SIRIUS Safety Integrated

Application Manual

Safety relays 3TK28

Application Manual

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SIRIUS Safety Integrated
Application Manual
- S.I.A.M. -

Safety relays 3TK28..
Safe load feeder 3RA71.

This documentation supplements the user manuals of safety relays **3TK28..** and safe load feeders **3RA71.**

Edition 02/2005

Note

The Safety Functional Examples are not binding and do not claim to be complete regarding the circuits shown, equipping and any eventuality. The Safety Functional Examples do not represent customer-specific solutions. They are only intended to provide support for typical applications. You are responsible in ensuring that the described products are correctly used. These Safety Functional Examples do not relieve you of the responsibility in safely and professionally using, installing, operating and servicing equipment. When using these Safety Functional Examples, you recognize that Siemens cannot be made liable for any damage/claims beyond the liability clause described above. We reserve the right to make changes to these Safety Functional Examples at any time without prior notice. If there are any deviations between the recommendations provided in these Safety Functional Examples and other Siemens publications - e.g. catalogue - then the contents of the other documents have priority.

Date: 02.2005

Authors: Patrick Gehlen, Dipl. Ing. (TH), A&D CD CC AE
Werner Krämer, Dipl. Ing. (TH), A&D CD CC TE

General terminology and abbreviations

OUT	The enable circuit is a safety-relevant output (refer to S, S_{el}, S_{tv} and $S_{el\ tv}$).
K1, K2, ...	Power contactors or positively-driven contacts (according to IEC 60947) of the power contactors for the feedback circuit of the safety relay.
S_{el}	Electronic signaling contact
NC contact	NC contact with the function of a signaling output.
NO contact	NO contact with the function of a safety-relevant output (enable circuit).
NO_{el}	Safety-related solid-state (semiconductor) output (enable circuit).
NO_{tv} , $NO_{el\ tv}$	NO contact that opens with a delay (enable circuit)! This contact is required to implement Stop Category 1 acc. to EN 60204-1.
V_s	The supply or operating voltage of safety relays. Comment: +24V DC is always available in the sensor circuit, independent of **V_s**.
	Positively-opening contacts (acc. to IEC 947-5-1). These are contacts that open as a direct result of a defined movement of an operator element of a switch through elements that are not equipped with springs. For the electrical equipment of machinery, it is mandatory that in all of the safety circuits, opening contacts are always positively-driven.
manual start	For a manual start, an enable signal is generated when the ON button is pressed. This function is also designated as static operation and is specified for EMERGENCY STOP devices (EN 60204-1, conscious action). *Safety relays with automatic start can be used up to Category 3: The feedback circuit is statically monitored.*
monitored start	For a monitored start, an enable signal is generated when the ON button is pressed. This function is also designated as static operation and is specified for EMERGENCY STOP devices (EN 60204-1, conscious action). *Possible with safety relays up to Category 4: The feedback circuit is dynamically monitored.*
automatic start	For an **automatic start,** an enable signal is generated without a manual agreement. This function is also designated as dynamic operation and is not permissible for E Stop devices.
cascading (cascading input)	Safety-relevant single-channel input of a safety relay that is internally evaluated just the same as a sensor signal: Logically AND'ed with other signal encoder inputs. If a voltage is not present, the safety relay safely shuts down the enable circuit (outputs). **Operational switching:** Depending on the particular safety relay, the enable circuits are switched with a monitored or an autostart (refer to the Safety Navigator 3TK28 in the Attachment)
categories acc. to EN 954-1	Categories B, 1, 2, 3 and 4 are described in EN 954-1:1999 (harmonized Standard in the Machinery Directive): The higher the Category, the higher the fault detection.
safe cable routing acc. to EN 60439-1	Cables with basic insulation may not be routed over sharp edges or should be routed e.g. in steel pipes/ducts (protective Class 2): This is used to exclude faults.
stop categories acc. to EN 60204-1	The Stop Categories represent Stop functions to Stop machinery and equipment in an emergency acc. to IEC 60204-1: 0 = instantaneous, 1 = delayed

Information on using the brochure

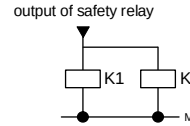
Symbols that have been used:

Supplementary information

Notes

General notes

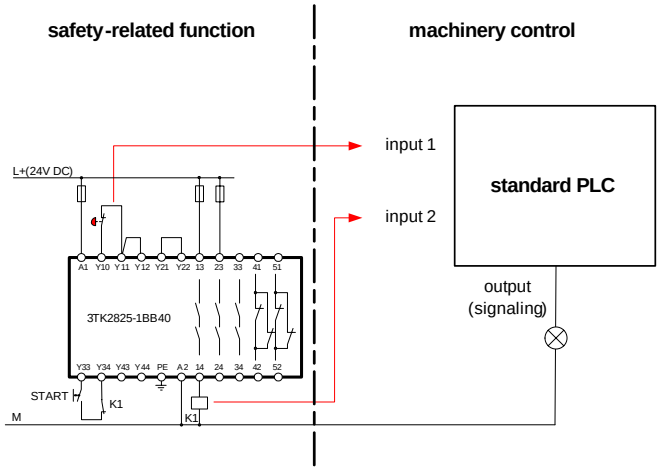
Note regarding all of the examples of Category 4 acc. to EN 954-1



Two (or also several) load contactors for Category 4 acc. to EN 954-1 may be connected to a single enable circuit in a control cabinet
(a short-circuit as fault can be excluded). Also refer to the Attachment.

Note for all examples of Category 2 acc. to EN 954-1

With this circuit example, Category 2 according to EN 954-1 can only be fulfilled if, when an actuator fails, either an alarm is automatically generated or the machine control initiates a safe condition:
Otherwise a second shutdown path is required.



category 2 according to EN 954-1

Note regarding safe separation and cable routing

The objective is to achieve a high degree of operational safety.
In order to protect against parasitic (vagabond) voltages, the different voltages in a cable or piece of equipment must be insulated against the highest voltage present
(protection against electric shock, IEC 61140)
Measure:
Do not route cables with basic insulation along sharp edges or route cables, for example, in a steel pipe or duct
(Protective Class 2):
This measure is used to exclude faults (the highest degree of insulation).

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Table of contents acc. function

E-Stop Monitoring, Stop-Category 0

E-Stop Monitoring, Stop-Category 0 and 1

Protective door-Monitoring, Stop-Category 0

Protective door Monitoring, Stop-Category 0 and 1

Magnet sensor Monitoring, Stop-Category 0

Light grid Monitoring, Stop-Category 0

Safety mat Monitoring, Stop-Category 0

Two hand Monitoring, Stop-Category 0

Two hand Monitoring with run-on distance check , Stop-Category 0

Two hand Monitoring and E-STOP Monitoring, Stop-Category 0

Safety pilot 3TK282. / 3TK283.

	category EN 954-1			sensors								stop-category EN 60204-1		funtions			safety-related OUT	OUT el.	signaling output	supply voltage V_s			
safety relay	2	3	4	E-Stop	protective door	light curtain / grid	magnet sensor	contact mat	two hand	Nachlaufweg	Erweiterung	0	1	cascading	autostart / monitore start	operational switching				24V DC	24 V AC	115V AC	230 V AC
safety relays with relay output																							
3TK2821	x	x		x	x							x			x / -		3NO		1NC	x	x		
3TK2822		x	x		x							x			x / -		2NO			x	x		
3TK2823		x	x	x								x			- / x		2NO			x	x		
3TK2824	x	x		x	x							x			x / -		2NO			x	x	x	x
3TK2825	x	x	x	x	x							x			x / x		3NO		2NC	x	x	x	x
3TK2827	x	x		x								x	x		- / x		2NO+2NOt_v		1NC	x	x	x	x
3TK2828	x	x			x							x	x		x / -		2NO+2NOt_v		1NC	x	x	x	x
3TK2830											x	x					4NO			x	x	x	x
3TK2834									x								2NO		2NC	x	x	x	x
3TK2835										x							3NO		1NC	x	x		

el. = safety-related electronic (semiconductor) outpout
OUT = safety-related output (contact, relay)
t_v = timed delayed output (stop-category 1)

NO = normally open contact / output
NC = normally closed

Safety pilot 3TK284. / 3TK285. / 3RA71.

	category EN 954-1			sensors								stop-category EN 60204-1		funtions			safety-related OUT	OUT el.	signaling output	supply voltage Vs			
safety relay	2	3	4	E-Stop	protective door	light curtain / grid	magnet sensor	contact mat	two hand	Nachlaufweg	Erweiterung	0	1	cascading	autostart / monitore start	operational switching				24V DC	24 V AC	115V AC	230 V AC
safety relays with electronic (semiconductor) outputs																							
3TK2840	x	x		x	x	x	x	x				x			x / x			2 [1]		x			
3TK2841	x	x	x	x	x	x	x	x				x		x [3]	x / x	x [3]		2		x			
3TK2842	x	x	x	x	x	x	x	x				x	x	x [3]	x / x	x [3]		1+1 t_v		x			
safety relays with electronic (semiconductor) / relay outputs																							
3TK2845	x	x	x	x	x	x	x	x				x	x	x [2]	x / x	x [2]	2NO	2	1 el.	x			
safety relays with auxiliary contacts																							
3TK2850	x	x		x	x	x	x	x				x			x / x		3NO		SIRIUS	x	x	x	x
3TK2851	x	x		x	x	x	x	x				x			x / x		2NO		1NO SIRIUS	x	x	x	x
3TK2852	x	x		x	x	x	x	x				x			x / x		6NO		1NO SIRIUS	x	x	x	x
3TK2853	x	x	x	x	x	x	x	x				x		x	x / x	x	3NO	1	SIRIUS	x			
3TK2856											x	x		x		x	6NO	1	1NO SIRIUS	x			
3TK2857											x		x	x		x	$3NO_{tv}$	1	SIRIUS	x			
safe load feeders																							
3RA710	x	x		x	x	x	x	x				x			x / x		3NO		SIRIUS	x	x	x	x
3RA711	x	x	x	x	x	x	x	x				x		x	x / x	x	3NO	1	SIRIUS	x			
3RA712											x	x		x		x	3NO	1	SIRIUS	x			
3RA713/4											x		x	x		x	$3NO_{tv}$	1	SIRIUS	x			

el. = safety-related electronic (semiconductor) outpout
OUT = safety-related output (contact, relay)
t_v = timed delayed output (stop-category 1)

NO = normally open contact / out
NC = normally closed
SIRIUS = using SIRIUS accessories

1) using of positively-driven actuators is required
2) operational switching is possible by using the cascading input 1
3) operational switching with autostart or monitored start
(depending on the selected start function of the safety relay)

Homologation 3TK28. / 3RA71.

Device	BG	TÜV	UL	CSA	AOPD EN 61496-1	Feuerungstechnik VDE 0116 (Burning technology)	EN 954-1	IEC 61508
3TK2821	X		X	X			X	
3TK2822	X		X	X			X	
3TK2823	X		X	X			X	
3TK2824	X		X	X			X	
3TK2825	X		X	X			X	
3TK2827	X		X	X			X	
3TK2828	X		X	X			X	
3TK2830	X		X	X			X	
3TK2834	X		X	X			X	
3TK2835	X		X	X			X	
3TK2840		X	X	X			X	X
3TK2841		X	X	X	X	X	X	X
3TK2842		X	X	X	X	X	X	X
3TK2845		X	X	X	X		X	X
3TK2850		X	X	X			X	X
3TK2851		X	X	X			X	X
3TK2852		X	X	X			X	X
3TK2853		X	X	X	X		X	X
3TK2856		X	X	X			X	X
3TK2857		X	X	X			X	X
3RA710		X	X	X			X	X
3RA711		X	X	X	X		X	X
3RA712		X	X	X			X	X
3RA713/4		X	X	X			X	X

Terminal connections 3TK28

Safety-relays 3TK282.

clamp	function	3TK2821	3TK2822	3TK2823	3TK2824 24V	3TK2824 115V / 230V	3TK2825	3TK2827 / 28
A1	Power supply L/+	X	X	X	X	X	X	X
A2	Power supply N/-	X	X	X	X	X	X	X
Y1, Y2	Feedback circuit / ON button between Y1-Y2	X			X			
Y10	Sensor circuit 1 one-channel between Y10 – Y11, bridge between Y11 – Y12 and Y21 – Y22						X	X
Y11, Y12	Sensor circuit 1 between Y11 – Y12		X[1)]	X[1)]		X	X[2)]	X[2)]
Y21, Y22	Sensor circuit 2 between Y21 – Y22		X[1)]	X[1)]		X[3)]	X	X
Y33, Y34	Feedback circuit, ON button between Y33 – Y34		X	X		X	X	X
Y43, Y44	Auto start, bridge between Y43 – Y44; monitored start, without bridge.						X	
13-14 23-24 33-34	Enable circuit S: instantaneous	X X X	X X	X X	X X	X X	X X X	X X
47-48 57-58	Enable circuit S_{tv}: delayed							X X
31-32 41-42 51-52	Signaling contacts Ö	X					X X	X

[1)] The safety relay can only be used for two-channel sensors.

[2)] For tow-channel sensors, bridge between Y10 – Y11

[3] For one-channel sensors to Y11 – Y12, bridge between Y21 – Y22

Safety-relays 3TK284. / 3TK285. / 3RA71.

Clamp	Function	3TK2840	3TK2841	3TK2842	3TK2850,51,52 3RA710*	3TK2853 3RA711*	3TK2856,57
A1	Power supply L/+	X	X	X	X	X	X
A2	Power supply N/-	X	X	X	X	X	X
1	Cascading input, start with positive voltage		X	X		X	X
3	Operational switching, (+24V supply for sensor „operational switching“)					X	X
4	Operational switching, input					X	X
Y11, Y12	Sensor circuit 1 between Y11 – Y12	X	X	X	X	X	
Y20	One-channel operation when a jumper to Y21 is inserted	X			X		
Y21, Y22	Sensor circuit 2 between Y21 – Y22	X	X	X	X	X	
Y32	Auto start when supplied with +24V		X	X		X	
Y33	Feedback circuit between Y33 – Y34 for automatic start	X			X		
Y33	Feedback circuit, ON button (+24V supply for feedback circuit, On button)					X	
Y34	Feedback circuit , ON button Input supplied by +24V	X	X	X	X	X	
Y35	Without cross-circuit fault detection for supply with a positive voltage		X	X		X	
2	Safety solid-state output					X	X
14 24	Safety solid-state output Enable circuit S_{el}: instantaneous	X X	X X	X			
28	Safety solid-state output Enable circuit $S_{el\ tv}$: delayed			X			

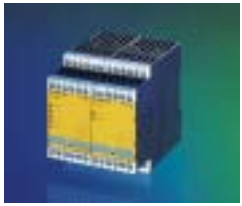
Safety-relays 3TK2845

Clamp	Function	3TK2845
A1	Power supply +	X
A2	Power supply -	X
1	Cascading input (automatic start), start with positive voltage	X
Y11	Sensor 1 circuit 1, output (test signal)	X
Y12	Sensor 1 circuit 1, input monitored start	X
Y21	Sensor 1 circuit 2, output (test signal)	X
Y22	Sensor 1 circuit 2 input monitored start	X
Y34	On button input	X
Y35	Cross-circuit fault detection sensor 1	X
Y41	Sensor circuit 1, output (test signal)	X
Y42	Sensor 2 circuit 1, input automatic start	X
Y51	Sensor 2 circuit 2, output (test signal)	X
Y52	Sensor 2 circuit 2, input automatic start	X
Y64	Feedback circuit to plus	X
Y65	Cross circuit detection Sensor 2	X
Y72	Sensor 3 key switch circuit 1, Input	X
Y82	Sensor 3 key switch circuit 2, Input	X
13-14 37-38	Enable circuit (S, S_{tv}: depending on device type)	X
24 48	Safety solid-state output (S_{el}, $S_{el\ tv}$: acc. device type)	X
52	Electronic solid-state signaling output	X

3TK282.
3TK283.

Safety relays with relays outputs



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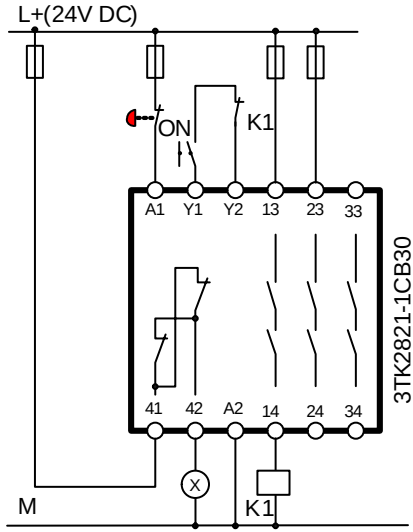
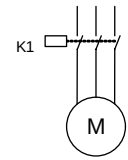
3TK2821

Category 2 (acc. EN 954-1)
E-Stop monitoring
Stop-Category 0

3NO 1NC
V_S 24 V DC
manual start





Not all faults are detected in the sensor circuit, e.g. a P fault in the A1 circuit.
The user must ensure that these types of faults do not occur.

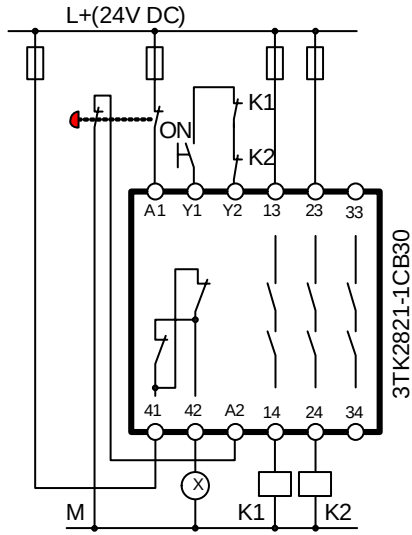
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively opening contacts may be used as sensors.
Using this circuit example, Category 2 according to EN 954-1 can only be fulfilled, if, when the actuator fails, either an alarm is automatically generated or the machine control initiates a safe condition. Otherwise a second shutdown path is required.

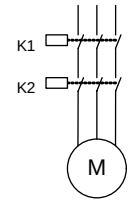
3TK2821

Category 3 (acc. EN 954-1)
E-Stop monitoring
Stop-Category 0

3NO 1NC
V_S 24 V DC
manual start

1





Not all faults are detected in the sensor circuit, e.g. a P fault in the A1 circuit.
The user must ensure that these types of faults do not occur.

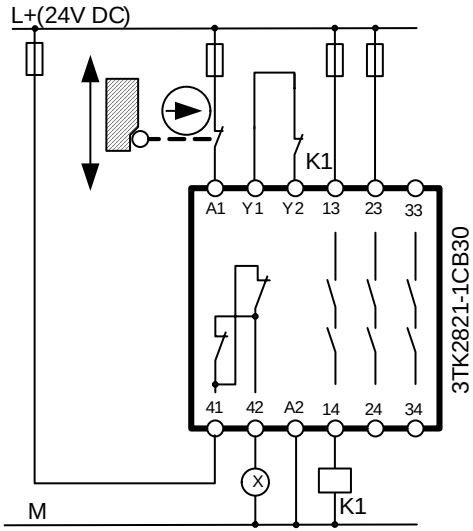
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.
Category 4 according to EN 954-1 can be achieved with supplementary measures, e.g. by routing cables in a safety-relevant fashion.

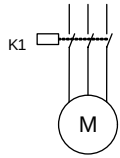
1

3TK2821

Category 2 (acc. EN 954-1)
Protective door monitoring
Stop-Category 0

3NO 1NC
V_S 24 V DC
auto start

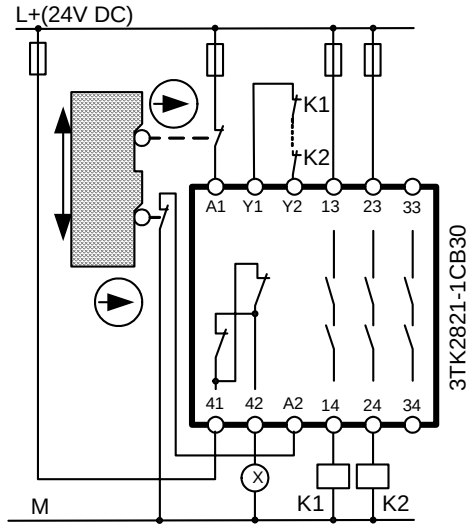


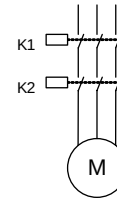


Not all faults are detected in the sensor circuit, e.g. a P fault in the A1 circuit. when a contact in the sensor welds. The user is responsible in ensuring that these types of faults do not occur.

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively opening contacts may be used as sensors.
Using this circuit example, Category 2 according to EN 954-1 can only be fulfilled, if, when the actuator fails, either an alarm is automatically generated or the machine control initiates a safe condition. Otherwise a second shutdown path is required.

3TK2821	**Category 3** (acc. EN 954-1) **Protective door monitoring** **Stop-Category 0**	**3NO 1NC** **V_s 24 V DC** **auto start**





Not all faults are detected in the sensor circuit, e.g. a P fault in the A1 circuit. when a contact in the sensor welds. The user is responsible in ensuring that these types of faults do not occur.

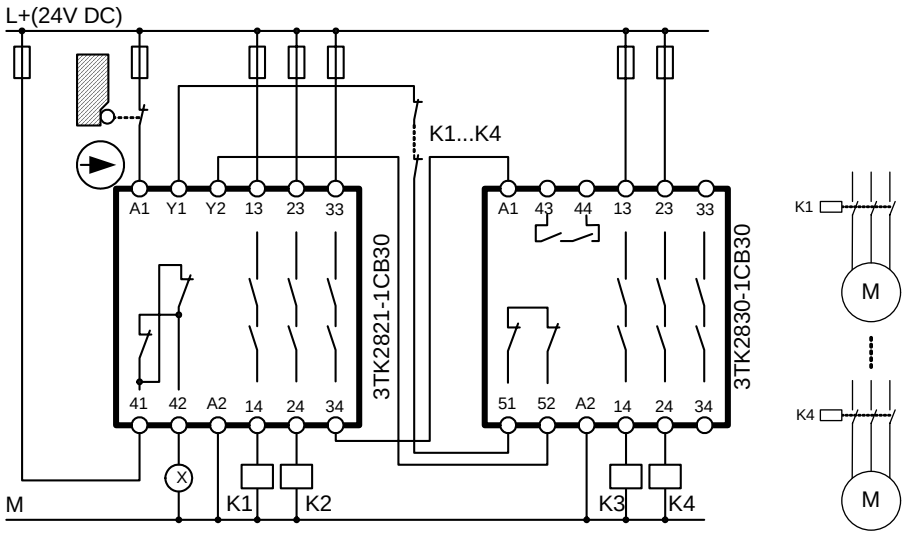
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.
Category 4 according to EN 954-1 can be achieved with supplementary measures, e.g. by routing cables in a safety-relevant fashion.

1

3TK2821 + 3TK2830

Category 2 (acc. EN 954-1)
Protective door monitoring
Stop-Category 0

6NO 1NC
V_S 24 V DC
auto start



Not all faults are detected in the sensor circuit, e.g. a P fault in the A1 circuit, when a contact in the sensor welds. The user is responsible in ensuring that these types of faults do not occur.

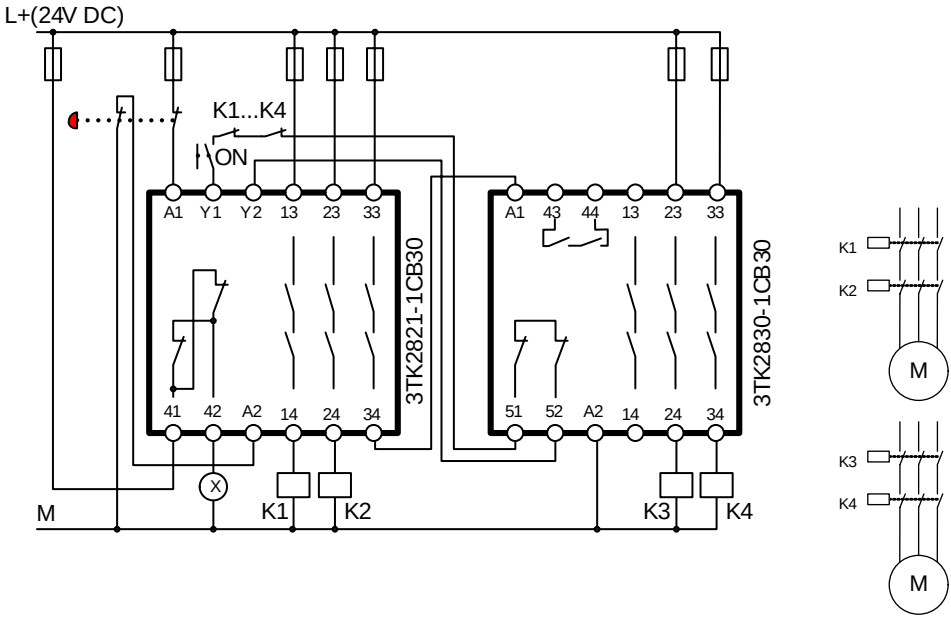
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively opening contacts may be used as sensors.
Using this circuit example, Category 2 according to EN 954-1 can only be fulfilled, if, when the actuator fails, either an alarm is automatically generated or the machine control initiates a safe condition. Otherwise a second shutdown path is required.
Up to eight 3TK2830 expansion devices may be connected to an FK (enable circuit) of the basic 3TK2821 device.
If several expansion devices are cascaded, then the response times must be added.
If faults can be excluded – such as a P fault or M fault – then it is permissible to control an expansion device (cascading) through one channel. This is always fulfilled within a control cabinet or when connecting cables are routed in a protected fashion.

3TK2821 + 3TK2830

Category 3 (acc. EN 954-1)
E-Stop monitoring
Stop-Category 0

6NO 1NC
V_S 24 V DC
manual start

1



Not all faults are detected in the sensor circuit, e.g. a P fault in the A1 circuit. when a contact in the sensor welds. The user is responsible in ensuring that these types of faults do not occur.

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.
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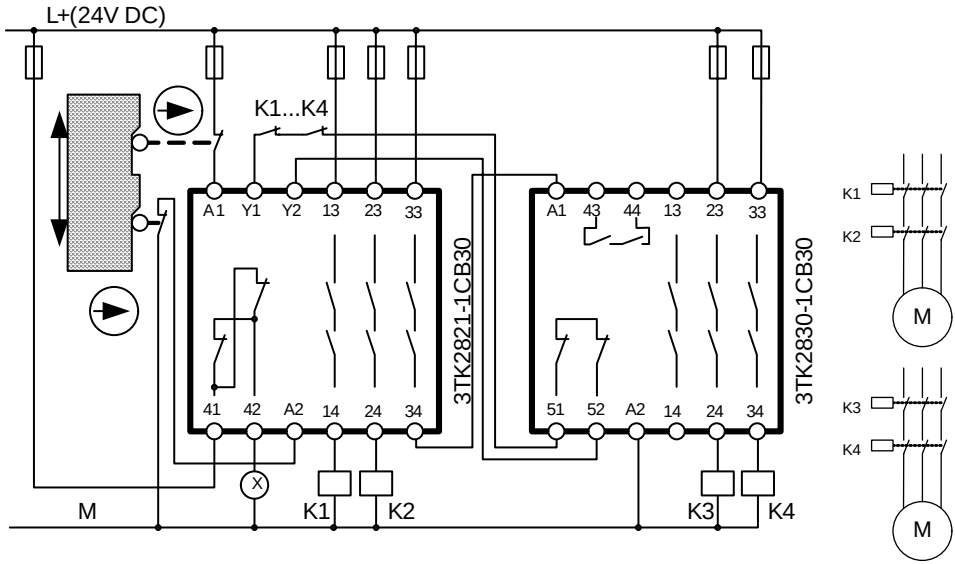
1

3TK2821 + 3TK2830

Category 3 (acc. EN 954-1)
Protective door monitoring
Stop-Category 0

6NO 1NC
V_S 24 V DC
auto start



Not all faults are detected in the sensor circuit, e.g. a P fault in the A1 circuit, when a contact in the sensor welds. The user is responsible in ensuring that these types of faults do not occur.

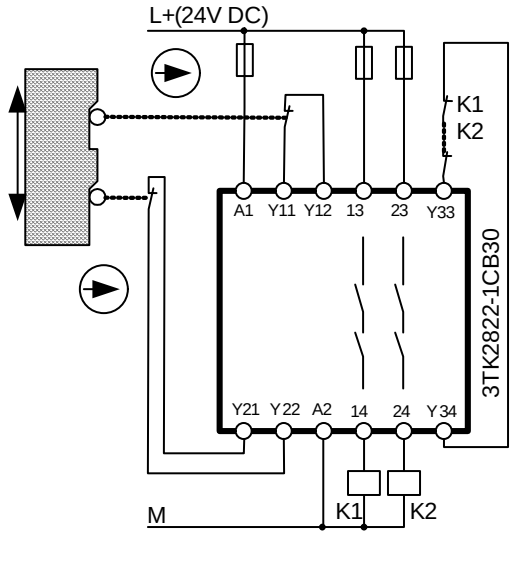
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.
If several expansion devices are cascaded, then the response times must be added.
If faults can be excluded – such as a P fault or M fault – then it is permissible to control an expansion device (cascading) through one channel. This is always fulfilled within a control cabinet or when connecting cables are routed in a protected fashion.

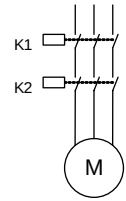
3TK2822

Category 4 (acc. EN 954-1)
Protective door monitoring
Stop-Category 0

2NO
V_s 24 V DC
auto start

1





The safety relay can only be used for two-channel sensors.

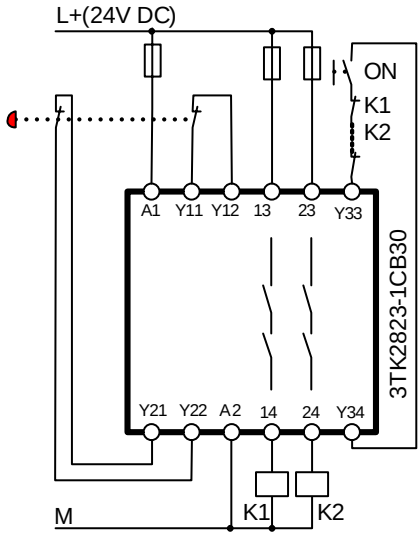
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively opening contacts may be used as sensors.
For Category 4, it is not permissible to connect several position switches in series to implement a protective door monitoring function (due to an inadequate level of fault detection).

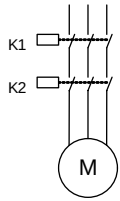
1

3TK2823

Category 4 (acc. EN 954-1)
E-Stop monitoring
Stop-Category 0

2NO
V_s 24 V DC
monitored start

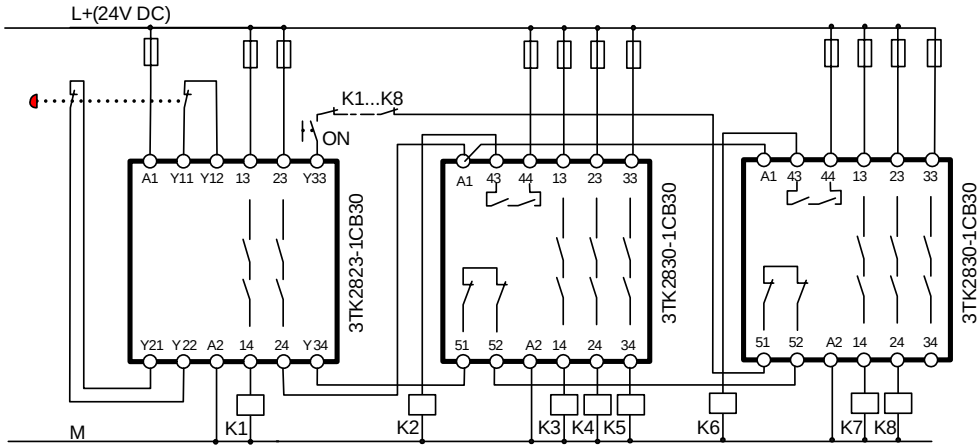


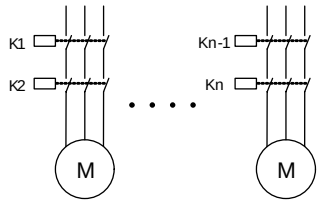


The safety relay can only be used for two-channel sensors.

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.
For Category 4, several EMERGENCY STOP commanding devices may be connected in series.

3TK2823 + 3TK2830 + 3TK2830	**Category 4 (acc. EN 954-1) E-Stop monitoring Stop-Category 0**	**9NO V_s 24 V DC monitored start**





Up to eight 3TK2830 expansion devices may be connected to an FK (enable circuit) of the basic 3TK2821 device.

The safety relay can only be used for two-channel sensors.

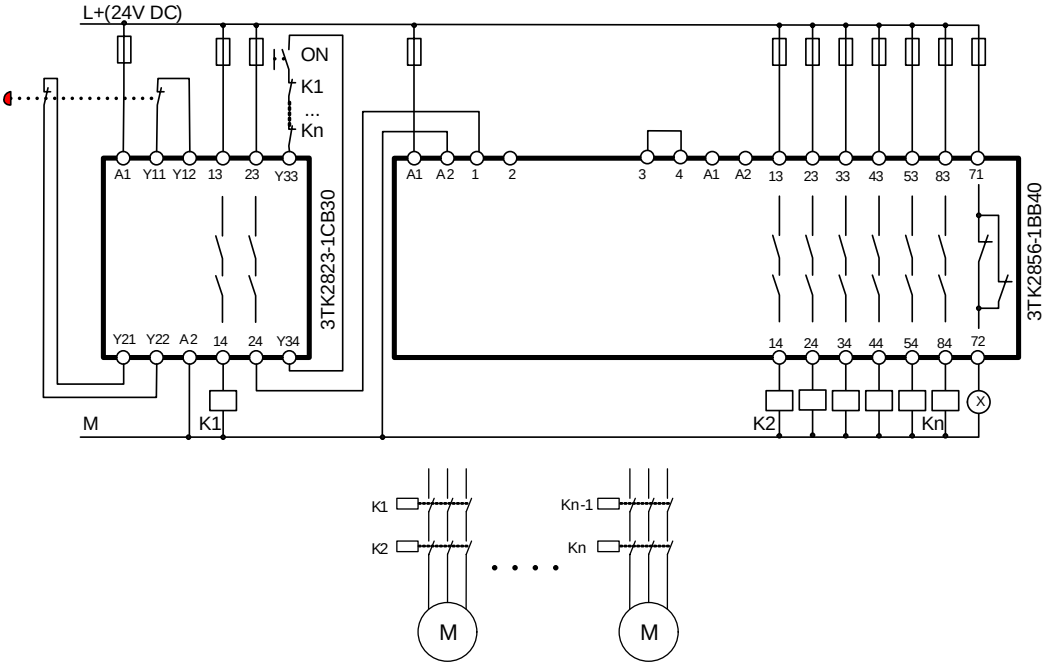
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.
If several expansion devices are cascaded, then the response times must be added.
If faults can be excluded – such as a P fault or M fault – then it is permissible to control an expansion device (cascading) through one channel. This is always fulfilled within a control cabinet or when connecting cables are routed in a protected fashion.
For Category 4, several EMERGENCY STOP commanding devices may be connected in series.

1

3TK2823 + 3TK2856

Category 4 (acc. EN 954-1)
E-Stop monitoring
Stop-Category 0

7NO 1NO$_{el.}$ 1NC
V_s 24 V DC
monitored start



The safety relay can only be used for two-channel sensors.

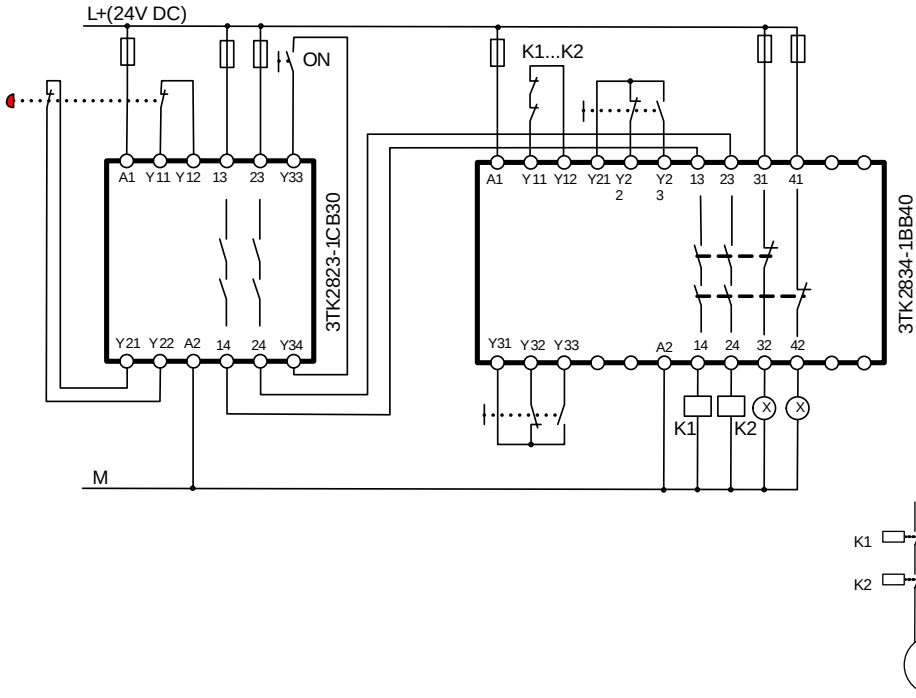
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.
If faults can be excluded – such as a P fault or M fault – then it is permissible to control an expansion device (cascading) through one channel. This is always fulfilled within a control cabinet or when connecting cables are routed in a protected fashion.
For Category 4, several EMERGENCY STOP commanding devices may be connected in series.

3TK2823 + 3TK2834

Category 4 (acc. EN 954-1)
E-Stop monitoring and
two hand monitoring
Stop-Category 0

2NO 2NC
V_S 24 V DC
monitored start

1



The safety relay 3TK2823 can only be used for two-channel sensors.

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.
For Category 4, several EMERGENCY STOP commanding devices may be connected in series.

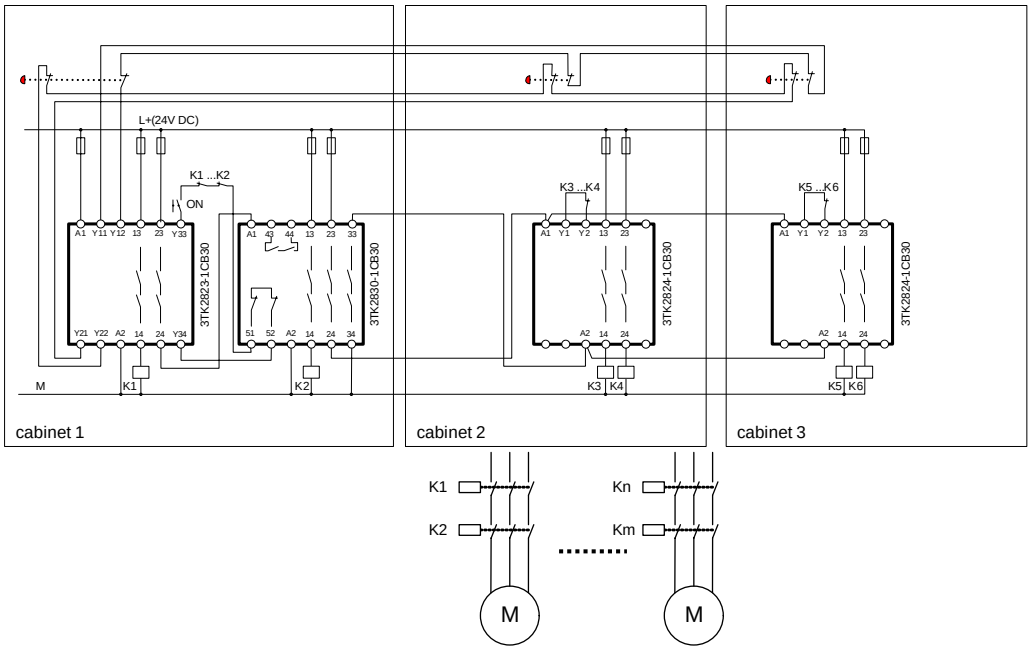
1

3TK2823 +
3TK2830 +
3TK2824 +
3TK2824

Category 4 (acc. EN 954-1)
E-Stop monitoring
Stop-Category 0

3 Switchboards
3 E-Stop
When an Emergency Stop button is pressed, all of the 3TK28 device in the switchboard shut up

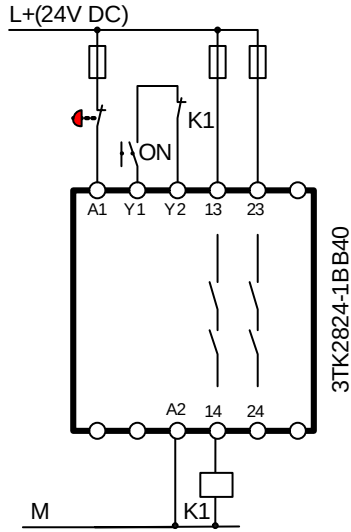
6NO
V_S 24 V DC
monitored start

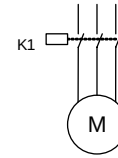


The safety relay can only be used for two-channel sensors.
EMERGENCY STOP commanding devices are monitored by a 3TK28 in cabinet 1:
When an EMERGENCY STOP commanding device is actuated, all of the actuators in the cabinets are shut down.
The actuators of a cabinet are monitored by the associated 3TK28.

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.
For Category 4, several EMERGENCY STOP commanding devices may be connected in series.

3TK2824	**Category 2 (acc. EN 954-1)** **E-Stop monitoring** **Stop-Category 0**	**2NO** **V_S 24 V DC** **manual start**





Not all faults are detected in the sensor circuit, e.g. a P fault in the A1 circuit. when a contact in the sensor welds. The user is responsible in ensuring that these types of faults do not occur.

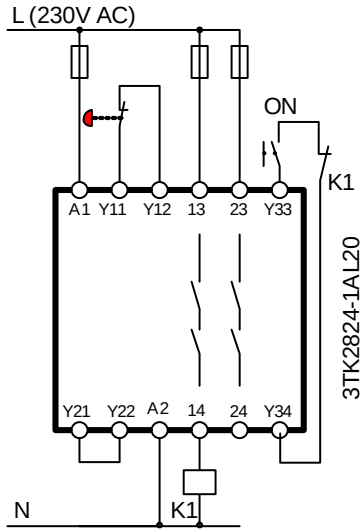
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.
Using this circuit example, Category 2 according to EN 954-1 can only be fulfilled, if, when the actuator fails, either an alarm is automatically generated or the machine control initiates a safe condition. Otherwise a second shutdown path is required.

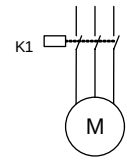
1

3TK2824-1AL20

Category 2 (acc. EN 954-1)
E-Stop monitoring
Stop-Category 0

2NO
V_s 230 V AC
manual start





Not all faults are detected in the sensor circuit – e.g. a P fault in Y11 Y12 circuit, M fault in the Y21 Y22 circuit, when a contact in the sensor welds. The user is responsible in ensuring that these types of faults do not occur.

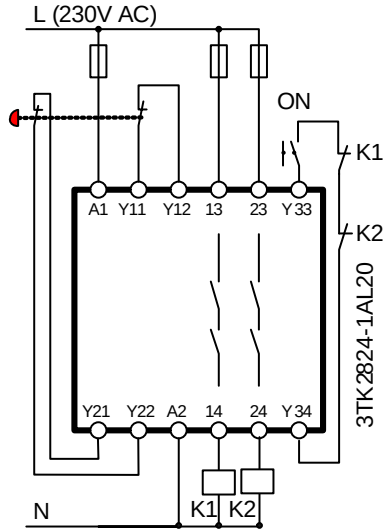
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.
Using this circuit example, Category 2 according to EN 954-1 can only be fulfilled, if, when the actuator fails, either an alarm is automatically generated or the machine control initiates a safe condition. Otherwise a second shutdown path is required.

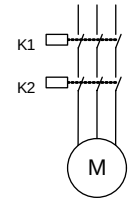
3TK2824-1AL20

Category 3 (acc. EN 954-1)
E-Stop monitoring
Stop-Category 0

2NO
V_s 230 V AC
manual start

1





Not all faults are detected in the sensor circuit – e.g. a P fault in Y11 Y12 circuit, M fault in the Y21 Y22 circuit, when a contact in the sensor welds. The user is responsible in ensuring that these types of faults do not occur.

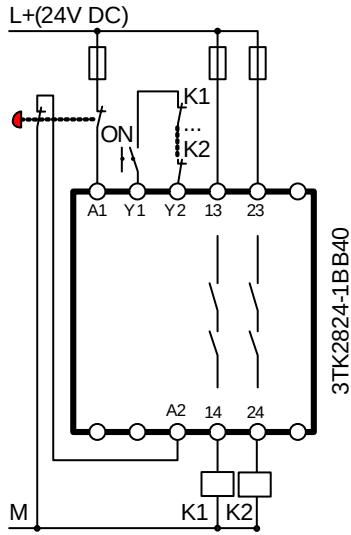
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

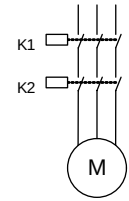
1

3TK2824

Category 3 (acc. EN 954-1)
E-Stop monitoring
Stop-Category 0

2NO
V_s 24 V DC
manual start





Not all faults are detected in the sensor circuit, e.g. a P fault in the A1 circuit. M fault in the A2 circuit, when a contact in the sensor welds. The user is responsible in ensuring that these types of faults do not occur.

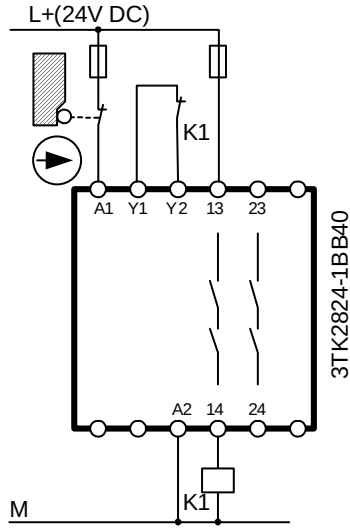
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

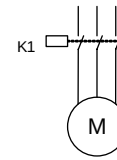
3TK2824

Category 2 (acc. EN 954-1)
protective door
monitoring
Stop-Category 0

2NO
V_s 24 V DC
auto start

1





Not all faults are detected in the sensor circuit – e.g. a P fault in A1 circuit, when a contact in the sensor welds. The user is responsible in ensuring that these types of faults do not occur.

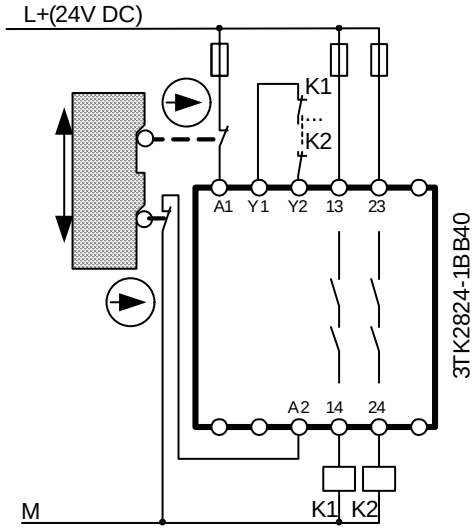
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.
Using this circuit example, Category 2 according to EN 954-1 can only be fulfilled, if, when the actuator fails, either an alarm is automatically generated or the machine control initiates a safe condition. Otherwise a second shutdown path is required.

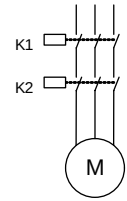
1

3TK2824

Category 3 (acc. EN 954-1)
protective door
monitoring
Stop-Category 0

2NO
V_s 24 V DC
auto start





Not all faults are detected in the sensor circuit, e.g. a P fault in the A1 circuit, when a contact in the sensor welds. The user is responsible in ensuring that these types of faults do not occur.

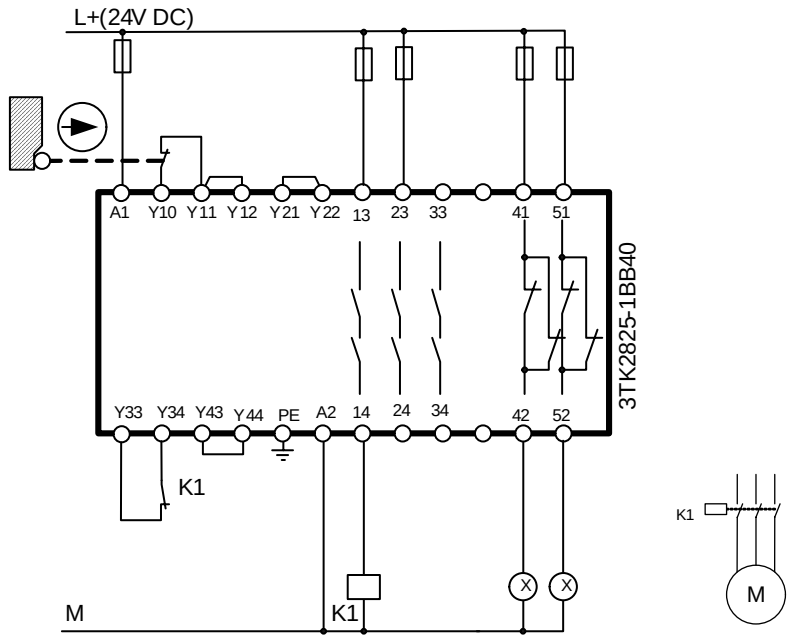
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2825

Category 2 (acc. EN 954-1)
protective door
monitoring
Stop-Category 0

3NO 2NC
V_S 24 V DC
auto start

1



Not all faults are detected in the sensor circuit – e.g. a P fault in Y10 Y11 circuit, when a contact in the sensor welds. The user is responsible in ensuring that these types of faults do not occur.

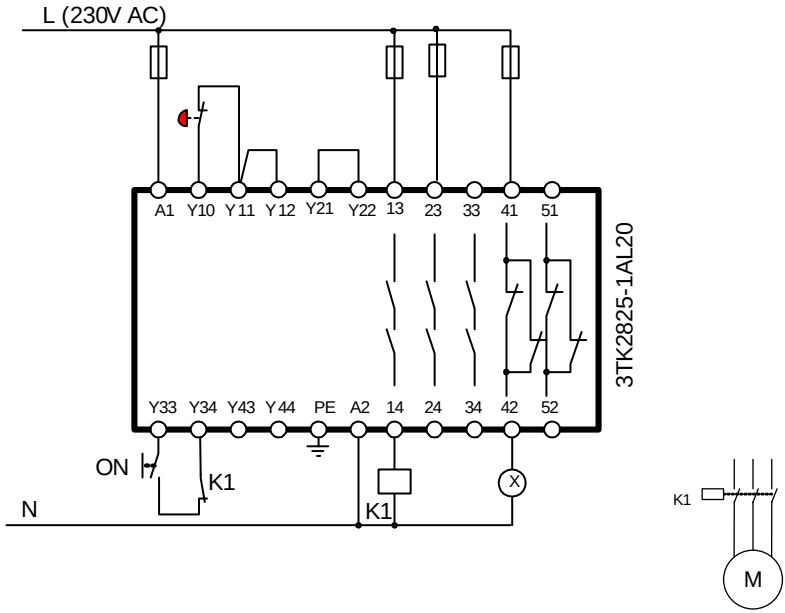
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.
Using this circuit example, Category 2 according to EN 954-1 can only be fulfilled, if, when the actuator fails, either an alarm is automatically generated or the machine control initiates a safe condition. Otherwise a second shutdown path is required.

1

3TK2825-1AL20

Category 2 (acc. EN 954-1)
E-Stop Monitoring
Stop-Category 0

3NO 2NC
V_s 230 V AC
monitored start



Not all faults are detected in the sensor circuit – e.g. a P fault in Y11 Y12 circuit, M fault in the Y21 Y22 circuit, when a contact in the sensor welds. The user is responsible in ensuring that these Types of faults do not occur.

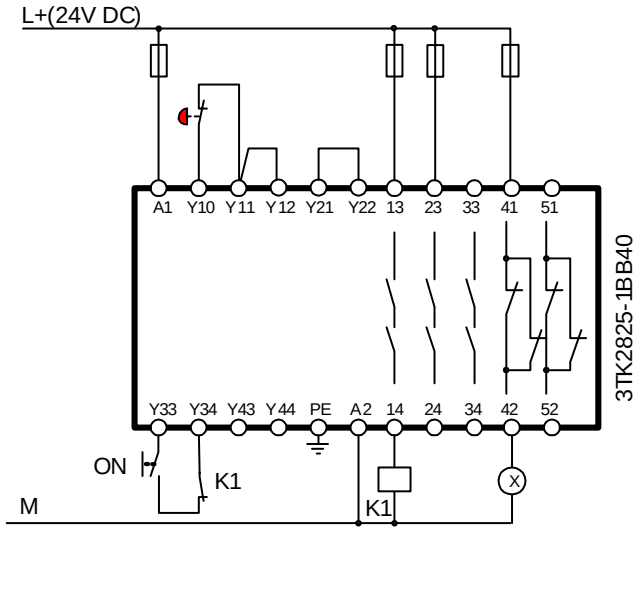
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.
Using this circuit example, Category 2 according to EN 954-1 can only be fulfilled, if, when the actuator fails, either an alarm is automatically generated or the machine control initiates a safe condition. Otherwise a second shutdown path is required.

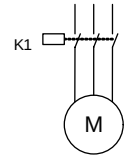
3TK2825

Category 2 (acc. EN 954-1)
E-Stop Monitoring
Stop-Category 0

3NO 2NC
V_S 24 V DC
monitored start

1





Only safety-relevant sensors with positively-opening contacts may be used as sensors. Two oactuators (e.g. contactors) should be used in the load circuit.

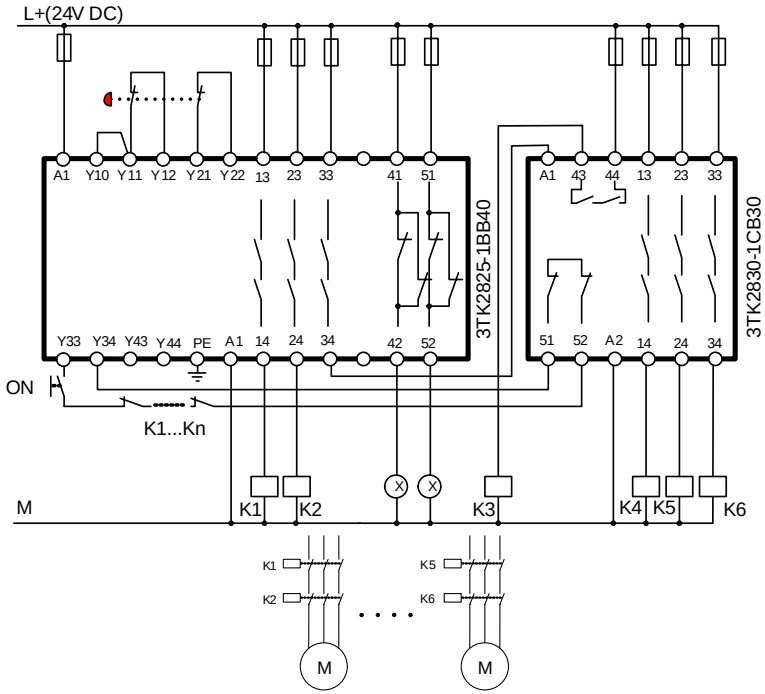
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.
Using this circuit example, Category 2 according to EN 954-1 can only be fulfilled, if, when the actuator fails, either an alarm is automatically generated or the machine control initiates a safe condition. Otherwise a second shutdown path is required.

1

3TK2825 + 3TK2830

Category 4 (acc. EN 954-1)
E-Stop Monitoring
Stop-Category 0

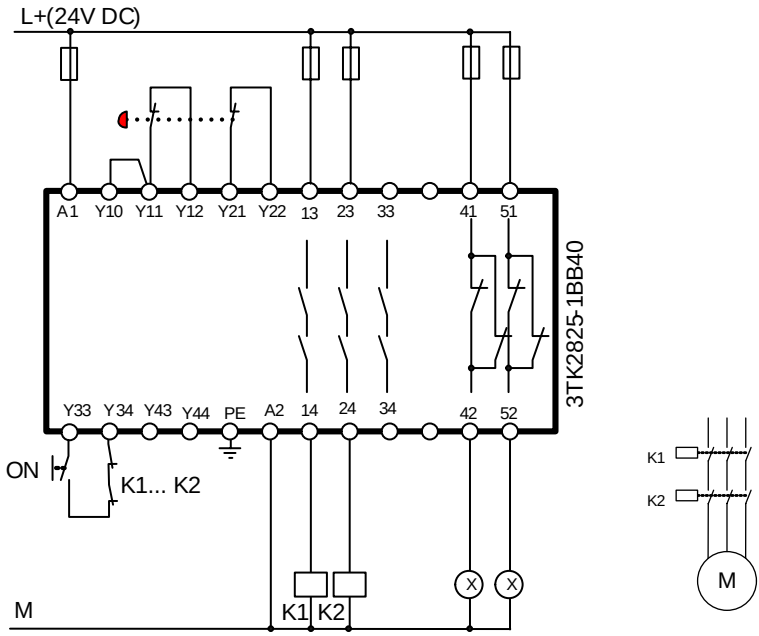
6NO 2NC
V_S 24 V DC
monitored start



Up to eight 3TK2830 expansion devices can be connected to an FK (enable circuit) of the 3TK2825 basic device. When several expansion devices are cascaded, the response times must be added. When circuit faults are excluded – such as P fault or M fault – then it is permissible to control an expansion device through one channel (cascading). This condition is always fulfilled within a control cabinet or when connecting cables are routed in a protected fashion.
For Category 4, several EMERGENCY STOP commanding devices may be connected in series.

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2825	**Category 4** (acc. EN 954-1) **E-Stop Monitoring** **Stop-Category 0**	**3NO 2NC** **V_S 24 V DC** **monitored start**	**1**



For Category 4, several EMERGENCY STOP commanding devices may be connected in series.

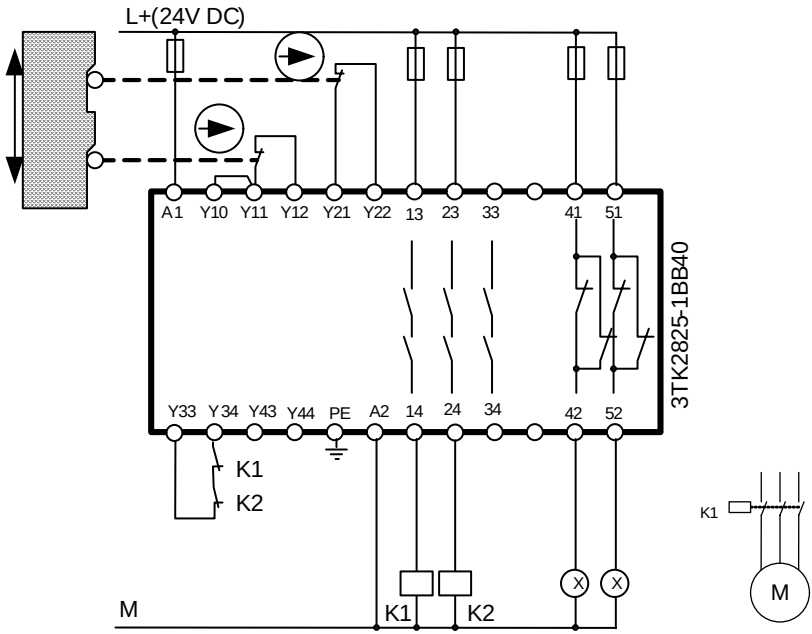
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

1

3TK2825

Category 4 (acc. EN 954-1)
protective door
monitoring
Stop-Category 0

3NO 2NC
V_S 24 V DC
autostart



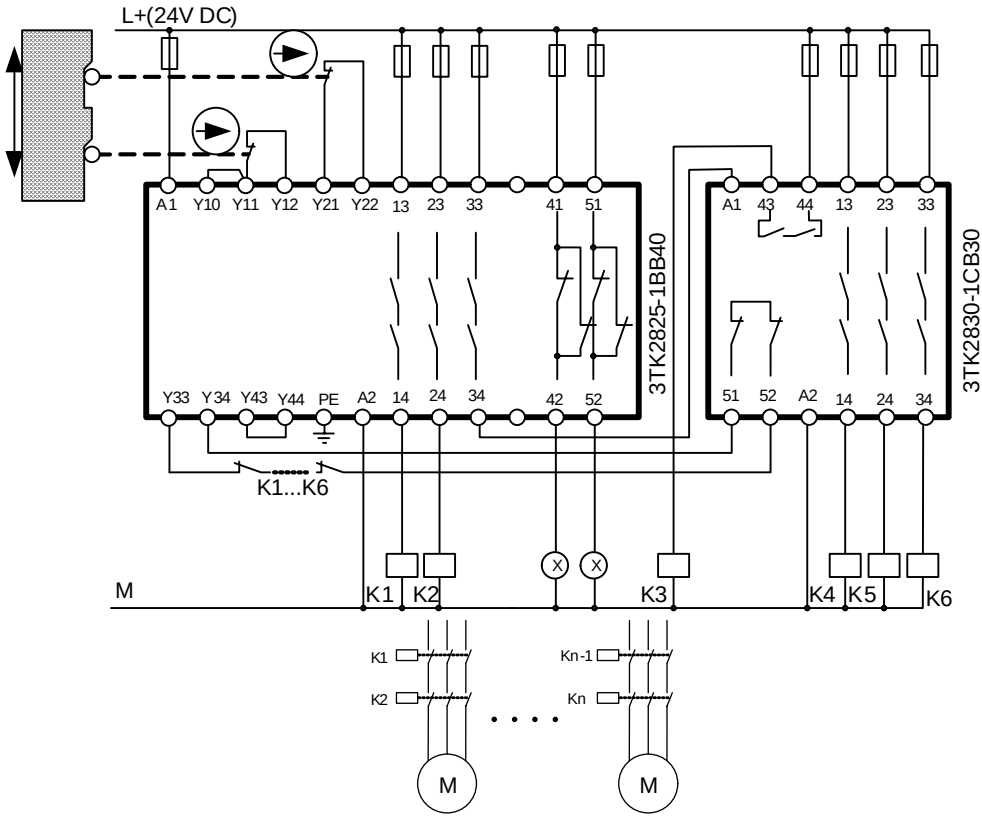
For Category 4, it is not permissible to connect several position switches in series to implement a protective door monitoring function (due to an inadequate level of fault detection).

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2825 + 3TK2830

Category 4 (acc. EN 954-1)
Protective door monitoring
Stop-Category 0

6NO 2NC
V_S 24 V DC
auto start



For Category 4, it is not permissible to connect several position switches in series to implement a protective door monitoring function (due to an inadequate level of fault detection). Up to eight 3TK2830 expansion devices can be connected to an FK (enable circuit) of the 3TK2825 basic device. When several expansion devices are cascaded, the response times must be added. When circuit faults are excluded – such as a P fault or a M fault – then it is permissible to control an expansion device through one channel (cascading). This condition is always fulfilled within a control cabinet or when connecting cables are routed in a protected fashion.

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

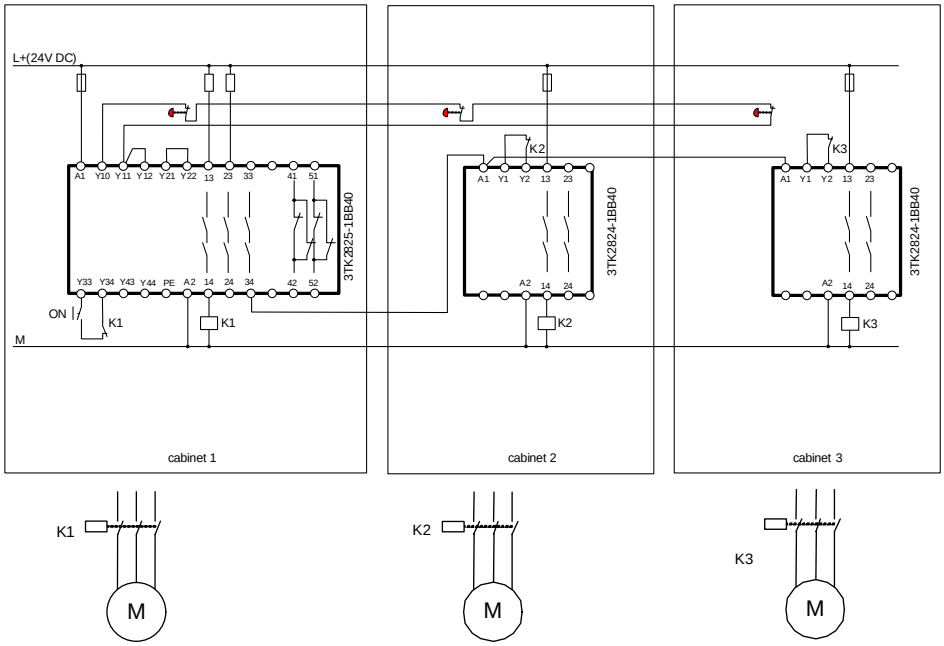
1

3TK2825 + 3TK2824 + 3TK2824

Category 2 (acc. EN 954-1)
E-Stop Monitoring
Stop-Category 0

E-Stop distributed over several cabinets

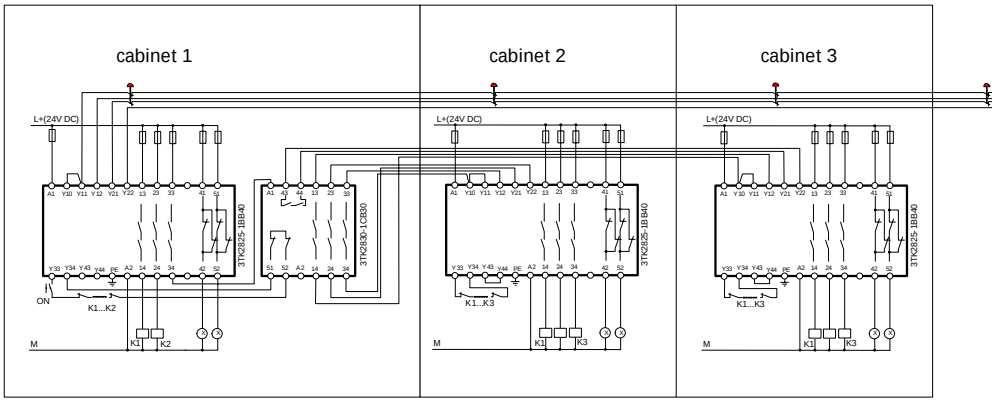
7NO 2NC
V_s 24 V DC
monitored start



EMERGENCY STOP is monitored by a 3TK2825; the 3TK28 monitors the actuators in the same control cabinet. Always control the subsequent safety devices from the same, first safety device. The reason for this is that when several safety relays are used in series, the response times must be added. The 3TK2825 is required in order to maintain, e.g. a total response time of e.g. 200ms.
Only safety-relevant sensors with positively-opening contacts may be used as sensors. Tow actuators (e.g. contactors) should be used in the load circuit.

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.
Using this circuit example, Category 2 according to EN 954-1 can only be fulfilled, if, when the actuator fails, either an alarm is automatically generated or the machine control initiates a safe condition. Otherwise a second shutdown path is required.

3TK2825 + 3TK2830 + 3TK2825 + 3TK2825	**Category 4 (acc. EN 954-1)** **E-Stop Monitoring** **Stop-Category 0** **E-Stop distributed over several cabinets**	**8NO 6NC** **V_S 24 V DC** **monitored start**



EMERGENCY STOP commanding devices are monitored by the 3TK2825 in cabinet 1: This is the reason that the response times do not have to be added. The actuators are monitored by the 3TK28 in the same control cabinet.

The 3TK2825 in cabinet 1 operates with a monitored start.
The 3TK2825 in cabinets 2 and 3 operate with an automatic start.
For Category 4, several EMERGENCY STOP commanding devices may be connected in series.

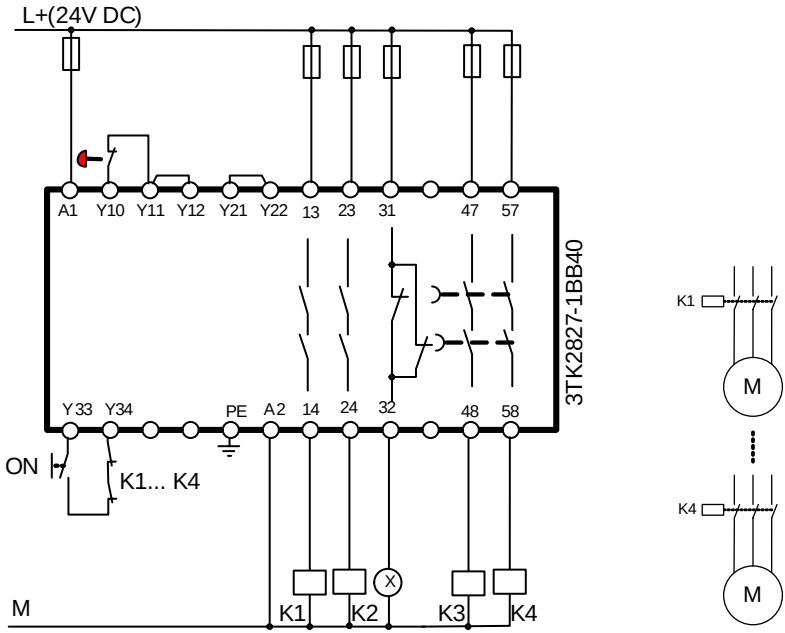
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

1

3TK2827

Category 2 (acc. EN 954-1)
E-Stop Monitoring
Stop-Category 0 and 1

2NO 2NO$_{tv}$ 1NC
V$_s$ 24 V DC
monitored start



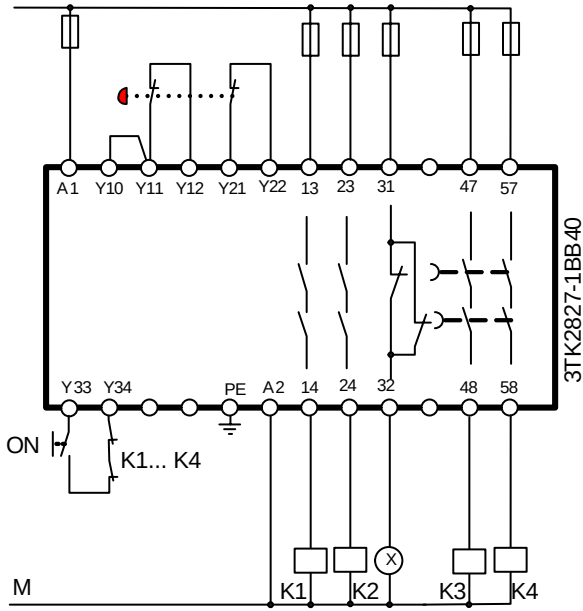
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.
Using this circuit example, Category 2 according to EN 954-1 can only be fulfilled, if, when the actuator fails, either an alarm is automatically generated or the machine control initiates a safe condition. Otherwise a second shutdown path is required.

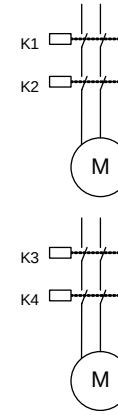
3TK2827

Category 3/4 (acc. EN 954-1)
E-Stop Monitoring
Stop-Category 0 and 1

2NO 2NO$_{tv}$ 1NC
V_s 24 V DC
monitored start

1





For Category 4, several EMERGENCY STOP commanding devices may be connected in series.

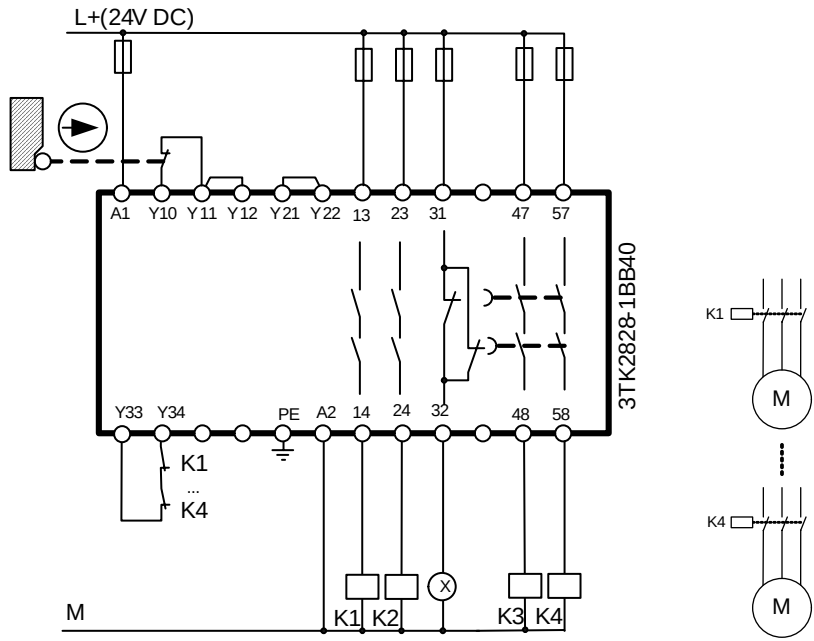
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.
The time-delayed outputs switch according to Category 3 in compliance with EN 954-1.

1

3TK2828

Category 2 (acc. EN 954-1)
Protective door monitoring
Stop-Category 0 and 1

2NO 2NO$_{tv}$ 1NC
V$_s$ 24 V DC
auto start



Tow actuators (e.g. contactors) should be used in the load circuit.

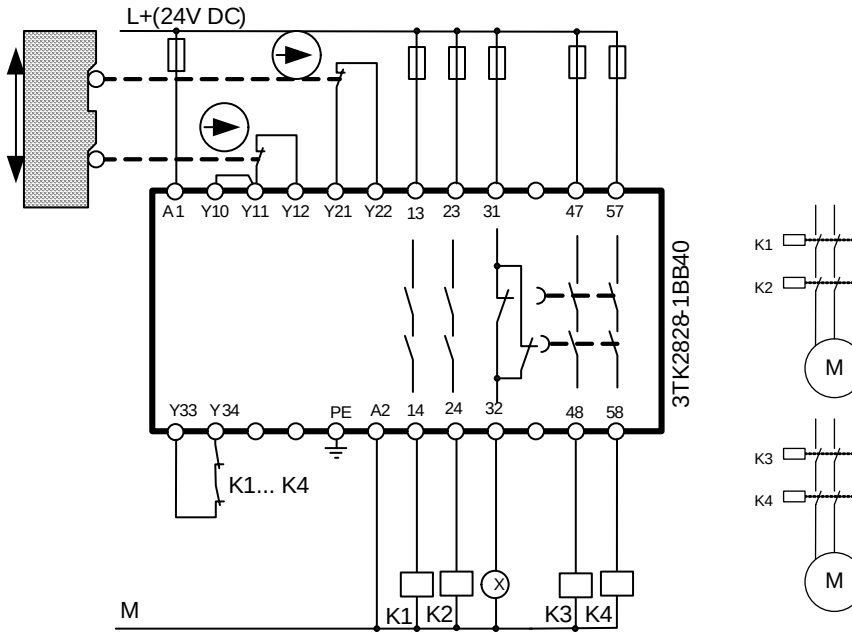
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.
Using this circuit example, Category 2 according to EN 954-1 can only be fulfilled, if, when the actuator fails, either an alarm is automatically generated or the machine control initiates a safe condition. Otherwise a second shutdown path is required.

3TK2828

Category 3/4 (acc. EN 954-1)
Protective door monitoring
Stop-Category 0 and 1

2NO 2NO$_{tv}$ 1NC
V$_s$ 24 V DC
auto start

1



For Category 4, it is not permissible to connect several position switches in series to implement a protective door monitoring function (due to an inadequate level of fault detection).

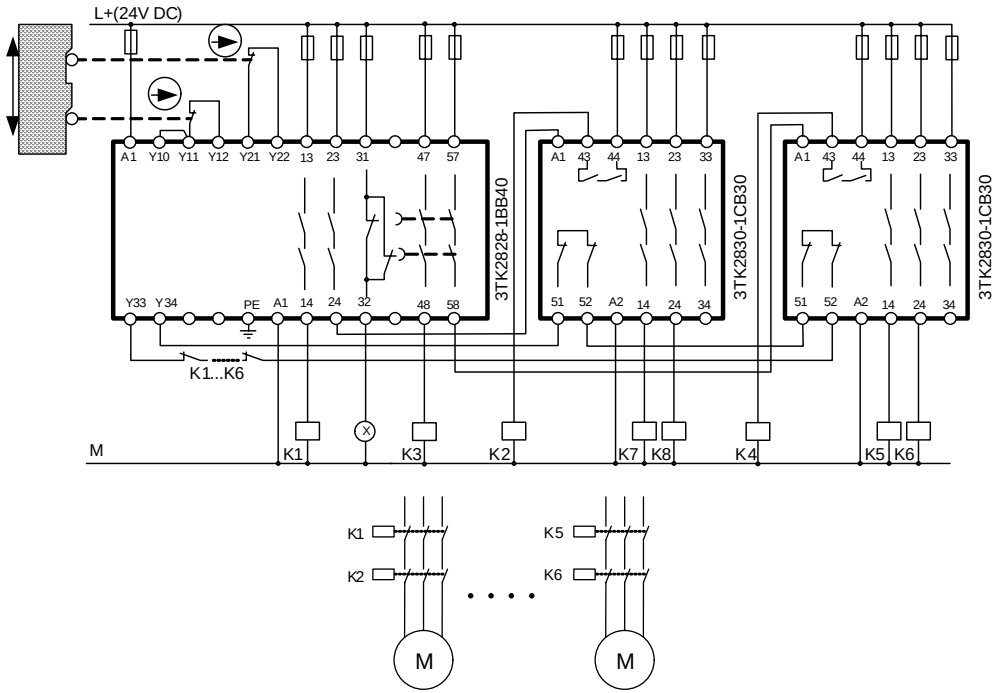
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.
The time-delayed outputs switch according to Category 3 in compliance with EN 954-1.

1

3TK2828 + 3TK2830 + 3TK2830

Category 3/4 (acc. EN 954-1)
Protective door monitoring
Stop-Category 0 and 1

4NO 4NO$_{tv}$ 1NC
V_s 24 V DC
auto start



For Category 4, it is not permissible to connect several position switches in series to implement a protective door monitoring function (due to an inadequate level of fault detection). Up to eight 3TK2830 expansion devices may be connected to an FK (enable circuit) of the basic 3TK2821 device.
When several expansion devices are cascaded, the response times must be added.
When circuit faults are excluded – such as a P fault or a M fault – then it is permissible to control an expansion device through one channel (cascading). This condition is always fulfilled within a control cabinet or when connecting cables are routed in a protected fashion.

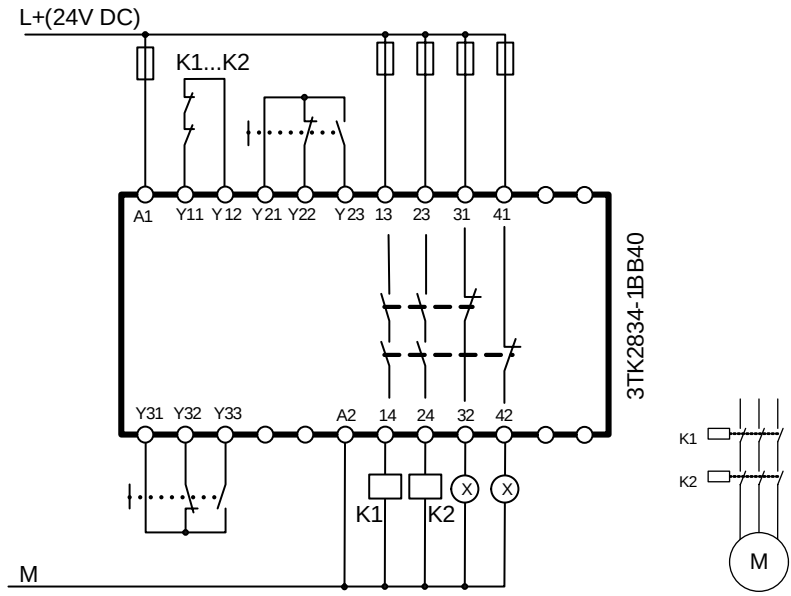
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2834

Category 4 (acc. EN 954-1)
Two hand Monitoring
Stop-Category 0

2NO 2NC
V_S 24 V DC
two hand operating

Type III C (EN 574)



When the pushbuttons are simultaneously actuated within 500 ms then the safety relay is switched-in.

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

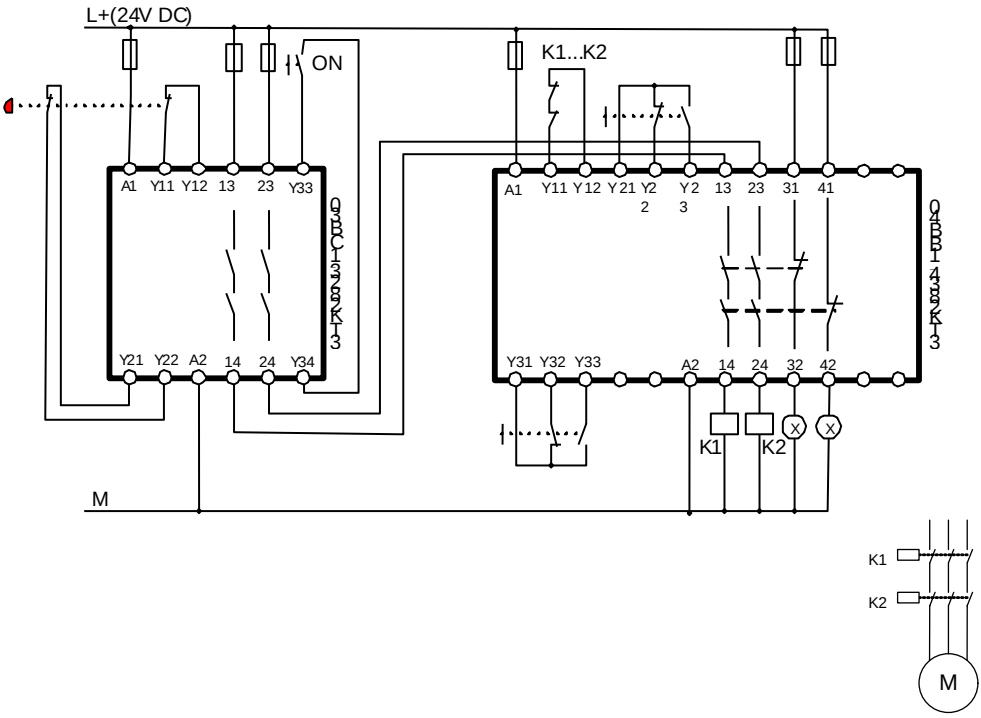
1

3TK2834 + 3TK2823

Category 4 (acc. EN 954-1)
E-Stop and Two hand
Monitoring
Stop-Category 0

2NO 2NC
V_s 24 V DC
monitored start
two hand operating

Type III C (EN 574)



For Category 4, several EMERGENCY STOP commanding devices may be connected in series. When the pushbuttons are simultaneously actuated within 500 ms then the safety relay is switched-in.

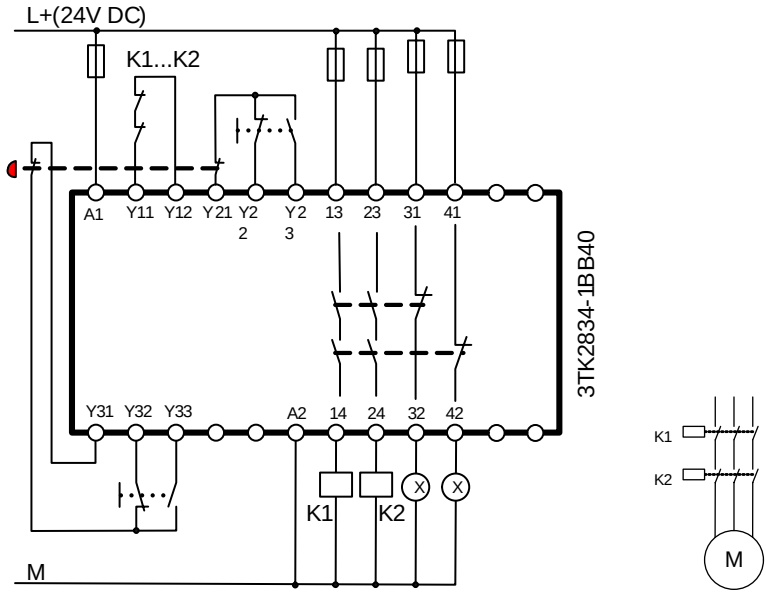
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2834

Category 4 (acc. EN 954-1)
E-Stop and Two hand
Monitoring
Stop-Category 0

2NO 2NC
V_s 24 V DC
monitored start
two hand operating

Type III C (EN 574)



For Category 4, several EMERGENCY STOP commanding devices may be connected in series.
Two hand operating with E-STOP Monitoring.
When the pushbuttons are simultaneously actuated within 500 ms then the safety relay is switched-in.

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

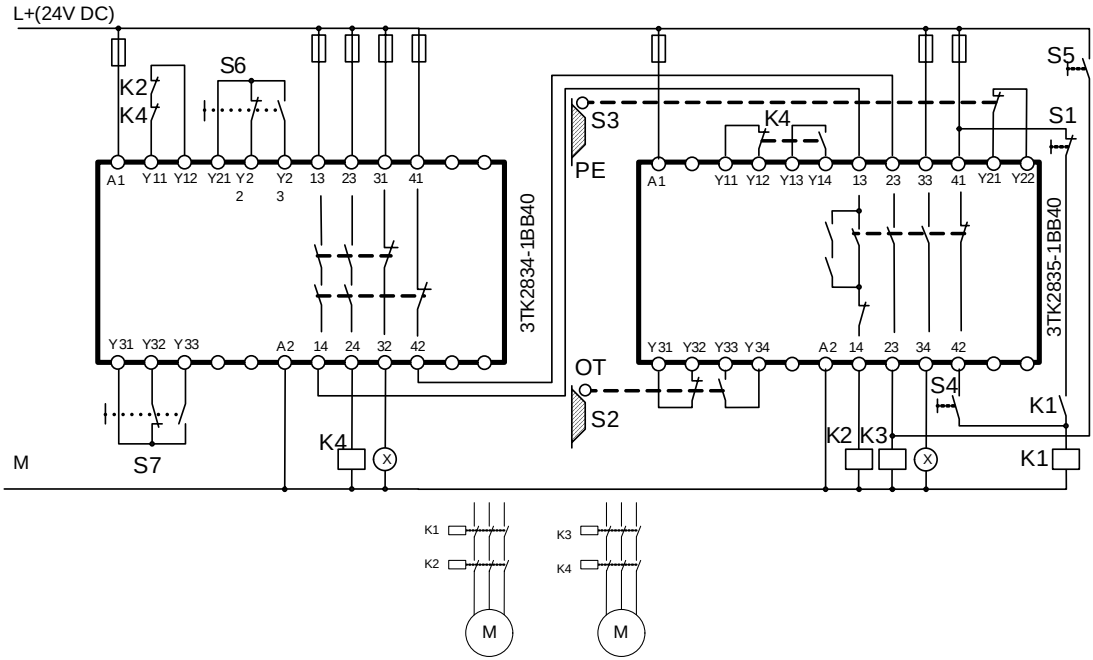
1

3TK2834 + 3TK2835

Category 4 (acc. EN 954-1)
Two hand Monitoring with run-on distance check
Stop-Category 0

Type III C (EN 574)

2NO 2NC
V_s 24 V DC
two hand operating



When the pushbuttons are simultaneously actuated within 500 ms then the safety relay is switched-in.

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

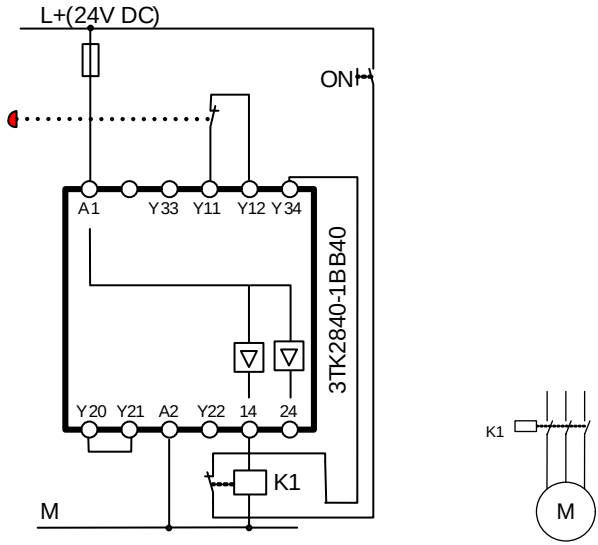
3TK284.

Safety relays with electronic outputs

3TK2840

Category 2 (acc. EN 954-1)
E-Stop Monitoring
Stop-Category 0

2NO$_{el.}$
V_S 24 V DC
monitored start



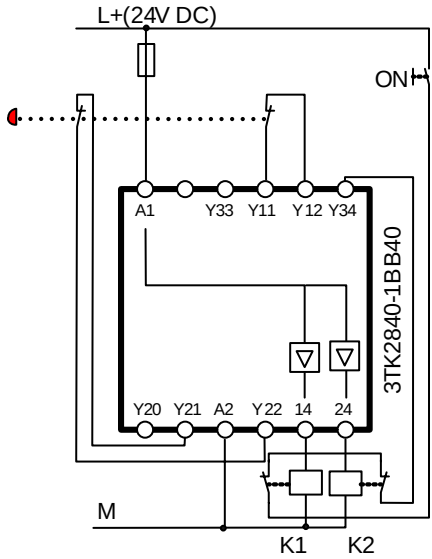
The output drivers (S_{el}) are only monitored via the external actuators – i.e. using the feedback circuit (Y34). This is the reason that this device may only be used in conjunction with positively-driven actuators.
Only safety-relevant sensors with positively-opening contacts may be used as sensors.

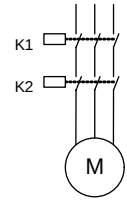
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2840

Category 3 (acc. EN 954-1)
E-Stop Monitoring
Stop-Category 0

$2NO_{el.}$
V_s 24 V DC
monitored start





The output drivers (S_{el}) are only monitored via the external actuators – i.e. using the feedback circuit (Y34). This is the reason that this device may only be used in conjunction with positively-driven actuators.
For Category 4, several EMERGENCY STOP commanding devices may be connected in series.

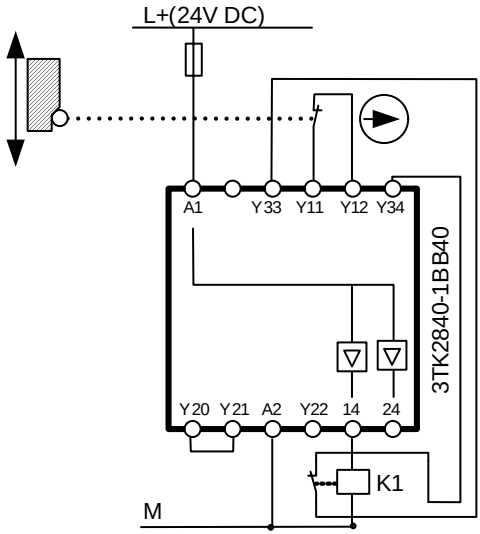
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

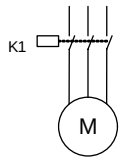
3TK2840

Category 2 (acc. EN 954-1)
protective door
Monitoring
Stop-Category 0

2NO$_{el.}$
V_s 24 V DC
auto start

2





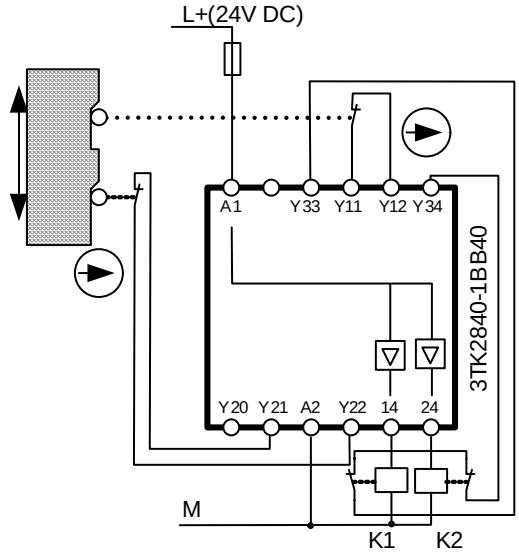
The output drivers (S_{el}) are only monitored via the external actuators – i.e. using the feedback circuit (Y34). This is the reason that this device may only be used in conjunction with positively-driven actuators.

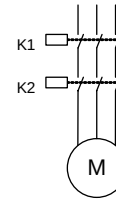
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.
Using this circuit example, Category 2 according to EN 954-1 can only be fulfilled, if, when the actuator fails, either an alarm is automatically generated or the machine control initiates a safe condition. Otherwise a second shutdown path is required.

3TK2840

Category 3 (acc. EN 954-1)
protective door
Monitoring
Stop-Category 0

2NO$_{el.}$
V_s 24 V DC
auto start





The output drivers (S_{el}) are only monitored via the external actuators – i.e. using the feedback circuit (Y34). This is the reason that this device may only be used in conjunction with positively-driven actuators.
For Category 4, it is not permissible to connect several position switches in series to implement a protective door monitoring function (due to an inadequate level of fault detection).

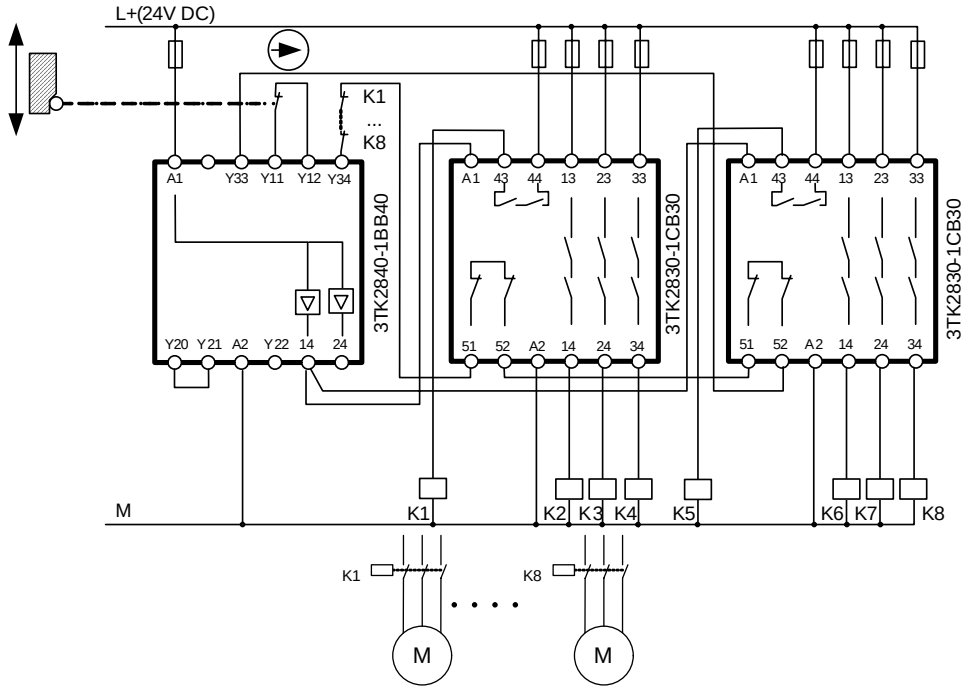
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2840 +
3TK2830 +
3TK2830

Category 2 (acc. EN 954-1)
protective door
Monitoring
Stop-Category 0

8NO
V_s 24 V DC
auto start

2



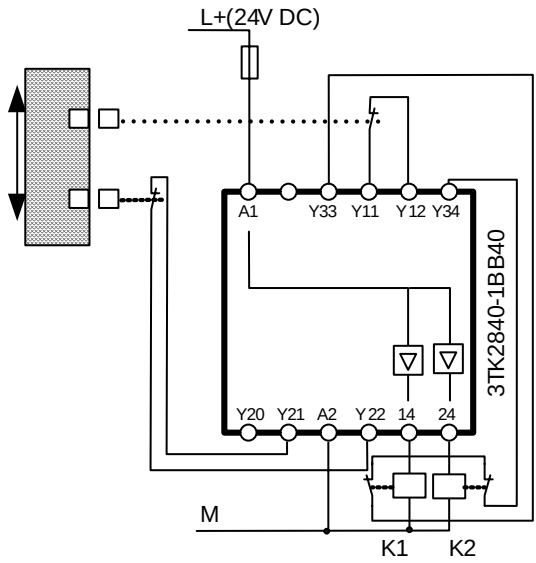
The output drivers (S_{el}) are only monitored via the external actuators – i.e. using the feedback circuit (Y34). This is the reason that this device may only be used in conjunction with positively-driven actuators.

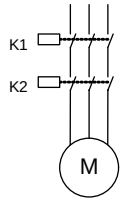
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.
Using this circuit example, Category 2 according to EN 954-1 can only be fulfilled, if, when the actuator fails, either an alarm is automatically generated or the machine control initiates a safe condition. Otherwise a second shutdown path is required.

3TK2840

Category 3 (acc. EN 954-1)
Magnet sensor Monitoring
Stop-Category 0

$2NO_{el.}$
V_s 24 V DC
auto start





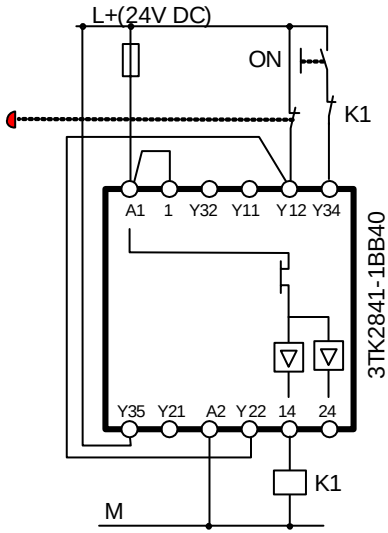
The output drivers (S_{el}) are only monitored via the external actuators – i.e. using the feedback circuit (Y34). This is the reason that this device may only be used in conjunction with positively-driven actuators.

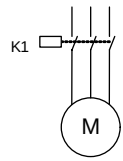
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.
Using this circuit example, Category 2 according to EN 954-1 can only be fulfilled, if, when the actuator fails, either an alarm is automatically generated or the machine control initiates a safe condition. Otherwise a second shutdown path is required.

3TK2841

Category 2 (acc. EN 954-1)
E-Stop Monitoring
Stop-Category 0

2NO$_{el}$
V_s 24 V DC
monitored start



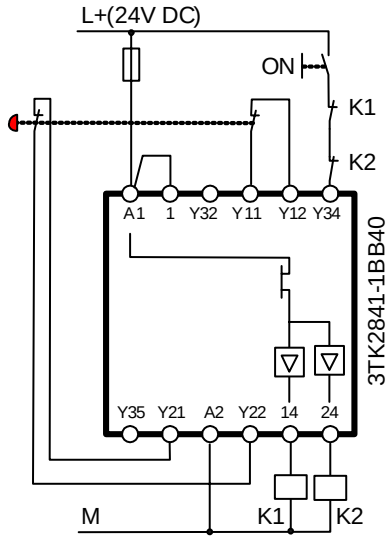


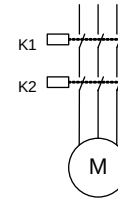
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.
Using this circuit example, Category 2 according to EN 954-1 can only be fulfilled, if, when the actuator fails, either an alarm is automatically generated or the machine control initiates a safe condition. Otherwise a second shutdown path is required.

3TK2841

Category 4 (acc. EN 954-1)
E-Stop Monitoring
Stop-Category 0

$2NO_{el}$
V_s 24 V DC
monitored start





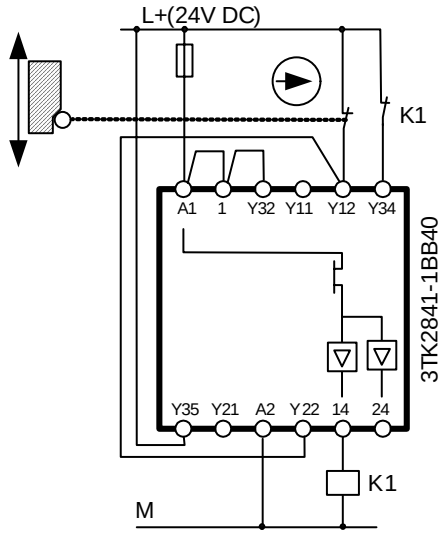
For Category 4, several EMERGENCY STOP commanding devices may be connected in series.

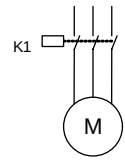
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2841

Category 2 (acc. EN 954-1)
protective door
Monitoring
Stop-Category 0

2NO$_{el}$
V_s 24 V DC
auto start



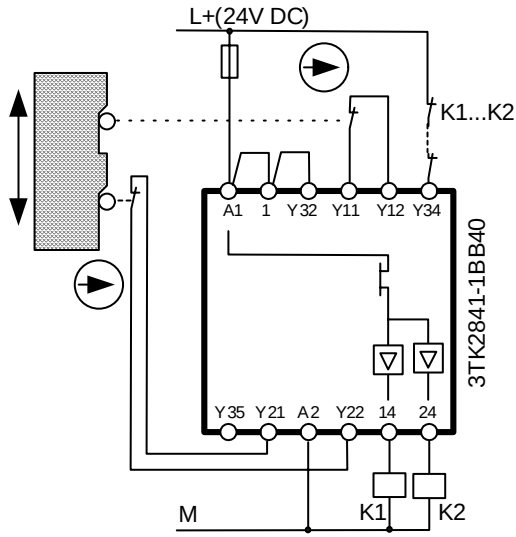


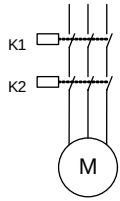
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.
Using this circuit example, Category 2 according to EN 954-1 can only be fulfilled, if, when the actuator fails, either an alarm is automatically generated or the machine control initiates a safe condition. Otherwise a second shutdown path is required.

3TK2841

Category 4 (acc. EN 954-1)
protective door
Monitoring
Stop-Category 0

$2NO_{el}$
V_s 24 V DC
auto start





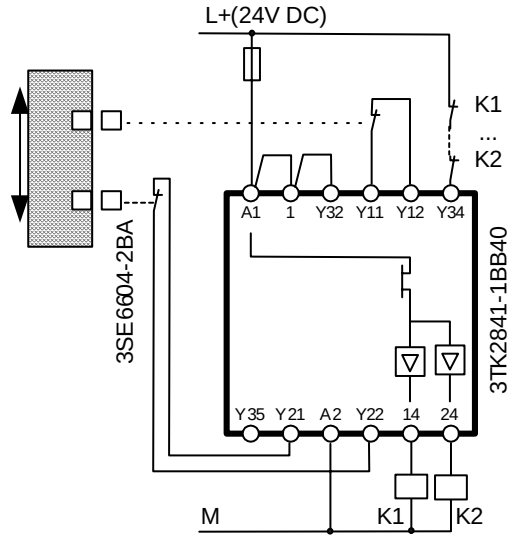
For Category 4, it is not permissible to connect several position switches in series to implement a protective door monitoring function (due to an inadequate level of fault detection).

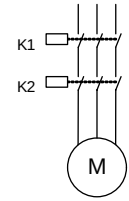
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2841

Category 4 (acc. EN 954-1)
Magnet sensor Monitoring
Stop-Category 0

$2NO_{el.}$
V_s 24 V DC
auto start





Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

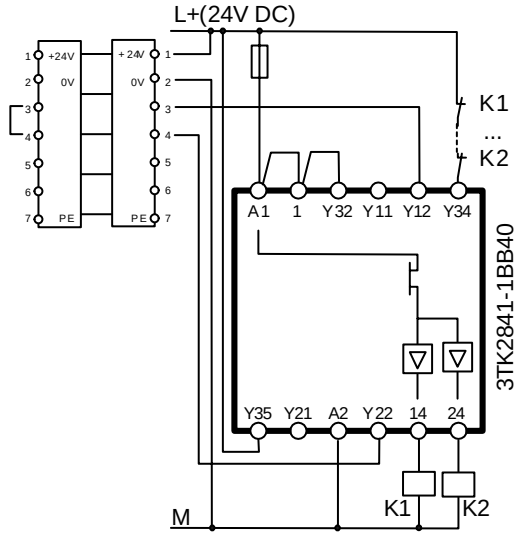
3TK2841

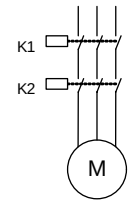
Category 4 (acc. EN 954-1)
Light grid Monitoring
Stop-Category 0

$2NO_{el.}$
V_S 24 V DC
auto start

Light grid

Type 4 (EN 61496-1)





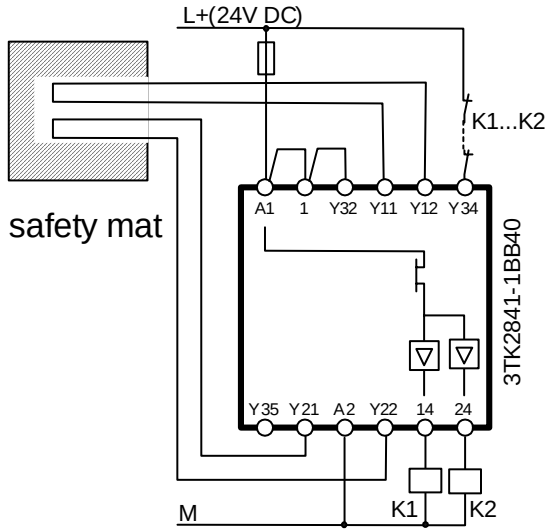
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

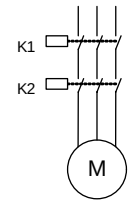
3TK2841

Category 3 (acc. EN 954-1)
safety mat Monitoring
Stop-Category 0

2NO$_{el.}$
V_s 24 V DC
auto start

2





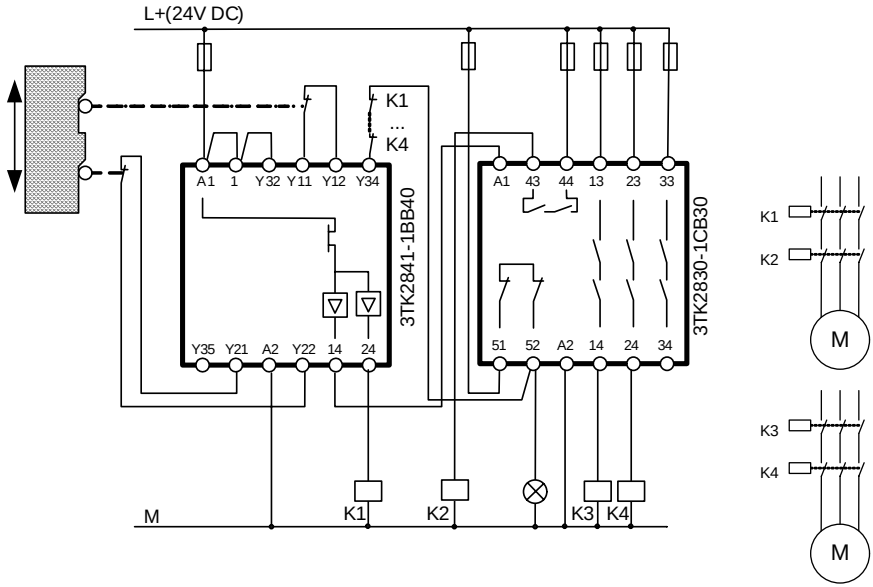
Category 3 according to EN 954-1 of this circuit is as a result of the safety mat.

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2841 +
3TK2830

Category 4 (acc. EN 954-1)
protective door
Monitoring
Stop-Category 0

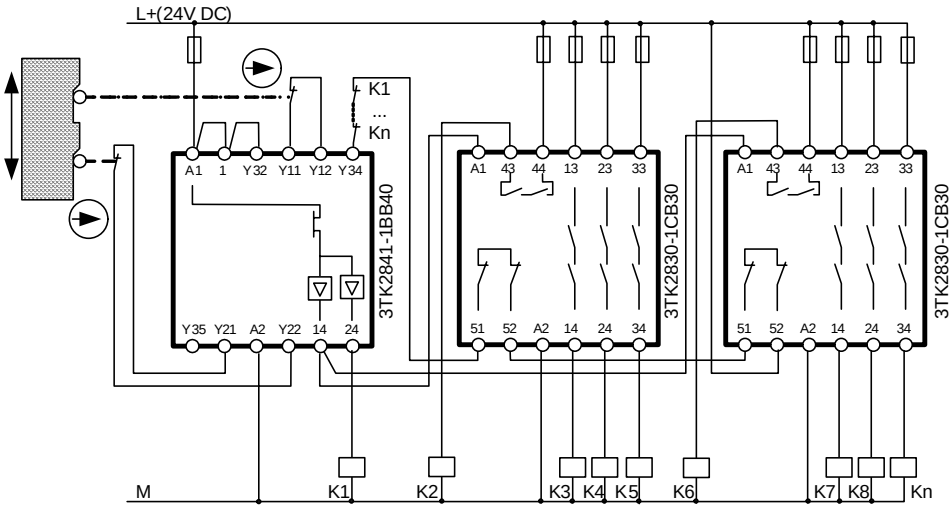
2NO$_{el}$ 5NC 1 signal lamp
V_s 24 V DC
auto start



For Category 4, it is not permissible to connect several position switches in series to implement a protective door monitoring function (due to an inadequate level of fault detection).

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2841 + 3TK2830 + 3TK2830	**Category 4 (acc. EN 954-1) protective door Monitoring Stop-Category 0**	**2NO$_{el}$ 6NO V$_s$ 24 V DC auto start**



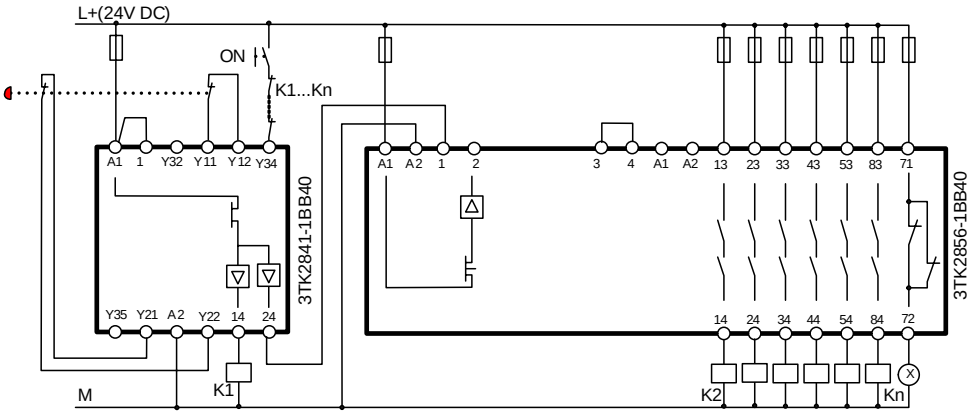
For Category 4, it is not permissible to connect several position switches in series to implement a protective door monitoring function (due to an inadequate level of fault detection).

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

**3TK2841 +
3TK2856**

**Category 4 (acc. EN 954-1)
E-Stop Monitoring
Stop-Category 0**

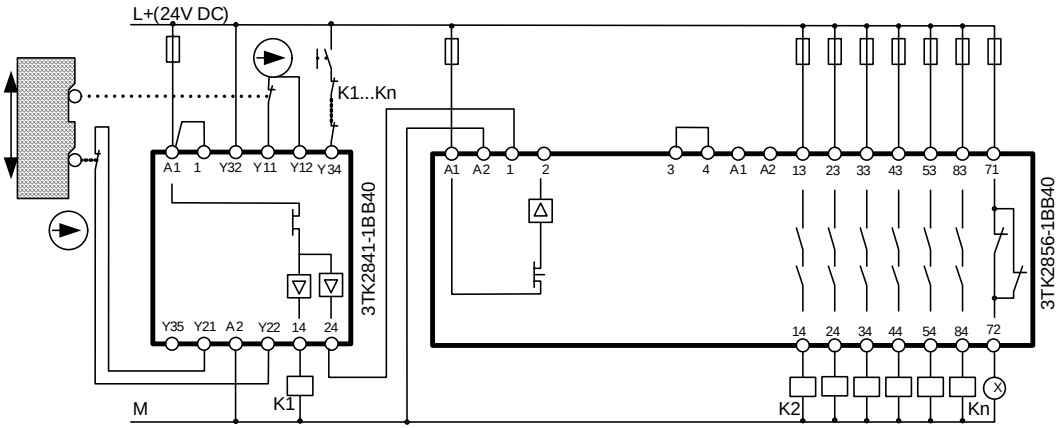
**2NO$_{el}$ 6NO 1NC
V_S 24 V DC
monitored Start**



For Category 4, several EMERGENCY STOP commanding devices may be connected in series.

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

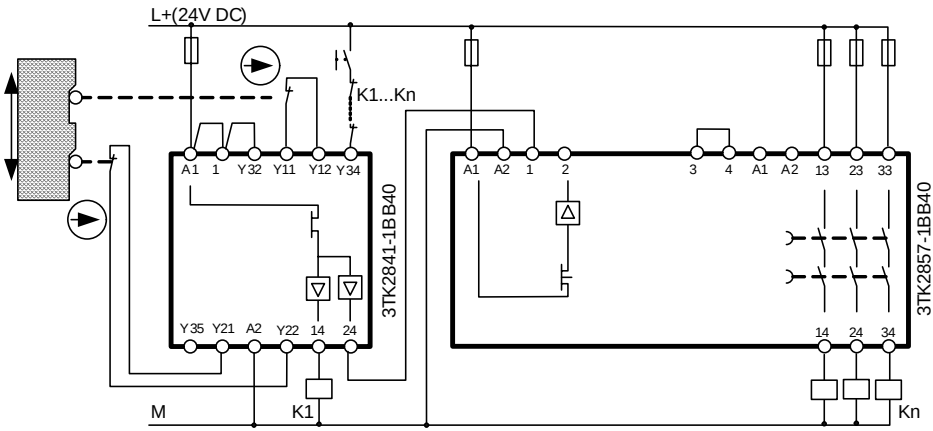
3TK2841 + 3TK2856	**Category 4** (acc. EN 954-1) **protective door** **Monitoring** **Stop-Category 0**	**2NO$_{el}$ 6NO 1NC** **V_S 24 V DC** **auto start**



For Category 4, it is not permissible to connect several position switches in series to implement a protective door monitoring function (due to an inadequate level of fault detection).

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

Safety relay	Function	Comments
3TK2841 + 3TK2857	**Category 4 (acc. EN 954-1)** **protective door** **Monitoring** **Stop-Category 0 and 1**	**2NO$_{el}$ 3NO$_{tv}$** **V$_s$ 24 V DC** **auto start**



For Category 4, it is not permissible to connect several position switches in series to implement a protective door monitoring function (due to an inadequate level of fault detection).

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

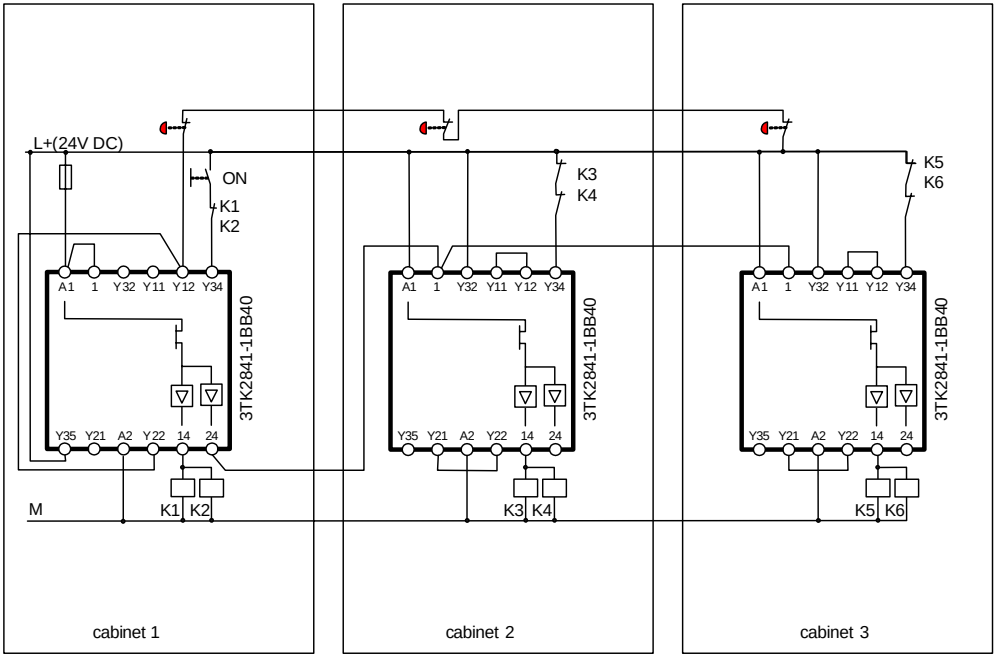
3TK2841 +
3TK2841 +
3TK2841

Category 2 (acc. EN 954-1)
E-Stop Monitoring
Stop-Category 0

6NO$_{el}$
V_s 24 V DC
monitored start

2

3 Switchboards
3 E-Stop
When an E-Stop button is pressed, all of the 3TK28 devices in the switchboard shut down.



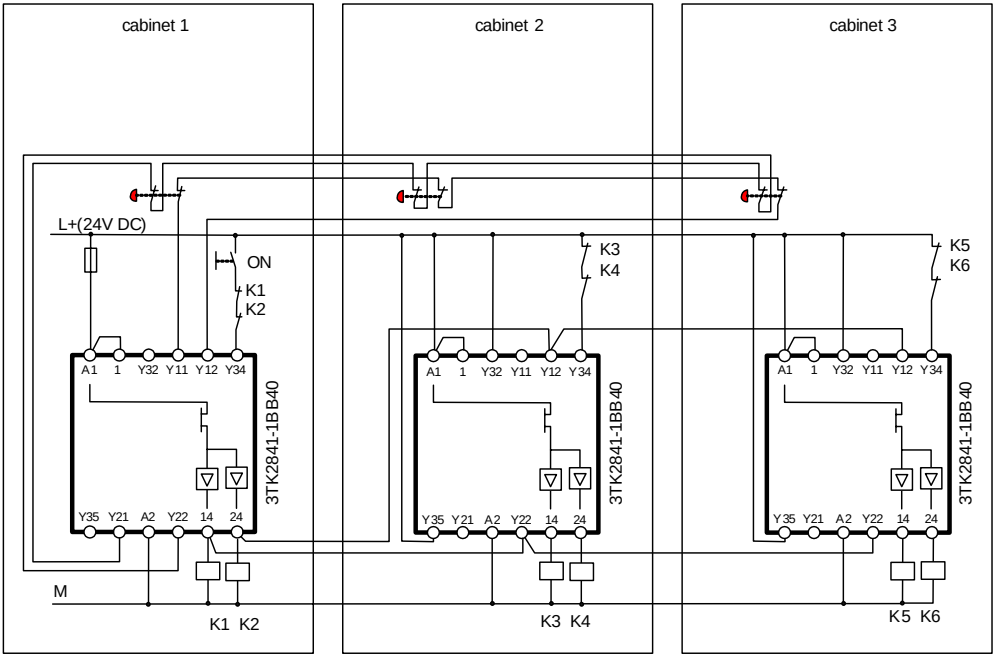
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.
Using this circuit example, Category 2 according to EN 954-1 can only be fulfilled, if, when the actuator fails, either an alarm is automatically generated or the machine control initiates a safe condition. Otherwise a second shutdown path is required.

3TK2841 +
3TK2841 +
3TK2841

Category 4 (acc. EN 954-1)
E-Stop Monitoring
Stop-Category 0

6NO$_{el}$
V_s 24 V DC
monitored start

3 Switchboards
3 E-Stop
When an E-Stop button is pressed, all of the 3TK28 devices in the switchboard shut down.



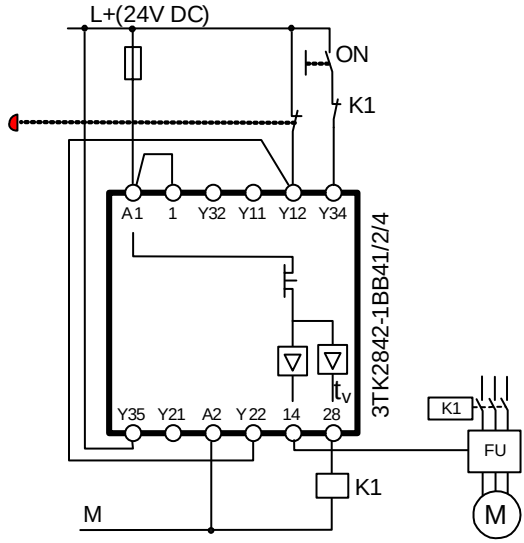
For Category 4, several EMERGENCY STOP commanding devices may be connected in series.

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2842

Category 2 (acc. EN 954-1)
E-Stop Monitoring
Stop-Category 0 and 1

$1NO_{el}$ $1NO_{el\ tv}$
V_s 24 V DC
monitored start



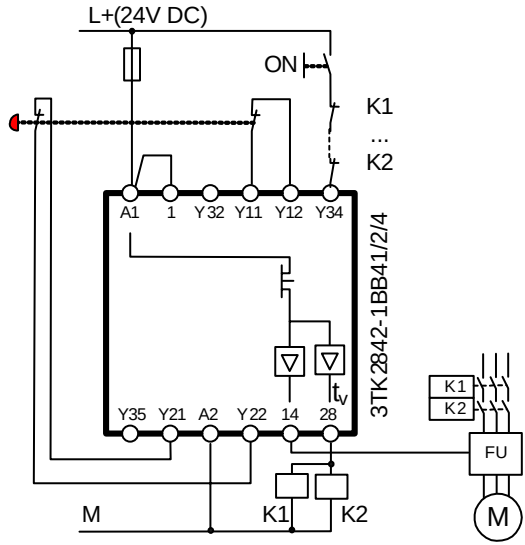
The controller enable of the frequency inverter is controlled directly – and the power contactor, with a time delay.

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.
Using this circuit example, Category 2 according to EN 954-1 can only be fulfilled, if, when the actuator fails, either an alarm is automatically generated or the machine control initiates a safe condition. Otherwise a second shutdown path is required.

3TK2842

Category 4 (acc. EN 954-1)
E-Stop Monitoring
Stop-Category 0 and 1

$1NO_{el}$ $1NO_{el\ tv}$
V_s 24 V DC
monitored start



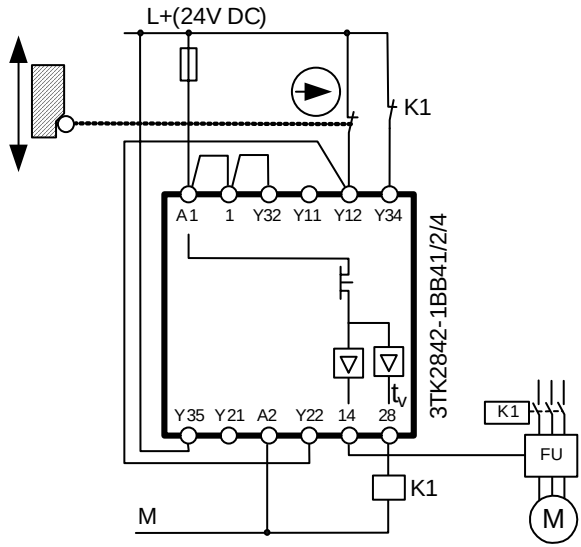
The controller enable of the frequency inverter is controlled directly – and the power contactor, with a time delay.
For Category 4, several EMERGENCY STOP commanding devices may be connected in series.

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2842

Category 2 (acc. EN 954-1)
protective door
Monitoring
Stop-Category 0 and 1

1NO$_{el}$ 1NO$_{el\ tv}$
V$_s$ 24 V DC
auto start



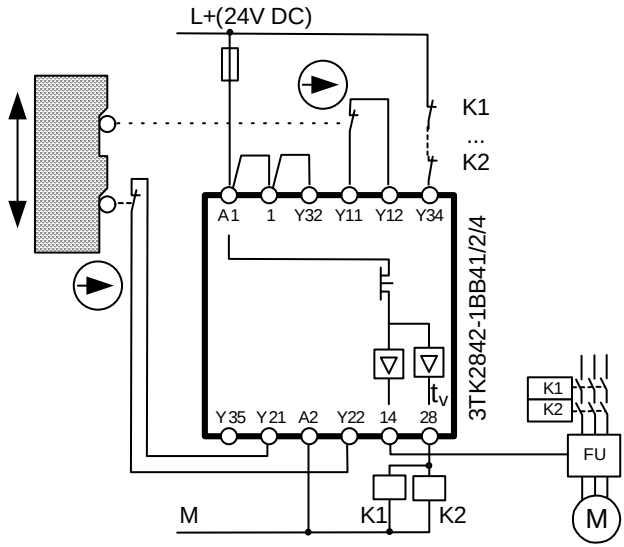
The controller enable of the frequency inverter is controlled directly – and the power contactor, with a time delay.

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.
Using this circuit example, Category 2 according to EN 954-1 can only be fulfilled, if, when the actuator fails, either an alarm is automatically generated or the machine control initiates a safe condition. Otherwise a second shutdown path is required.

3TK2842

Category 4 (acc. EN 954-1)
protective door
Monitoring
Stop-Category 0 and 1

1NO$_{el}$ 1NO$_{el\ tv}$
V$_s$ 24 V DC
auto start



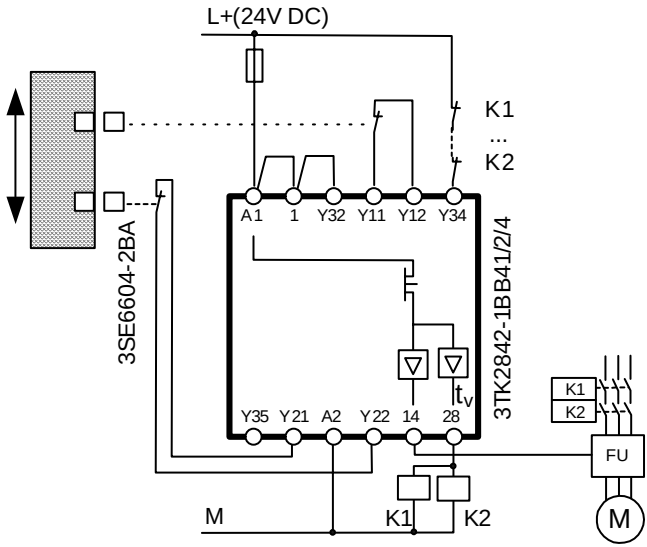
The controller enable of the frequency inverter is controlled directly – and the power contactor, with a time delay.
For Category 4, it is not permissible to connect several position switches in series to implement a protective door monitoring function (due to an inadequate level of fault detection).

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2842

Category 4 (acc. EN 954-1)
Magnet sensor Monitoring
Stop-Category 0 and 1

$1NO_{el}$ $1NO_{el\ tv}$
V_s 24 V DC
auto start



The controller enable of the frequency inverter is controlled directly – and the power contactor, with a time delay.

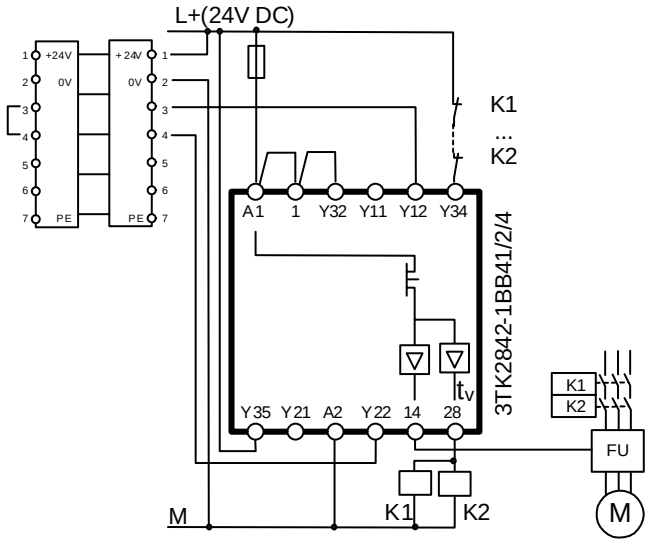
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2842

Category 4 (acc. EN 954-1)
Light grid Monitoring
Stop-Category 0 and 1

1NO$_{el}$ 1NO$_{el\ tv}$
V$_s$ 24 V DC
auto start

Light grid
Type 4 (EN 61496-1)



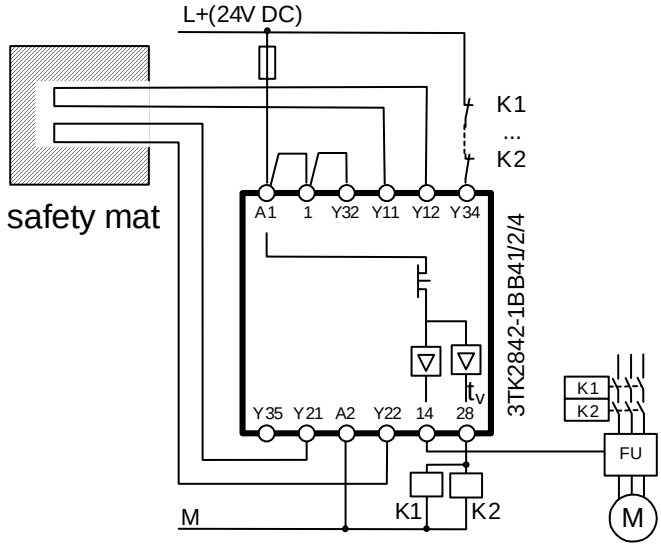
The controller enable of the frequency inverter is controlled directly – and the power contactor, with a time delay.

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2842

Category 3 (acc. EN 954-1)
Safety mat Monitoring
Stop-Category 0 and 1

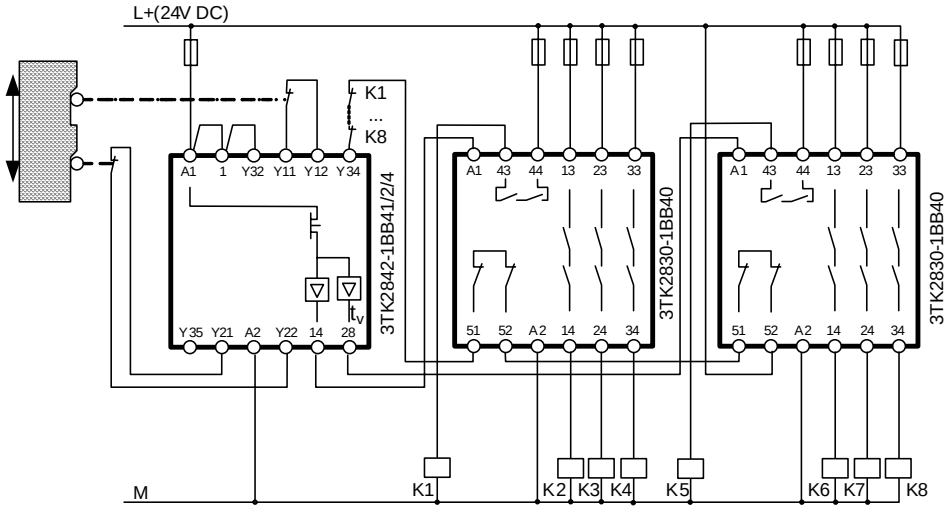
$1NO_{el}$ $1NO_{el\ tv}$
V_S 24 V DC
auto start



Category 3 according to EN 954-1 of this circuit is as a result of the safety mat.
The controller enable of the frequency inverter is controlled directly – and the power contactor, with a time delay.

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

Safety relay	Function	Comments
3TK2842 + 3TK2830 + 3TK2830	**Category 4 (acc. EN 954-1) protective door Monitoring Stop-Category 0 and 1**	**4NO 4NO$_{tv}$ V_s 24 V DC auto start**



For Category 4, it is not permissible to connect several position switches in series to implement a protective door monitoring function (due to an inadequate level of fault detection).

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

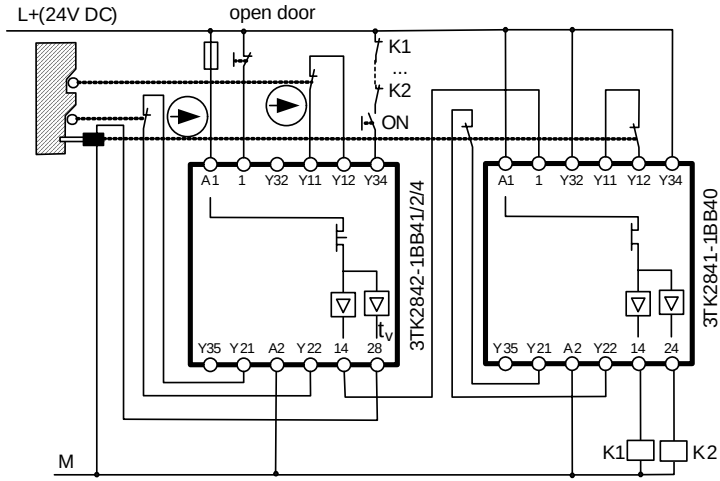
3TK2842 + 3TK2841

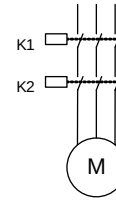
Category 4 (acc. EN 954-1)
protective door
Monitoring
Stop-Category 0 and 1

With interlocking, type-controlled

2NO$_{el}$ 1NO$_{el}$ tv
V$_s$ 24 V DC
monitored start

2





The tumbler mechanism of the position switch - interlocked with solenoid - is controlled with a time delay. For Category 4, it is not permissible to connect several position switches in series to implement a protective door monitoring function (due to an inadequate level of fault detection).

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2845

Safety relays with relays and electronic outputs

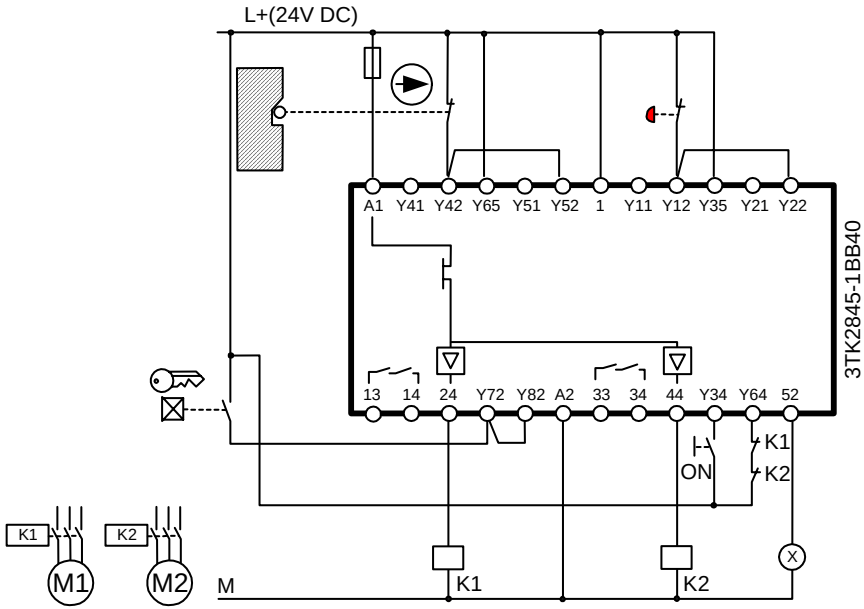
3TK2845

Category 2 (acc. EN 954-1)
E-Stop and protective door Monitoring
Stop-Category 0

2NO 2NO$_{el}$ 1M$_{el}$
V$_s$ 24 V DC
manual start

Key-operated switch, that jumpers the protective door for the service mode

3



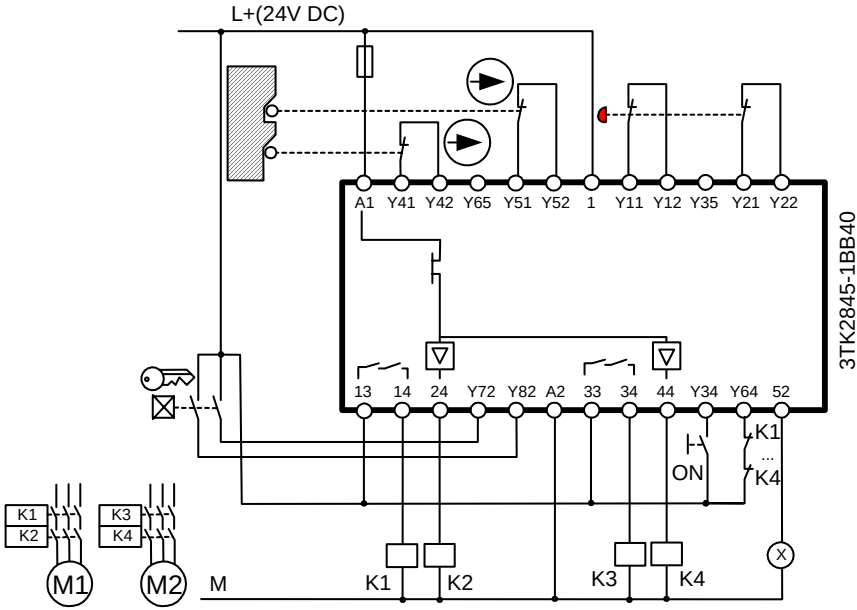
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.
Using this circuit example, Category 2 according to EN 954-1 can only be fulfilled, if, when the actuator fails, either an alarm is automatically generated or the machine control initiates a safe condition. Otherwise a second shutdown path is required.

3TK2845

Category 4 (acc. EN 954-1)
E-STOP and Protective door Monitoring
Stop-Category 0

2NO 2NO$_{el}$ 1S$_{el}$
V$_s$ 24 V DC
monitored start

Key-operated switch, that jumpers the protective door for the service mode



For Category 4, several EMERGENCY STOP commanding devices may be connected in series. For Category 4, it is not permissible to connect several position switches in series to implement a protective door monitoring function (due to an inadequate level of fault detection).

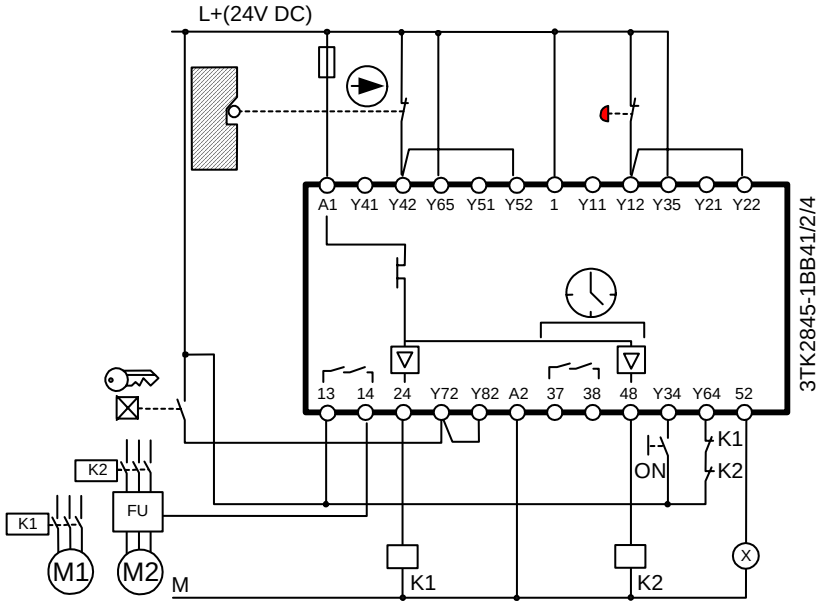
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2845

Category 2 (acc. EN 954-1)
E-Stop and protective door Monitoring
Stop-Category 0 and 1

1NO 1NO$_{el}$ / 1NO$_{tv}$ 1NO$_{el\ tv}$ /1S$_{el}$
V$_s$ 24 V DC
manual start

Key-operated switch, that jumpers the protective door for the service mode



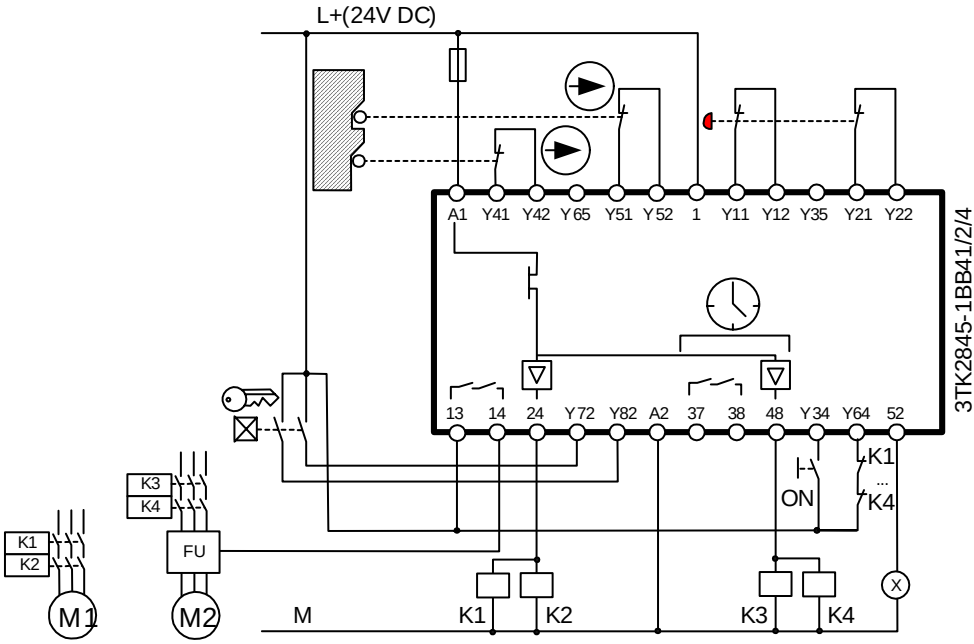
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2845

Category 4 (acc. EN 954-1)
E-Stop and protective door Monitoring
Stop-Category 0 and 1

1NO 1NO$_{el}$ / 1NO$_{tv}$ 1NO$_{el\ tv}$ /1S$_{el}$
V$_s$ 24 V DC
monitored start

Key-operated switch, that jumpers the protective door for the service mode



For Category 4, several EMERGENCY STOP commanding devices may be connected in series. For Category 4, it is not permissible to connect several position switches in series to implement a protective door monitoring function (due to an inadequate level of fault detection).

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

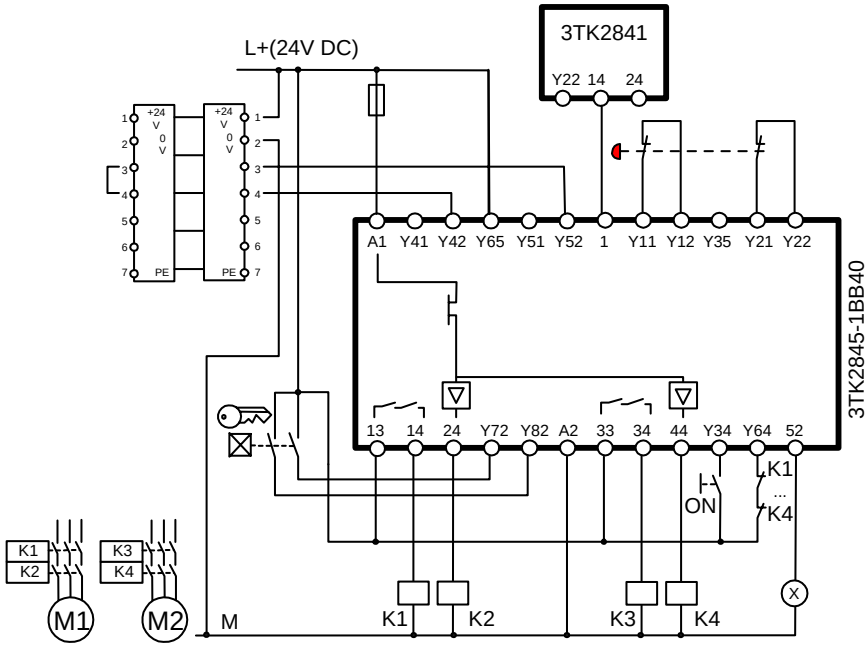
3TK2845 + 3TK2841

Category 4 (acc. EN 954-1)
E-Stop and Light grid Monitoring
Stop-Category 0

Key-operated switch, that bypasses the light grid type 4 (EN 61496-1) for service operation

2NO 2NO$_{el}$ 1S$_{el}$
V$_s$ 24 V DC
monitored start

3



For Category 4, several EMERGENCY STOP commanding devices may be connected in series.

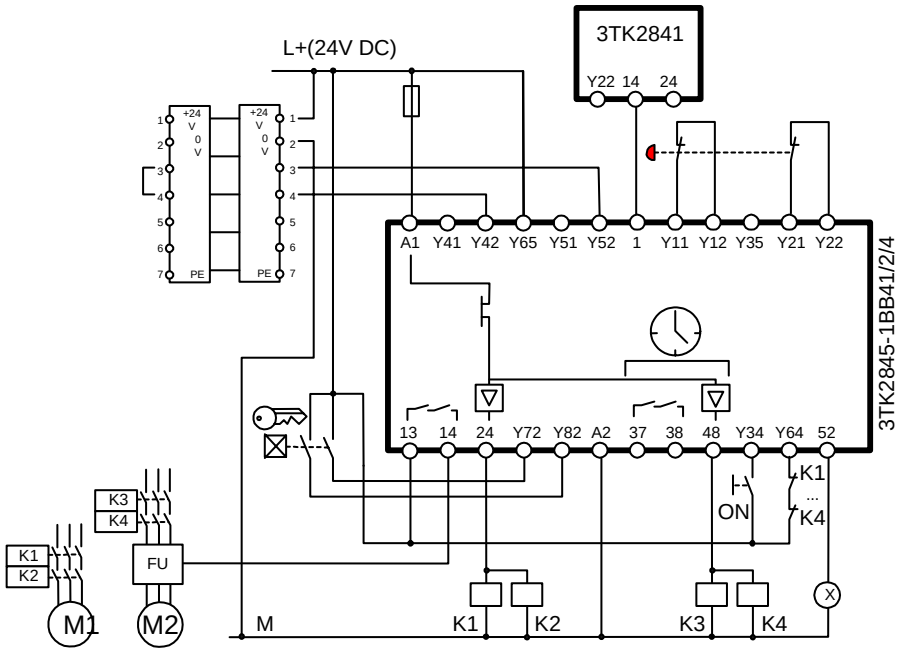
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2845 + 3TK2841

Category 4 (acc. EN 954-1)
E-Stop and Light grid Monitoring
Stop-Category 0 and 1

Key-operated switch, that bypasses the light grid type 4 (EN 61496-1) for service operation

1NO 1NO$_{el}$ / 1NO$_{tv}$ 1NO$_{el\ tv}$ /1S$_{el}$
V$_s$ 24 V DC
monitored start



For Category 4, several EMERGENCY STOP commanding devices may be connected in series.

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

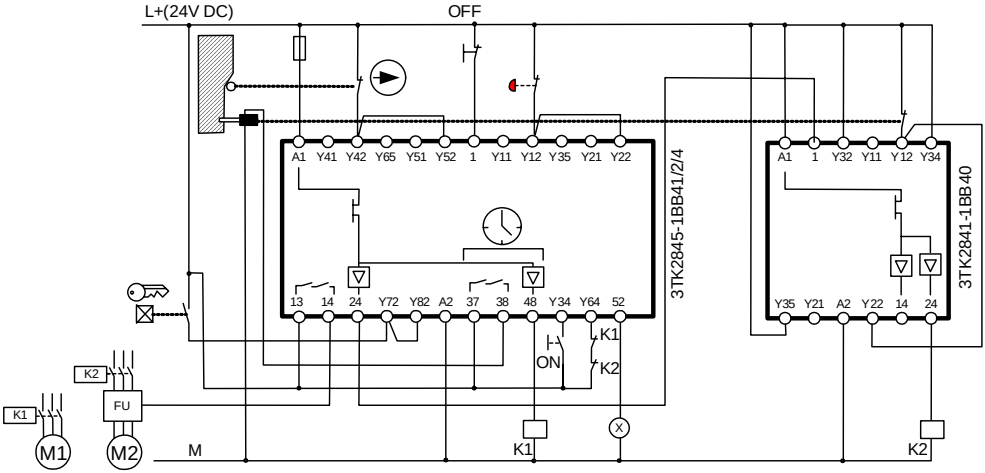
3TK2845 + 3TK2841

Category 2 (acc. EN 954-1)
E-Stop and protective door Monitoring
Stop-Category 0 and 1

1NO 2NO$_{el}$ / 1NO$_{tv}$ 1NO$_{el\ tv}$ /1S$_{el}$
V$_s$ 24 V DC
manual start

Key-operated switch, that jumpers the protective door for the service mode

3



The tumbler mechanism of the position switch - interlocked with solenoid - is controlled with a time delay.

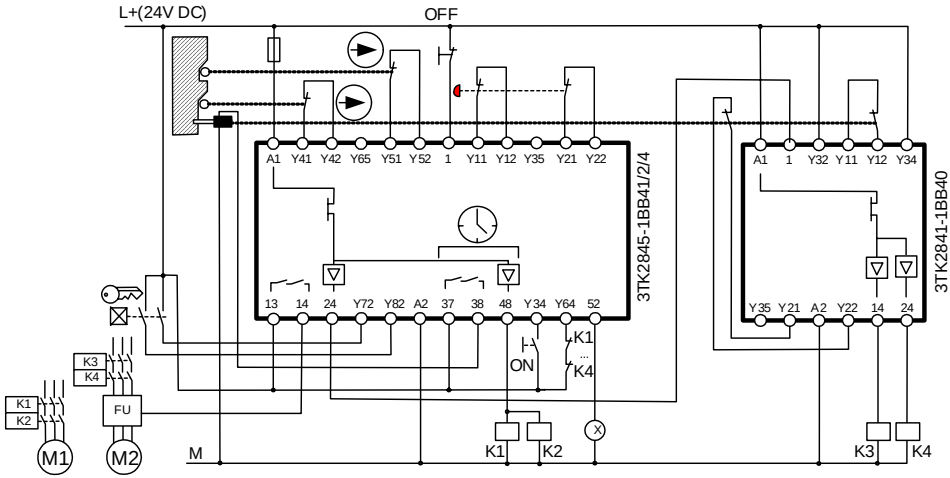
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2845 + 3TK2841

Category 4 (acc. EN 954-1)
E-Stop and protective door Monitoring
Stop-Category 0 and 1

1NO 2NO$_{el}$ / 1NO$_{tv}$ 1NO$_{el\ tv}$ /1S$_{el}$
V$_s$ 24 V DC
monitored start

Key-operated switch, that jumpers the protective door for the service mode



The tumbler mechanism of the position switch - interlocked with solenoid - is controlled with a time delay. Two load contactors in a cabinet for Category 4 acc. to EN 954-1 may be connected to an enable circuit (a short-circuit fault can be excluded).
For Category 4, several EMERGENCY STOP commanding devices may be connected in series.
For Category 4, it is not permissible to connect several position switches in series to implement a protective door monitoring function (due to an inadequate level of fault detection).

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK285.

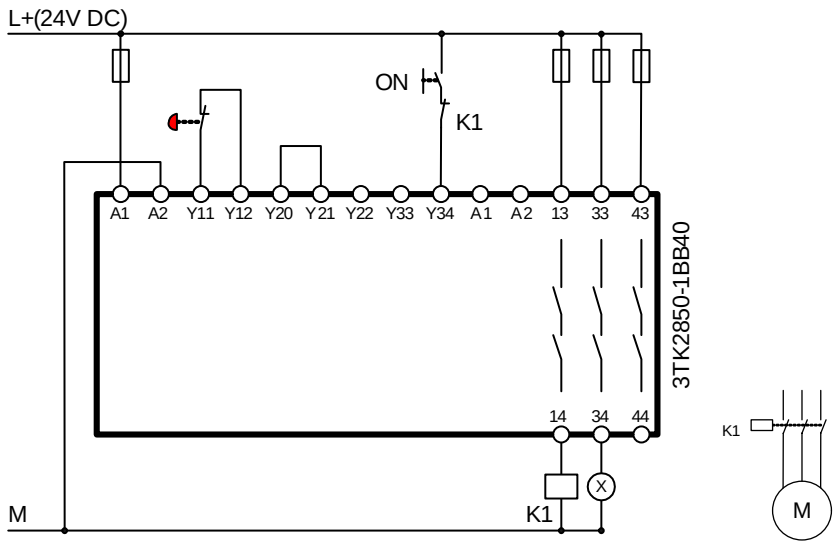
Safety relays with auxiliary relays

3TK2850

Category 2 (acc. EN 954-1)
E-Stop Monitoring
Stop-Category 0

3NO
V_s 24 V DC
monitored start

Signaling using SIRIUS accessories



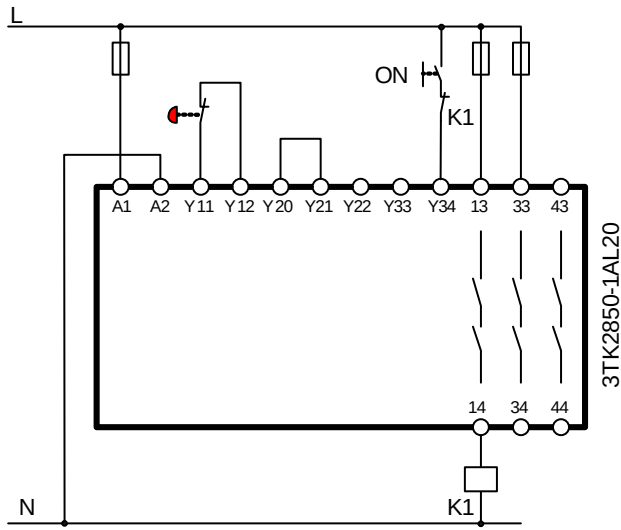
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

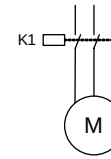
3TK2850-1LA20

Category 2 (acc. EN 954-1)
E-Stop Monitoring
Stop-Category 0

3NO
V_s 230 V AC
monitored start

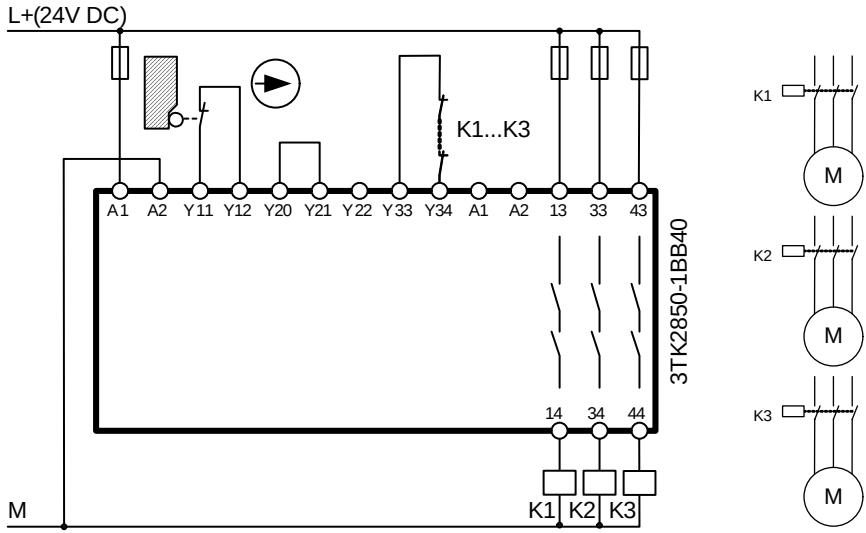
Signaling
using SIRIUS accessories





Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2850	**Category 2 (acc. EN 954-1)** **protective door** **Monitoring** **Stop-Category 0**	**3NO** **V_s 24 V DC** **auto start** **Signaling** **using SIRIUS accessories**



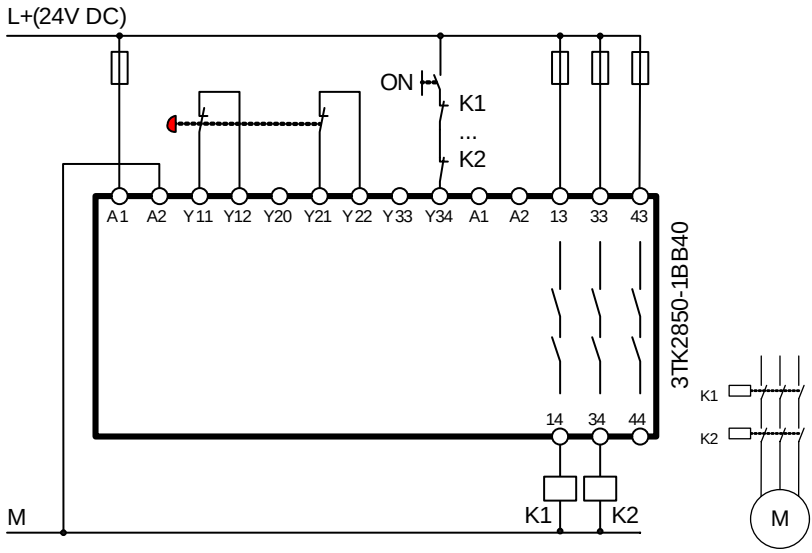
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2850

Category 3 (acc. EN 954-1)
E-Stop Monitoring
Stop-Category 0

3NO
V_s 24 V DC
monitored start

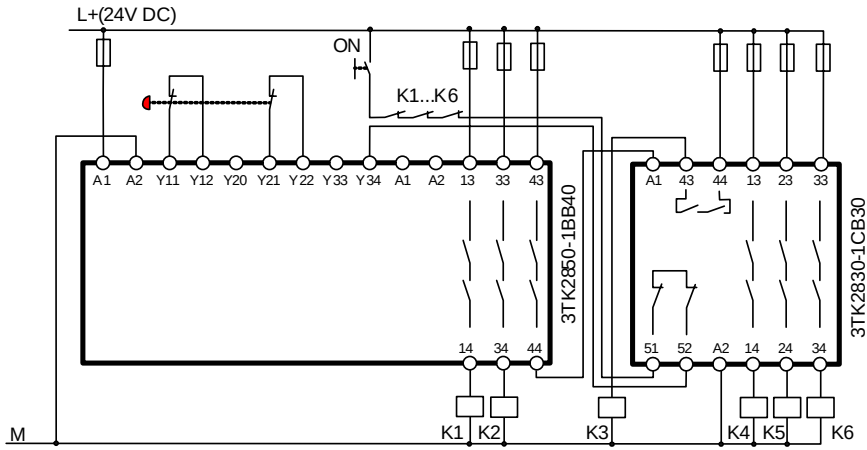
Signaling
using SIRIUS accessories



Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2850 + 3TK2830	**Category 3** (acc. EN 954-1) **E-Stop Monitoring** **Stop-Category 0**	**6NO** **V_s 24 V DC** **monitored start**

Signaling using SIRIUS accessories



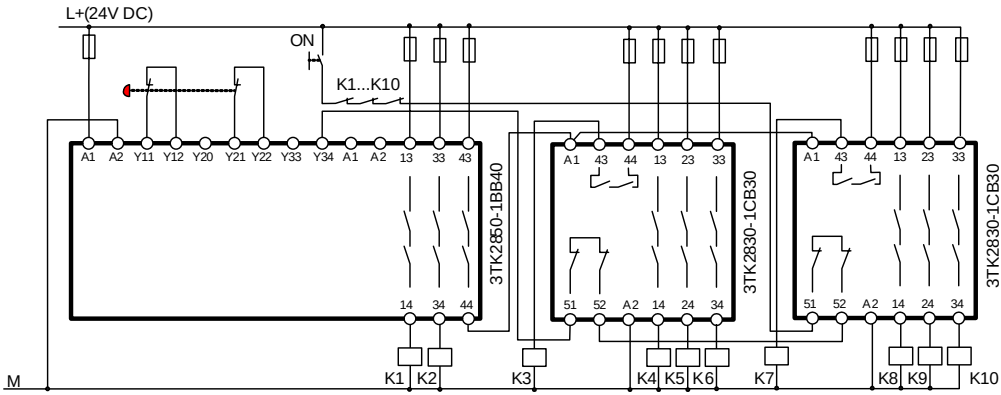
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2850 +
3TK2830 +
3TK2830

Category 3 (acc. EN 954-1)
E-Stop Monitoring
Stop-Category 0

10S
V_S 24 V DC
monitored start

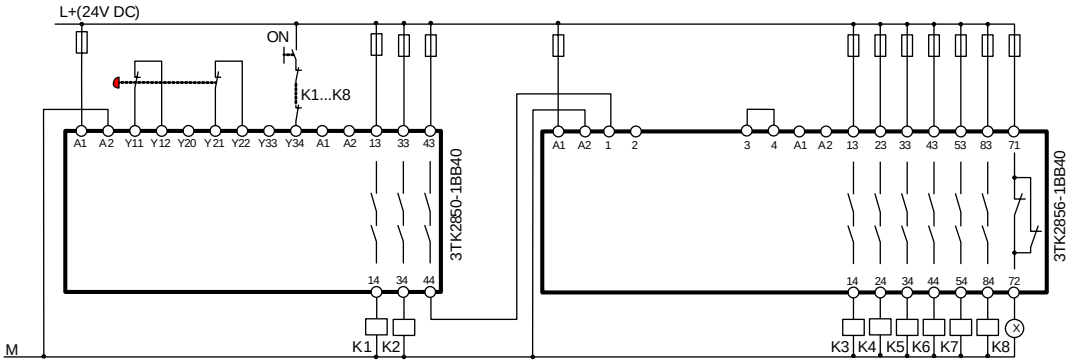
Signaling
using SIRIUS accessories



Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2850 + 3TK2856	**Category 3 (acc. EN 954-1)** **E-Stop Monitoring** **Stop-Category 0**	**8S 1NC** **V_s 24 V DC** **monitored start**

Signaling using SIRIUS accessories



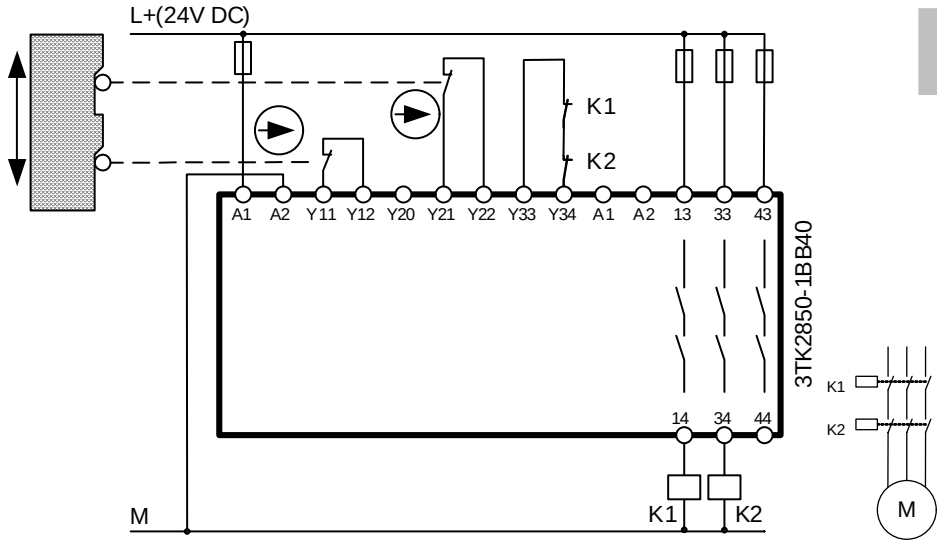
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2850

Category 3 (acc. EN 954-1)
protective door
Monitoring
Stop-Category 0

3NO
V_s 24 V DC
auto start

Signaling
using SIRIUS accessories



Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

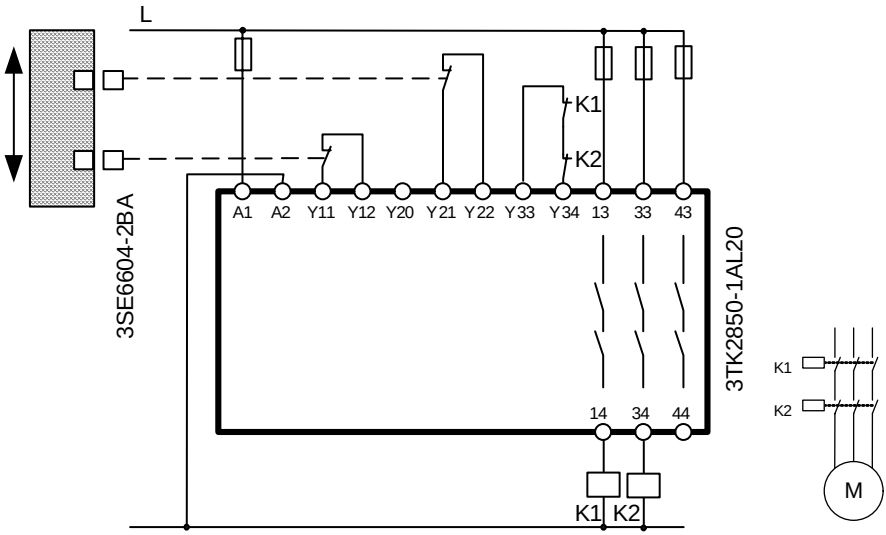
3TK2850-1LA20

Category 3 (acc. EN 954-1)
Magnet sensor Monitoring
Stop-Category 0

3NO
V_s 230 V AC
auto start

Signaling
using SIRIUS accessories

4



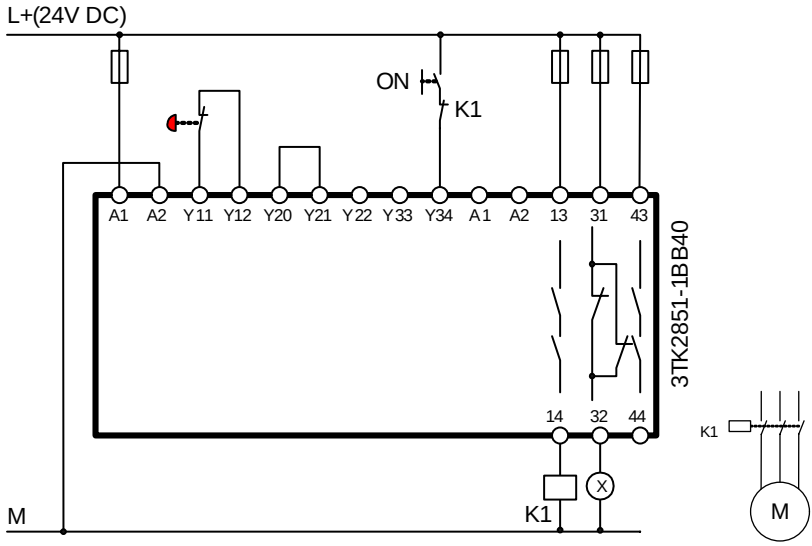
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2851

Category 2 (acc. EN 954-1)
E-Stop Monitoring
Stop-Category 0

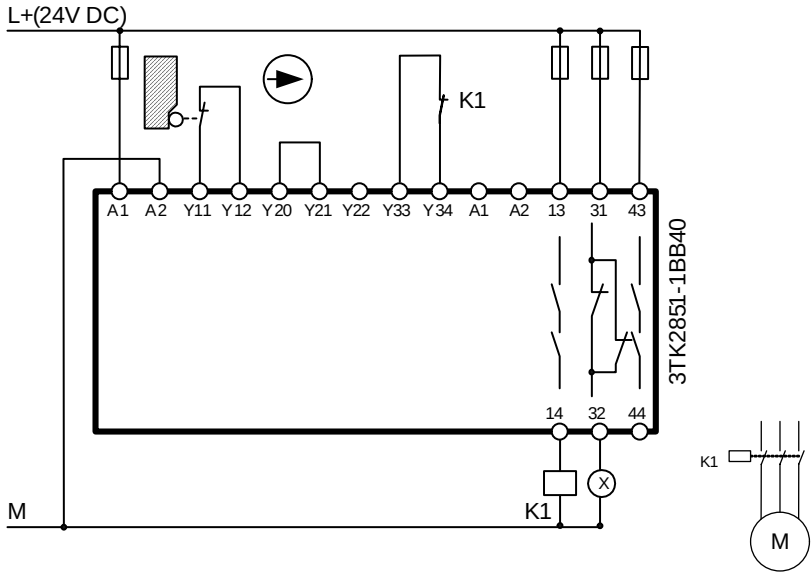
2NO 1NC
V_s 24 V DC
monitored start

Signaling
using SIRIUS accessories



Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2851	**Category 2 (acc. EN 954-1)** **protective door** **Monitoring** **Stop-Category 0**	**2NO 1NC** **V_S 24 V DC** **auto start**
		Signaling **using SIRIUS accessories**



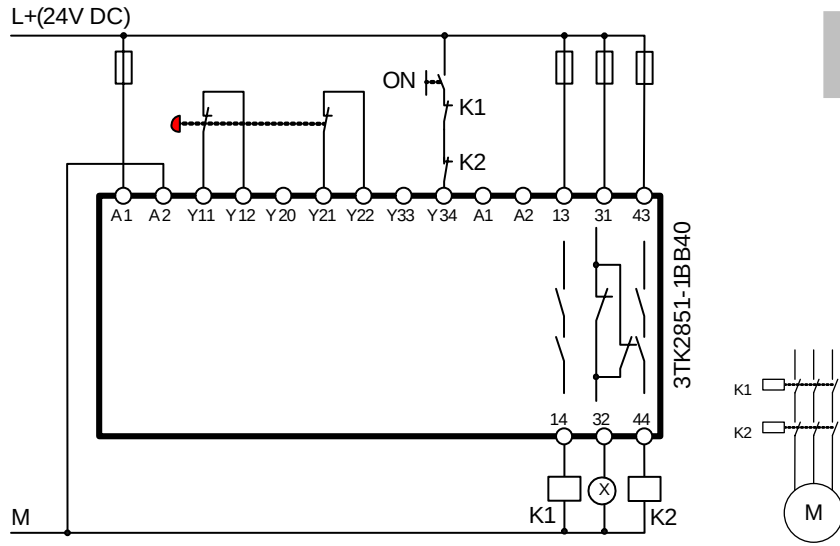
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2851

Category 3 (acc. EN 954-1)
E-Stop Monitoring
Stop-Category 0

2NO 1NC
V_S 24 V DC
monitored start

Signaling
using SIRIUS accessories



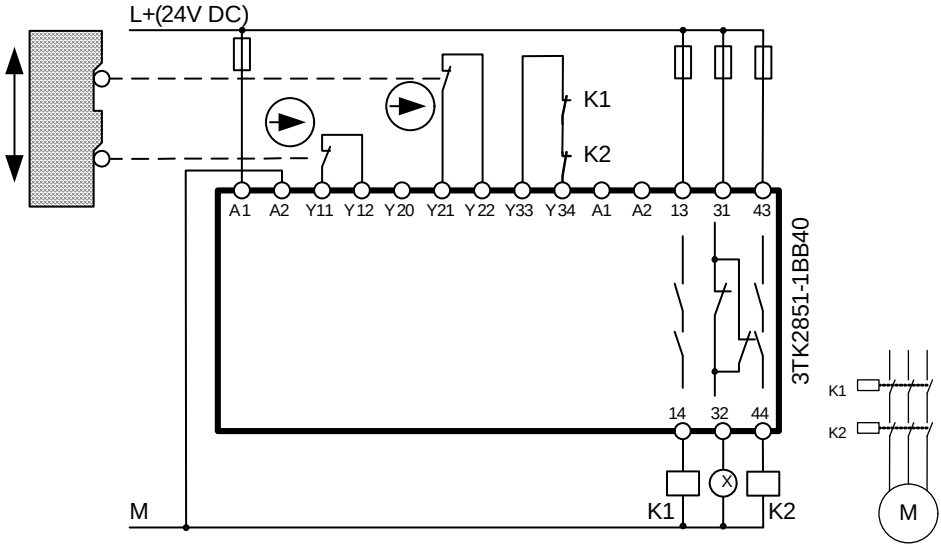
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2851

Category 3 (acc. EN 954-1)
protective door
Monitoring
Stop-Category 0

2NO 1NC
V_S 24 V DC
auto start

Signaling
using SIRIUS accessories



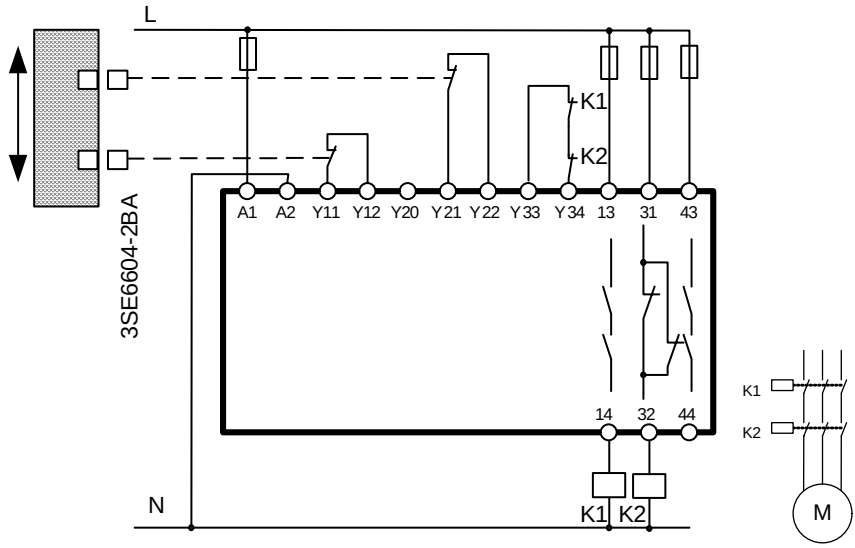
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2851-1LA20

Category 3 (acc. EN 954-1)
Magnet sensor Monitoring
Stop-Category 0

2NO 1NC
V_s 230 V AC
auto start

Signaling using SIRIUS accessories



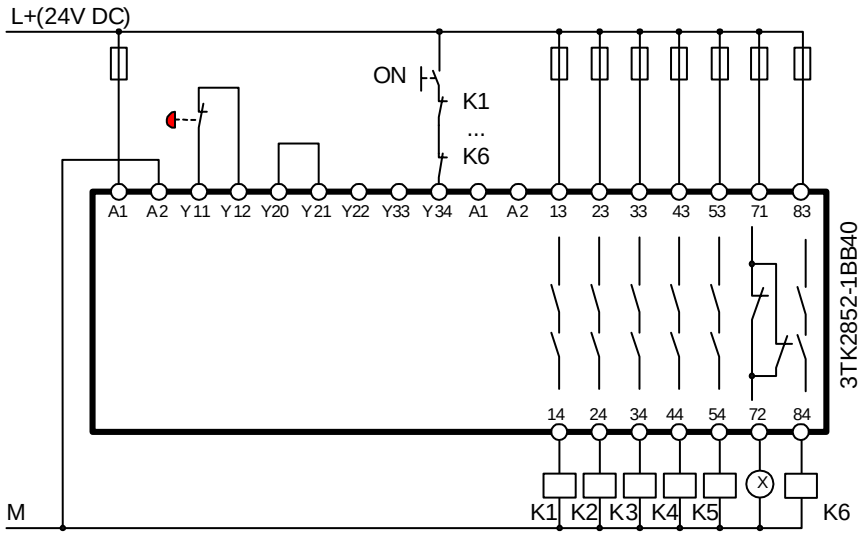
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2852

Category 2 (acc. EN 954-1)
E-Stop Monitoring
Stop-Category 0

6NO 1NC
V_S 24 V DC
monitored start

Signaling
using SIRIUS accessories



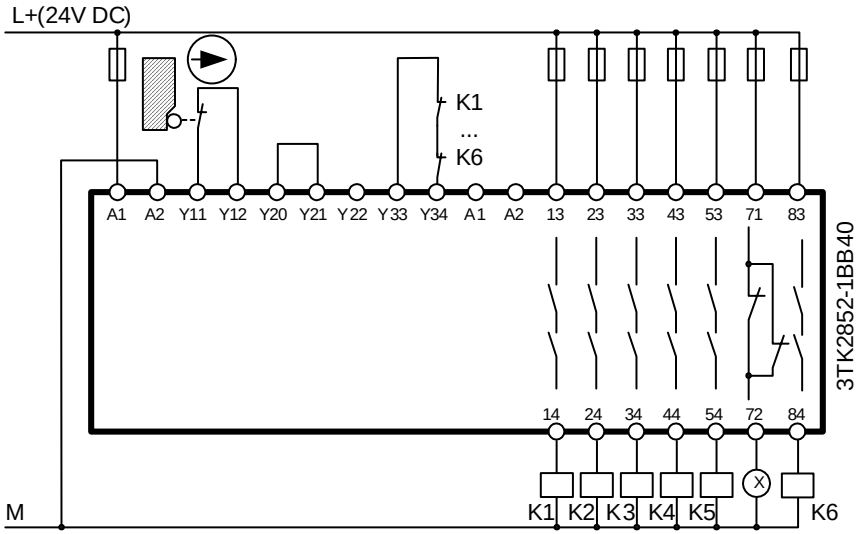
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2852

Category 2 (acc. EN 954-1)
protective door
Monitoring
Stop-Category 0

6NO 1NC
V_S 24 V DC
auto start

Signaling
using SIRIUS accessories



Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

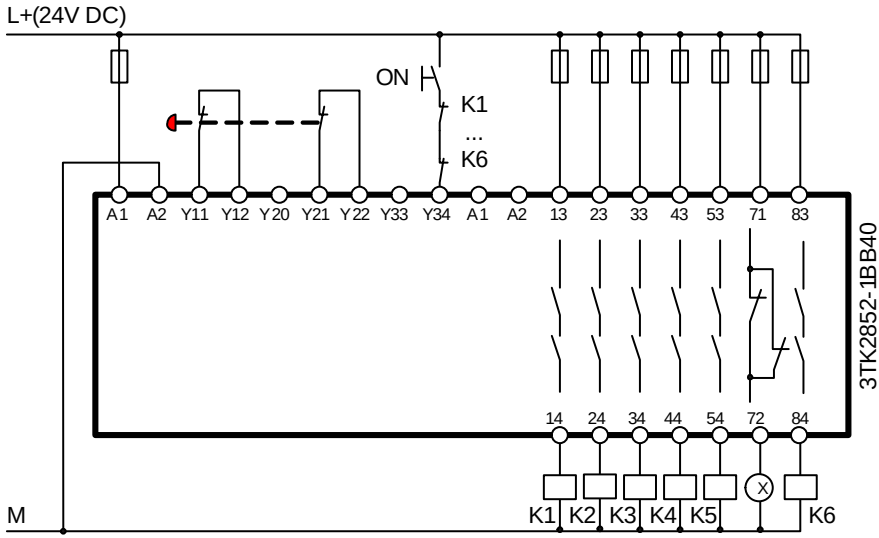
3TK2852

Category 3 (acc. EN 954-1)
E-Stop Monitoring
Stop-Category 0

6NO 1NC
V_S 24 V DC
monitored start

Signaling using SIRIUS accessories

4



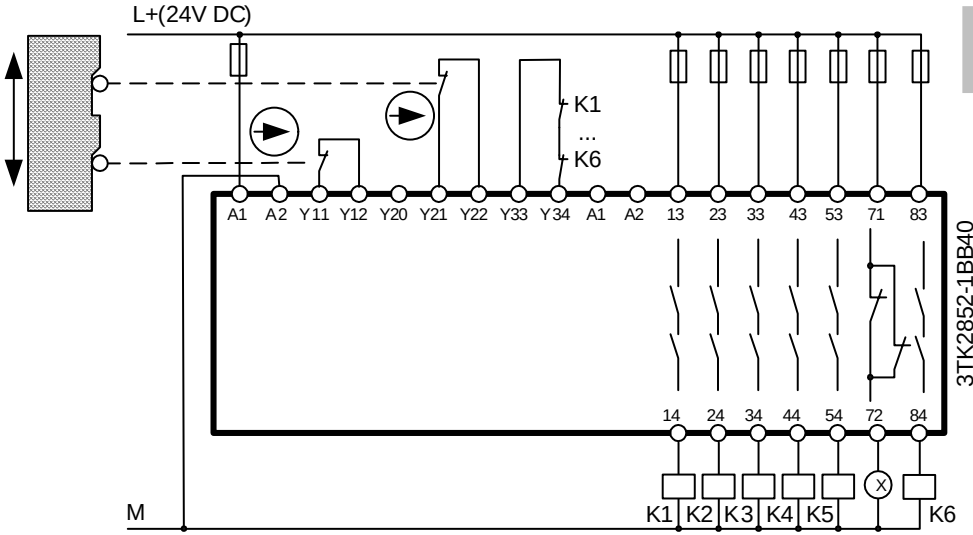
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2852

Category 3 (acc. EN 954-1)
protective door
Monitoring
Stop-Category 0

6NO 1NC
V_S 24 V DC
auto start

Signaling
using SIRIUS accessories



Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

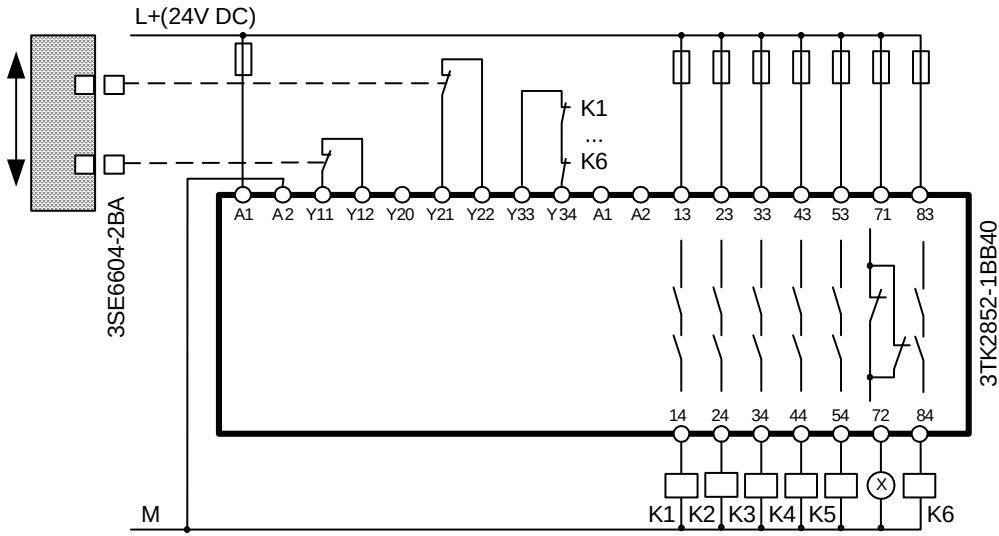
3TK2852

Category 3 (acc. EN 954-1)
Magnet sensor Monitoring
Stop-Category 0

6NO 1NC
V_s 24 V DC
auto start

Signaling
using SIRIUS accessories

4



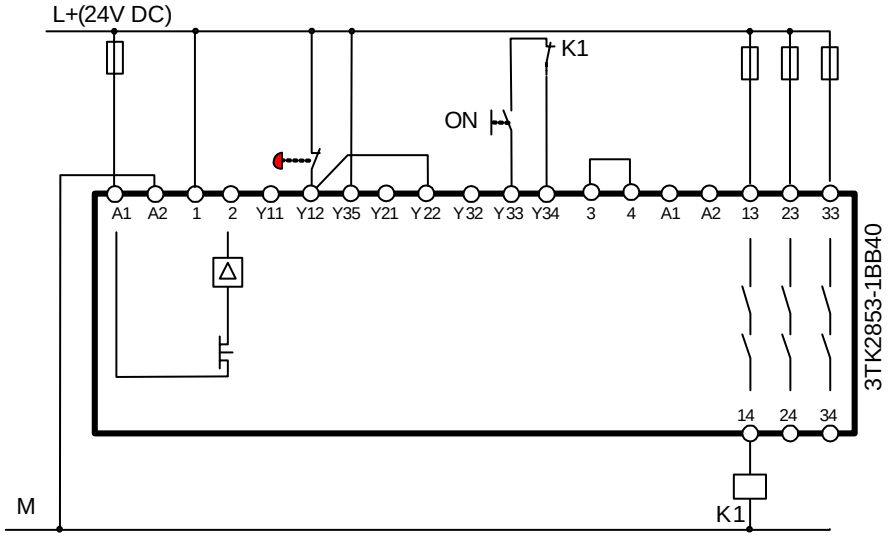
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2853

Category 2 (acc. EN 954-1)
E-Stop Monitoring
Stop-Category 0

3NO 1NO$_{el}$
V_s 24 V DC
monitored start

Signaling
using SIRIUS accessories

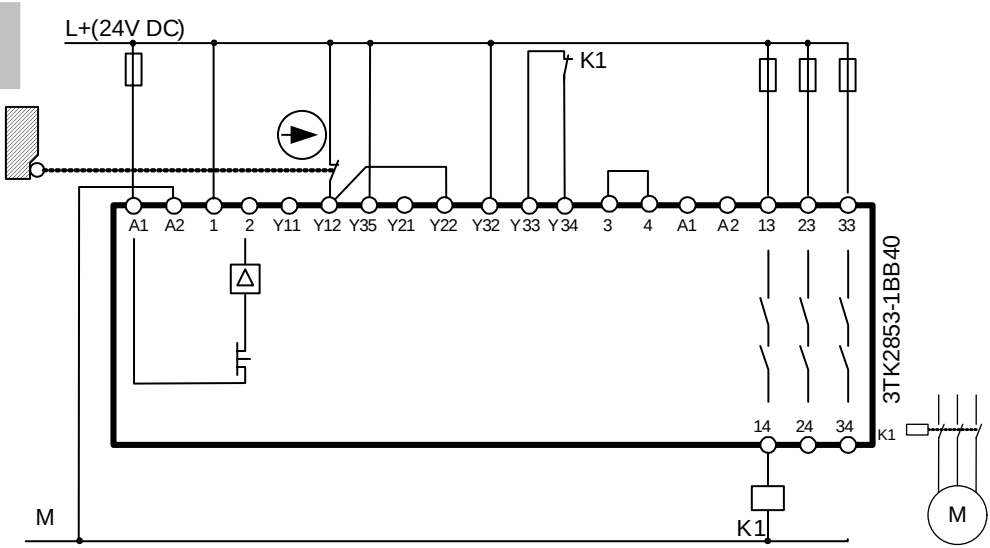


Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2853	**Category 2 (acc. EN 954-1)** **protective door** **Monitoring** **Stop-Category 0**	**3NO 1NO$_{el}$** **V_s 24 V DC** **auto start**

Signaling
using SIRIUS accessories

4



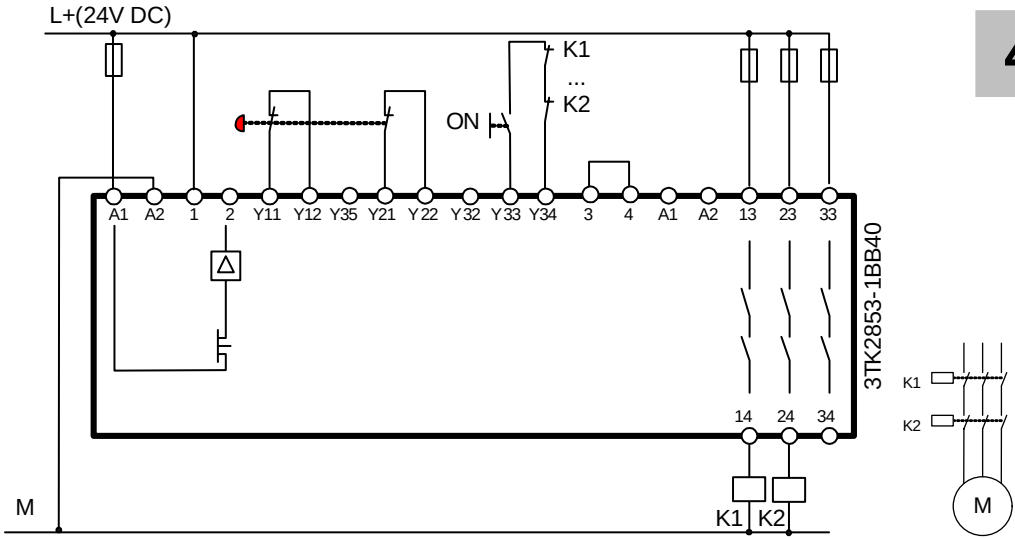
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2853

Category 4 (acc. EN 954-1)
E-Stop Monitoring
Stop-Category 0

3NO 1NO$_{el}$
V_s 24 V DC
monitored start

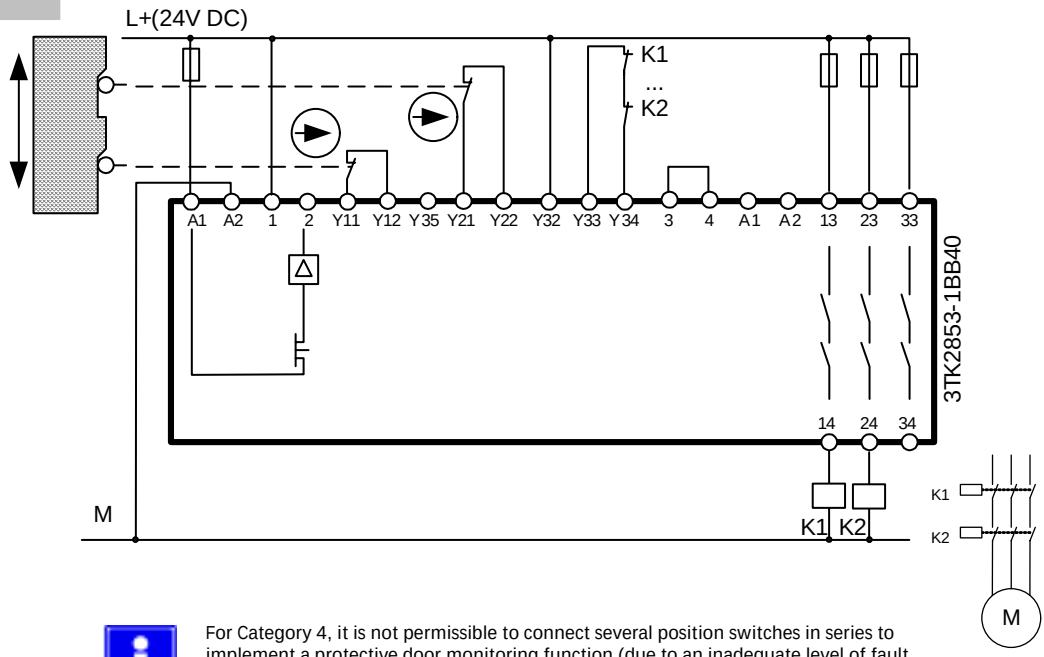
Signaling
using SIRIUS accessories



Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2853	**Category 4 (acc. EN 954-1)** **protective door** **Monitoring** **Stop-Category 0**	**3NO 1NO$_{el}$** **V_s 24 V DC** **auto start**
		Signaling **using SIRIUS accessories**

4



For Category 4, it is not permissible to connect several position switches in series to implement a protective door monitoring function (due to an inadequate level of fault detection).

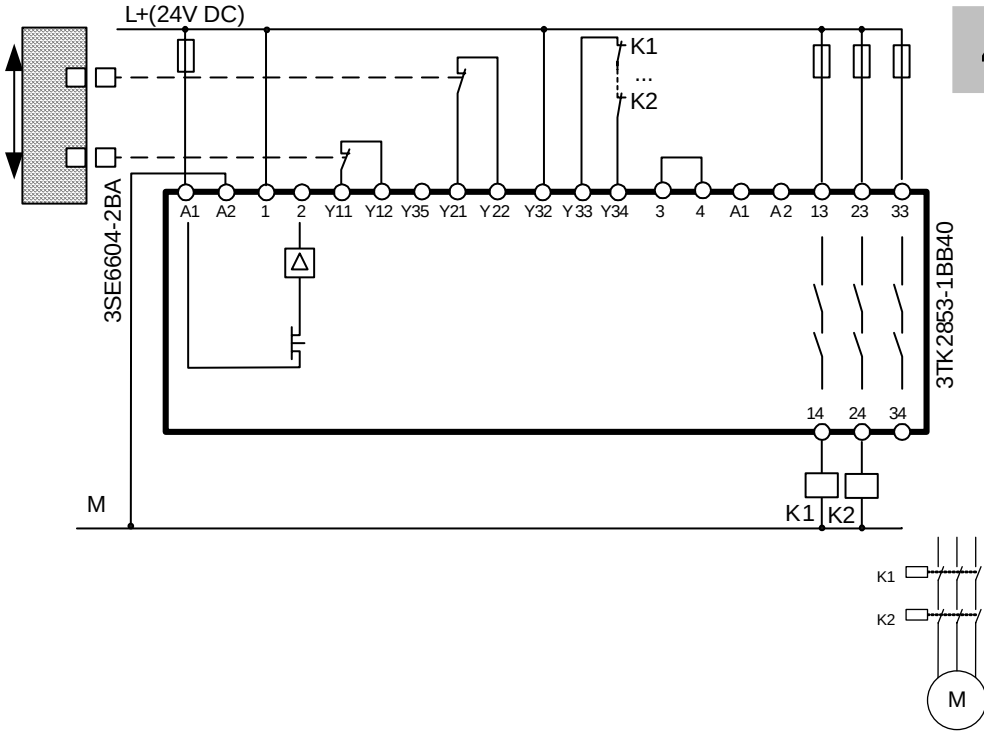
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2853

Category 4 (acc. EN 954-1)
Magnet sensor Monitoring
Stop-Category 0

3NO 1NO$_{el}$
V_s 24 V DC
auto start

Signaling
using SIRIUS accessories



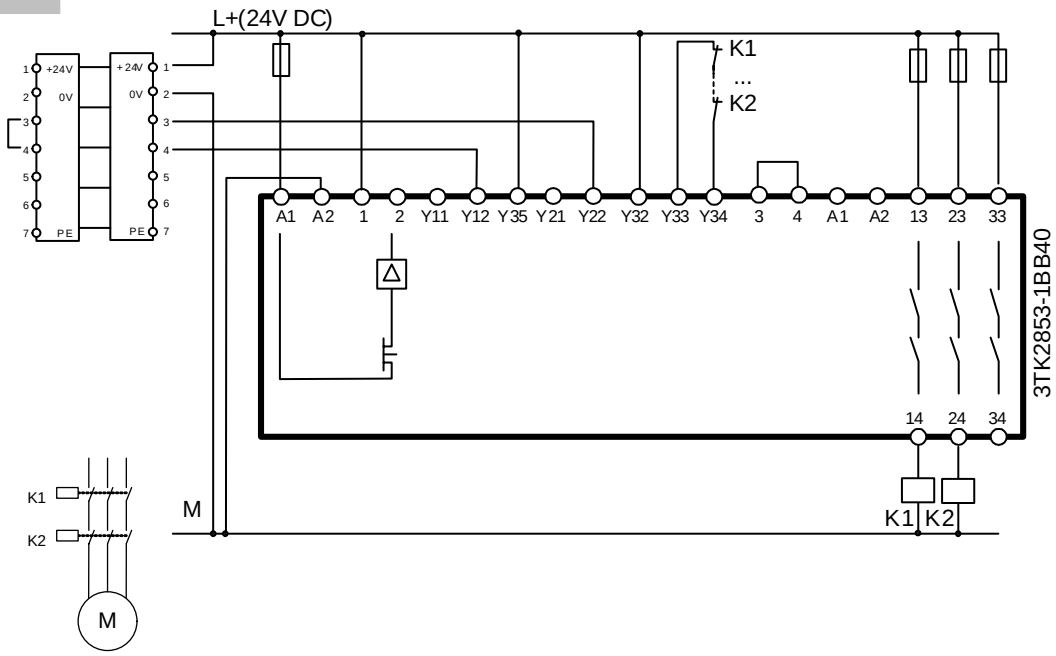
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2853

Category 4 (acc. EN 954-1)
Light grid Monitoring
Stop-Category 0

3NO 1NO$_{el}$
V_s 24 V DC
auto start

Signaling
using SIRIUS accessories



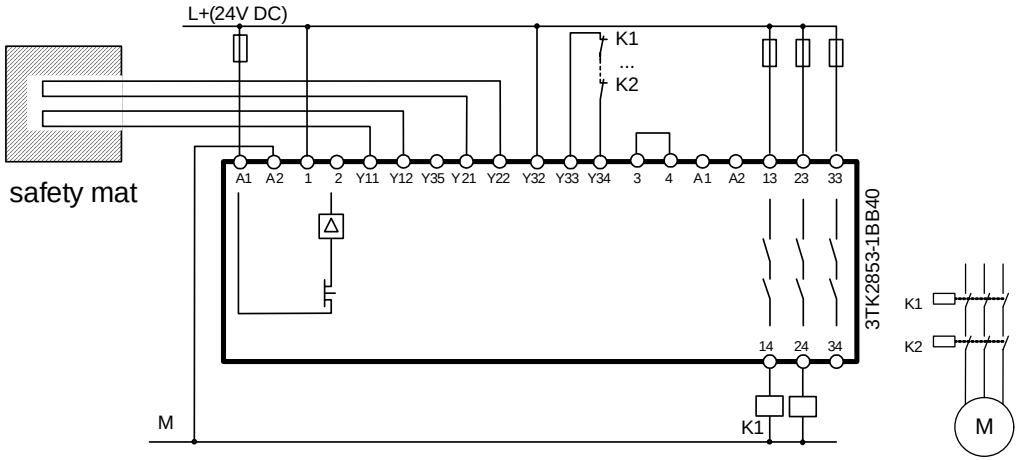
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2853

Category 3 (acc. EN 954-1)
Safety mat Monitoring
Stop-Category 0

3NO 1NO$_{el}$
V_s 24 V DC
auto start

Signaling
using SIRIUS accessories

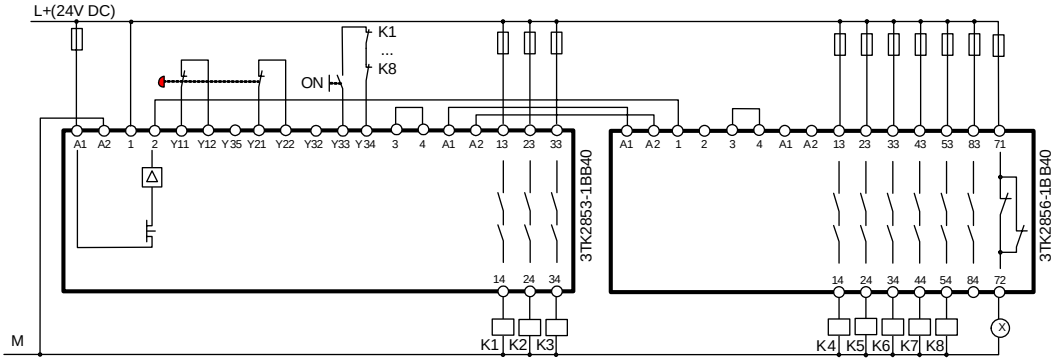


Category 3 according to EN 954-1 of this circuit is as a result of the safety mat.

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2853 + 3TK2856	**Category 4 (acc. EN 954-1)** **E-Stop Monitoring** **Stop-Category 0**	**9NO 1NO$_{el}$** **V_S 24 V DC** **monitored start**

Signaling using SIRIUS accessories



For Category 4, several EMERGENCY STOP commanding devices may be connected in series.

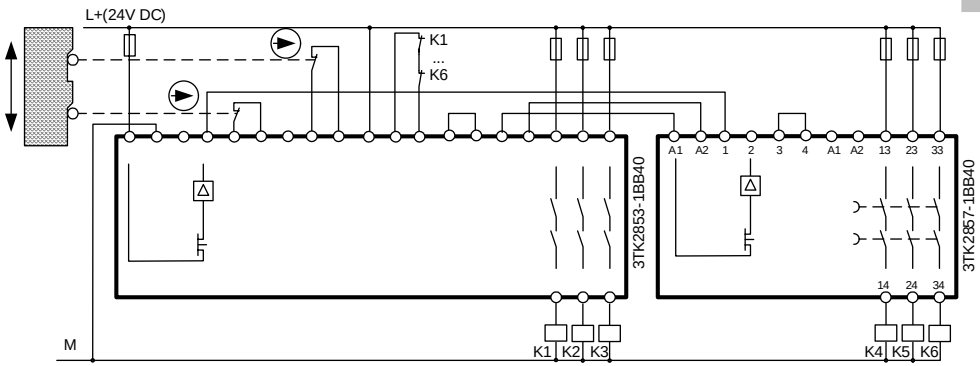
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3TK2853 + 3TK2857

Category 4 (acc. EN 954-1)
protective door
Monitoring
Stop-Category 0

3NO 1NO$_{el}$ 3NO$_{tv}$
V$_s$ 24 V DC
auto start

Signaling using SIRIUS accessories



For Category 4, it is not permissible to connect several position switches in series to implement a protective door monitoring function (due to an inadequate level of fault detection).

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3RA71.

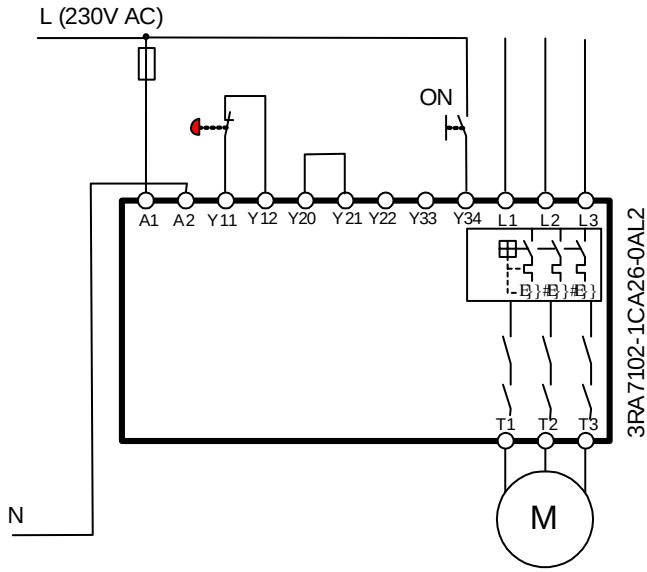
Safe load feeders

3RA710-...-0AL2

Category 2 (acc. EN 954-1)
E-Stop Monitoring
Stop-Category 0

3NO
V_s 230 V AC
monitored start

Signaling using SIRIUS accessories



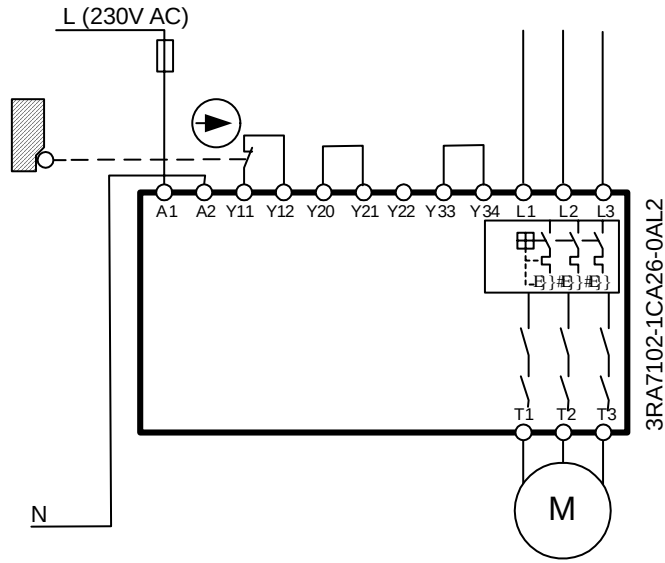
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3RA710-...-0AL2

Category 2 (acc. EN 954-1)
protective door
Monitoring
Stop-Category 0

3NO
V_S 230 V AC
auto start

Signaling
using SIRIUS accessories



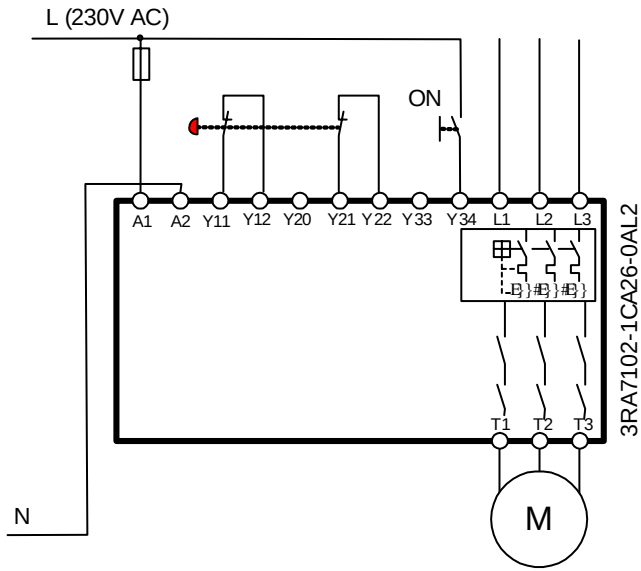
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3RA710-...-0AL2

Category 3 (acc. EN 954-1)
E-Stop Monitoring
Stop-Category 0

3NO
V_s 230 V AC
monitored start

Signaling using SIRIUS accessories



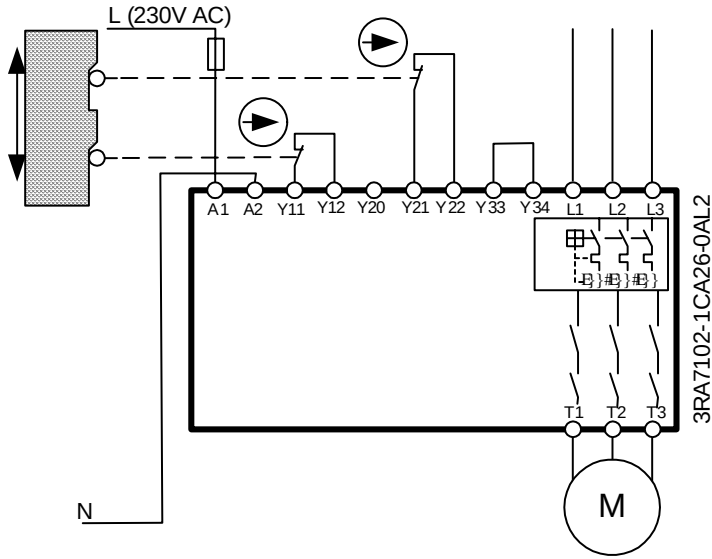
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3RA710-...-0AL2

Category 3 (acc. EN 954-1)
protective door
Monitoring
Stop-Category 0

3NO
V_s 230 V AC
auto start

Signaling
using SIRIUS accessories



5

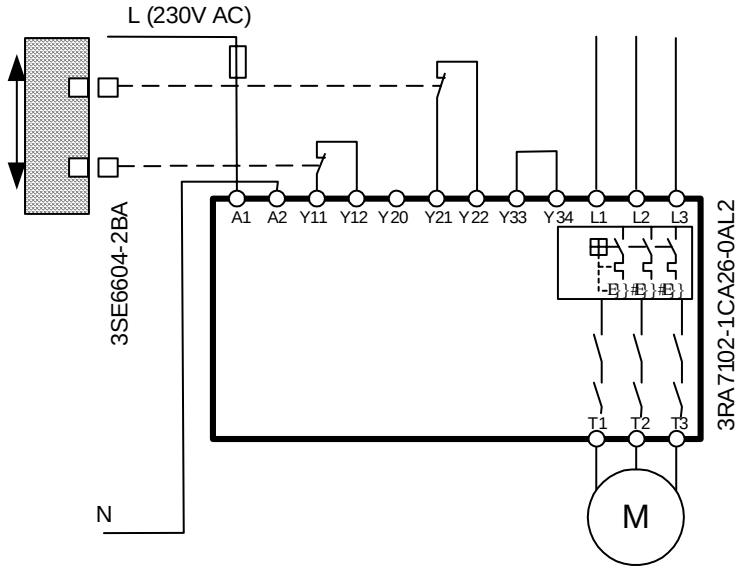
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3RA710-...-0AL2

Category 3 (acc. EN 954-1)
Magnet sensor Monitoring
Stop-Category 0

3NO
V_s 230 V AC
auto start

Signaling
using SIRIUS accessories



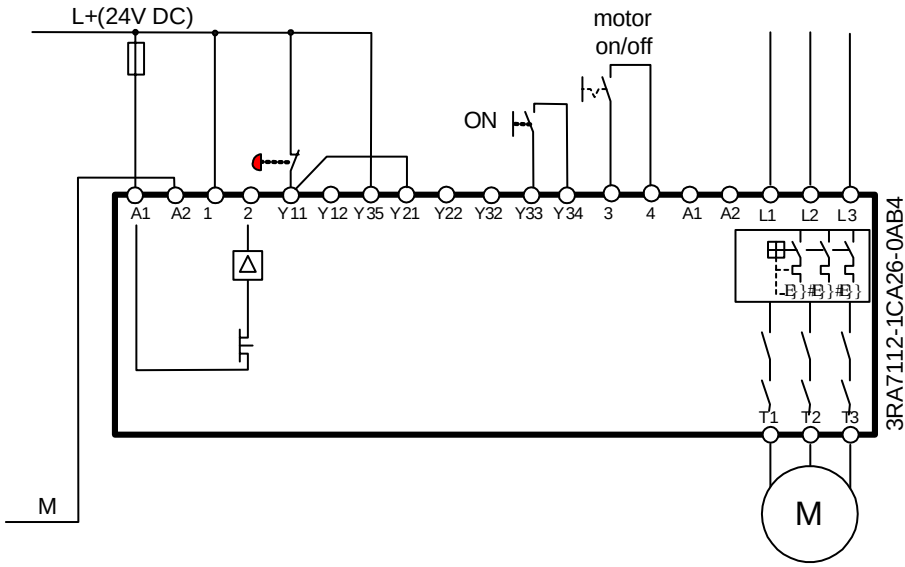
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3RA711

Category 2 (acc. EN 954-1)
E-Stop Monitoring
Stop-Category 0

3NO 1NO$_{el}$
V_s 24 V DC
monitored start

Signaling
using SIRIUS accessories



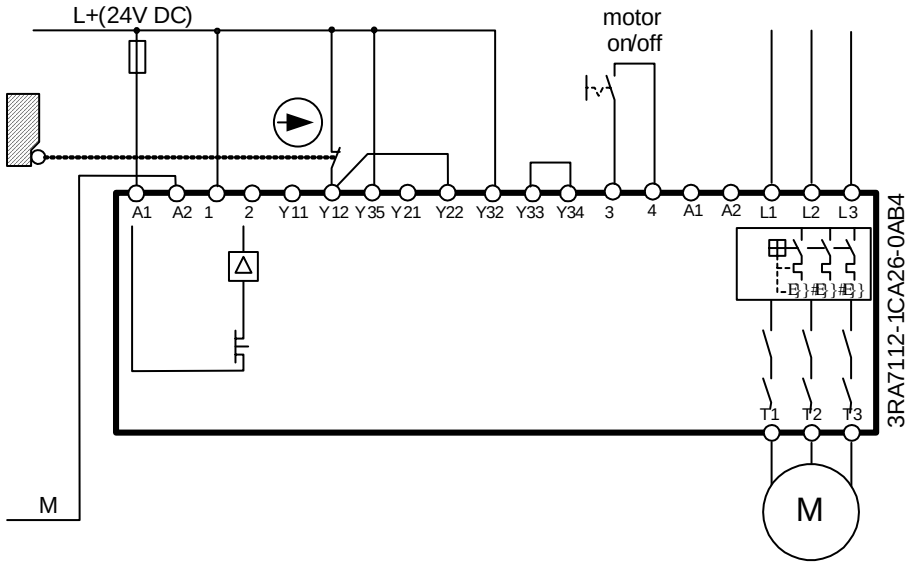
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3RA711

Category 2 (acc. EN 954-1)
protective door
Monitoring
Stop-Category 0

3NO 1NO$_{el}$
V_s 24 V DC
auto start

Signaling
using SIRIUS accessories



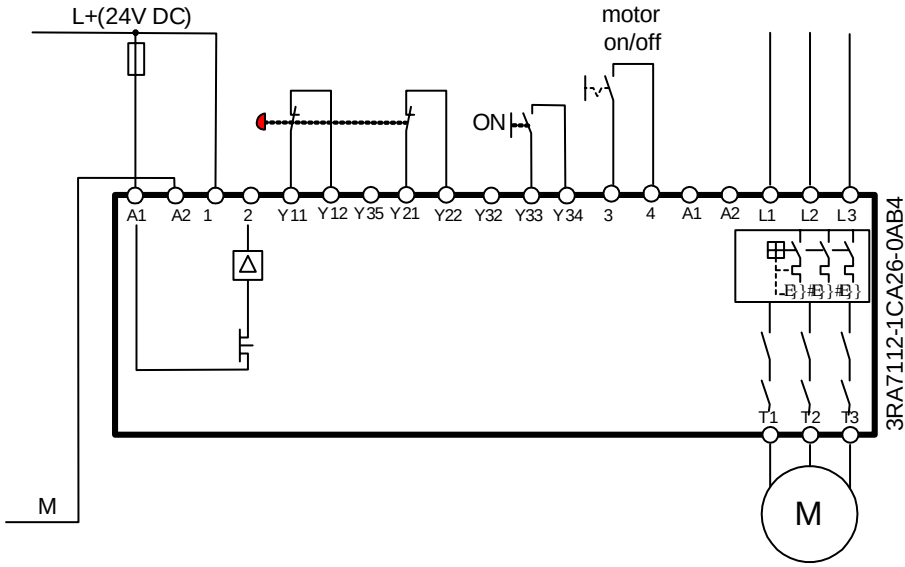
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3RA711

Category 4 (acc. EN 954-1)
E-Stop Monitoring
Stop-Category 0

3NO 1NO$_{el}$
V_s 24 V DC
monitored start

Signaling
using SIRIUS accessories

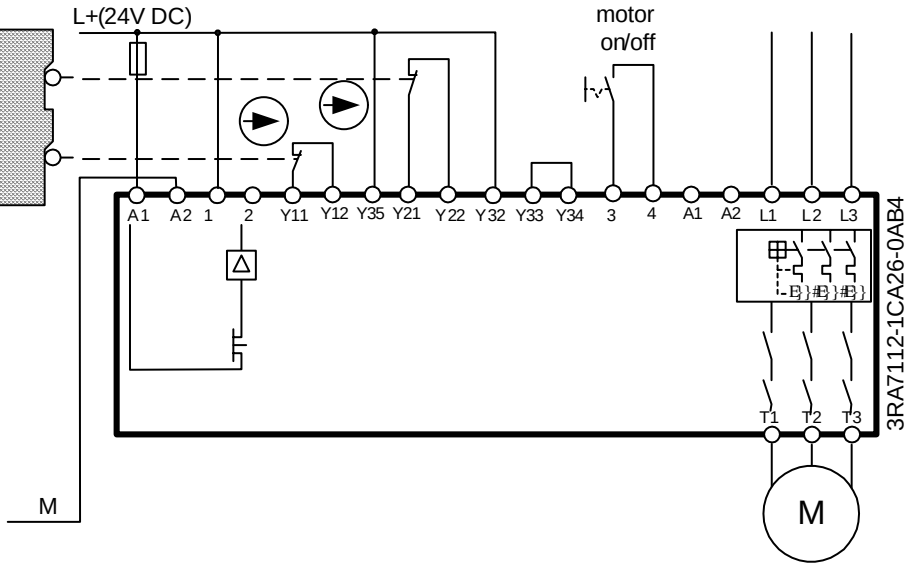


For Category 4, several EMERGENCY STOP commanding devices may be connected in series.

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3RA711	**Category 4 (acc. EN 954-1)** **protective door** **Monitoring** **Stop-Category 0**	**3NO 1NO$_{el}$** **V_s 24 V DC** **auto start**

Signaling
using SIRIUS accessories



For Category 4, it is not permissible to connect several position switches in series to implement a protective door monitoring function (due to an inadequate level of fault detection).

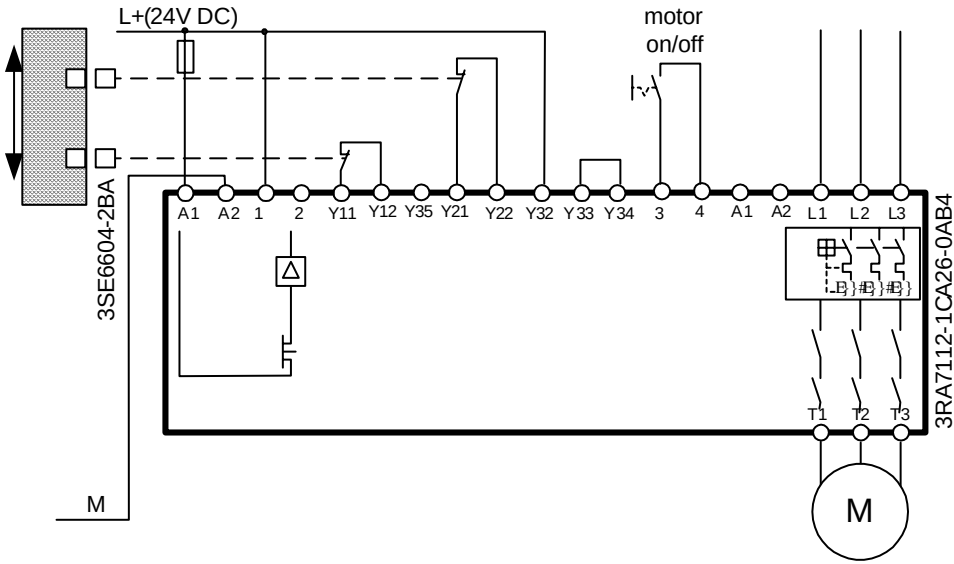
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3RA711

Category 4 (acc. EN 954-1)
Magnet sensor Monitoring
Stop-Category 0

3NO 1NO$_{el}$
V_s 24 V DC
auto start

Signaling
using SIRIUS accessories



Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

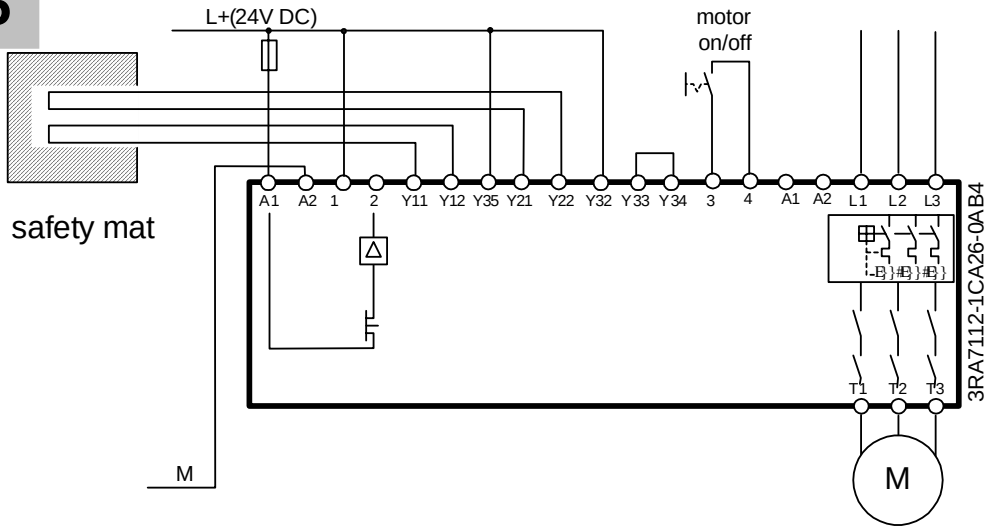
3RA711

Category 3 (acc. EN 954-1)
Safety mat Monitoring
Stop-Category 0

3NO 1NO$_{el}$
V_s 24 V DC
auto start

Signaling
using SIRIUS accessories

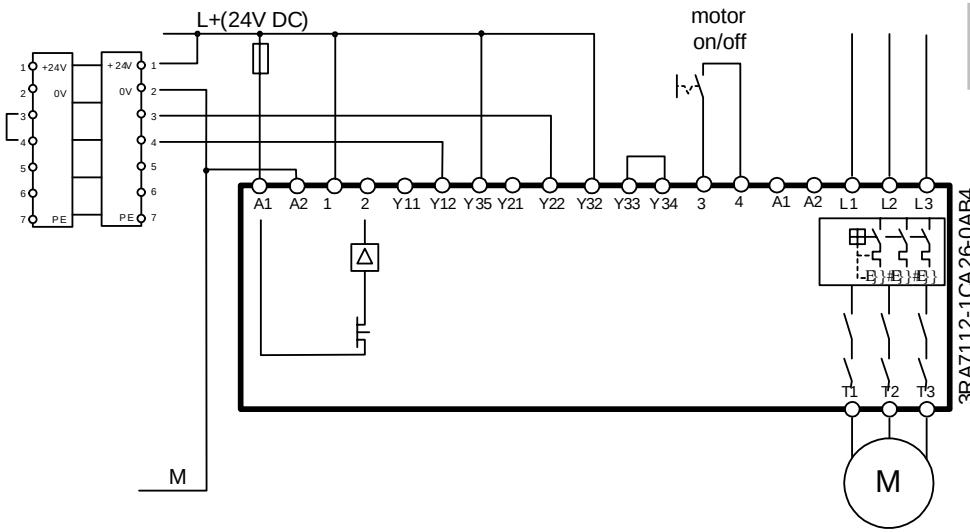
5



Category 3 according to EN 954-1 of this circuit is as a result of the safety mat.

Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

Safety relay	Function	Comments
3RA711	**Category 4 (acc. EN 954-1)** **Light grid Monitoring** **Stop-Category 0**	**3NO 1NO$_{el}$** **V_S 24 V DC** **auto start**
	Light grid **Type 4 (EN 61496-1)**	**Signaling** **using SIRIUS accessories**



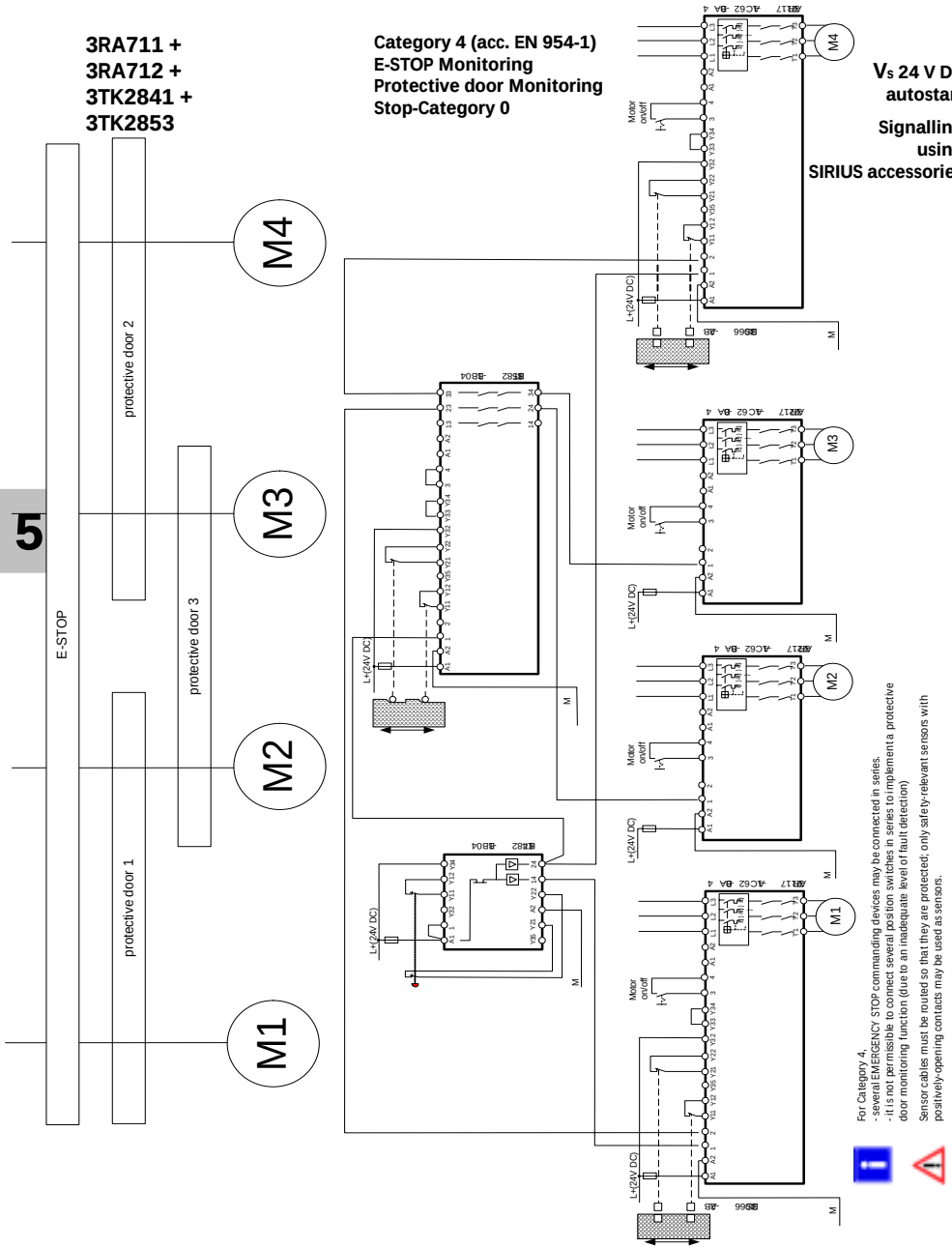
Sensor cables must be routed so that they are protected; only safety-relevant sensors with positively-opening contacts may be used as sensors.

3RA711 +
3RA712 +
3TK2841 +
3TK2853

Category 4 (acc. EN 954-1)
E-STOP Monitoring
Protective door Monitoring
Stop-Category 0

V_S 24 V DC autostart

Signalling using SIRIUS accessories



ANNEX

Categories acc. to EN 954-1

For safety-relevant parts and components of control systems, potential risks are evaluated that are classified in Categories B and 1 to 4 acc. to EN 954-1.This classification should not be considered a hierarchic classification!

A simplified representation can be considered as follows:

	Brief summary of the requirements	**System behavior**	**Principle**
4	Requirements of B must be fulfilled; a **single fault** must be detected before or **at the next demand** upon the safety function.	When faults occur, the safety function is always performed; **the faults are detected in time** to prevent the loss of the safety function.	Mainly characterized by the **structure of the control**
3	Requirements of B must be fulfilled, a **single fault** may not lead to the loss of the safety function; single faults must be detected	The safety function is always performed when **single faults** occur	
2	Requirements of B must be fulfilled; the safety function shall be **checked, additionally** at suitable time intervals.	The occurrence of a fault can lead to the loss of the safety function between the **checks**.	
1	Requirements of B must be fulfilled; **well-proven** components and safety principles shall be used.	The same system behavior as B, however with a **higher** safety-relevant **reliability**	Mainly characterized by the **selection of components**
B	The control must be designed so that it can withstand the **expected influences**	The occurrence of one fault can lead to the **loss of the safety function**	

A

The categories are not hierarchic

EN 954-1

A risk analysis determines the danger and the resulting hazard. This hazard represents a risk for man, machine and the environment. This risk can be reduced to a residual risk (minimized) by applying suitable measures. The residual risk that can be tolerated requires, among others, external measures (e.g. a protective fence) and an appropriate Category for the safety-relevant parts of the control system!

Example:
There is a hazard, e.g. as a result of a robot (in a machining cell), that could injure a person if he or she enters the hazardous zone (this could also result in death). There are two possible solutions:

Protective measure A: A protective fence without protective door (and without any other possibility of accessing the hazardous zone) is erected around the cell with the robot. This prevents access to this hazardous zone. This means that there is an extremely low residual risk: This corresponds to Category 1. However, the disadvantage of this solution is that it takes considerable effort to enter the cell with the robot (e.g. when carrying-out maintenance work).

Protective measure B: A protective fence with a protective door (this being the only access possibility) is erected around the robot cell. When the protective door is opened, the robot is brought into a safe condition.

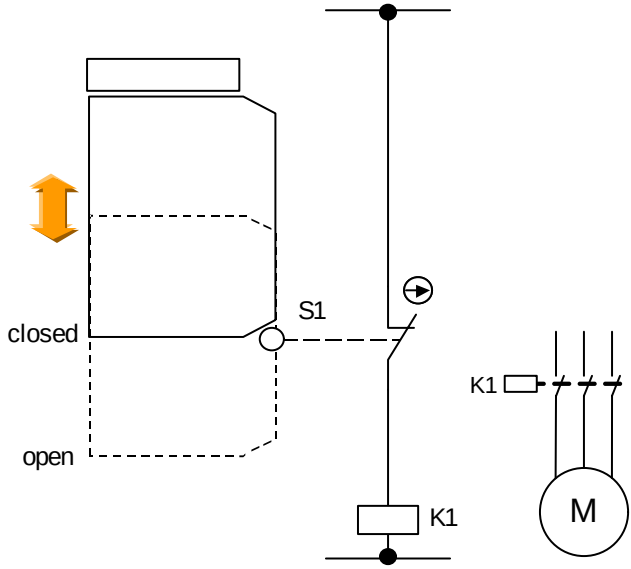
This means that the residual risk corresponds to Category 3; this is because the operator may not be injured if he wishes to regularly enter the cell with the robot.

The increase of the degree of safety using additional measures – e.g. by over-dimensioning the load contactors – does not result in a higher Category!

EN 954-1

This does not result in a fault exclusion!

Category 1 acc. EN 954-1



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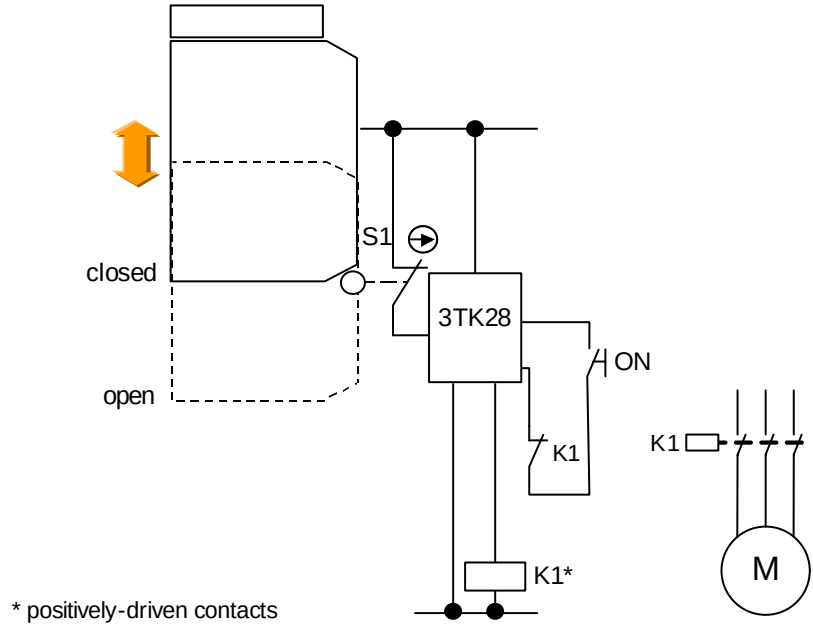
Category 2 acc. EN 954-1



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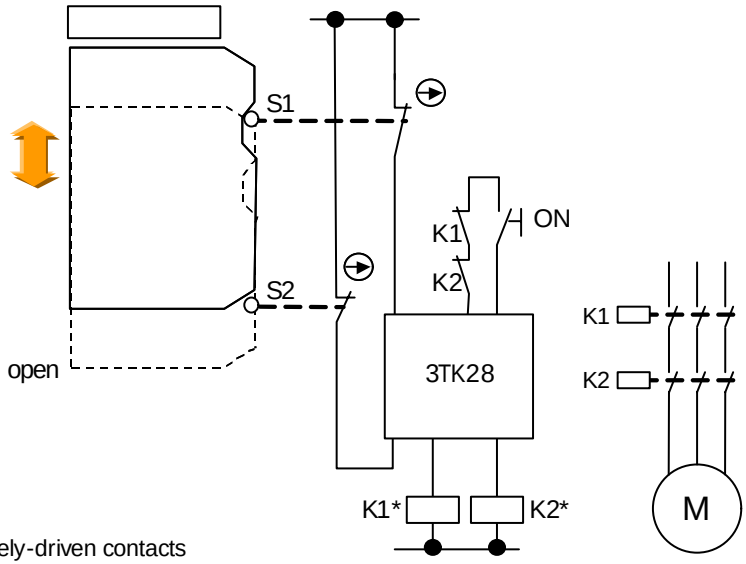
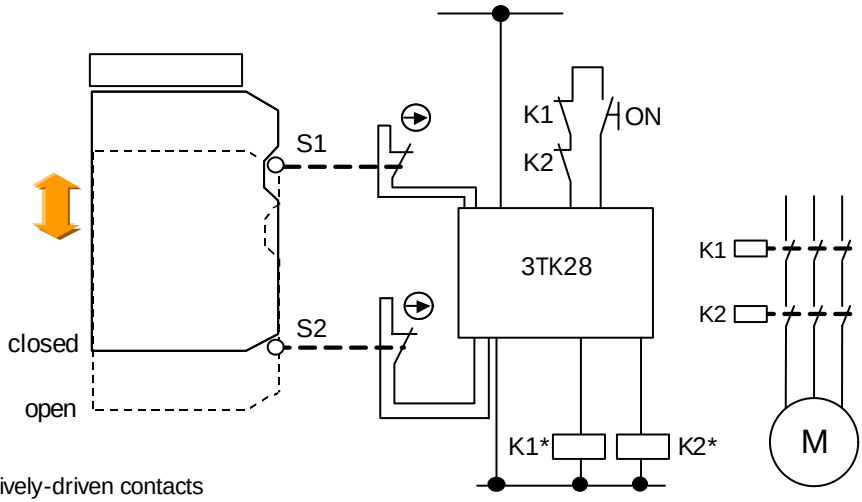
Category 3 acc. EN 954-1



* positively-driven contacts

A

Category 4 acc. EN 954-1



* positively-driven contacts

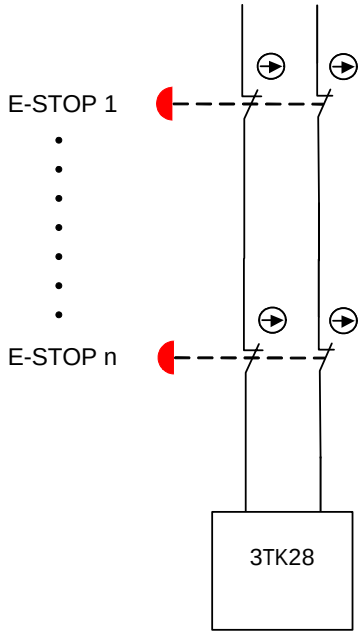
A

Serial connection up to category 4

E-STOP command element

EN 954-1
ISO 12100-1 (EN 292-1)

EMERGENCY STOP command devices may always be connected in series: It can be excluded that the EMERGENCY STOP devices fail and are simultaneously actuated.



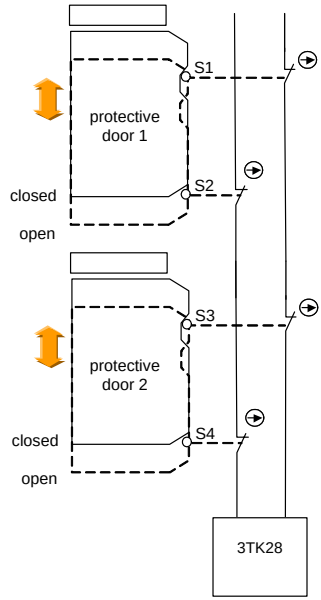
A

Serial connection up to category 3

Protective door monitoring

EN 954-1
ISO 12100-1 (EN 292-1)

Position switches may be connected in series if several protective doors are not regularly and simultaneously opened (as otherwise faults cannot be detected).



For Category 4, it is not permissible to connect several position switches in series to implement a protective door monitoring function (due to an inadequate level of fault detection).

A

Serial connection

up to category 3

E-Stop command element and protective door monitoring

EN 954-1
ISO 12100-1 (EN 292-1)

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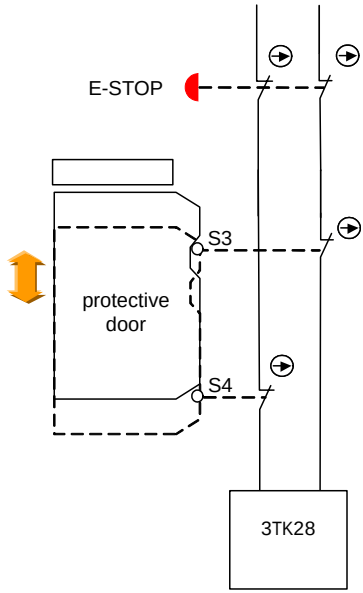
E-Stop command elements and position switches may be connected in series if several protective doors are not regularly and simultaneously opened and E-Stop is actuated (as otherwise faults cannot be detected).



For Category 4, it is not permissible to connect several position switches and E-Stop command elements in series to implement a protective door monitoring function (due to an inadequate level of fault detection).

Manual start, monitored start and auto start

This is possible with the various safety relays.

EN 954-1

A safety relay can be manually monitored or automatically started.

For a **manual** or **monitored** start, when pressing the ON button – after checking the input image and after a positive test of the safety relay, an enable signal is generated. This function is also designated as static operation and is specified for EMERGENCY STOP devices (EN 60204-1, conscious action).
Contrary to a manual start, the monitored start evaluates a signal change of the ON button. This means that the actuation of the ON button cannot be tampered/ manipulated with.

For an **automatic start**, without a manual agreement, but after the input image has been checked and a positive test of the safety relay, an enable signal is generated.
This function is also designated as dynamic operation and is not permissible for EMERGENCY STOP devices.
Protective devices that cannot be entered but mechanically isolate (e.g. guard) operate with an automatic start.

Comment: A manual start can be implemented with a safety relay with automatic start, if, in the feedback circuit, in addition to the positively-opening contacts of the load contactors, an ON button is additionally connected in series.

Manual start is possible up to Category 3.

This is possible with safety relays with automatic start.

EN 954-1

A manual start is permissible for an EMERGENCY STOP device up to Category 3 according to EN 954-1 (ISO 13849-1).

Monitored start is necessary from Category 4.

This is possible with safety relays with monitored start

EN 954-1

For Category 4 according to EN 954-1 (ISO 13849-1), a monitored start is necessary for an EMERGENCY STOP device: An unexpected start must be completely excluded.

Safety-relevant (protected) routing, safe separation

IEC 61140-1
EN 50187

The objective is to achieve a high degree of operational safety.
In order to protect against parasitic (vagabond) voltages, the different voltages in a cable or piece of equipment must be insulated with respect to the highest voltage present
(protection against electric shock, IEC 61140):
⇓ cable insulation between cables/conductors at different potentials;
⇓ AS-i modules must fulfill, between AS-i interface and $V_{auxiliary}$ the requirements according to EN 50187 regarding the air and creepage distances and the voltage strength of the insulation of the relevant parts and components.

Protective door monitoring with tumbler mechanism

EN 954-1
ISO 12100-1 (EN 292-1)
EN 60204-1

Non-safety-relevant control
of the tumbler mechanism is possible
up to Category 3

Safety-relevant control
of the tumbler mechanism is required
from Category 4

A

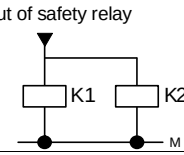
The objective of a tumbler mechanism is to maintain an isolating, protective device (e.g. guard) in the closed position.
The tumbler mechanism must be connected with the control so that
a) The isolating, protective device may only be opened if there is no motion present in the machine that is potentially hazardous,
b) The machine may only start when the isolating, protective device (e.g. guard) is closed and is interlocked.
Comment:

- *Up to Category 3 according to EN 954-1 (ISO 13849-1), the tumbler mechanism does not have to be controlled in a safety-relevant fashion.*
  For Category 4 according to EN 954-1 (ISO 13849-1), the control must always be realized in a safety-relevant fashion.
  The position monitoring of the interlocking device (solenoid) must, from Category 3 onwards, be individually monitored according to EN 954-1 (ISO 13849-1) – and may not be switched in series with the monitoring of the separate actuator (due to the poor level of fault detection).

One output for category 3 and 4 with two switch gears

EN 954-1

One safety-related output can be used in the cabinet
to actuate one or more switch gears up to category 4 according to EN 954-1
(fault due to short circuit can be excluded)



Technical Assistance for low-voltage switchgear

In person from Mon. - Fri. 8.00 to 17.00 (CET)
Telephone: +49 (911)-895-5900
E-Mail: technical-assistance@siemens.com
Internet: http://www.siemens.de/lowvoltage

By fax, 24 hours a day
Fax: +49 (911)-895-5907

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NOTICES

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Siemens AG

Automation and Drives
P.O. Box 48 48
90327 Nuremberg, Germany

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Subject to change without prior notice 04/05
Order No. L3-Z333-x-x-7600
Printed in Germany