Contactors and relays

Contactors and relays
Contactor relays

Contactor relays

Contactor relays are often used in control and regulating functions. They are used in large quantities for the indirect control of motors, valves, clutches and heating equipment.

In addition to the simplicity which they offer in project engineering, panel building, commissioning and maintenance, the high level of safety which they afford is a major factor in their favor.

Security

The contactor relay contacts themselves constitute a considerable safety feature. By design and construction they ensure potential isolation between the actuating circuit and the operating circuit, in the de-energized state, between the contact input and output. All DIL contactor relays have double-break contacts.

The Employers' liability insurance association demands that, for control systems of power-driven metalwork presses, the contacts of contactors must be interlocked and opposing. Interlocking means that the contacts are mechanically connected to one another such that N/C contacts and N/O contacts can never be closed simultaneously. At the same time, it is necessary to ensure that the contact gaps are at least 0.5 mm over the lifespan, even when defective (e.g. when a contact is welded). The contactor relays DILER and DILA fulfil this requirement.

Contactor relays DIL

Two contactor relay series are available as a modular system:

- Contactor relays DILER,
- Contactor relays DILA.

Modular system

The modular system has many advantages for the user. The system is formed around basic units, which are equipped with additional functions by means of modules. Basic units are intrinsically functional units, consisting of an AC or DC drive and four auxiliary contacts.

Modules having auxiliary functions

Auxiliary contact modules having 2 or 4 contacts. The combination of N/O and N/C contacts is according to EN 50011. The auxiliary contact modules of the contactors DILEM and DILM cannot be snapped onto the basic device to prevent duplication of terminal markings e.g. contact 21/22 on the basic device and 21/22 on the add-on auxiliary contact module.

The DILA and DILM7 to DILM38 contactors of the DILA-XHIR22 auxiliary contact are available specially for switching the smallest signals for electronic applications.

Contactors and relays
Contactor relays

The system and the Standard

European Standard EN 50011 “Terminal markings, distinctive numbers and reference letters for certain contactor relays” has a direct bearing on the use and application of the modular system. There are various types, which the Standard differentiates between by means of reference numbers and reference letters, depending on the number and position of the N/O and N/C contacts in the device, and their terminal markings.

Ideally devices with the reference letter E should be used. The basic devices DILA-40, DILA-31, DILA-22 as well as DILER-40, DILER-31 and DILER-22 comply with the E version.

For 6 and 8 pole contactor relays, the “E” version means that four N/O contacts must be arranged in the lower/rear contact level. If, for example, the available auxiliary contact modules are used in the DILA-22 and DILA-31, they result in contact configurations with reference letters X and Y.

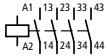
Below are 3 examples of contactors with 4 N/O and 4 N/C contacts with different reference letters. Version E is to be preferred.

Example 1

DILA-XHI04

\+

DILA-40



≙ 44 E

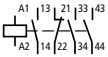
DILA40/04

Example 2

DILA-XHI13

\+

DILA-31



≙ 44 X

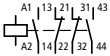
DILA31/13

Example 3

DILA-XHI22

\+

DILA-22

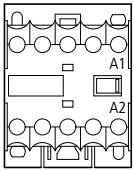


≙ 44 Y

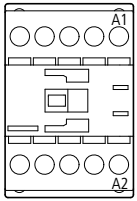
DILA22/22

Contactors and relays
Contactor relays

Coil connections



DILER



DILA

On the top positioned terminals A1–A2 of the contactor DILER the following accessories are connected to limit the relay coil switch off breaking voltage peaks:

- RC suppressors
- Free-wheel diode suppressors
- Varistor suppressors

On the contactor relay DILA the coil connection A1 is at the top and A2 at the bottom. As suppressor circuits the following are connected on the front:

- RC suppressors
- Varistor suppressors

The DC operated contactors DILER and DILA have an integrated suppressor circuit.

Suppressor circuit

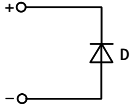
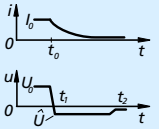
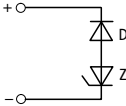
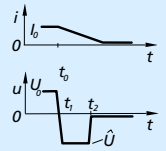
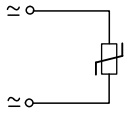
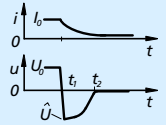
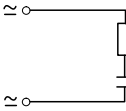
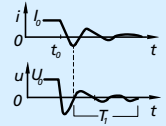
Electronic equipment is nowadays being increasingly used in combination with conventional switching devices such as contactors. This equipment includes programmable logic controllers (PLCs) timing relays and coupling modules, whose operation can be adversely affected by disturbances from interactions between all the components.

One of the disturbance factors occurs when inductive loads, such as coils of electromagnetic switching devices, are switched off. High cut-off induction voltages can be produced when such devices are switched off and, under some circumstances, can destroy adjacent electronic devices or, via capacitive coupling mechanisms, can generate interference voltage pulses and thus cause function disturbances.

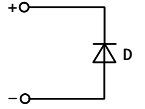
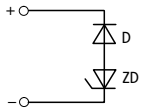
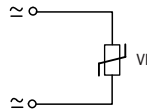
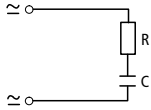
Since interference-free disconnection is impossible without an accessory, the coils may be connected to a suppressor module, depending on the application. The advantages and disadvantages of the various suppressor circuits are explained in the following table.

Notes

Contactors and relays
Contactor relays

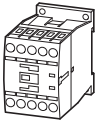
Circuit diagram	Load current and voltage responses	Protected against polarity reversal also for AC	Additional drop-out delay	Induction voltage limiting defined
		–	Very long	1 V
		–	average	U_{ZD}
		Yes	Short	U_{VDR}
		Yes	Short	–

Contactors and relays
Contactor relays

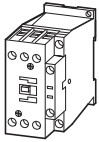
Circuit diagram	Damping also below U_{LIMIT}	Additional heat dissipation through circuitry	Notes	
	–	–	Advantages:	Dimensioning uncritical, minimum possible induction voltage, very simple and reliable
			Disadvantage:	Long drop-out delay
	–	–	Advantages:	Very short drop-out delay. Dimensioning uncritical. Simple construction
			Disadvantage:	No damping below U_{ZD}
	–	–	Advantages:	Dimensioning uncritical. High energy absorption. Very simple construction
			Disadvantage:	No damping below U_{VDR}
	Yes	Yes	Advantages:	HF damping due to stored energy, immediate de-energization, highly suitable for AC.
			Disadvantage:	Precise dimensioning required

Contactors and relays
Contactors DIL, overload relays Z

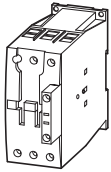
Overview of DIL contactors, 3-pole



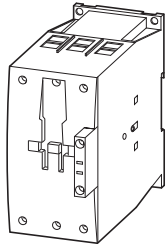
DILM7 … DILM15



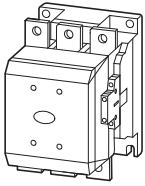
DILM17 … DILM38



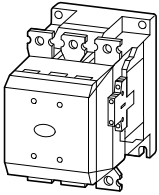
DILM40 …DILM72



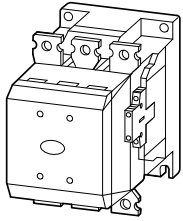
DILM80 … DILM170



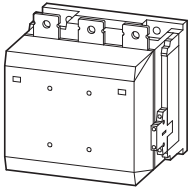
DILM185A,
DILM225A



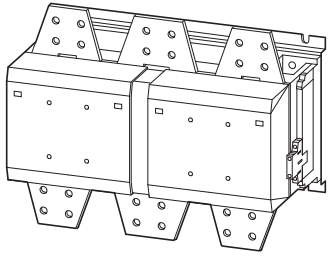
DILM250,
DILM300A



DILM400 … DILM570



DILM580 … DILM1000
DILH1400

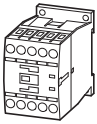


DILM1600
DILH2000, DILH2200, DILH2600

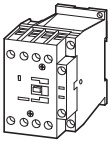
Contactors and relays
Contactors DIL, overload relays Z

Overview DILP contactors, 4 pole

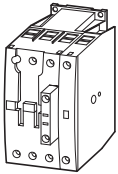
DILEM4



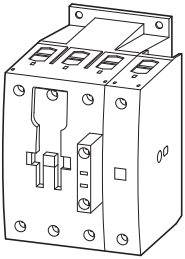
DILMP20



DILMP32 … DILMP45



DILMP63 … DILMP80



DILMP125 … DILMP200

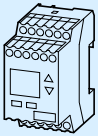
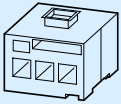
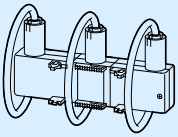
Part no.	Rated operational current 50 – 60 Hz open Conventional thermal current $I_{th} = I_e$, AC-1 open		
	40 °C A	50 °C A	60 °C A
DILEM4	22	20	19[1)]
DILMP20	22	21	20
DILMP32-10	32	30	28
DILMP45-10	45	41	39
DILMP63	63	60	54
DILMP80	80	76	69
DILMP125	125	116	108
DILMP160	160	150	138
DILMP200	200	188	172

1) At 55 °C

Contactors and relays
Contactors DIL, overload relays Z

Rated operating current I_e [A] AC-3 at 400 V	max. rating [kW] AC-3				Conventional thermal current $I_{th} = I_e$ [A] AC-1 at 40 °C	Type
	220 V, 230 V	380 V, 400 V	660 V, 690 V	1000 V		
6.6	1.5	3	3	–	22	**DILEEM**
9	2.2	4	4	–	22	**DILEM**
12	3.5	5.5	4	–	22	**DILEM12**
7	2.2	3	3.5	–	22	**DILM7**
9	2.5	4	4.5	–	22	**DILM9**
12	3.5	5.5	6.5	–	22	**DILM12**
15.5	4	7.5	7	–	22	**DILM15**
17	5	7.5	11	–	40	**DILM17**
25	7.5	11	14	–	45	**DILM25**
32	10	15	17	–	45	**DILM32**
38	11	18.5	17	–	45	**DILM38**
40	12.5	18.5	23	–	60	**DILM40**
50	15.5	22	30	–	80	**DILM50**
65	20	30	35	–	98	**DILM65**
72	25	37	35	–	98	**DILM72**
80	25	37	63	–	110	**DILM80**
95	30	45	75	–	130	**DILM95**
115	37	55	90	–	160	**DILM115**
150	48	75	96	–	190	**DILM150**
170	52	90	140	–	225	**DILM170**

Contactors and relays
Contactors DIL, overload relays Z

Part no.	Auxiliary contact blocks		Overload relays	Electronic motor protection system ZEV
	For surface mounting	For side mounting		
DILEEM DILEM DILEM12	02DILEM 11DILEM 22DILEM	–	ZE-0.16 up to ZE-12	ZEV + ZEV-XSW-25 ZEV-XSW-65 ZEV-XSW-145 ZEV-XSW-820 
DILM7 DILM9 DILM12 DILM15	DILA-XHI(V)… DILM32-XHI…	–	ZB12-0,16 up to ZB12-16 ZEB12-1.65 up to ZEB12-20	
DILM17 DILM25 DILM32 DILM38		DILM32-XHI11-S	ZB32-0,16 up to ZB32-38 ZEB32-1.65 up to ZEB32-45	
DILM40 DILM50 DILM65 DILM72 DILM80 DILM95 DILM115 DILM150 DILM170	DILM150-XHI(V) …	DILM1000-XHI(V) …	ZB65-10 up to ZB65-75 ZEB65-45 up to ZEB65-100 ZB150-35 up to ZB150-175 ZEB150-100	

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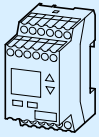
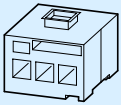
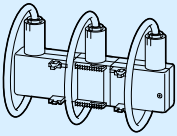
Contactors and relays
Contactors DIL, overload relays Z

Rated operating current I_e [A] AC-3 at 400 V	max. rating [kW] AC-3 220 V, 230 V	380 V, 400 V	660 V, 690 V	1000 V	Conventional thermal current $I_{th} = I_e$ [A] AC-1 at 40 °C	Type
185	55	90	140	108	337	**DILM185A**
225	70	110	150	108	356	**DILM225A**
250	75	132	195	108	400	**DILM250**
300	90	160	195	132	430	**DILM300A**
400	125	200	344	132	612	**DILM400**
500	155	250	344	132	857	**DILM500**
580	185	315	560	600	980	**DILM580**
650	205	355	630	600	1041	**DILM650**
750	240	400	720	800	1102	**DILM750**
820	260	450	750	800	1225	**DILM820**
1000	315	560	1000	1100	1225	DILM1000
1600	500	900	1600	1770	2200	DILM1600
1400	–	–	–	–	1714	DILH1400
2000	–	–	–	–	2450	DILH2000
2200	–	–	–	–	2700	DILH2200
2600	–	–	–	–	3185	DILH2600

Contactors and relays
Contactors DIL, overload relays Z

Part no.	Auxiliary contact blocks		Overload relays	Electronic motor protection system ZEV
	For surface mounting	For side mounting		
DILM185A	–	DILM1000-XHI…	Z5-70/FF225A up to Z5-250/FF225A	ZEV + ZEV-XSW-25 ZEV-XSW-65 ZEV-XSW-145 ZEV-XSW-820 
DILM225A				
DILM250		DILM820-XHI…	Z5-70/FF250 up to Z5-300/FF250	
DILM300A			ZW7-63 up to ZW7-630	
DILM400				
DILM500				
DILM580				
DILM650				
DILM750			–	
DILM820				
DILM1000			–	–
DILM1600				
DILH1400			–	–
DILH2000				
DILH2200			–	–
DILH2600			–	–

Accessories

Device	DILE(E)M	DILM7 to DILM170		DILM185A to DILM500	DILM580 to DILM2000
		AC	DC		
Suppressor circuit	DC	–	✓	✓	✓
RC suppressors	✓	✓	–	–	–
Varistor suppressors	✓	✓	–	–	–
Motor suppressor module	–	to DILM15	to DILM15	–	–
Star-point bridge	✓	✓	✓	✓	–
Paralleling link	✓	✓	✓	to DILM185A	–
Mechanical interlock	✓	✓	✓	✓	✓
Sealable shroud	✓	–	–	–	–
Cable terminals	–	–	–	✓	to DILM820
Individual coils	–	from DILM17	from DILM17	✓	✓
Electronic modules	–	–	–	✓	✓
Electronic modules including coils	–	–	–	✓	✓
Terminal shroud	–	–	–	✓	✓ 1)
Timer module	–	to DILM38	to DILM38	–	–

1) Terminal cover to DILM1000

Contactors DILM

These are designed and tested to IEC/EN 60 947, VDE 0660. For every motor rating between 3 kW and 900 kW (at 400 V) there is a suitable contactor available.

Equipment features

- Magnet system
  Due to the new electronic operation the DC contactors from 17 to 72 A have a sealing power of only 0.5 W. Even for 170 A is only 2.1 W necessary.
- Accessible control voltage connections
  The coil connections are on the front of the contactor. They are not covered by the main current wiring.
- Can be controlled directly from the PLC
  The contactors DILA and DILM to 38 A can be controlled directly from the PLC.
- Integrated suppressor DC
  With all DC contactors DILM a suppressor is integrated in the electronics.
- Plug-in suppressor circuits AC
  With all AC contactors DILM up to 170 A a suppressor can be simply plugged in on the front when required.
- Conventional control of contactors DILM185A to DILM2600 via coil terminals A1-A2.
- Additional actuation of contactors DILM250 to DILH2600:
  – Directly from a PLC via terminals A3-A4
  – By a low-power contact via terminals A10-A11.
- Conventional control of contactors DILM250-S to DILM500-S via coil connections A1-A2. There are two coil terminals (110 to 120 V 50/60 Hz and 220 to 240 V 50/60 Hz).
- All contactors up to DILM170 are finger and back-of-hand proof to VDE 0160 Part 100. Additional terminal covers are available from DILM185 onwards.
- Double-frame terminal for contactors DILM7 to DILM170
  With the new double frame-clamp the cable connection area is not limited by the screw. They give total security with varying cross sections and have protection against incorrect insertion to ensure safe connection.
- Integrated auxiliary contact
  The contactors up to DILM32 have an integrated auxiliary contact as N/O or N/C contact.
- Screw or spring-cage terminal
  The contactors DILE(E)M and DILA/DILM12, including the corresponding auxiliary contacts, up to 2000 A, are available with screw or spring terminals.
- Contactors with screwless terminals
  They have spring-cage terminals in the mains current circuit as well as for the coil connections and auxiliary contacts. The shake proof and maintenance free spring-cage terminals can terminate two conductors each of 0.75 to 2.5 mm^2 with or without ferrules.
- Connection terminals
  Up to DILM72 the connection terminals for all auxiliary contacts and coils as well as for main conductors can be tightened with a Pozidriv screwdriver size 2. For contactors DILM80 to DILM170 Allen screws are used.

- Mounting
  All contactors can be fitted on to a mounting plate with fixing screws. DILE(E)M and DILM up to 72 A can also be snapped on to a 35 mm top-hat rail to IEC/EN 60715.
- Mechanical interlock
  With two connectors and a mechanical interlock an interlocked contactor combination up to 170 A can be achieved without extra space requirement. The mechanical interlock ensures that both connected contactors cannot be simultaneously be operated. Even with a mechanical shock the contacts of both contactors cannot close simultaneously.

In addition to individual contactors, complete contactor combinations are also available:

- DIUL reversing contactors from 3 to 75 kW/400 V
- SDAINL star-delta starters from 5.5 to 132 kW/400 V

DC operated contactors

The market for DC operated contactors is growing due to the increasing use of electronics. Whilst AC operated contactors were used 20 years ago with additional resistors and specially wound DC coils with a lot of copper were used till recently, the next quantum leap has started. Electronic components are now in use for the drives of DC operated contactors.

The xStart contactor series DILM7 to DILM225A has been particularly optimized in the development of DC actuated contactors. The DILM17 to DILM225A DC operated contactors are no longer switched on or off in the conventional way using a coil but by means of an electronic unit.

The integration of electronics in the contactor drives makes different technical features possible which enable the contactors to offer outstanding performance in their daily use.

Universal voltage coils

The DILM17 to DILM225A DC operated contactors cover the entire DC control voltage range with only 4 control voltage variants.

	Rated actuation voltage
RDC24	24 - 27 V DC
RDC60	48 - 60 V DC
RDC130	110 - 130 V DC
RDC240	200 - 240 V DC

Contactors and relays
Contactors DIL

Voltage tolerance
Contactors are built in compliance with the IEC/EN 60947-4-1 standard. The requirement for operational safety even with small mains supply fluctuations is implemented with the reliable switching of contactors at between 85 to 110 % of the rated control circuit voltage. The DC operated DILM17 to DILM225A contactors now cover an even wider range in which they switch reliably. They allow reliable operation between 0.7 x U_{cmin} and 1.2 x U_{cmax} of the rated actuation voltage. The greater voltage tolerance than stipulated by the standard increases operating safety even with less stable mains conditions.

Suppressor circuit
Conventionally operated contactors generate voltage peaks at the coil to current change dI/dt which can have a negative effect on other components in the same actuating circuit. To prevent damage, contactor coils are often connected in parallel with additional suppressor circuits (RC suppressors, varistors or diodes).

Thanks to their electronics, the DC actuated contactors DILM17 to DILM225A switch without any effect on the network. An additional suppressor is therefore unnecessary since the coils do not generate any external overvoltages. The other DILM7 to DILM15 DC operated contactors have a built-in suppressor circuit.

When using DC operated contactors from Eaton in the project design, the issue of transient voltage surge suppression in control circuits is therefore unnecessary since all DC operated contactors are free of system disturbance or are provided with a suppressor circuit.

Contactor dimensions
The electronic circuit offers the coil a higher inrush consumption and reduces this after the closing operation to the required sealing power. This enables the AC and DC operated contactors to be implemented with the same dimensions. When designing AC and DC operated contactors for a project, the additional problem of different mounting depths is eliminated so that the same accessories can be used.

Pick-up and hold-in power
The electronic circuit on the DILM17 to DILM225A DC operated contactors controls their operation. A suitably high power is provided for the pickup to ensure the reliable switching of the contactor. A very low sealing power is required for holding the contactor. The electronics only provides this power.

Rated power [1]	Contactor	Power consumption	
		Pick-up	Sealing
7.5-15 kW	DILM17 DILM25 DILM32 DILM38	12 W	0.5 W
18.5-37 kW	DILM40 DILM50 DILM65 DILM72	24 W	0.5 W
37-45 kW	DILM80 DILM95	90 W	1.3 W
55-90 kW	DILM115 DILM150 DILM170	149 W	2.1 W
90-110 kW	DILM185A DILM225A	180 W	2.1 W

[1] AC-3 at 400 V

For project design, the reduced sealing power also means a considerable reduction in the heat dissipation in the switch cabinet. This allows side by side mounting of the contactors in the switch cabinet.

Contactors and relays
Contactors DIL

Applications

The three-phase motor dominates the electric motor sector. Apart from individual low-power drives, which are often switched directly by hand, most motors are controlled using contactors and contactor combinations. The power rating in kilowatts (kW) or the current rating in amperes (A) is therefore the critical feature for correct contactor selection.

Physical motor design results in that rated currents for the same rating sometimes differ widely. Furthermore it determines the ratio of the transient peak current and the starting current to the rated operational current (I_e).

Switching electrical heating installations, lighting fittings, transformers and power factor correction installations, with their typical individual characteristics, increases the wide range of different uses for contactors.

The operating frequency can vary greatly in every application. The difference can be, for example, from less than one operation per day up to a thousand operations or more per hour. Quite often, in the case of motors, a high operating frequency coincides with inching and plugging duty.

Contactors are actuated by hand or automatically, using various types of command devices, depending on the travel, time, pressure or temperature. Any interrelationships required between a number of contactors can easily be produced by means of interlocks via their auxiliary contacts.

The auxiliary contact of the contactor DILM can be used as mirror contact to IEC/EN 60947-4-1 Appendix F to show the condition of the main contacts. A mirror contact is an N/C contact that cannot be simultaneously closed with the N/O main contacts.

Other applications

- Contactors for capacitors for power factor correction DILK for 12.5 to 50 kvar/400 V.
- Lighting contactors for DILL lighting systems for 12 to 20 A/400 V (AC-5a) or 14 to 27 A/400 V (AC-5b).

Contactors and relays
Overload relays Z

Motor protection using Z thermal overload relays

Overload relays are included in the group of current-dependent protective devices. They monitor the temperature of the motor winding indirectly via the current flowing in the supply cables, and offer proven and cost-efficient protection from destruction as a result of:

- Non starting,
- Overload,
- Phase failure.

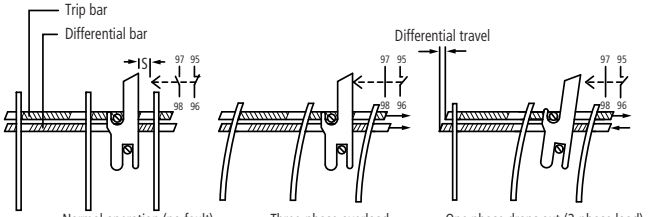
5

Overload relays operate by using the characteristic changes of shape and state of the bimetal when subjected to heating. When a specific temperature is reached, they operate an auxiliary switch. The heating is caused by resistances through which the motor current flows. The equilibrium between the reference and actual value occurs at various temperatures depending on the magnitude of the current.

Tripping occurs when the response temperature is reached. The tripping time depends on the magnitude of the current and preloading of the relay. Whatever the current, the relay must trip out before the motor insulation is endangered, which is why EN 60947-4-1 states maximum response times. To prevent nuisance tripping, minimum times are also given for the limit current and locked-rotor current.

Phase failure sensitivity

Overload relays Z offer, due to their design, an effective protection against phase failure. They have phase failure sensitivity to IEC 60947-4-1 and VDE 0660 part 102 and therefore can also provide protection for Ex e motors (→ following diagrams).



Normal operation (no fault) three-phase overload One phase drops out

① Trip bridge
② Differential bar
③ Differential travel

Contactors and relays
Overload relays Z

When the bimetallic strips in the main current section of the relay deflect as a result of three-phase motor overloading, all three act on a trip bar and a differential bar. A shared trip lever switches over the auxiliary contact when the limits are reached. The trip and differential bars lie against the bimetallic strips with uniform pressure. If, in the event of phase failure for instance, one bimetallic strip does not deflect (or recover) as strongly as the other two, then the trip and differential bars will cover different distances. This differential movement is converted in the device by a step-up mechanism into a supplementary tripping movement, and thus accelerates the tripping action.

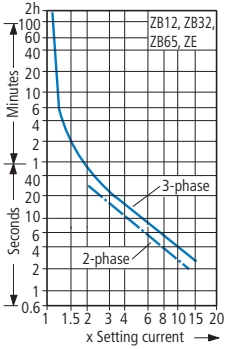
Design note → Section "Motor protection in special applications", page 8-8

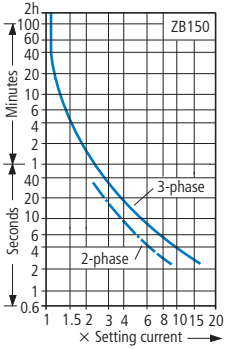
Further information to motor protection → Section "All about Motors", page 8-1

Tripping characteristics

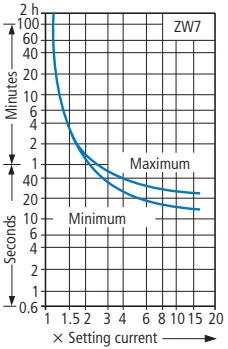
The overload relays ZE, ZB12, ZB32, ZB65 and the ZB150 up to 175 A are, due to the German Physical/Technical Bureau (PTB), suitable for protection of Ex e-motors to the ATEX-Guidelines 94/9 EG. In the relevant manual all tripping characteristics are printed for all currents.

These characteristic curves are mean values of the spreads at an ambient air temperature of 20 °C from cold. The tripping time is dependant upon the current. When units are warm, the tripping delay of the overload relay drops to about a quarter of the value shown.





Contactors and relays
Overload relays Z



Contactors and relays
ZEB electronic overload relay

Operating principle and control

Like the thermal overload relays operating on the bimetallic operating principle, electronic motor-protective relays are current-dependent protective devices. ZEB electronic motor-protective relays are an alternative to a bimetal overload relay.

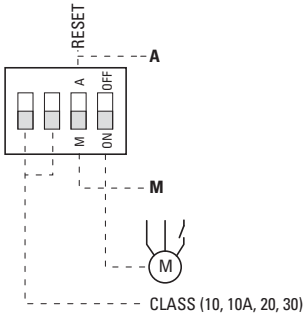
The measuring of the actual motor current present in the three phase conductors of a motor feeder is implemented on the ZEB overload relay with integrated current transformers for the range from 0.3 to 100 A.

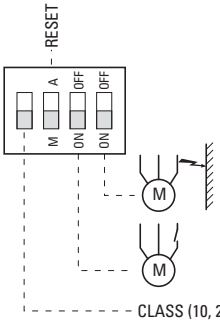
Like the ZEB, overload relays with electronic wide-range overload protection operate with a larger current transfer ratio. Compared to conventional bimetal relays, this provides the device with a wide current setting range ratio of 1:5.

The ZEB…-GF overload relay provides optional protection of the motor from earth faults. It adds the currents of the phases and evaluates any imbalance. If the imbalance is greater than 50 % of the set rated motor current, the relay trips.

By selecting one of the 4 tripping classes (CLASS 10A, 10, 20, 30) via DIP switches, the protected motor can be adapted to normal or heavy starting conditions. This allows the thermal reserves of the motor to be utilized safely. The overload relay does not require any auxiliary voltage and is fed internally via the current transformer.

Setting the DIP switches





The ZEBs come with the usual NC contacts (95-96) and NO contacts (97-98) for overload relays.

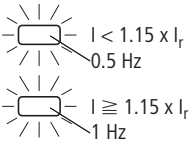
Contactors and relays
ZEB electronic overload relay

The current of the motor is set via a setting dial. It is also possible to switch off phase failure sensitivity via the DIP switches when protecting single phase motors.

The manual or automatic reset can also be set on the DIP switch.

No external power supply is required thanks to the independently fed electronic circuit.

A diagnostics LED gives a visual warning of an overload.



ZEB electronic overload relays can be fitted directly to DILM contactors up to 100 A.

Separate mounting (rail mounting) is only possible with ZEB…/KK.

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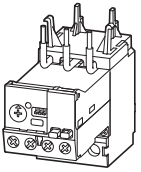
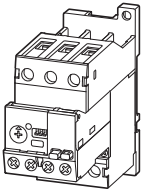
Device overview

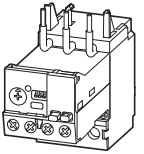
ZEB12, ZEB32
Direct mounting



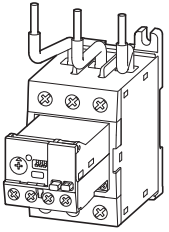
ZEB32…/KK
Separate mounting



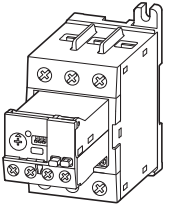
ZEB65
Direct mounting



ZEB150
Direct mounting

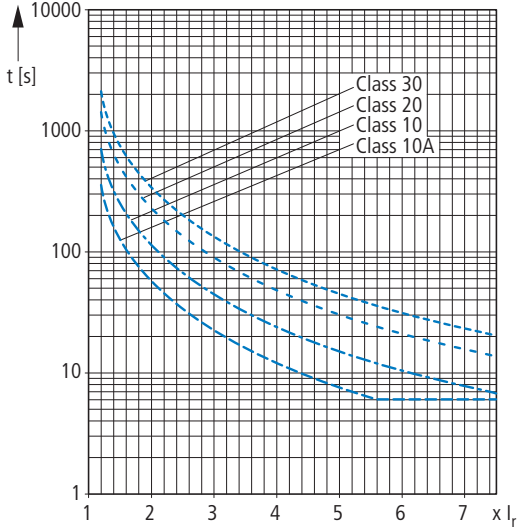


ZEB150…/KK
Separate mounting



Contactors and relays
ZEB electronic overload relay

Tripping characteristics



Class	t_A (s)						
I_r	x 3	x 4	x 5	x 6	x 7.2	x 8	x 10
30	133.5	72.5	45.7	31.4	21.7	17.5	11.2
20	89.0	48.3	30.4	21.0	14.5	11.7	7.5
10	44.5	24.2	15.2	10.5	7.2	6.0	6.0
10A	22.3	12.1	7.6	6.0	6.0	6.0	6.0

Contactors and relays
ZEV electronic motor-protective system

Operating principle and control

Like electronic overload relays operating on the bimetallic strip principle, electronic motor-protective relays are current-dependent protective devices.

The acquisition of the actual flowing motor current in the three external conductors of the motor connections is with motor protection system ZEV with separate push-through sensors or a sensor belt. These are combined with an evaluation unit so that separate arrangement of the current sensor and the evaluation unit is possible.

The current sensor is based on the Rogowski principle from the measurement technology. The sensor belt has no iron core, unlike a current transformer, therefore it doesn´t become saturated and can measure a very wide current range.

Due to this inductive current detection, the conductor cross-sections used in the load circuit have no influence on the tripping accuracy. With electronic overload relays, it is possible to set higher current ranges than is possible with electromechanical thermal overload relays. In the ZEV System, the entire protected range from 1 to 820 A is covered using only an evaluation unit.

The ZEV electronic motor-protective system carries out motor protection both by means of indirect temperature measurement via the current and also by means of direct temperature measurement in motors with thermistors.

Indirectly, the motor is monitored for overload, phase failure and unbalanced current consumption.

With direct measurement, the temperature in the motor winding is detected by means of one or more PTC thermistors. In the event of excessive temperature rise, the signal is passed to the tripping unit and the auxiliary contacts are actuated. A reset is not possible until the thermistors cool to less than the response temperature. The built-in thermistor connection allows the relay to be used as complete motor protection.

In addition, the relay protects the motor against earth faults. Small currents flow out even in the event of minor damage to the motor winding insulation. These fault currents are registered on an external core-balance transformer which adds together the currents in the phases, evaluates them and reports fault currents to the microprocessor in the relay.

By selecting one of the eight tripping classes (CLASS) allows the motor to be protected to be adapted from normal to extended starting conditions. This allows the thermal reserves of the motor to be used safely.

Contactors and relays
ZEV electronic motor-protective system

The overload relay is supplied with an auxiliary voltage. The evaluation unit has a multi-voltage version, which enables all voltages between 24 V and 240 V AC or DC to be applied as supply voltage. The devices have monostable behavior; they trip out as soon as the supply voltage fails.

In addition to the usual N/C contact (95-96) and the N/O contact (97-98) for overload relays the motor protection relay ZEV is equipped with a programmable N/O contact (07-08) and a programmable N/C contact (05-06). The above mentioned, usual contacts react directly via thermistors or indirectly via the current, to the detected temperature rise of the motor, including phase failure sensitivity.

The programmable contacts can be assigned to various signals, such as

- Earth-fault,
- Pre-warning at 105 % thermal overload,
- Separate indication of thermistor tripping,
- Internal device fault.

The function assignment is menu-guided using a display. The motor current is entered without tools using the function keys, and can be clearly verified on the display.

In addition the display allows a differential diagnostics of trip reasons, and therefore a faster error handling is possible.

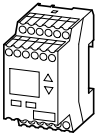
Tripping in the event of a three-pole balanced overload at x-times the set current takes place within the time specified by the tripping class. The tripping delay in comparison with the cold state is reduced as a function of the preloading of the motor. Very good tripping accuracy is achieved and the tripping delays are constant over the entire setting range.

If the motor current imbalance exceeds 50 %, the relay trips after 2.5 s.

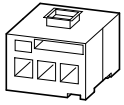
The accreditation exists for overload protection of explosion proof motors of the explosion protection “enhanced safety” Ex e to guideline 94/9/EG as well as the report of the German Physical/Technical Bureau (PTB report) (EG-Prototype test certificate number PTB 10 ATEX 3007). Further information can be found in the manual MN03407008Z-DE/EN “Motor protection system ZEV, overload monitoring of motors in Ex e areas”.

Contactors and relays
ZEV electronic motor-protective system

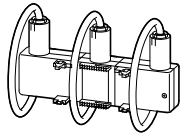
Device overview



Evaluation unit
1 to 820 A



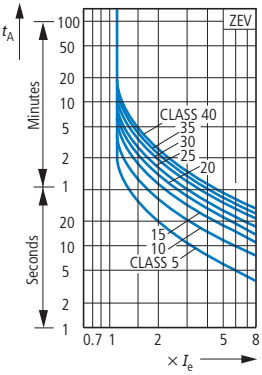
Current sensors
1 to 25 A
3 to 65 A
10 to 145 A



Sensor belt
40 to 820 A

5

Tripping characteristics



Tripping characteristics for 3-phase loads

These tripping characteristics show the relationship between the tripping time from cold to the current (multiples of set current I_E). After preloading with 100 % of the set current and the temperature rise to the operational warm state associated with it, the stated tripping delays t_A are reduced to approx. 15 %.

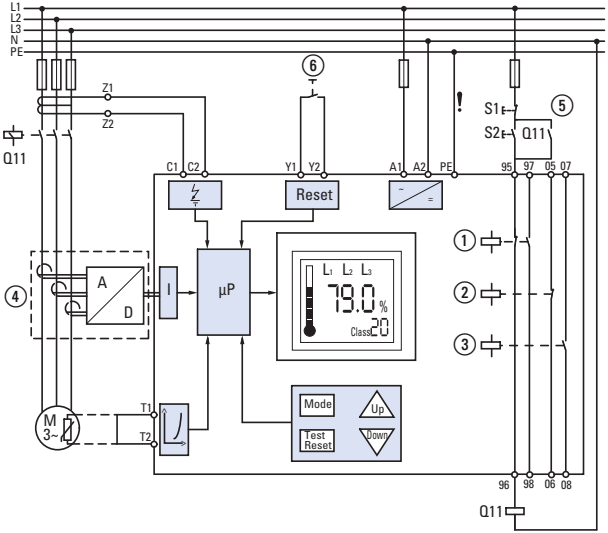
Tripping limits for 3-pole balanced load

Pick-up time:

< 30 min. at up to 115 % of the set current,
> 2 h at up to 105 % of the set current from cold.

Contactors and relays
ZEV electronic motor-protective system

Electronic motor-protective system ZEV with earth-fault protection and thermistor monitored motor

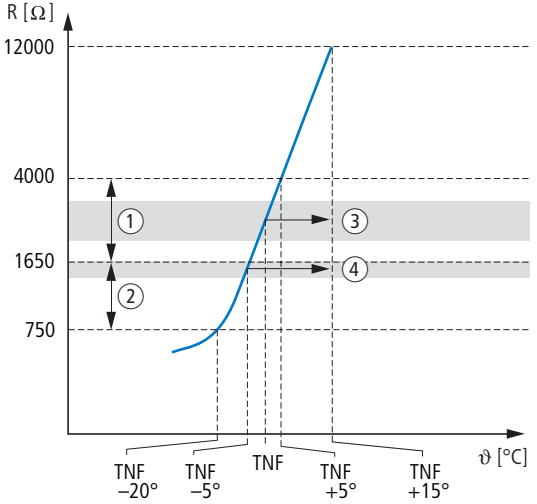


① Fault
② Parameterizable contact 1
③ Parameterizable contact 2
④ Current sensor with A/D transducer
⑤ Self hold-in of the contactor prevents an automatic re-start after the control voltage has failed and then returned (important for Ex e applications, → MN03407008Z-DE/EN)
⑥ Remote reset

Contactors and relays
ZEV electronic motor-protective system

Thermistor protection

With thermistor motor protection, to DIN 44081 and DIN 44082, up to six PTC thermistor temperature sensors with a thermistor resistance of $R_K \leqq 250\ \Omega$ or nine with a $R_K \leqq 100\ \Omega$ can be connected to terminals T1-T2.



TNF = Nominal response temperature

① Tripping range IEC 60947-8
② Re-switch on range IEC 60947-8
③ Trip block at 3200 Ω ±15 %
④ Re-switch on at 1500 Ω +10 %

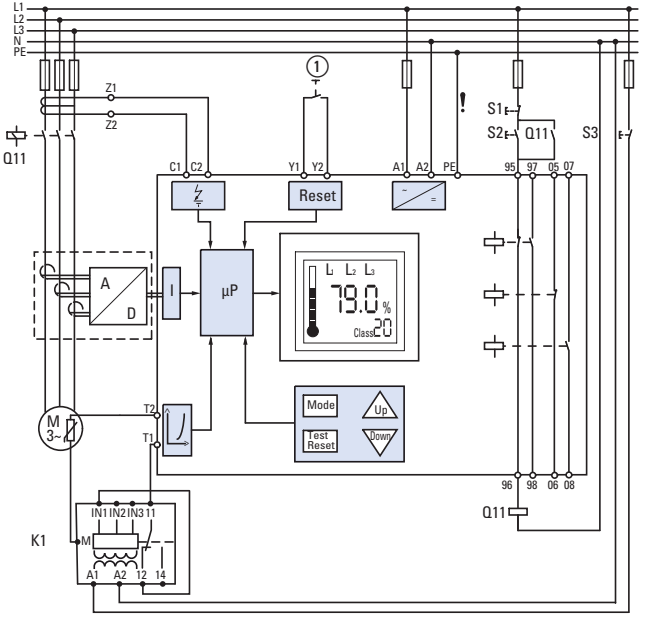
The ZEV switches off at R = 3200 Ω ±15 % and switches on again at R = 1500 Ω +10 %. The contacts 95-96 and 97-98 change over in the event of a shutdown caused by a signal at the thermistor input.

Additionally, the thermistor tripping can be programmed to different trip messages on contacts 05-06 or 07-08.

With temperature monitoring with thermistors, no dangerous condition can occur should a sensor fail as the device would directly switch off.

Contactors and relays
ZEV electronic motor-protective system

Electronic motor-protective system ZEV with short-circuit monitoring at the thermistor input



Short-circuits in the thermistor circuit can be detected if required by the additional use of a current monitoring relay K1 (e.g. type EIL 230 V AC from Crouzet).

Basic data

- Short-circuit current in the sensor circuit ≦ 2.5 mA,
- max. cable length to sensor 250 m (unscreened),
- Total cold resistance ≦ 1500 Ω,
- Programming ZEV: “Auto reset”,
- Setting current monitoring relay:
  – Device to lowest current level,
  – Overload tripping,
  – Store the tripping,
- Confirmation of the short-circuit after clearing with pushbutton S3.

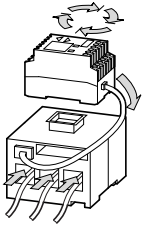
Contactors and relays
ZEV electronic motor-protective system

Device mounting

The mounting of the device is very simple due to the clip-on and the push-through cable entry.

Mounting details of every device can be found in the instructional leaflet IL03407080Z or the manual MN03407008Z-DE/EN.

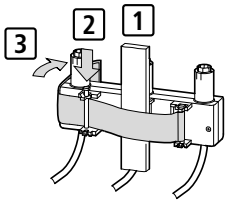
ZEV mounting and current sensor



- Place the ZEV in the desired mounting position.
- Click the ZEV on the current sensor.
- Position motor conductors through the current sensor.

Mounting on the current conductors

Due to the fixing band the Rogowski sensor ZEV-XSW-820 is particularly easy to mount. And this saves the user time and money.

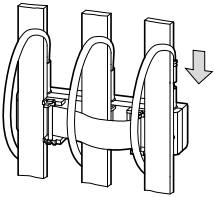


1 Wrap the band around the current conductors.

2 Engage the fixing pin.

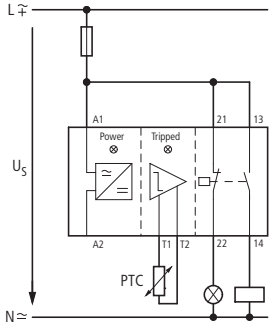
3 Pull the fixing band tight and close with the velcro fastener.

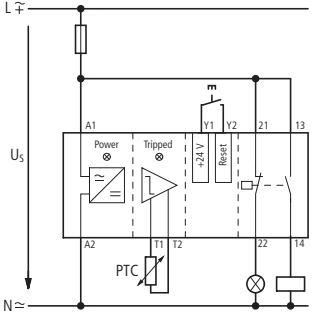
Attaching the sensor coils → following figure



Contactors and relays
Thermistor overload relay for machine protection EMT6

EMT6 for PTC thermistors





Method of operation

The output relay is actuated when the control voltage is switched on and the resistance of the PTC thermistor temperature sensor is low. The auxiliary contacts operate. On reaching the nominal response temperature (NAT), the sensor resistance becomes high and causes the output relay to drop-out. The defect is indicated by an LED. As soon as the sensors have cooled enough so that the respective smaller resistance is reached the EMT6-(K) switches automatically on again. With the EMT6-(K)DB(K) the automatic re-switch on can be defeated by switching the device to “Hand”. The unit is reset using the reset button.

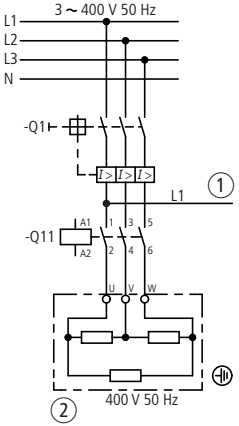
The EMT6-K(DB) and EMT6-DBK are fitted with a short-circuit recognition in sensor circuit monitor. Should the resistance in the sensor circuit fall below 20 Ω it trips. The EMT6-DBK also has a zero voltage safe reclosing lockout and stores the fault by a voltage drop. Switching on again is possible only after the fault has been rectified and the control voltage is present again.

Since all the units use the closed-circuit principle, they also respond to a wire breakage in the sensor circuit.

The thermistor machine protection relays EMT6… are accredited for protection of Ex e motors to ATEX-Guideline 94/9 EG by the German Physical/Technical Bureau. For protection of Ex e motors the ATEX-Guidelines require short-circuit recognition in the sensor circuit. Because of their integrated short-circuit recognition the EMT6-K(DB) and EMT6-DBK are especially suitable for this application.

Contactors and relays
Thermistor overload relay for machine protection EMT6

EMT6 as contact protection relay



Application example

Control of a storage tank heater

① Actuating circuit
② Heater

Q11: Heater protection

5

Functional description

For this see circuit page 5-35.

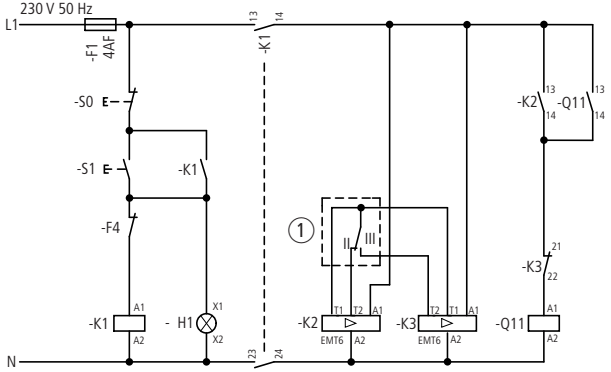
Switching on the heater
The heater can be switched on provided the main switch Q1 is switched on, the safety thermostat F4 has not tripped and the condition $T \leqq T_{min}$ is satisfied. When S1 is actuated, the control voltage is applied to the contactor relay K1, which maintains itself via a N/O contact. The changeover contact of the contact thermometer has the position I-II. The low resistance sensor circuit of the EMT6 guarantees that Q11 is actuated via K2 N/O contact 13-14; Q11 goes to self-maintain.

Switching off the heater
The heater protection Q11 stays in self maintain until the main switch Q1 is switched off, the pushbutton S0 is pressed, the thermostat trips or $T = T_{max}$.

When $T = T_{max}$ the changeover contact of the contact thermometer has the position I-III. The sensor circuit of the EMT6 (K3) is low resistance, the N/C contact K3/21-22 open. The main protection Q11 drops out.

Contactors and relays
Thermistor overload relay for machine protection EMT6

Safety against wire breakage
Security against wire breakage in the sensor circuit of K3 (e.g. non-recognition of the limit value T_{max}) is guaranteed by the use of a safety thermostat that when T_{max} is exceeded it's normally closed contact F4 switches off so that "switch off by de-energization" is carried out.



1 Contact thermometer changeover contacts
I-II position at $T \leqq T_{min}$
I-III position at $T \leqq T_{max}$

S0: Off

S1: Start

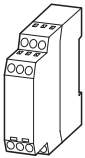
F4: Safety thermostat

K1: Control voltage "On""

K2: Switch on at $T \leqq T_{min}$

K3: Switch off at T_{max}

Contactors and relays
CMD contactor monitoring device



Operating principle

The CMD (Contactor Monitoring Device) monitors the main contacts of a contactor for welding. It compares the contactor control voltage with the state of the main contactors and indicates this reliably with a mirror contact (IEC EN 60947-4-1 Ann. F). If the contactor coil is de-energized and the contactor does not drop out, the CMD trips the backup circuit-breaker, motor-protective circuit-breaker or switch-disconnector via an undervoltage release.

The CMD also monitors the functioning of the internal relay using an additional auxiliary make contact of the monitored contactor. For this the auxiliary make and break contact is positively driven. The break contact is designed as a mirror contact.

Approved switchgear combinations

To ensure the functional reliability of the entire unit, consisting of contactor, circuit-breaker and CMD, the CMD is only approved for use with specific contactors as well as motor-protective circuit-breakers/circuit-breakers/or switch-disconnectors. CMD can be used for monitoring the welding of all DILEM and DILM7 to DILH2000 contactors. All auxiliary break contacts of these contactors are designed as mirror contacts and can be used for monitoring tasks. The NZM1 to NZM4 or N1 to N4 can be used as backup motor-protective circuit-breakers/circuit-breakers or switch-disconnectors when fitted with a NZM…-XUVL undervoltage releases.

Applications

These combinations are used in safety-oriented applications. Previously, the series connection of two contactors was recommended with circuits of safety category 3 and 4. Now one contactor and the contactor monitoring device is sufficient for safety category 3. The CMD contactor monitoring relay is used for emergency-stop applications in compliance with EN 60204-1. It can also be used in the American automotive industry. In this sector there is a demand for solutions that reliably detect the welding of the motor starters and disconnect the motor feeder safely.

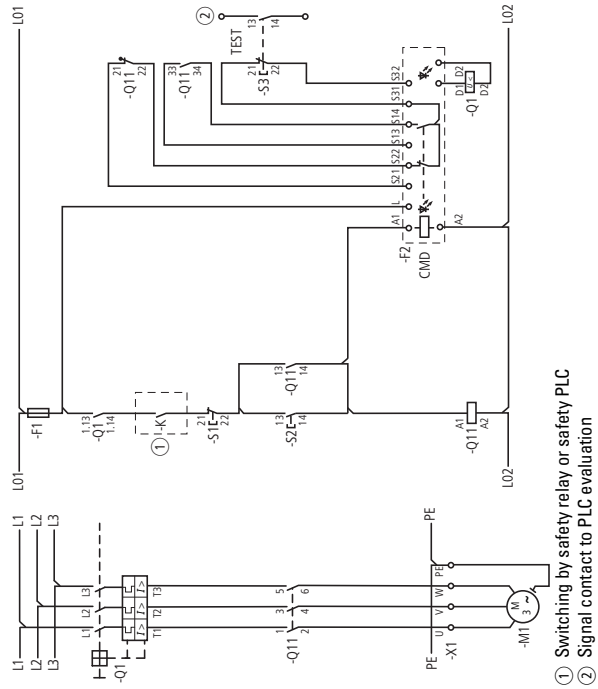
The CMD is approved as a safety module by the German employers' liability insurance association. It also has UL and CSA approval for the North American market.

Further information can be found in the manuals

- CMD(24VDC) MN04913001Z-EN
- CMD(110-120VAC), CMD(220-240VAC) MN04913002Z-EN

Contactors and relays
CMD contactor monitoring device

Circuit for DOL starters



Contactors and relays

CMD contactor monitoring device

Circuit for reversing starters