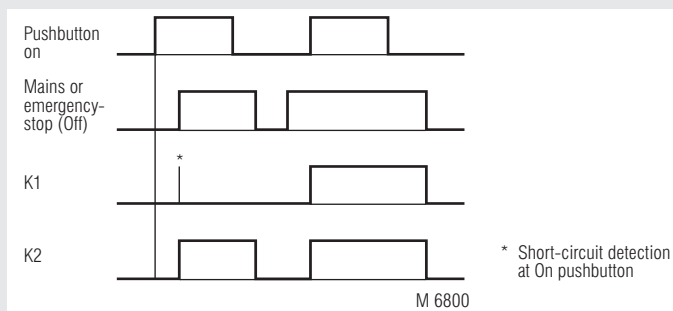
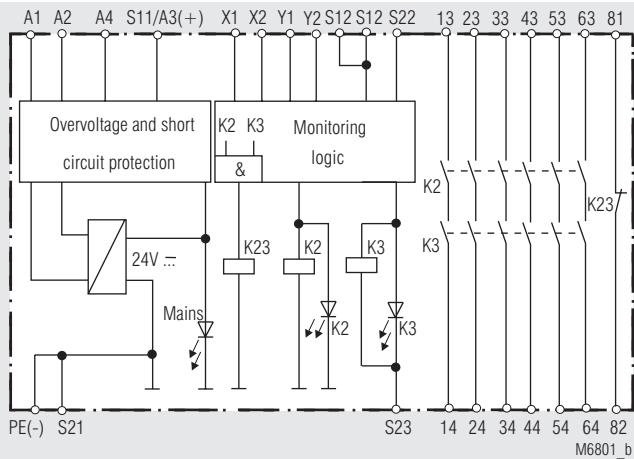


### Function Diagram



### Block Diagram



- According to
  - Performance Level (PL) e and category 4 to EN ISO 13849-1: 2008
  - SIL Claimed Level (SIL CL) 3 to IEC/EN 62061
  - Safety Integrity Level (SIL) 3 to IEC/EN 61508
- Output: max. 6 NO, 1 NC contacts or 1 NO contact for AC 250 V
- 1-channel or 2-channel connection
- Line fault detection at On pushbutton
- Feedback circuit X1-X2 for monitoring external contactors
- Integrated short-circuit and overvoltage protection
- LED displays for channels 1 and 2 and supply
- Removable terminal strips
- Wire connection: also 2 x 1.5 mm<sup>2</sup> stranded ferruled (isolated), DIN 46 228-1/-2/-3-4 or 2 x 2.5 mm<sup>2</sup> stranded ferruled DIN 46 228-1/-2/-3
- Optionally with release delayed NO contact to 10 min
- Optionally automatic On function after connection of operating voltage or activation via On pushbutton
- Optionally cross fault detection in emergency stop control circuit
- Optionally dual voltage version
- Width 100 mm

### Approvals and Markings



\* see variants

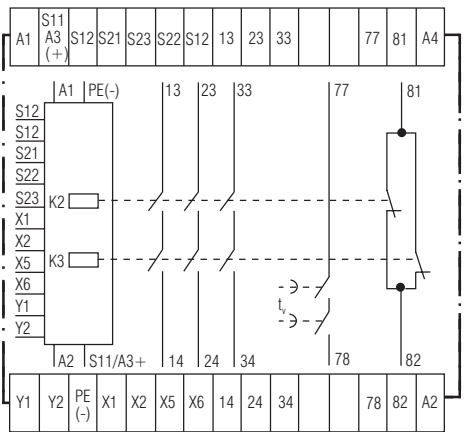
### Applications

- Protection of people and machines
- Emergency stop circuits on machines
- Monitoring of safety gates

### Indication

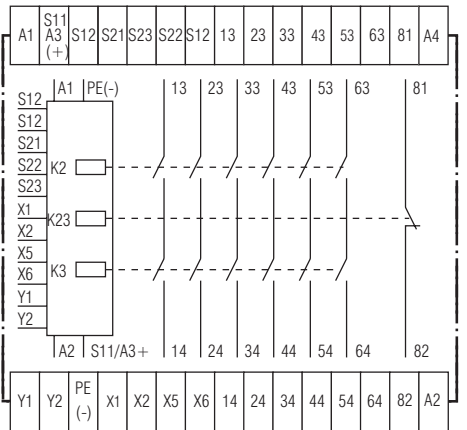
- |                        |   |
|------------------------|---|
| LED power supply:      | on, when operating voltage present      |
| LED K2:                | on, when supply on relay K2             |
| LED K3:                | on, when supply on relay K3             |
| only at BO 5988/4_ _ , |   |
| BO 5988/5_ _ :         |   |
| LED KT2, KT3:          | on, when delayed contacts are energized |

## Circuit Diagrams



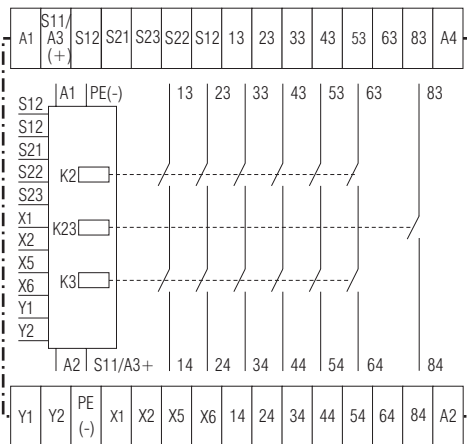
M 7173

BO 5988.47



M 7172

BO 5988.61



M7414\_a

BO 5988.62

## Connection Terminals

| Terminal designation                           | Signal designation  |
|--|---|
| A1, S11/A3 (+)                                 | + / L   |
| A2, A4   | - / N   |
| S12, S22, S23, X2, X5, Y2                      | Inputs  |
| PE (-), S11/A3 (+), S21, X1, X6, Y1            | Outputs   |
| 13, 14, 23, 24, 33, 34, 43, 44, 53, 54, 63, 64 | Forcibly guided NO contacts for release circuit                 |
| 81, 82   | <b>only .47:</b><br>Forcibly guided indicator output            |
| 81, 82   | <b>only .61:</b> indicator output (NC)                          |
| 83, 84   | <b>only .62:</b> indicator output (NO)                          |
| 77, 78   | NO contact release delay<br>Forcibly guided for release circuit |

## Notes

Jumper assignment for functions:

Activation via On pushbutton / or automatic On function

| On push-button<br>Y1 - Y2 | Jumper<br>X5 - X6 | Function  |
|---------------------------|-------------------|---|
|                           |                   | The output contacts are switches only after operation of the On pushbutton.<br>Line fault monitoring at the On pushbutton |
|                           |                   | Automatic On function for operating voltage Off/On or after emergency stop release  |

Line fault detection at the On pushbutton:

The output contacts cannot be closed if the On pushbutton is already closed before the voltage is applied to S12, S22 (also in the event of a line fault at the On pushbutton).

A line fault at the On pushbutton which occurs after activation of the device is recognized when switching-on takes place again and closing of the output contacts is then prevented.

If a line fault occurs at the On pushbutton after the voltage is already present at S12, S22, undesired activation will take place, because this line fault does not differ from the normal closing function.

The gold-plated contacts of the BO 5988 also mean that this module is suitable for switching small loads of 1 mVA ... 7 VA, 1 mW ... 7 W in the range 0.1 ... 60 V, 1 ... 300 mA. The contacts also permit the maximum switching current. However, since the gold plating is burnt off at this current level, the device is no longer suitable for switching small loads after this.

The PE terminal permits operation of the device in IT systems with insulation monitoring and also serves as a reference point for testing the control voltage. The internal short-circuit protection will be bridged on DC devices, if the protective ground is connected to terminal PE.

One or more extension modules BN 3081 or external contactors with forcibly guided contacts may be used to multiply the number of contacts of the emergency stop module BO 5988.

## ATTENTION - AUTOMATIC START!



According to IEC/EN 60 204-1 part 9.2.5.4.2 it is not allowed to restart automatically after emergency stop. Therefore the machine control has to disable the automatic start after emergency stop.

## Technical Data

### Input

#### Nominal voltage $U_N$

BO 5988.--/00:

BO 5988.--/24:

DC 24 V

DC 24 V<sup>1)</sup> + AC 24 V<sup>2)</sup>

DC 24 V<sup>1)</sup> + AC 48 V<sup>2)</sup>

DC 24 V<sup>1)</sup> + AC 110 V<sup>2)</sup>

DC 24 V<sup>1)</sup> + AC 230 V<sup>2)</sup>

DC 24 V<sup>1)</sup> + AC 240 V<sup>2)</sup>

<sup>1)</sup> at terminals A3-A4

<sup>2)</sup> at terminals A1-A2

AC 0.8 ... 1.1  $U_N$

DC 0.9 ... 1.2  $U_N$

DC 0.8 ... 1.1  $U_N$

AC: approx. 6 VA, DC: approx. 3 W

50 / 60 Hz

#### Voltage range:

at 10 % residual ripple:

at 48 % residual ripple:

#### Nominal consumption:

#### Nominal frequency:

#### Control voltage

at S11:

at S21:

#### Control current:

#### Minimum voltage

at terminals S12, S22:

#### Recovery time:

typ. DC + 24 V

0 V

typ. DC 110 mA

DC 21 V with activated device

2 s

A minimum switch-off time of 10 s must be observed if the line fault monitoring function at the On pushbutton is active

## Technical Data

### Output

#### Contact

|             |  |
|-------------|--|
| BO 5988.61: | 6 NO, 1 NC indicator contact                         |
| BO 5988.62: | 6 NO, 1 NO indicator contact                         |
| BO 5988.47: | 3 NO, 1 NC indicator contact<br>1 NO release delayed |

The NO contacts 13...63 / 14...64 are safety contacts.

**ATTENTION! The NC contact 81-82 and the NO contact 83-84 can only be used for monitoring.**

#### Operate time

|                    |            |
|--------------------|------------|
| manual restart:    | typ. 30 ms |
| automatic restart: | 1 s        |

#### Release time

|   |              |
|---|--------------|
| opening in secondary circuit (S12-S22): | 30 ms ± 50 % |
|---|--------------|

|                                       |               |
|---------------------------------------|---------------|
| opening in supply circuit BO 5988.47: | 100 ms + 50 % |
|---------------------------------------|---------------|

|                         |              |
|-------------------------|--------------|
| BO 5988.61, BO 5988.62: | 50 ms + 50 % |
|-------------------------|--------------|

**Time delay  $t_v$ :** Auxiliary supply is not necessary during elapse of time:

|                  |             |             |
|------------------|-------------|-------------|
| BO 5988.47/1 __: | 0.1 ... 1 s | 0.3 ... 3 s |
|                  | 0.5 ... 5 s | 1 ... 10 s  |

BO 5988.47/2 \_\_: 1 s, 3 s, 5 s, 10 s  
Auxiliary supply must be connected during elapse of time:

|                  |             |               |
|------------------|-------------|---------------|
| BO 5988.47/4 __: | 0.1 ... 1 s | 0.1 ... 1 min |
|                  | 0.3 ... 3 s | 0.3 ... 3 min |
|                  | 1 ... 10 s  | 0.5 ... 5 min |
|                  | 3 ... 30 s  | 1 ... 10 min  |

BO 5988.47/5 \_\_: 1 s, 3 s, 10, 30 s  
1 min, 3 min, 5 min, 10 min

#### Repeat accuracy

|                                      |                         |
|--------------------------------------|-------------------------|
| BO 5988.47/1 __ and BO 5988.47/2 __: | ± 15 % of setting value |
|--------------------------------------|-------------------------|

|                                      |                        |
|--------------------------------------|------------------------|
| BO 5988.47/4 __ and BO 5988.47/5 __: | ± 1 % of setting value |
|--------------------------------------|------------------------|

**Contact type:** Relay, forcibly guided

**Nominal output voltage:** AC 250 V  
DC: see limit curve for arc-free operation

Signalling contact of BO 5988.61 and BO 5988.62: AC 10 ... 250 V, DC 10 ... 120 V for AC/DC 0.1 ... 1 A

**Thermal current  $I_{th}$ :** see total current limit curve (max. 10 A in one contact path)

release delayed NO contact 77-78 at BO 5988.47: max. 8 A

#### Switching capacity

to AC 15

|             |                |                   |
|-------------|----------------|-------------------|
| NO contact: | 5 A / AC 230 V | IEC/EN 60 947-5-1 |
| NC contact: | 2 A / AC 230 V | IEC/EN 60 947-5-1 |

|  |               |                   |
|--|---------------|-------------------|
| BO 5988.47 release delayed NO contact: | 3 A / AC 230V | IEC/EN 60 947-5-1 |
|--|---------------|-------------------|

|             |               |                   |
|-------------|---------------|-------------------|
| to DC 13    |               |                   |
| NO contact: | 4 A / DC 24 V | IEC/EN 60 947-5-1 |
| NC contact: | 4 A / DC 24 V | IEC/EN 60 947-5-1 |

|  |               |                   |
|--|---------------|-------------------|
| BO 5988.47 release delayed NO contact: | 4 A / DC 24 V | IEC/EN 60 947-5-1 |
|--|---------------|-------------------|

|                            |  |                   |
|----------------------------|--|-------------------|
| <b>Electrical life</b>     |  |                   |
| to AC 15 at 2 A, AC 230 V: | 10 <sup>5</sup> switching cycles         | IEC/EN 60 947-5-1 |
| to DC 13 at 2 A, AC 230 V: | > 240 x 10 <sup>3</sup> switching cycles | IEC/EN 60 947-5-1 |

|   |                          |
|---|--------------------------|
| <b>Permissible operating frequency:</b> | 600 switching cycles / h |
|---|--------------------------|

**Short circuit strength**  
max. fuse rating: 6 A gL IEC/EN 60 947-5-1  
max. line circuit breaker: C 10 A

**Mechanical life:** 30 x 10<sup>6</sup> switching cycles

## Technical Data

### General Data

**Operating mode:** Continuous operation

#### Temperature range

operation: - 15 ... + 50°C

storage: - 25 ... + 85 °C

**altitude:** < 2.000 m

#### Clearance and creepage distances

rated impuls voltage / pollution degree: 4 kV / 2 (basis insulation) IEC 60 664-1

#### EMC

Electrostatic discharge: 8 kV (air) IEC/EN 61 000-4-2

HF irradiation: 10 V / m IEC/EN 61 000-4-3

Fast transients: 2 kV IEC/EN 61 000-4-4

#### Surge voltages

between wires for power supply: 0.5 kV IEC/EN 61 000-4-5

between wire and ground: 2 kV IEC/EN 61 000-4-5

HF-wire guided: 10 V IEC/EN 61 000-4-6

Interference suppression: Limit value class B EN 55 011

#### Degree of protection

Housing: IP 40 IEC/EN 60 529

Terminals: IP 20 IEC/EN 60 529

**Housing:** Thermoplastic with V0 behaviour according to UL subject 94

**Vibration resistance:** Amplitude 0.35 mm IEC/EN 60 068-2-6 frequency 10 ... 55 Hz

**Climate resistance:** 15 / 050 / 04 IEC/EN 60 068-1

**Terminal designation:** EN 50 005

**Wire connection:** 1 x 4 mm<sup>2</sup> solid or 1 x 2.5 mm<sup>2</sup> stranded ferruled (isolated) or 2 x 1.5 mm<sup>2</sup> stranded ferruled (isolated) DIN 46 228-1/-2/-3/-4 or 2 x 2.5 mm<sup>2</sup> stranded ferruled DIN 46 228-1/-2/-3

**Wire fixing:** Plus-minus terminal screws M 3.5 box terminal with wire protection

**Mounting:** DIN rail IEC/EN 60 715

**Weight:** 850 g

#### Dimensions

**Width x height x depth:** 100 x 74 x 121 mm

#### Safety Related Data

##### Values according to EN ISO 13849-1:

|                          |         |                 |
|--------------------------|---------|-----------------|
| Category:                | 4       |                 |
| PL:                      | e       |                 |
| MTTF <sub>d</sub> :      | 178.5   | a (year)        |
| DC / DC <sub>avg</sub> : | 99.0    | %               |
| d <sub>op</sub> :        | 365     | d/a (days/year) |
| h <sub>op</sub> :        | 24      | h/d (hours/day) |
| t <sub>Zyklus</sub> :    | 2600000 | s/Zyklus        |
|                          | ≥ 1     | /mth (month)    |

##### Values according to IEC/EN 62061 / IEC/EN 61508:

|                          |          |   |
|--------------------------|----------|---|
| SIL CL:                  | 3        | IEC/EN 62061                            |
| SIL:                     | 3        | IEC/EN 61508                            |
| HFT:                     | 1        |   |
| DC / DC <sub>avg</sub> : | 99.0     | %                                       |
| SFF:                     | 99.7     | %                                       |
| PFH <sub>D</sub> :       | 2.78E-10 | h <sup>-1</sup> (instantaneous contact) |
| PFH <sub>D</sub> :       | 9.12E-11 | h <sup>-1</sup> (delayed contacts)      |
| T <sub>1</sub> :         | 20       | a (year)                                |

<sup>1)</sup> HFT = Hardware-Failure Tolerance

**Info** At delayed contacts: Performance Level (PL) d and category 3 according to EN ISO 13849 for delays up to 30 s max. For longer delays Performance Level (PL) c and category 1.

The values stated above are valid for the standard type BO 5988.47/124.

Safety data for other variants are available on request.

The safety relevant data of the complete system has to be determined by the manufacturer of the system.

## Standard Types

BO 5988.61/024 DC 24 V + AC 230 V 50 / 60 Hz  
 Article number: 0040375 stock item

- Dual voltage version
- Output: 6 NO contacts, 1 NC contact as monitoring contact
- Width: 100 mm

BO 5988.47/124 DC 24 V + AC 230 V 50 / 60 Hz 1 ...10 s  
 Article number: 0040430 stock item

- Dual voltage version
- Output: 3 NO contacts, 1 NC contact as monitoring contact, 1 release delayed NO contact
- With adjustable time delay  $t_v$  to 10 s
- Width: 100 mm

## Variants

BO 5988. \_\_ / 61: with UL approval (Canada/USA)

Auxiliary supply is not necessary during elapse of time:

BO 5988.47 / 1 \_\_: 3 NO / 1 NC contacts +  $t_v$  adjustable  
 BO 5988.47 / 2 \_\_: 3 NO / 1 NC contacts +  $t_v$  fixed

Auxiliary supply must be connected during elapse of time:

BO 5988.47 / 4 \_\_: 3 NO / 1 NC contacts +  $t_v$  adjustable  
 BO 5988.47 / 5 \_\_: 3 NO / 1 NC contacts +  $t_v$  fixed

Without time delay  $t_v$ :

BO 5988.61 / 0 \_\_: 6 NO / 1 NC contacts as monitoring contact  
 BO 5988.62 / 0 \_\_: 6 NO / 1 NC contacts as monitoring contact  
 BO 5988. \_\_ / \_00: single voltage model  
 BO 5988. \_\_ / \_24: dual voltage model

BO 5988.61 / 324: Dual voltage model 0.5 s operate delay with automatic restart

## Ordering example for variants

BO 5988.47/124 1 ... 10 s DC 24 V + AC 230 V 50 / 60 Hz

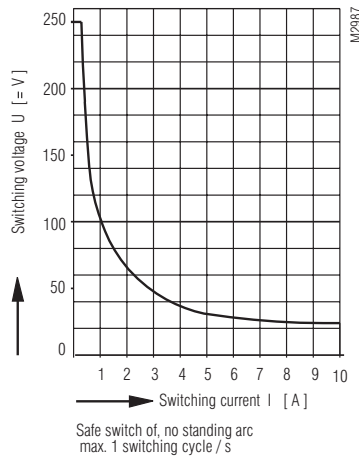
Nominal frequency  
 Nominal voltage  
 Time delay  
 00: 1 nominal voltage  
 24: 2 nominal voltages  
 0: without  $t_v$

without auxiliary supply during time elapse:  
 1:  $t_v$  adjustable  
 2:  $t_v$  fixed

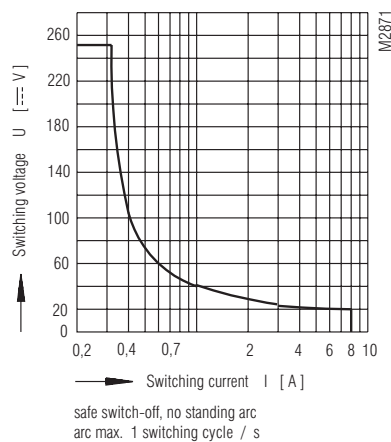
with auxiliary supply during time elapse:  
 4:  $t_v$  adjustable  
 5:  $t_v$  fixed

Contacts  
 Type

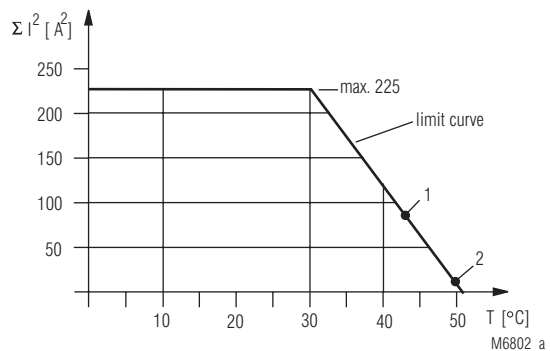
## Characteristics



Limit curve for arc-free operation with resistive load (instantaneous contact)



Limit curve for arc-free operation with resistive load (delayed contacts)



## Total current limit curve

It is necessary to use the square of the currents in order to obtain a linear limit curve.

## General formula for determination of the maximum ambient temperature

- Sum of currents<sup>2</sup> per safety contact = value on scale  $\Sigma I^2$  (A<sup>2</sup>)
- Max. ambient temperature  $T$  = Cross point of scale  $\Sigma I^2$  (A<sup>2</sup>) with limit curve

## Example 1

- $(4A)^2 + (4A)^2 + (4A)^2 + (4A)^2 + (4A)^2 + (4A)^2 = 96 A^2$  (Scale  $\Sigma I^2$ )
- Max. ambient temperature  $T = 43^\circ C$  (point 1)

## Example 2

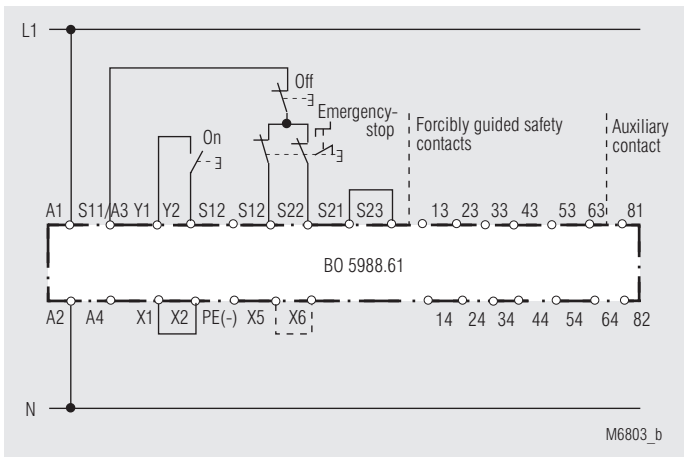
- $(0.5 A)^2 + (1 A)^2 + (2 A)^2 + (1 A)^2 = 6.25 A^2$  (Scale  $\Sigma I^2$ )
- Max. ambient temperature  $T = 49^\circ C$  (point 2)

## Please note:

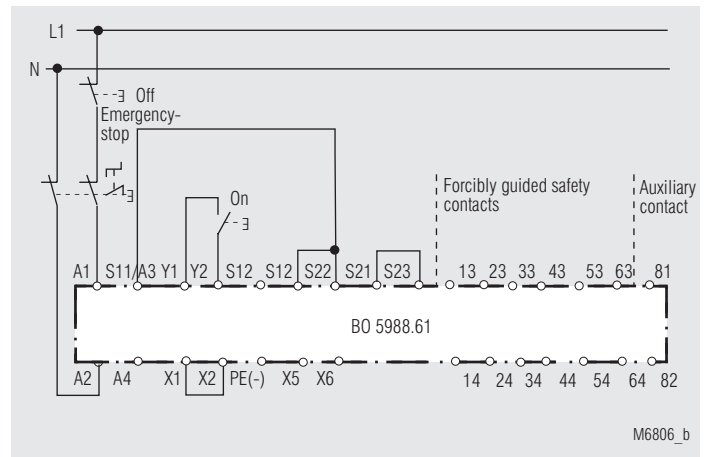
The total current<sup>2</sup> can still be 1.5 A<sup>2</sup> at 50°C, i.e. 0.5 A per safety contact

- $(0.5 A)^2 + (0.5 A)^2 + (0.5 A)^2 + (0.5 A)^2 + (0.5 A)^2 + (0.5 A)^2 = 1.5 A^2$
- Max. ambient temperature = 50°C

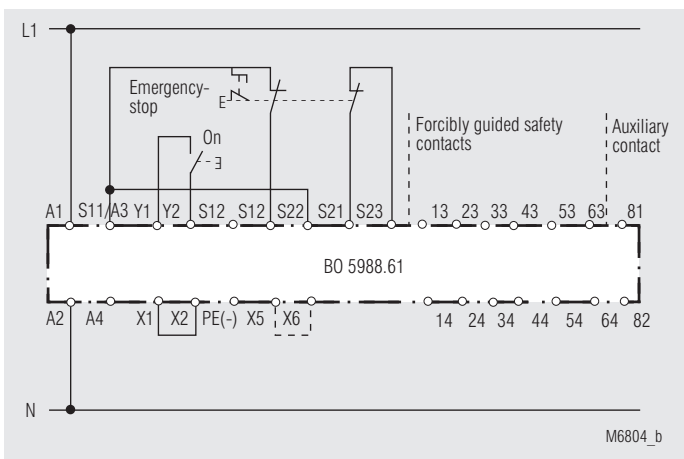
## Application Examples



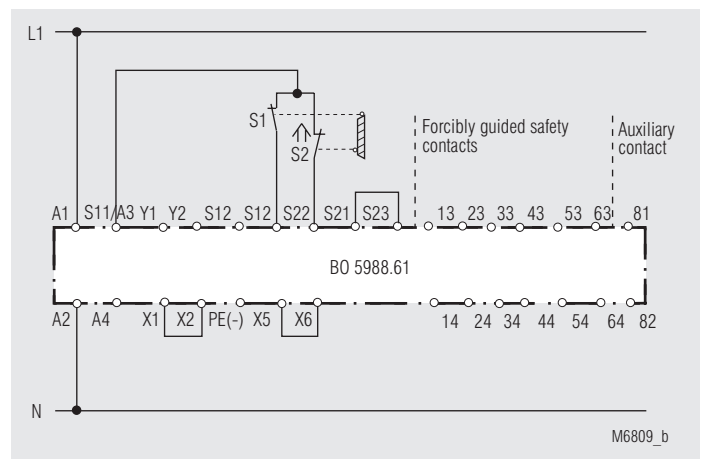
Two-channel emergency stop circuit without cross fault detection.  
Activation via On pushbutton. - - - Jumper X5 - X6:  
A jumper must be fitted X5 - X6 for the automatic On function.  
The On pushbutton is not required.  
Suited up to SIL3, Performance Level e, Cat. 4



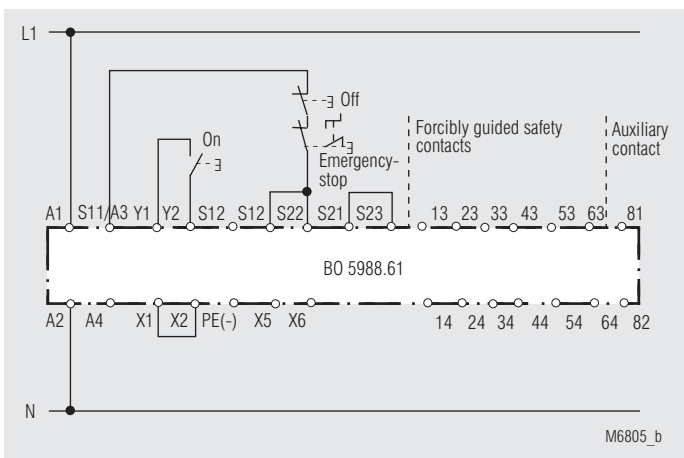
Two-pole emergency stop circuit with emergency stop control device in the supply circuit.  
Application for long emergency stop loops where the control voltage drops below the minimum voltage of 21 V.  
**Attention:**  
Single faults (e.g. line faults at the emergency stop control device) are not detected with this external circuit configuration.  
Suited up to SIL3, Performance Level e, Cat. 4



Two-channel emergency-stop circuit with cross fault detection.  
Activation via On pushbutton. - - - Jumper X5 - X6:  
A jumper must be fitted X5 - X6 for the automatic On function.  
The On pushbutton is not required.  
Suited up to SIL3, Performance Level e, Cat. 4

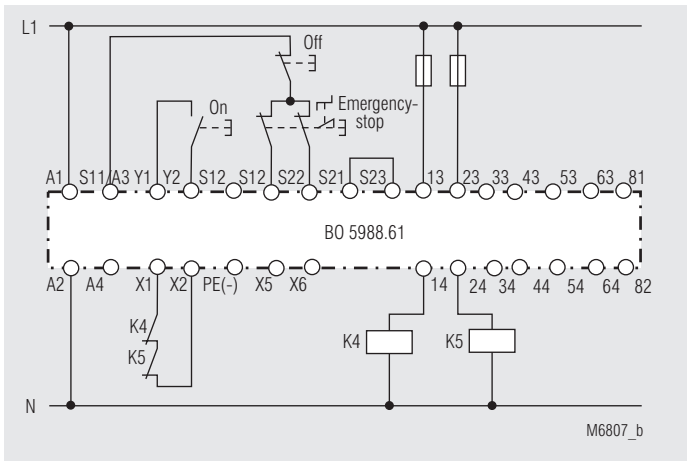


Two-channel monitoring of a safety gate. S1 must not close before S2.  
Suited up to SIL3, Performance Level e, Cat. 4



One-channel emergency stop circuit. This circuit does not have any redundancy in the emergency stop control device circuit.  
Suited up to SIL2, Performance Level d, Cat. 3

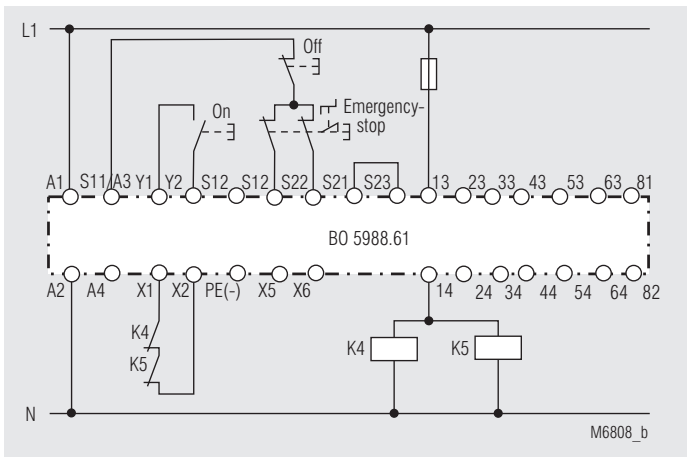
## Application Examples



Contact reinforcement by external contactors, two-channel.

The output contacts can be reinforced by external contactors with forcibly guided contacts for switching currents > 8 A. Functioning of the external contactors is monitored by looping the NC contacts into the closing circuit (terminals X1 - X2).

Suited up to SIL3, Performance Level e, Cat. 4



Contact reinforcement by external contactors with reduced safety level.

Suited up to SIL3, Performance Level e, Cat. 4