Moeller® series

**Manual**

10/12 MN04913001Z-EN
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# Contactor monitoring device CMD(24VDC), CMDTD


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**Original Operating Instructions**
The German-language edition of this document is the original operating manual.

**Translation of the original operating manual**
All editions of this document other than those in German language are translations of the original German manual.

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See revision protocol in the "About this manual" chapter



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Translation: Terence Osborn

# Danger!
# Dangerous electrical voltage!

**Before commencing the installation**

- Disconnect the power supply of the device.
- Ensure that devices cannot be accidentally restarted.
- Verify isolation from the supply.
- Earth and short circuit.
- Cover or enclose neighbouring units that are live.
- Follow the engineering instructions (IL/AWA) of the device concerned.
- Only suitably qualified personnel in accordance with EN 50110-1/-2 (VDE 0105 Part 100) may work on this device/system.
- Before installation and before touching the device ensure that you are free of electrostatic charge.
- The functional earth (FE) must be connected to the protective earth (PE) or to the potential equalisation. The system installer is responsible for implementing this connection.
- Connecting cables and signal lines should be installed so that inductive or capacitive interference does not impair the automation functions.
- Install automation devices and related operating elements in such a way that they are well protected against unintentional operation.
- Suitable safety hardware and software measures should be implemented for the I/O interface so that a line or wire breakage on the signal side does not result in undefined states in the automation devices.
- Ensure a reliable electrical isolation of the low voltage for the 24 volt supply. Only use power supply units complying with IEC 60364-4-41 (VDE 0100 Part 410) or HD 384.4.41 S2.
- Deviations of the mains voltage from the rated value must not exceed the tolerance limits given in the specifications, otherwise this may cause malfunction and dangerous operation.
- Emergency stop devices complying with IEC/EN 60204-1 must be effective in all operating modes of the automation devices. Unlatching the emergency-stop devices must not cause restart.
- Devices that are designed for mounting in housings or control cabinets must only be operated and controlled after they have been installed with the housing closed. Desktop or portable units must only be operated and controlled in enclosed housings.

- Measures should be taken to ensure the proper restart of programs interrupted after a voltage dip or failure. This should not cause dangerous operating states even for a short time. If necessary, emergency-stop devices should be implemented.
- Wherever faults in the automation system may cause damage to persons or property, external measures must be implemented to ensure a safe operating state in the event of a fault or malfunction (for example, by means of separate limit switches, mechanical interlocks etc.).

# Content

# About this Manual

**Target group**

This manual is aimed at specialist personnel involved in the design, installation, commissioning and maintenance of plant safety functions.

It describes the use of the CMD contactor monitoring device in safety-related control systems.

**Writing conventions**

Symbols used in this manual have the following meanings:

**Caution!**
Warning!
warns of the possibility of serious damage and slight injury.

**Danger!**
warns of the possibility of serious damage and slight injury or death.

Draws your attention to interesting tips and supplementary information.

For greater clarity, the name of the current chapter is shown in the header of the left-hand page and the name of the current section in the header of the right-hand page. Pages at the start of a chapter and empty pages at the end of a chapter are exceptions.

## Abbreviations and symbols

| | |
|---|---|
| IFA | Institute for Occupational Safety and Health (BGIA) |
| SIL | Safety Integrated Level |
| PL | Performance Level |
| CCF | Common cause failure |
| $DC_{avg}$ | Average diagnostic coverage |
| $MTTF_d$ | Mean time to dangerous failure |
| $B_{10d}$ | Lifespan up to a dangerous failure |
| $n_{op}$ | Mean number of annual switch operations |
| LED | LED |

## List of revisions

| Edition date | page | Subject | New | Modification | Omitted |
|---|---|---|---|---|---|
| 10/12 | 4, 6, 14 | BGIA → IFA | | ✓ | |
| | 6, 7, 13 | PKZ2 | | | ✓ |
| | 9 | Engineering IEC/EN 60204-1 | ✓ | | |
| | 15 | Installation | ✓ | | |
| 04/10 | 17 | Figure4 „Reversing starter" | | ✓ | |

# 1 CMD contactor monitoring relays

**Application of the CMD**

In the event of an emergency in safety-related electrical control circuits, the hazardous plant section is shut down from the main power supply by means of contactors → Emergency stop (stopping in the event of an emergency) in accordance with IEC/EN 60204-1.

For Category 3 control systems in compliance with EN/ISO 13849, the connection of two contactors in series is recommended. This technique can be replaced using one contactor and the CMD contactor monitoring device connected to the backup circuit-breaker/motor-protective circuit-breaker in the plant.

The contactors must be provided with an auxiliary NC contact that operates as a mirror contact in accordance with IEC/EN 60947-4-1 Annex F. The contactors also require an additional auxiliary NO contact. The motor-protective circuit-breakers/circuit-breakers are provided with an undervoltage release.

In the event of a hazard the contactor is disconnected via an upstream safety PLC or a safety relay by means of an enable contact. The CMD compares the control voltage of the contactor with the status of the main contacts. The status of the main contacts is monitored via an auxiliary NC contact that acts as a mirror contact in accordance with IEC/EN 60947-4-1 Annex F.

If the contactor is welded, the status of the main contacts does not correspond to the status of the control voltage. The undervoltage release of the backup circuit-breaker is tripped via an internal relay in the CMD. This disconnects the outgoer. The undervoltage release prevents the welded contactor from be switched on again.

The CMD contactor monitoring device is approved by the IFA in combination with Eaton contactors and circuit-breakers (→ section "System overview", Page 6). It is also provided with a CE declaration of conformity and an EU type testing certificate.

## System overview

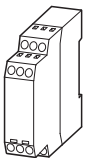


Figure 1: Contactor monitoring devices

The CMD contactor monitoring device requires a control power supply.

CMD(24VDC), CMDTD: control voltage 24 V DC

The CMD relay can be combined with the following Eaton contactors, motor-protective circuit-breakers and circuit-breakers:

- Contactors/contact modules, fitted with an auxiliary NC contact as mirror contact and an additional auxiliary NO contact
  Control voltage 24 V DC:
  - DILM(C)7, DILM(C)9, DILM(C)12, DILM(C)15, DILM(C)17, DILM(C)25, DILM(C)32, DILM(C)40, DILM(C)50, DILM(C)65, DILM(C)72, DILM(C)80, DILM(C)95, DILM(C)115, DILM(C)150, DILM(C)170
  - DILEEM-G and DILEM-G
  - DILM185A, DILM225A, DILM250, DILM300A, DILM400, DILM500

→ The contactor must be provided with an auxiliary NC contact that is designed as a mirror contact in accordance with IEC/EN 60947-4-1 Annex F.

The auxiliary NO contact and auxiliary NC contact must be interlocked opposing in accordance with IEC/EN 60947-5-1 Annex L.

The contactor and the CMD are fed with the same control voltage.

- Motor-protective circuit-breakers, circuit-breakers and switch-disconnectors, fitted with an undervoltage release
  - NZM1, N1 + NZM1-XUVL
  - NZM2, N2 + NZM2/3-XUV
  - NZM3, N3 + NZM2/3-XUV
  - NZM4, N4 + NZM4-XUV

## Improper use

The CMD contactor monitoring device has only been tested and approved in combination with the Eaton contactors and circuit-breakers that are listed in section "System overview", (→ page 6).

→ The CMD must therefore only be combined with these devices.

# 2 Engineering

**Distinction from other regulations**

The safety-related part of the CMD contactor monitoring device's control system has EN/ISO 13849-1 approval. The CMD is used for safety-related applications in machine control systems. It has not been assigned to a SIL category as per IEC/EN 61508. The system must be set up as per IEC/EN 60204-1.

**Performance Level**

The CMD contactor monitoring device can be used to set up control systems that meet the requirements of performance level (PL) "d" as per
EN/ISO 13849-1. The control system's setup meets the requirements of category "3" as per EN/ISO 13849-1.
In order to reach a PL of "d", a common-cause failure (CCF) analysis must be performed for the control system.

The control system must meet the requirements of one of the following two combinations of the average diagnostic coverage ($DC_{avg}$) and the mean time to dangerous failure ($MTTF_d$):

- $DC_{avg}$ = low and $MTTF_d$ = medium to high,
  or
- $DC_{avg}$ = medium and $MTTF_d$ = medium.

**Control system of category 3**

The CMD contactor monitoring device can be used in combination with DOL starters or reversing starters. The schematics are shown in section "Connection" (→ page 15).

→ Two CMD relays are required in reversing starter circuits.

To attain category 3, faults were excluded by wiring inside a control cabinet.

On disconnection via the undervoltage release, a time delay of 100 ms ±20 % can occur.

An enable circuit must be protected with a max. 2 A gG/gL fuse to protect the internal relay contacts.

**Average diagnostic coverage $DC_{avg}$**

Disconnection in the event of a hazardous situation is implemented from two units that are included in the calculation as parallel channels:

- Channel 1: contactor,
- Channel 2: series connection of the CMD and undervoltage release of the motor-protective circuit-breaker/circuit-breaker.

The mirror contacts used allows a $DC_{avg}$ = 99 % to be applied to channel 1.

For channel 2 the $DC_{avg}$ for the CMD was calculated at $DC_{avg}$ = 90 %. The undervoltage release can be estimated a $DC_{avg}$ = 60 % provided that regular inspections are carried out.

→ The function of the undervoltage release must be tested manually at regular intervals.

The generally recognized inspection frequency is a hundred times more often than the $MTTF_d$. The test interval can be determined from:

$$T_{Test} = \frac{MTTF_d}{100} \quad \text{(formula 1)}$$

→ section "Mean time to dangerous failure MTTFd" (→ page 11).

It is recommended that the test is carried out under no-load conditions.

## Mean time to dangerous failure $MTTF_d$

The $MTTF_d$ time for the components is based on

$$MTTF_d = \frac{B_{10d}}{0.1 \times n_{op}} \quad \text{(formula 2)}$$

with
$B_{10d}$: Lifespan up to a dangerous failure (→ Tables)

$n_{op}$: Average number of annual switch operations

The $MTTF_d$ time for the CMD contactor monitoring device was calculated at $MTTF_d$ = 125 years. This value is based on a maximum operating frequency of 350, 400 operations/year (1 operation per minute, 16 hours per day, 365 days a year).

The $MTTF_d$ time of the contactors depends on the application. The utilization category in accordance with IEC/EN 60947-4-1 and the operating frequency are an important factor here. Depending on the utilization category, the following values can be applied to $B_{10d}$, →Tabelle 1:

Table 1: $B_{10d}$ values for contactors

| Contactor | $B_{10d}$ value | | |
|---|---|---|---|
| | Utilization category AC-3 [Mill. switch operations] | Utilization category AC-4 [Mill. switch operations] | Utilization category AC-1 [Mill. switch operations] |
| DILM7 | 1.3 | 0.2 | 0.6 |
| DILM9 | 1.3 | 0.2 | 0.6 |
| DILM12 | 1.3 | 0.2 | 0.6 |
| DILM15 | 0.75 | 0.2 | 0.6 |
| DILM17 | 1.3 | 0.2 | 0.6 |
| DILM25 | 1.3 | 0.2 | 0.6 |
| DILM32 | 1.3 | 0.2 | 0.6 |
| DILM40 | 1.3 | 0.2 | 0.6 |
| DILM50 | 1.3 | 0.2 | 0.6 |
| DILM65 | 1.3 | 0.2 | 0.6 |
| DILM72 | 0.75 | 0.2 | 0.6 |
| DILM80 | 1.3 | 0.2 | 0.6 |
| DILM95 | 1.3 | 0.2 | 0.6 |
| DILM115 | 1.3 | 0.2 | 0.6 |
| DILM150 | 1.3 | 0.2 | 0.6 |
| DILM170 | 0.75 | 0.2 | 0.6 |
| DILM185 | 1.3 | 0.04 | 1.2 |
| DILM225 | 1.3 | 0.04 | 0.6 |
| DILM250 | 1.3 | 0.04 | 0.4 |
| DILM300 | 1.3 | 0.04 | 1.7 |
| DILM400 | 1.3 | 0.04 | 1.2 |
| DILM500 | 1.3 | 0.04 | 0.3 |

The $MTTF_d$ time of the contactor is calculated according to formula 2 with the mean annual number of switch operations depending on the application.

The $MTTF_d$ value of the undervoltage release depends on the application. The following values can be estimated for $B_{10d}$:

Table 2: $B_{10d}$ values for undervoltage release

| **Undervoltage release** | **$B_{10d}$ value [Switch operations]** |
|---|---|
| NZM1 | 10000 |
| NZM2 | 10000 |
| NZM3 | 7500 |
| NZM4 | 5000 |

At an assumed operating frequency of 3 operations per day up to NZM2 and 1.33 operations per day for the NZM3 and NZM4 the $MTTF_d$ value is:

Table 3: $MTTF_d$ values for undervoltage releases

| **Undervoltage release** | **$B_{10d}$ value [Switch operations]** | **Operations per working day** | **$n_{op}$ [O/year]** | **$MTTF_d$ [Years]** |
|---|---|---|---|---|
| NZM1 | 10000 | 3 | 750 | 133 |
| NZM2 | 10000 | 3 | 750 | 133 |
| NZM3 | 7500 | 1.33 | 333 | 225 |
| NZM4 | 5000 | 1.33 | 333 | 150 |

→ An annual inspection meets the requirements in accordance with section "Average diagnostic coverage DCavg" (→ page 10).

For further calculation of the safety function see EN/ISO 13849.

**Approvals**

The CMD contactor monitoring device is approved by the IFA in combination with Eaton contactors and circuit-breakers (→ section "System overview", Page 6).
A CE declaration of conformity and a prototype test certification are also available.

The CMD has UL and CSA approval for the US and Canadian markets.

**Product standard**

The CMD contactor monitoring device meets the product standard for Low-voltage switchgear and controlgear – Part 5-1:
Control circuit devices and switching elements – Electromechanical control circuit devices, DIN/EN 60947-5-1 (IEC 60947-5-1).

**Electromagnetic compatibility (EMC)**

No particular EMC measures are required for the CMD contactor monitoring device.

The CMD complies with the following standards:

- DIN/EN 61000-6-2: EMC generic standard, interference immunity for the industrial environment,
- DIN/EN 61000-6-4: EMC generic standard, emitted interferences for the industrial environment.

# 3 Installation

## Mounting

The CMD contactor monitoring device is mounted on a top-hat rail. Any mounting position is possible.

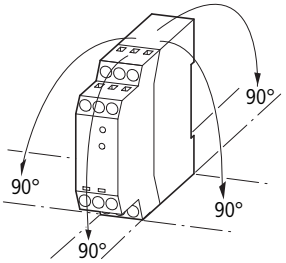



Figure 2: Mounting positions for CMD

→ The electrical mounting space must at least meet the requirements of IP54 protection.

During installation, a lateral clearance of at least 22.5 mm must be kept from other devices.

## Connection

The CMD relay can be used for DOL starters and for reversing starters.

→ All connected devices, such as pushbuttons, must have a rated insulation voltage $U_i \geqq 300$ V.

## Connection for DOL starters

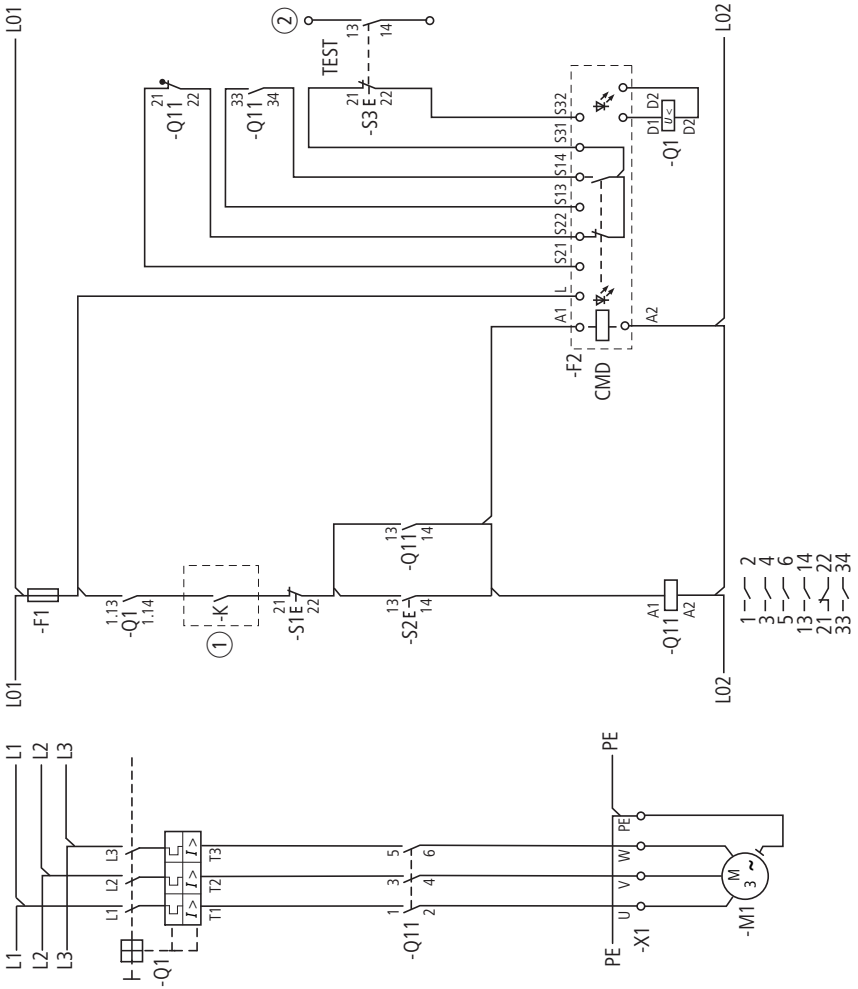



Figure 3: DOL starter

① Switching by safety relay or safety PLC

② Signal contact to PLC evaluation

## Connection for reversing starters

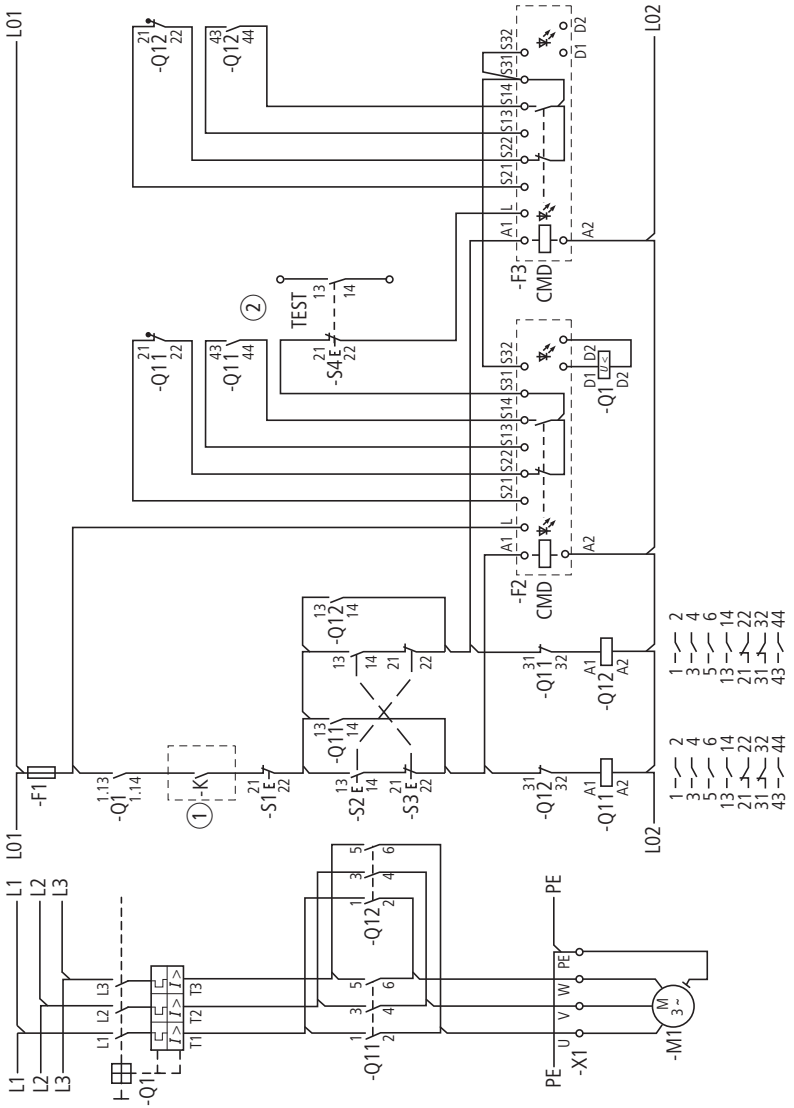



Figure 4: Reversing starter

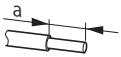
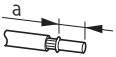
① Switching by safety relay or safety PLC

② Signal contact to PLC evaluation

## Wiring

The following cables can be used for wiring at the terminals at the CMD contactor monitoring device.

Table 4: Conductor cross-sections

|  |  | | | |
|---|---|---|---|---|
| **mm²** | **mm²** | **AWG** | **N/m** | **lb-In** |
| 1 × (0.5 - 2.5) | 1 × (0.5 - 2.5) | 20 - 14 | 0.8 - 1.2 | 7.0 - 10.6 |
| 2 × (0.5 - 1.5) | 2 × (0.5 - 1.5) | – | 0.8 - 1.2 | – |



⚠ IP2X
a ≦ 6 mm

→ The same cable cross-section must be used when wiring two cables in one terminal.

A size Z2 Phillips screwdriver or standard screwdriver size 0.8 × 4 to 5.5 are recommended tools for wiring the terminals on the CMD relay.

# 4 Operating the device

**Function messages**

The CMD contactor monitoring device is fitted with two internal LEDs for status indication at the device.

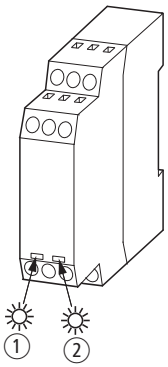



Figure 5: LED indication

① A green LED labelled „Contr." (Control)
The „Contr." LED indicates the control for the CMD and the contactor.

② A green UVR (Undervoltage Release) LED
The UVR LED indicates the state of the power supply to the undervoltage release. If the LED is off, the circuit-breaker has been tripped by the undervoltage release.

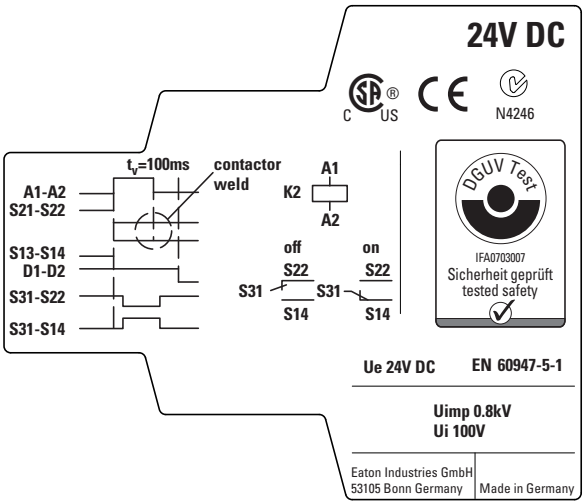
## Test function

The control system must be tested regularly during operation via the Test button. An annual test is sufficient. The test determines the reliable operation of the undervoltage release. The test button must be provided with another NO contact in addition to the NC contact for the actual test. This contact signals the test to a PLC which then indicate the next text interval.

→ The test should be carried out in no-load conditions.

# Appendix

## Nameplate



| Technical Data | General | | |
|---|---|---|---|
| Standards | | | IEC/EN 60947; UL, CSA |
| Lifespan, mechanical | | | |
| DC operated | Operations | $\times 10^6$ | 3 |
| Maximum operating frequency | Operations | $\times 10^6$ | 9000 |
| Climatic proofing | | | • Damp heat, constant, to IEC 60068-2-78<br>• Damp heat, cyclic, to IEC 60068-2-30 |
| Ambient air temperature | | | |
| Storage | | °C | -40 - 80 |
| Open[1)] | | °C | -25 - 50 |
| Mounting position | | | Any |
| Mechanical shock resistance (IEC/EN 60068-2-27) | | | |
| Half-sinusoidal shock 10 ms | | | |
| N/O | | g | 4 |
| NC | | g | 4 |
| Degree of protection | | | IP20 |
| Protection against direct contact when actuated from front (VDE 0106 Part 100) | | | Finger- and back-of-hand proof |
| Weight | | kg | 0.1 |
| Terminal capacity | | | |
| solid | | $mm^2$ | 1 × (0.75 - 2.5)<br>2 × (0.75 - 1.5) |
| Flexible with ferrule | | $mm^2$ | 1 × (0.75 - 2.5)<br>2 × (0.75 - 1.5) |
| Solid or stranded | | AWG | 20 - 14 |
| Terminal Screw | | | M3.5 |
| Pozidriv screwdriver | | Size | 2 |

| | | | |
|---|---|---|---|
| Standard screwdriver | | MM | 0.8 × 5.5 / 1 × 6 |
| max. tightening torque | | N/m | 1.2 |

1) Minimum clearance to adjacent devices: 22.5 mm

## Contacts

| | | | |
|---|---|---|---|
| Rated impulse withstand voltage | $U_{imp}$ | V AC | 800 |
| Overvoltage category/ pollution degree | | | III/3 |
| Rated insulation voltage | $U_i$ | V AC | 100 |
| Rated operational voltage | $U_e$ | V DC | 24 |
| Conventional thermal current | $I_{th}$ | mA | 65 |
| Short-circuit protective device maximum fuse | | | |
| EN 60269-1 | | A gG/gL | 2 |

## Magnet systems

| | | | |
|---|---|---|---|
| Voltage tolerance | | | |
| Pick-up voltage | | | |
| AC operated | Pick-up | × $U_c$ | 0.85 - 1.1 |
| DC operated | Pick-up | × $U_c$ | 0.85 - 1.1 |
| Power consumption | | | |
| DC operated | Pick-up = sealing | W | 4 |
| Duty factor | | % DF | 100 |
| Delay time | $t_u$ | ms | 100 ±20 % |

## Dimensions