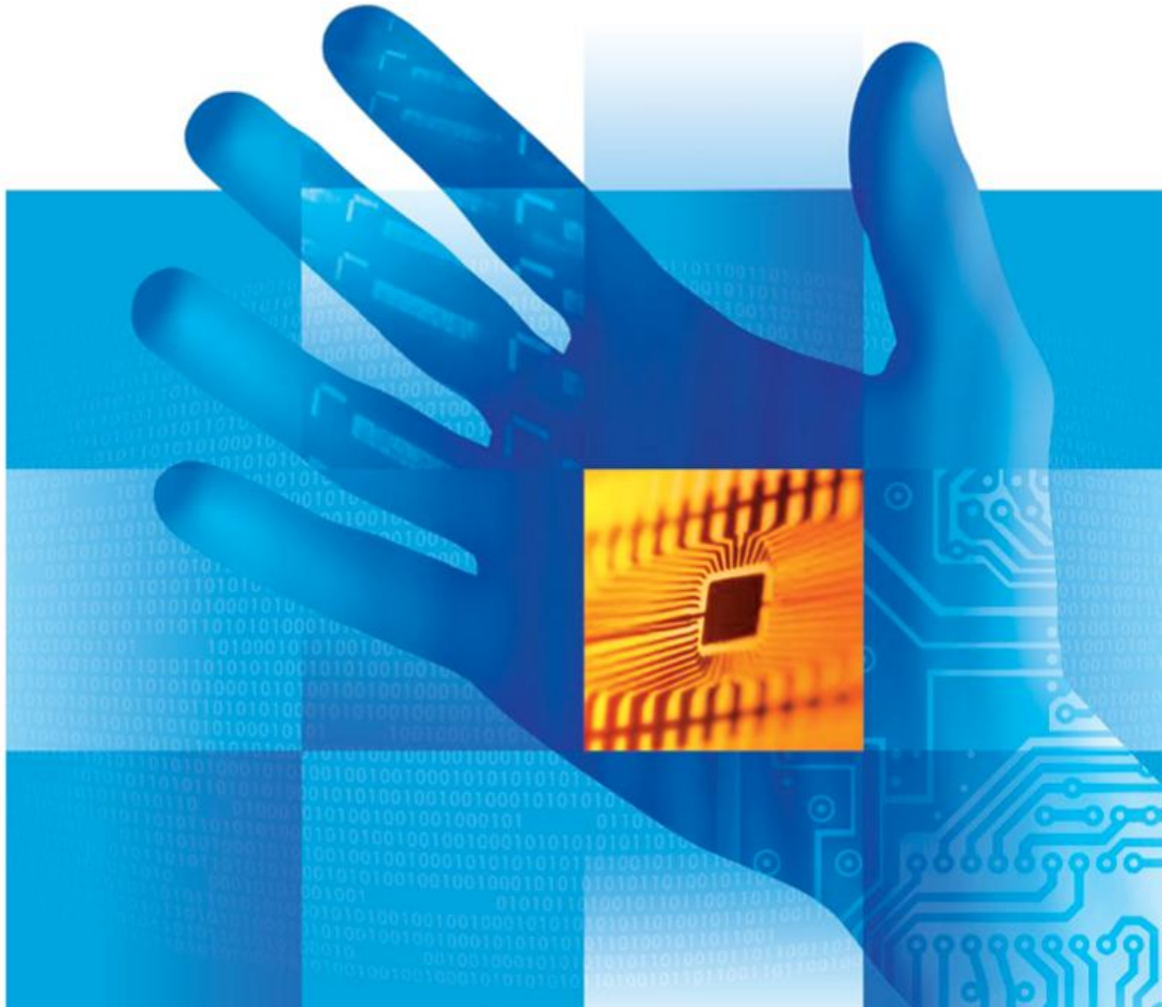
EVROPSKÁ UNIE
Evropské strukturální a investiční fondy
Operační program Výzkum, vývoj a vzdělávání

MINISTERSTVO ŠKOLSTVÍ, MLÁDEŽE A TĚLOVÝCHOVY

8. FUNDAMENTALS OF LOGIC CONTROL



Doc. Ing. Stanislav Kocman, Ph.D.

19. 2. 2018, Ostrava

LECTURE PLAN

- division, logical operations, relay logic
- contactless logic control, basic logic gates
- safety related parts of control systems
- safety relays, examples of applications

Division, logical operations, relay logic

Division of logic control

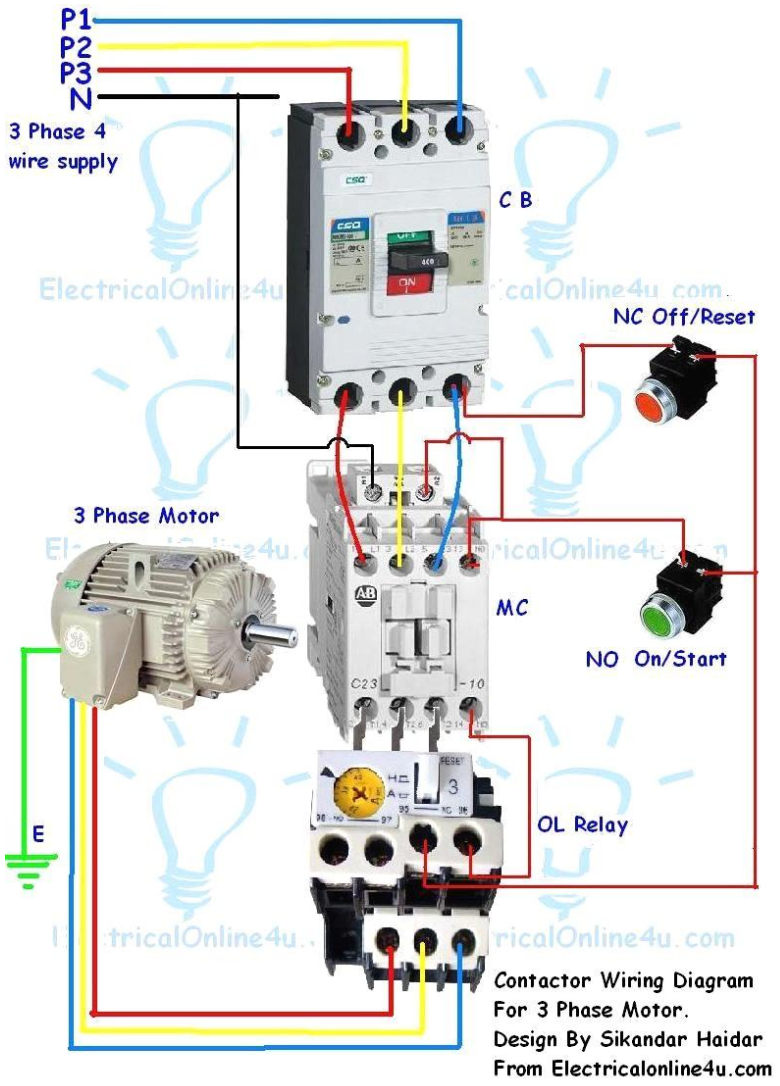
- manually operated
- automatically operated
  - relay logic
  - logic module
  - programmable logic controller (PLC)
  - single-board computer
  - microcontroller
- safety systems

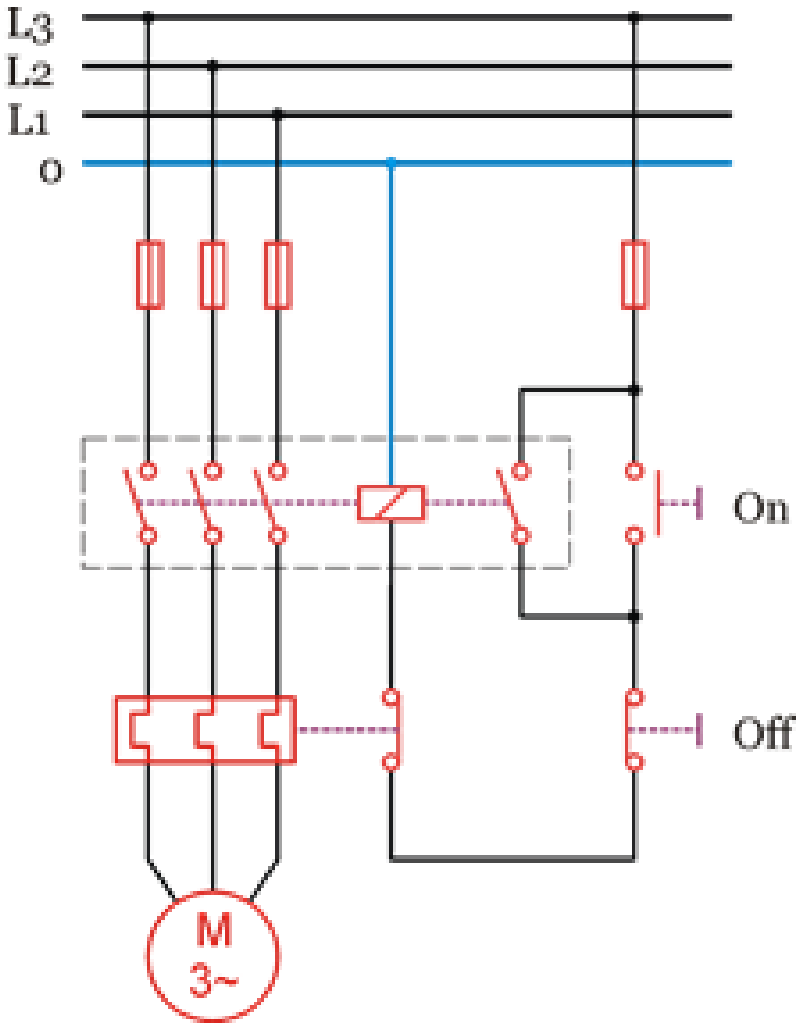
Examples of logical operations (electrical drives)

- switch on
- start-up and controlled start-up
- speed adjusting or changing
- change of rotational or feed direction
- stopping
- braking and controlled braking
- light signaling and tone beep
- lockout

Relay logic

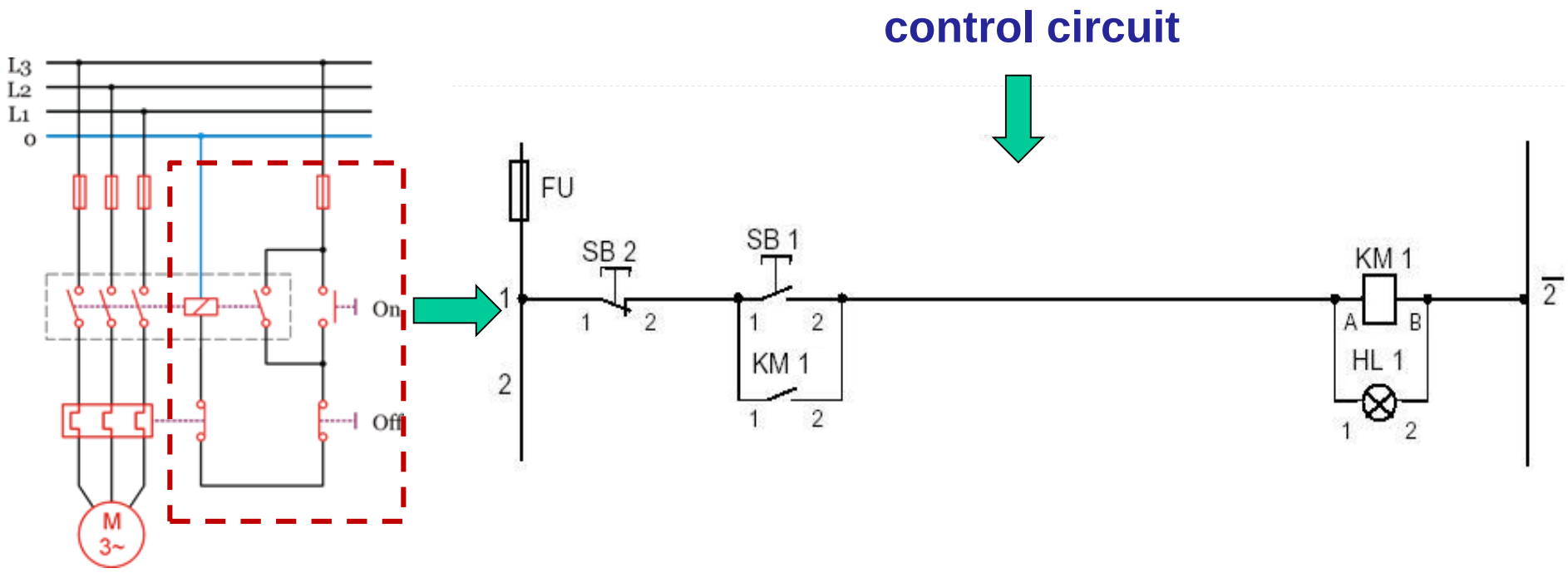
Start-up of electrical motor





Relay logic

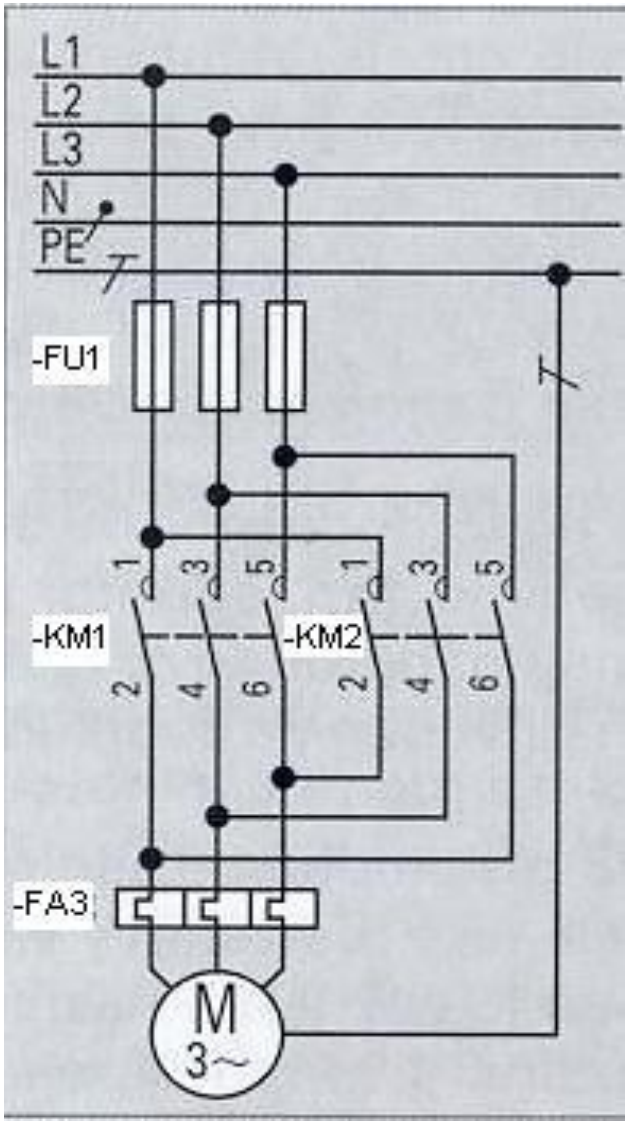
Start-up of electrical motor: ladder diagram



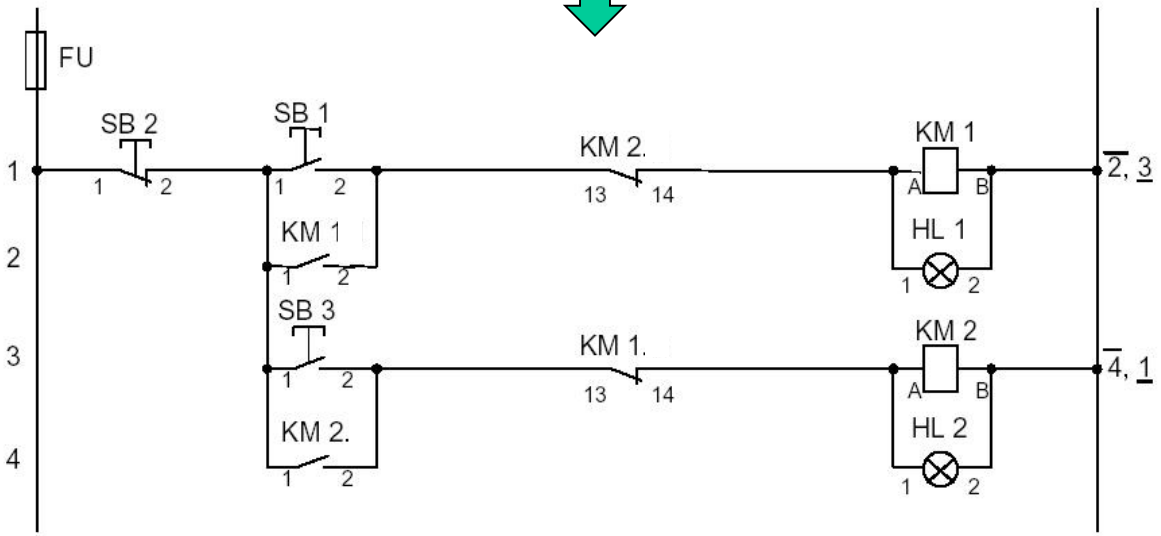
Relay logic

Reversible drive

power circuit



control circuit

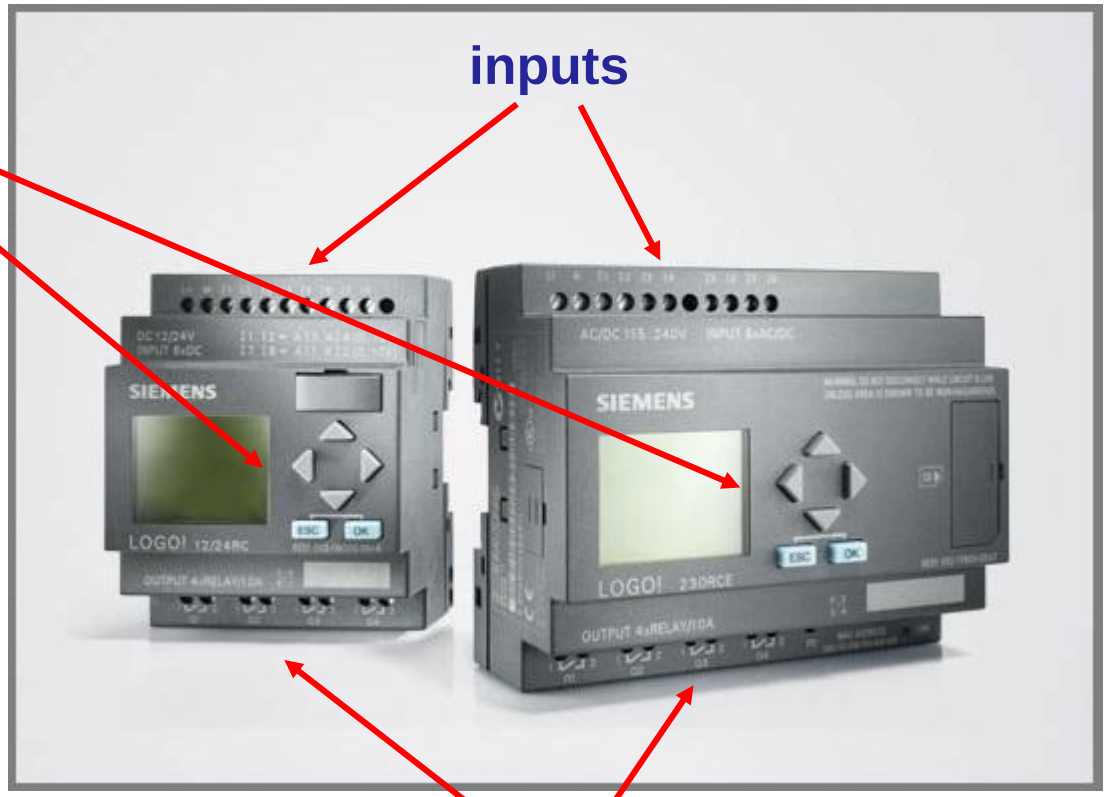


Contactless logic control

Logic module

programming interface

inputs

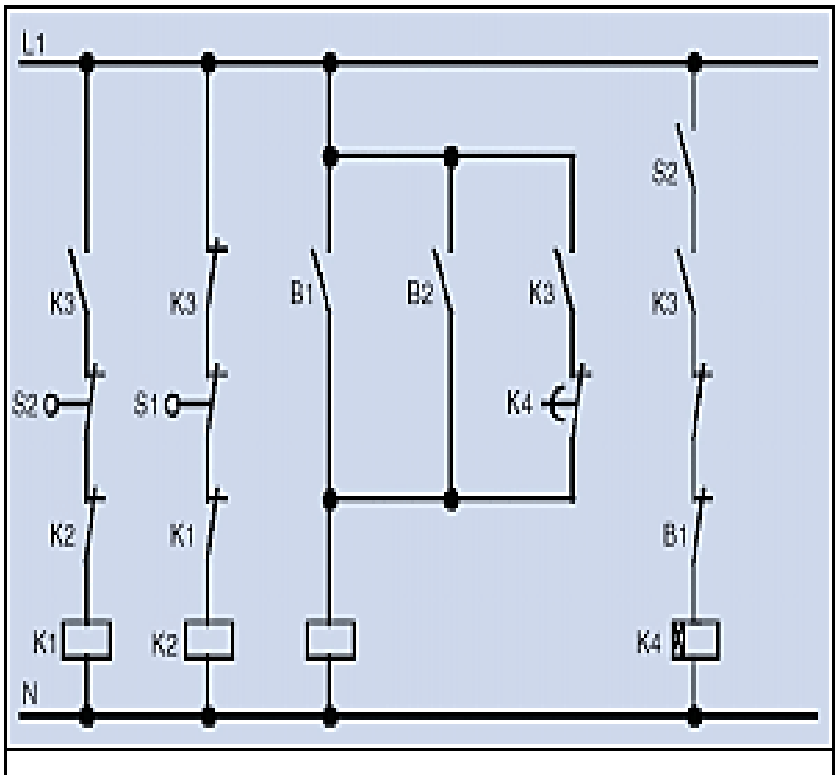


outputs

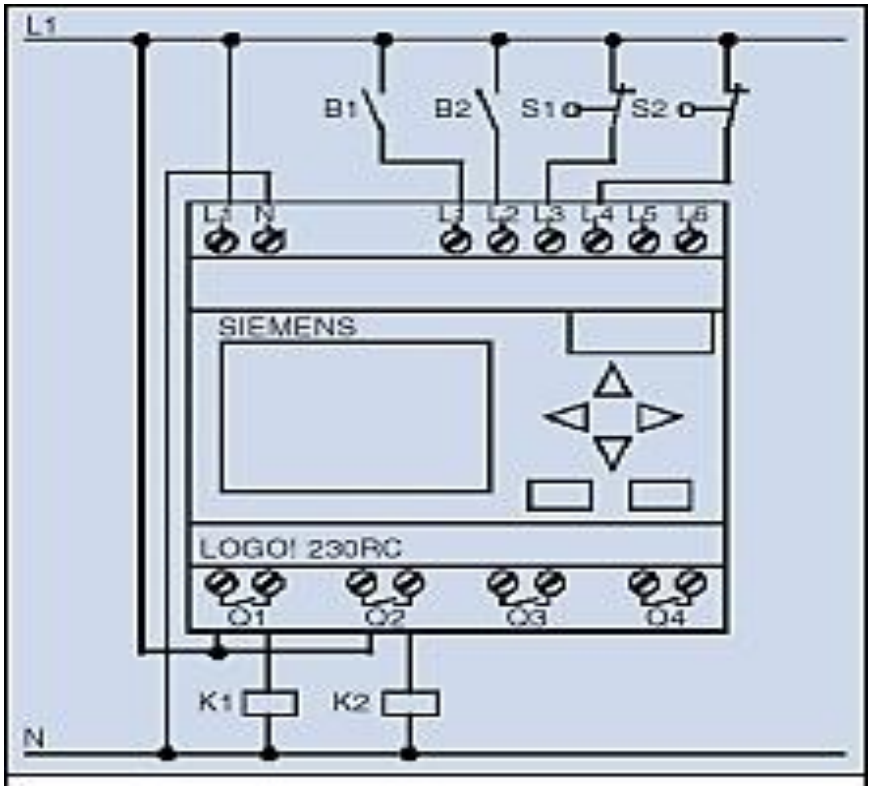
Comparison of relay and logic module logic

Example of automatic door open

Relay logic



Logic module logic

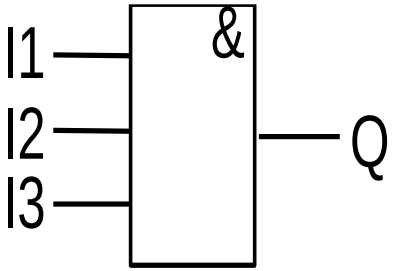
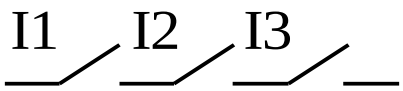


Advantages of logic module over relay logic

- **small dimension**
- **low losses**
- **insensibility against environment**
- **higher switching rate and speed**
- **reliability is more**
- **reduced hard-wiring (it is easier to make changes in software than in hardware)**
- **cost effective control system**

Basic logic gates

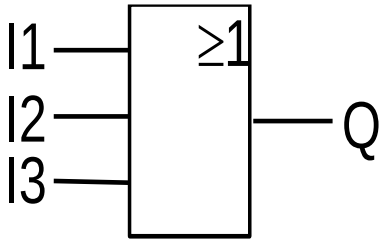
Logic module

<table>
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<tr><td>AND</td><td>
</td><td>
<table>
<tr><th>I1</th><th>I2</th><th>I3</th><th>Q</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>0</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>0</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>0</td></tr>
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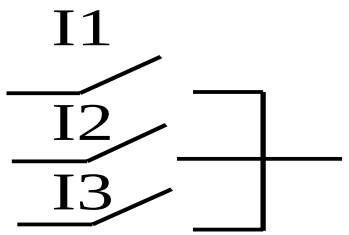
Basic logic gates

Logic module

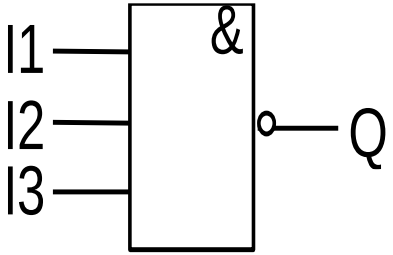
OR



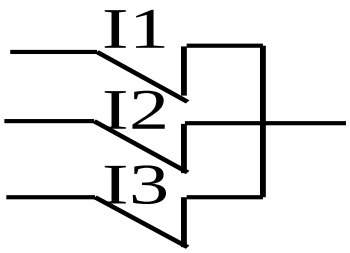
I1	I2	I3	Q
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1



NAND



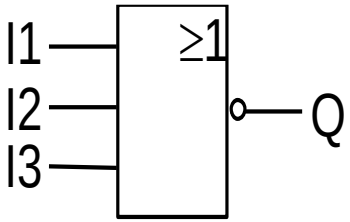
I1	I2	I3	Q
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0



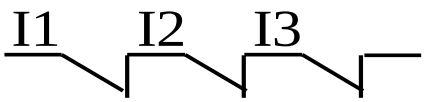
Basic logic gates

Logic module

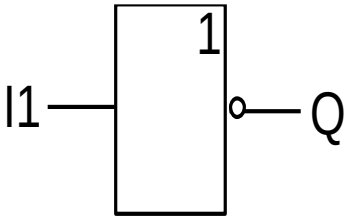
NOR



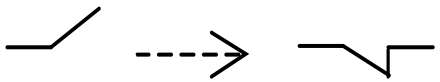
I1	I2	I3	Q
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0



NOT



I1	Q
0	1
1	0



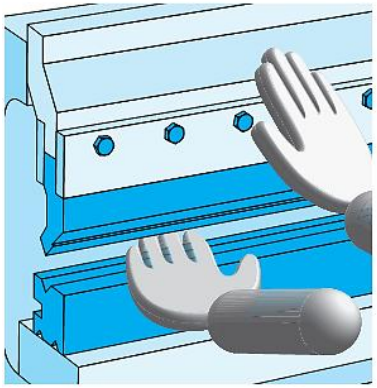
Safety related parts of control systems

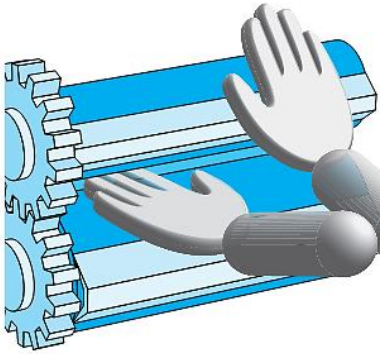
Priorities

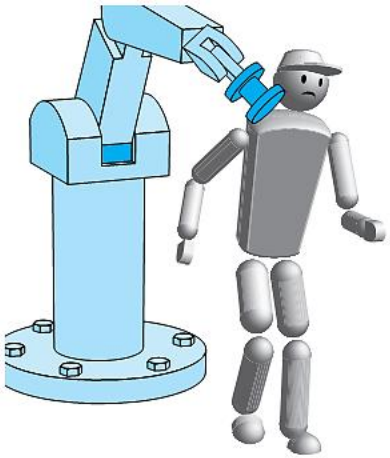
- take into account rules of safety work
- to protect hazardous situations on devices
- to identify the hazards
- to state hazardous zones
- device safe operation
- risks related to the potential hazard
- severity of the potential harm
- probability of occurrence

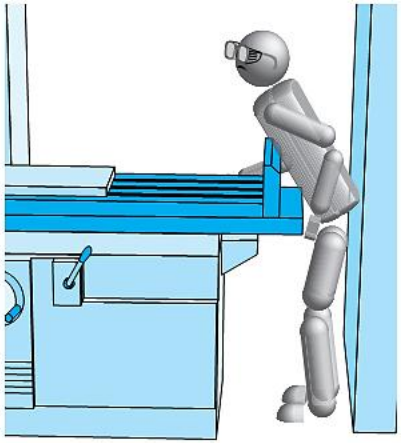
Hazardous situations

Mechanical risks

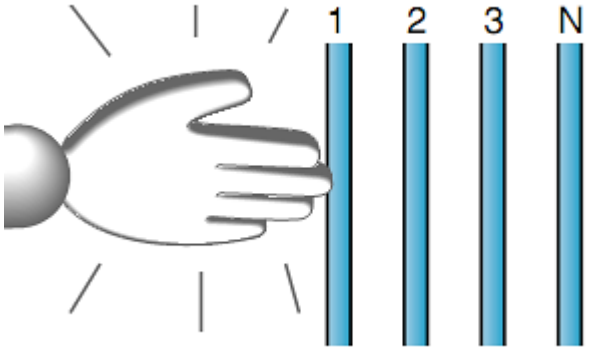




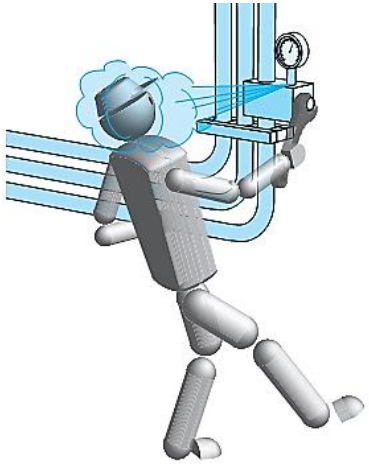


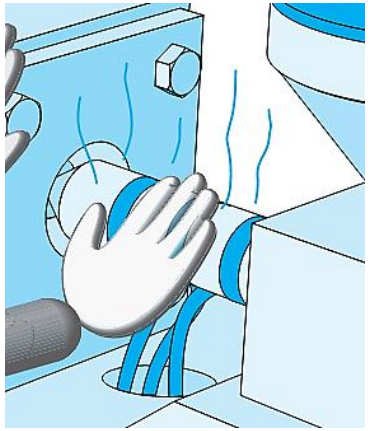


Electrical risks

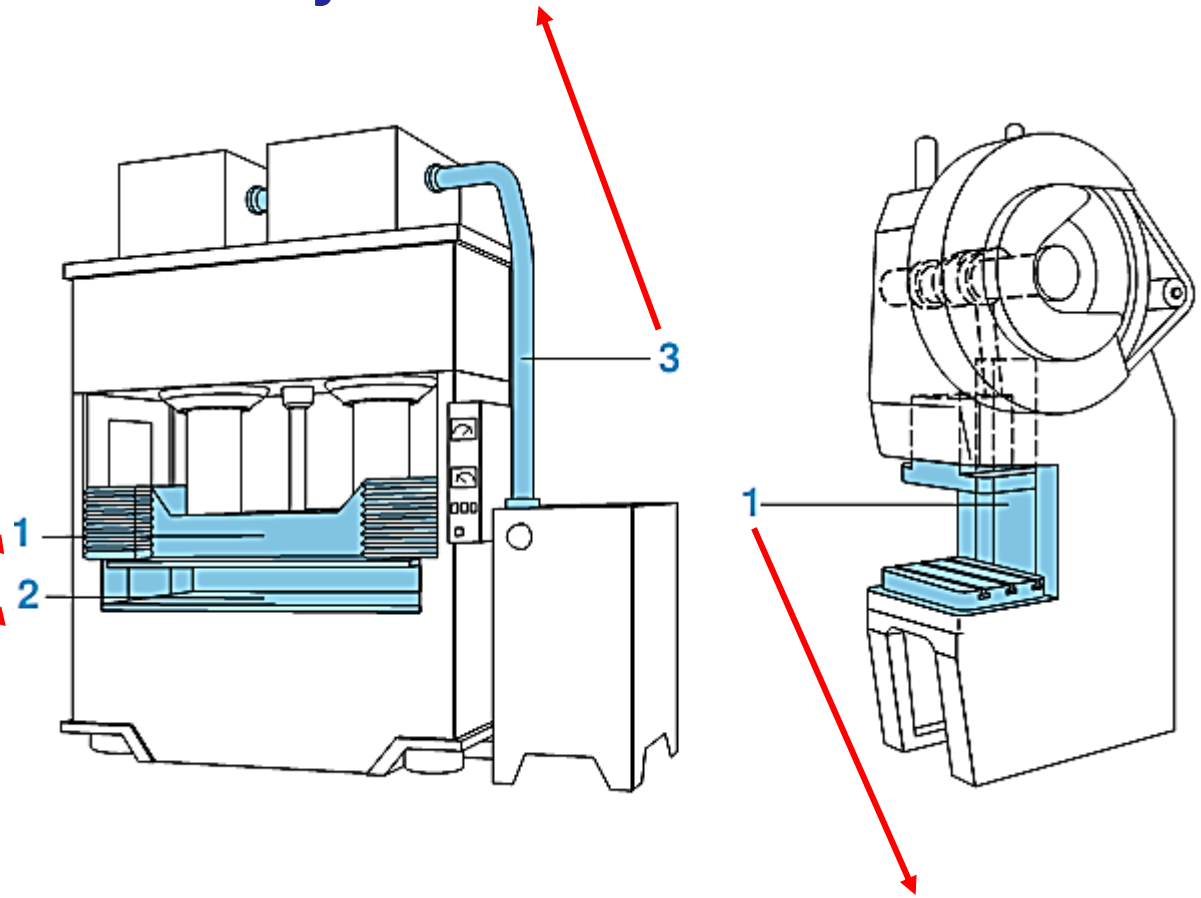


Physio-chemical risks





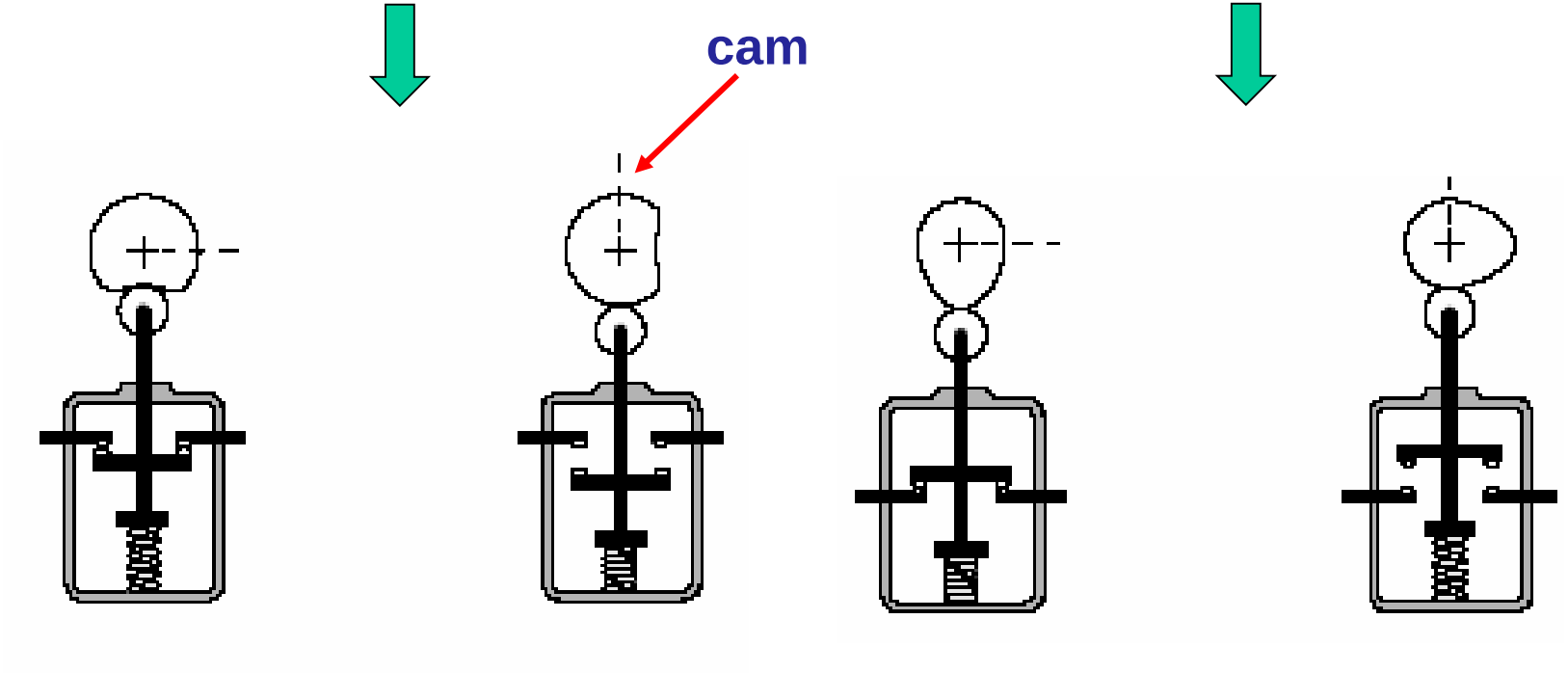
Hazardous zones



Safety relay and contactor

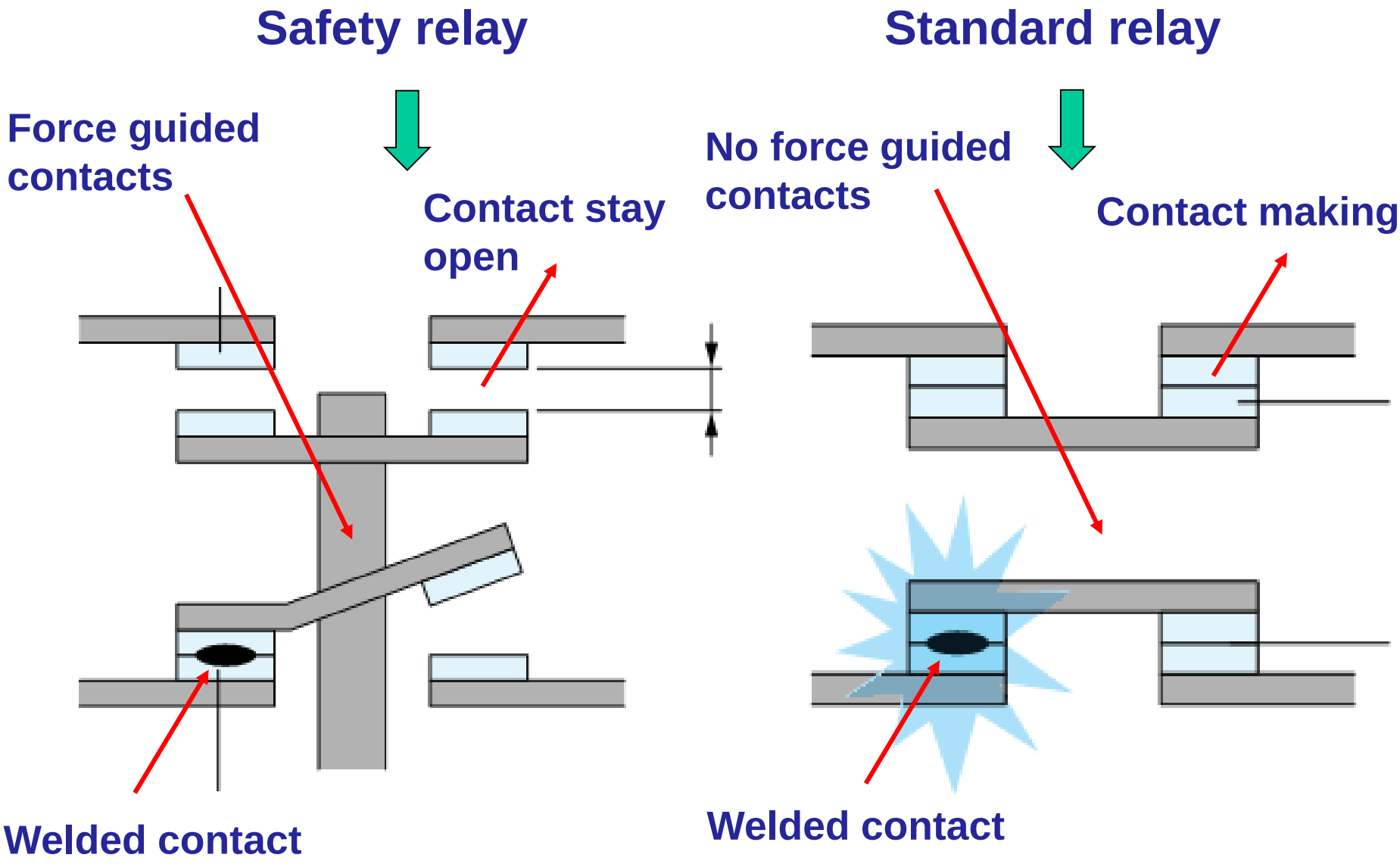
Safety relay

Standard relay

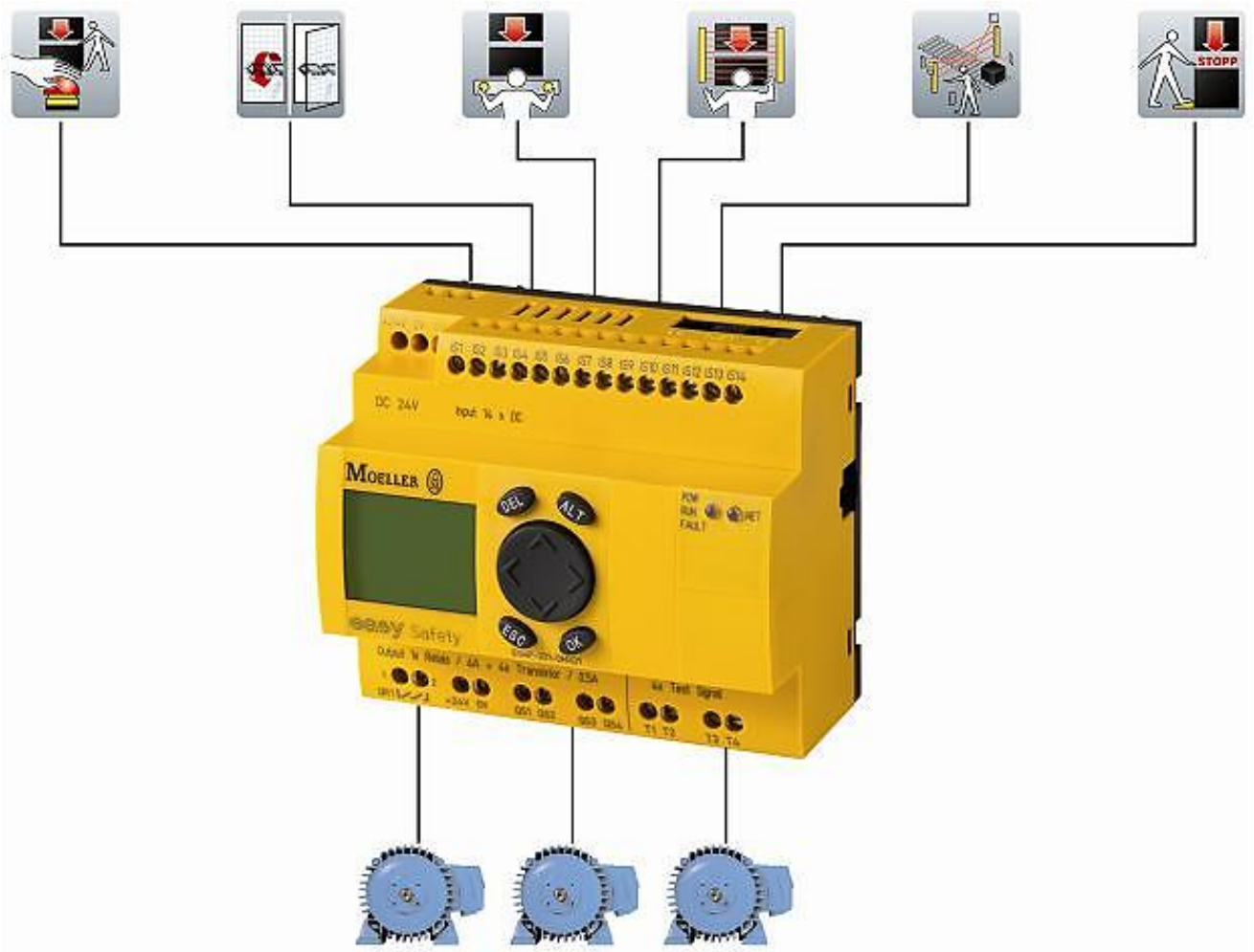


Force guided relay

Safety relay and contactor



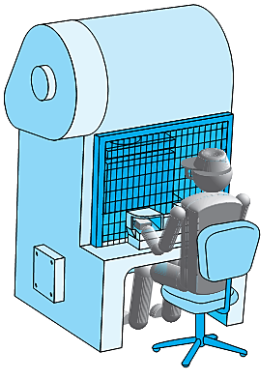
Safety relays, examples of applications

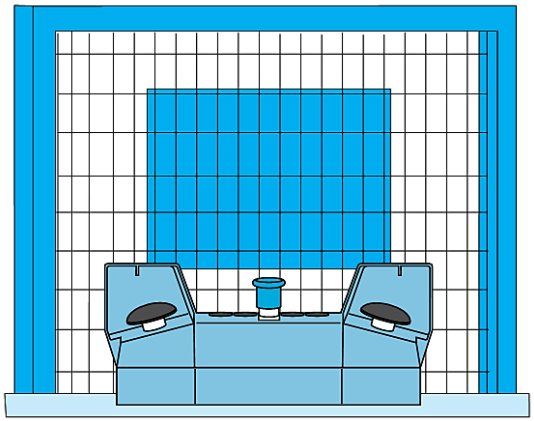


Safety functions

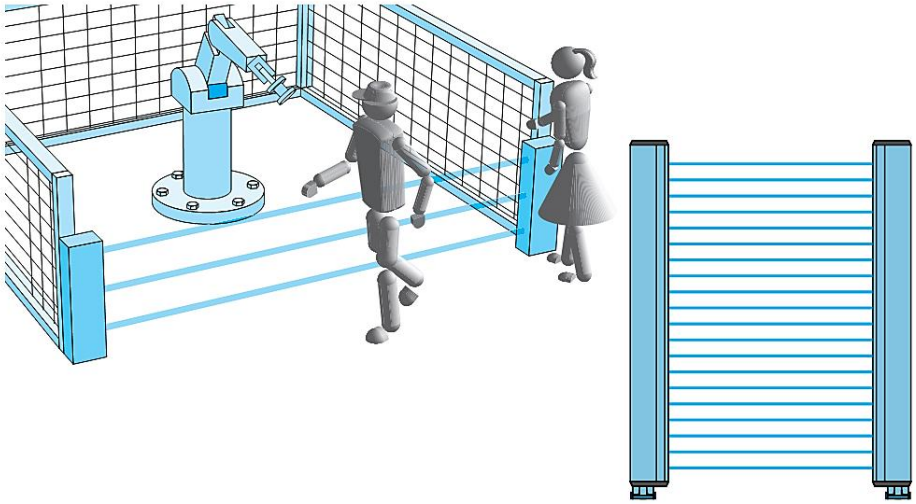
- monitoring of safety signals – control systems
  - safety relays, safety controllers or safety PLCs
- protective devices to permit tasks such as loading/unloading, cleaning, setting, adjustment
- light curtains to detect approach to dangerous areas
- safety mats to detect persons
- solenoid interlocks (powered guards) to prevent opening of guards
- two hand control stations and footswitches
- emergency stop

Safety functions: examples











Using electronic safety relays
to evaluate pressure sensitive mats.