the OFF position.

(EN 60 947-5-1)

The execution of a contact isolation as direct result of a fixed movement of the operating element of the switch by means of non-flexible parts (e. g. not dependent on a spring).

Positive opening force (EN 60 947-5-1)

Actuating force or torque (of a rotary switch) which is required on the opening element to obtain positive opening operation.

Positive opening travel (EN 60 947-5-1)

Minimum travel from the start of the operation of the operating element until the final position of the positive opening operation of the contacts to be opened.

Positively driven contact elements (IEC 17B/861/CD)

Combination of n make contact and m break contact elements which are connected mechanically so that they cannot be closed at the same time.

Power disconnecting device

A manually operated switch which is always required for the electrical equipment of machines. Its task is to disconnect the electrical equipment in order to exclude hazards occurring when cleaning, repairing, maintaining the machine concerned as well as for long periods. A power disconnecting device must

1. Be an operating element that is externally accessible;
2. Have only one OFF and ON position with assigned limit stops;
3. Mark the two switch positions with “O” and “I”;
4. Be lockable in the OFF position;
5. Cover the connection terminals against accidental contact;
6. Have a minimum switching capacity for load disconnectors and motor switches for AC-23.

Protective conductor (EN 60 204-1)

A conductor which is required for some measures of protection against electric shock, for electrically connecting any of the following parts:

- Exposed conductive parts
- Extraneous conductive parts
- Main earth terminal

(in accordance with IEC 826-04-05)

Protective extra-low voltage (PELV) (IEC 364-4-41)

Protective measure by which circuits with voltages of up to 50 V AC and 120 V DC are operated without an earth and which are potentially isolated from circuits with higher voltages. Protective extra-low voltage provides protection against contact voltages which are too high, in the event of direct and indirect contact caused by an insulation fault.

Protective extra-low voltage with isolation (PELV) (IEC 364-4-41/VDE 0100 Part 410)

Low voltages up to 50 V AC and 120 V DC, which are safely isolated from other circuits and where active parts and bodies are earthed.

→ Protective low voltage

Protective isolation

Protective measure by which the operating equipment is potentially isolated from the mains supply (isolating transformer, motor generator) and not earthed.

Redundancy (EN 60 204-1)

The application of more than one device or system, or part of a device or system with the objective of ensuring that in the event one failing to perform its function, another is available to perform that function.

Reliability (EN 292-1)

The ability of a machine or components, or equipment, to perform a required function under specified conditions and for a given period of time without failing.

Reset, manual (EN 954-1)

A function within the safety-related parts of a control system to manually restore given safety functions before the restarting of a machine.

Risk (EN 292-1)

A combination of the probability and the degree of the possible injury or damage to health in a hazardous situation.

Risk assessment (EN 292-1)

A comprehensive estimation of the probability and the degree of the possible injury or damage to health in a hazardous situation in order to select appropriate safety measures.

Risk reduction by design (EN 292-1)

Risk reduction by design involves:

- Avoiding or reducing as many of the hazards as possible by suitable choice of design features and
- Limiting exposure to hazards which are unavoidable or cannot be reduced sufficiently; this is achieved by reducing the need for operator intervention in danger zones.

Safe isolation

Reinforced or double isolation which prevents the voltage transfer from one circuit to another. The safe isolation is mainly applied between main and auxiliary circuits of switching devices as well as with safety and isolation transformers.

Safeguard (EN 60 204-1)

A → guard or safeguard is used in a safety function to protect persons from a present or impending hazard.

Safeguarding (EN 60 204-1)

Those safety measures consisting of specific technical means, called safeguards (guards, protective devices) in order to protect persons from hazards that cannot be reasonably removed or sufficiently restricted by the design.

Safeguarding, technical (EN 292-1)

Safety measures consisting of the use of specific technical means called safeguards (guards, safety devices) to protect persons from the hazards which cannot reasonably be removed or sufficiently limited by design.

Safety functions of controllers (EN 954-1)

A function initiated by input signals and processed by safety-related parts of controllers, which enables the machine (as a system) to obtain a safe status.

Safety measure (safety function) (EN 60 204-1)

A means that eliminates or reduces a hazard.

Safety of a machine (EN 292-1)

The capability of a machine to execute its function(s) and to be transported, mounted, installed, maintained, dismantled and disposed, under the conditions of the application in accordance with the standard as defined by the manufacturer in the operating instructions (which is also mentioned in some cases for certain periods in the operating instructions) without causing injury or damage to health.

Safety of controls (EN 954-1)

The capability of safety-related components of a controller to execute their safety function(s) for a defined period in accordance with the defined category.

Safety position switch

Position switch which has a separate actuator which makes the actuator tamper proof via a mechanical coding. Safety position switches are used for position monitoring of protection coverings such as doors, flaps and shrouds.

Safety-related part of a control system (EN 954-1)

A part of a subordinate part (parts) of a control system which reacts (react) to input signals and generates (generate) safety-related output signals.

The combined safety-related parts of a control system start where the safety-related signals are entered and terminate on the output of the power control elements (see Annex A of EN 292-1: 1991). This also applies to monitoring systems.

Safety switch

Enclosed main switch very close to the drive or load, used for the release during maintenance and repair work. A safety switch is usually required if the relation between the main switch and load is not clear, or the main switch is not to be switched off. Each operator can ensure that no unauthorized person switches on the device by fitting a padlock.

Safety transformer

Isolating transformer with an output voltage ≤ 50 V. Safety transformers are used in systems with protected extra-low voltage (PELV).

Self maintaining

Property of a circuit in which a contactor remains in the "pick-up position" after an actuating pulse. When the actuation voltage is switched on by means of the ON actuator, this is normally bridged by an auxiliary contact of the contactor so that the voltage on the actuation coil is maintained.

Servicing level (operating level) (EN 60 204-1)

Level on which personnel normally stand when operating or maintaining electrical equipment.

Short-circuit (EN 60 947-1/IEV 151-03-41)

Conductive connection of two or more points in a circuit which normally have different voltages with a low resistance and impedance. The short-circuit is an operating state which causes a current exceeding the maximum current load capacity due to a fault or a faulty connection.

Appendix

Definitions

Short-circuit current (EN 60 204-1)

Overcurrent resulting from a short-circuit due to a fault or an incorrect connection in an electrical circuit (IEV 441-11-07).

Simultaneous (EN 60 204-1)

Connection actions; used to describe a situation in which two or more control circuit devices are in the actuated state at the same time (not necessarily synchronous)

Simultaneous operation (EN 574)

The simultaneous operation of both operating elements at the same time irrespective of the time difference between the start of one input signal and that of the other one.

Skilled individual (EN 60 204-1)

An individual with technical training, technical knowledge or sufficient experience as well as knowledge of valid standards, to enable that individual to judge and recognize possible dangers involved.

Standstill with Emergency-stop

Switching device of an Emergency-stop device which should prevent hazards to persons or damage to machines or material.

Startup (machine startup) (EN 1037)

The transition from the stop position of a machine or part of the machine to motion.

Note: The definition includes other functions such as movement functions, e. g. activation of a laser beam.

STOP – Category 0 (EN 60 204-1)

Stopping by immediate disconnection of the supply to the machine drives (e. g. uncontrolled stop).

STOP – Category 1 (EN 60 204-1)

A controlled stop where the supply to the machines is maintained to obtain the stand still status and the supply is only disconnected if the stand still status is achieved.

STOP – Category 2 (EN 60 204-1)

A controlled stop in which the supply to the machine drives is maintained.

Stop, controlled (EN 60 204-1)

The stopping of machine motion by setting the command signal to "0" once the stop signal has been recognized by the control system but retaining power to the machine actuators during the stopping process.

Stop, uncontrolled (EN 60 204-1)

The stopping of machine motion by removing power to the machine actuators, all brakes or other mechanical stopping devices being activated.

Stop, unexpected (accidental) (EN 292-1)

Each startup which can cause a risk to persons when it occurs accidentally.

(EN 1037)

Each startup which is caused by:

- A start command caused by a fault in the control system or an external influence acting on it;
- A start command caused by faulty operation by personnel on a start operating element or other parts of the machine, e. g. on a sensor or a power control element;
- Restoration of the power supply after an interruption;
- External/internal influences (gravity, wind, self-ignition in internal combustion engines...) with parts of the machine.

Stopping time, time up to removal of the hazard (EN 1088)

Time from the release of the stop command by the interlocking device to the point when the risk caused by the hazardous machine function is no longer present.

Switching device (EN 60 204-1)

A device designed to make or break the current in one or more electric circuits (IEV 441-14-01).

Synchronous actuation (EN 574)

A special case of simultaneous actuation where the time shift between the start of the input signal and the start of the other signal is less or equal to 0.5 s.

Tamper-proof

1. Term for the requirement of the employer's liability insurance association for protection against manipulation on position switches for the protection of personnel: "No hazardous movement of the tool (working machine) may be initiated by bypassing the protection device, e. g. by actuating the limit switch or by operation with simple tools such as screwdrivers, bolts, pieces of wire."
2. An Emergency-stop device is tamper-proof if an executed release operation cannot be canceled without auxiliary means or prescribed procedures. The switching device locks in the release position. The accidental or controlled manipulation (inching mode) is excluded.

Two-hand control (EN 574)

A device that requires at least the simultaneous operation by both hands, to initiate and maintain the operation of a machine as long as a hazard is present, in order to achieve a protective measure solely for the operator.

Two-hand control, portable (EN 574)

A movable device which can be used in more than one specified position, in relation to the danger zone area of the machine which it controls.

Type A standards (EN 292-2)

These standards (safety basic standards) contain basic concepts, design principles and general aspects which apply to all machines, devices and systems.

Type B standards (EN 292-2)

These standards (safety group standards) deal with a safety aspect or a kind of device required for more safety which can be used for a number of machines, devices and systems.

- Type B1 standards refer to special safety aspects (e. g. safety distances, surface temperatures, noise).
- Type B2 standards refer to safety-related devices (e. g. two-hand controls, locking devices, contact mats, isolating protection devices).



Type C standards (EN 292-2)

These standards (machine safety standards) contain detailed safety requirements for a certain machine or groups of machines.

**Undervoltage release
(EN 60 947-1/IEV 441-16-42)**

A shunt release which permits a mechanical switching device to open or close, with or without time-delay, when the voltage across the terminals of the release falls below a predetermined value.

Undervoltage releases are used in Emergency-stop devices, as a method of preventing restart after a voltage failure and in electrical interlocking devices.

Appendix

12.2 Machine and safety components to Annex IV of the Machine Directive

“Hazardous” machines and safety components in accordance with Annex IV of the Machinery Directive

Type of machines and safety components for which the procedure in accordance with article 8, section 2, b) and c) apply

A. Machines

1. Circular saws (single or multi-blade) for working with wood and analogous materials or for working with meat and analogous materials.²⁾

1.1. Sawing machines with fixed tool during operation, having a fixed bed with manual feed of the workpiece or with a demountable power feed.²⁾

1.2. Sawing machines with fixed tool during operation, having a manually operated reciprocating saw-bench or carriage.²⁾

1.3. Sawing machines with fixed tool during operation, having a built-in mechanical feed device and manual loading and/or unloading.²⁾

1.4. Sawing machines with movable tool during operation, with a mechanical feed device and manual loading and/or unloading.

2. Hand-fed surface planing machines for woodworking.

3. Thickness¹⁾ for one-side dressing with manual loading and/or unloading for woodworking.

4. Band-saws with a fixed or mobile bed and band-saws with a mobile carriage, with manual loading and/or unloading, for working with wood and analogous materials or for working with meat and analogous materials.²⁾

5. Combined machines of the types referred to in 1 to 4 and 7 for working with wood and analogous materials.²⁾

6. Hand-fed tenoning machines with several tool holders for woodworking.

7. Hand-fed vertical spindle moulding machines for working with wood and analogous materials.²⁾

8. Portable chain saws for woodworking.

9. Presses, including press-brakes, for the cold working of metals, with manual loading and/or unloading, whose movable working parts may have a travel exceeding 6 mm and a speed exceeding 30 mm/s.

10. Injection moulding or compression moulding machines with manual loading or unloading.

11. Injection or compression rubber moulding machines with manual loading or unloading.

12. Machinery for mining:¹⁾

- Machinery on rails; locomotives and brake vans,
- Hydraulic powered roof supports
- Internal combustion engines to be fitted to machinery for mining work.

13. Manually loaded trucks for the collection of household refuse incorporating a compression mechanism¹⁾

14. Guards and detachable transmission shafts with universal joints as described in Section 3.4.7¹⁾

15. Lifts for vehicles¹⁾

16. Machines for the lifting of persons involving a risk of falling from a vertical height of more than 3 m¹⁾

17. Machines for the manufacture of pyrotechnics.¹⁾

B. Safety components²⁾

1. Sensor controlled devices designed specifically to detect persons in order to ensure their safety (optical barriers, sensor mats, electromagnetic detectors, etc.).

2. Logic units which ensure the safety functions of two-hand controls.

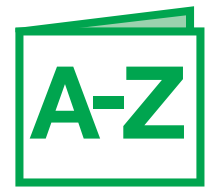
3. Automatic mobile protective mechanisms on machines in accordance with letter A in 9, 10 and 11.

4. Rollover protective structures (ROPS)

5. Falling object protective structures (FOPS)

¹⁾ Modified by Council Directive 91/368/EEC of 20.6.1991, AB1. No. L 198 of 22.7.1991, page 24

²⁾ Modified by Council Directive 93/44/EEC of 19.6.1993, AB1. No. L 175 of 19.7.1993, page 18



Appendix

12.3 Requirements for existing machines

The following general regulations apply to existing machines:

Provisional regulations for machines ¹⁾ in accordance with the Machinery Directive 89/392/EEC and Corrigendum to Council Directive 89/655/EEC			
Concerning the minimum safety and health requirements for the use of work equipment by workers at work Period:	Machine compliance with	Machine may be further operated by the first user without modification ²⁾ Period:	Machinery must be retrofitted in accordance with/to the directive (Annex) and its national additional requirements
until 31.12.1992 (old machines)	the national regulations valid until 31.12.1992	until 31.12.1996	at least until 31.12.1996, if deviations of the national regulations exist
between 01.01.1993 and 31.12.1994	the Machinery Directive; EC declaration of conformity available, CE marking available	without time limit	not applicable
	the valid national regulations valid until 31.12.1992, but not the Machinery Directive	until 31.12.1996	at least until 31.12.1996, if deviations of the national regulations exist
from 01.01.1995	the Machinery Directive; EC declaration of conformity available, CE marking available	without time limit	not applicable

¹⁾ Without provisional regulations for certain machines; does not apply to the trade of used machines

²⁾ The Machinery Directive applies to modification or essential change; repair and maintenance are not considered modifications

Corrigendum concerning the minimum safety and health requirements for the use of work equipment 89/655/EEC

The employer must provide working material which ensures the safety and health of the employees when used.

The directive describes the minimum requirements placed on working material, such as machines. The national requirements (legislation) can exceed these minimum requirements.

The following requirements are stated in the annex of the directive:

- Actuating systems, clearly visible and outside the danger zone
- Commissioning only possible by intentional actuation (see chapter 2: Preventing restarts)
- Actuating system provided for safe disconnection
- Emergency-stop device provided according to the hazard and the stopping time (see also chapter 1: Emergency-stop circuit with STOP category 0 and 1)
- No hazard caused by ejected objects or emissions

- Guards against hazard by movable or very cold/hot parts

- Protection against electric shock (see chapter 7: Protection against electric shock)

Further requirements for mobile equipment as well as equipment for lifting loads and persons are covered in the Directive 95/63/EC of 05.12.95, the amendment of the Directive 89/655 EEC.

Ordering addresses for EC Directives are given on page 115.

Appendix

12.4 Samples of declarations of conformity

EC-Declaration of Conformity

In accordance with the EC Directive

- Machines 89/392/EEC, Annex II A
- Electromagnetic Compatibility 89/336/EEC
- Low-voltage 73/23/EEC
-

Design of the machine

Make

Type designation

is developed, designed and manufactured in compliance with the EC Directive 89/392/EEC by

Name of Company

The following harmonized standards have been observed:

- EN 292, Safety of machines, devices and systems
- EN 60 204-1, electrical equipment for industrial machines
-
-
-
-
-
-

The following national standards, directives and specifications have been observed:

-
-
-

Complete technical documentation is available. The operating instructions for the machine concerned is available

- in the original version
- in the national language of the user.....

The notified body

-

has been requested to

- file the documentation in compliance with Annex VI of EC directive 89/392/EEC
- check the correct application of the harmonized standards and certify the compliance of the documentation with Annex VI EC Directive 89/392/EEC.....
- EC type-examination, test certification no.

Place, date

Signature

Details of undersigned



**Manufacturer declaration
in compliance with EC Machinery Directive 89/392/EEC, Annex II B
to installed machine**

Design of the machine

Make

Type designation

is developed, designed and manufactured in compliance with the EC Directive 89/392/EEC by

Name of Company

The following harmonized standards have been observed:

- EN 292, Safety of machines, devices and systems
- EN 60 204-1, electrical equipment for industrial machines
-
-
-
-

The following national standards, directives and specifications have been observed:

-
-
-

Complete technical documentation is available. The operating instructions for the machine concerned is available

- in the original version
- in the national language of the user.....

The commissioning of this machine/part of the machine is not permissible until it has been ensured that the machine in which it is to be incorporated complies with the regulations of the EC Machinery Directive.

.....

Place, date	Signature	Details of undersigned
-------------	-----------	------------------------

Appendix

Samples of declarations of conformity

EC-Declaration of Conformity
in accordance with the EC Machinery Directive 89/392/EEC, Annex II C
for Safety Components

The design of the safety component

Make

Type designation

is developed, designed and manufactured in compliance with the EC Directive 89/392/EEC by

Name of Company

Description of functions

.....
.....

The following harmonized standards have been observed:

- EN 292, Safety of machines, devices and systems
- EN 60 204-1, electrical equipment for industrial machines
-
-
-
-
-

The following national standards, directives and specifications have been observed:

-
-

-
-

Complete technical documentation is available. The operating instructions for the machine concerned is available

- in the original version
- in the national language of the user.....

The notified body

.....

has been requested to

- file the documentation in compliance with Annex VI of EC directive 89/392/EEC
- check the correct application of the harmonized standards and certify the compliance of the documentation with Annex VI EC Directive 89/392/EEC.....
- EC type-examination, test certification no.

Place, date

Signature

Details of undersigned



Appendix

12.5 Addresses for obtaining regulations

Ordering addresses for the new regulations

(only some of the possible addresses given)

EC Directives

HMSO Books

49 High Holborn
London WC1V 6HB
England
Tel. (0)207 404 1213
Fax. (0)207 831 1326

DIN EN Standards

Beuth-Verlag GmbH

Burggrafenstraße 6
10787 Berlin
Germany
Tel. (030) 26 01-22 40

Standards and draft standards available.

BS EN Standards

BSI

389 Cheswick High Road
London W4 4AL
England
Tel. (0)208 996 7000
Fax. (0)208 996 7001

European Safety Standards (EN) - Lists

Normenausschuss Maschinenbau im DIN

Lyoner Straße 18
60528 Frankfurt
Germany
Tel. (069) 6 60 33 41 oder 6 60 33 42
www.VDMA.ORG/NAM

An overview of safety standards for machines with explanations on the EC Machinery Directive

Device Safety Directive

Carl Heymanns Verlag KG

Luxemburger Straße 449
50939 Cologne
Germany
Tel. (0221) 4 60 10 92

Wirtschaftsverlag NW

Verlag für neue Wissenschaft GmbH
Postfach 10 11 10
27511 Bremerhaven
Germany
Tel. (0471) 4 60 93-95

"Machines" directory for the device safety directive

W. Kohlhammer GmbH

70549 Stuttgart
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Tel. (0711) 7 86 32 99

Appendix

12.6 Bibliography

Main Catalogue HPL 0211, Moeller, Bonn	EN 292-1 (11/91) Safety of machinery – basic concepts, general principles for design; part 1: basic terminology, methodology
Wiring manual TBO-004, Moeller, Bonn	EN 292-2 (06/95) Safety of machinery – basic concepts, general principles for design; part 2: technical principles and specifications
Safety in the control circuit in accordance with the machine directive, J. Volberg VER 07-818, Moeller, Bonn	EN 418 (01/93) Safety of machinery – Emergency-stop equipment, functional aspects. Principles for design.
CEN safety standards for machines Standards Committee Machine Construction Frankfurt/Main Germany	EN 574 (1996) Safety of machinery – Two-hand control devices - Functional aspects - Principles for design
	EN 954-1 (12/96) Safety of machinery – Safety-related components of controls
	EN 1037 (12/95) Safety of machinery – Prevention of unexpected start-up
	EN 1050 (11/96) Safety of machinery – Risk assessment
	EN 1088 (12/95) Safety of machinery – Interlocking devices associated with guards
	EN 60 204-1 (1992) Safety of machinery – Electrical equipment of industrial machines
	EN 60947-1 (1991) Low-voltage switching devices

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