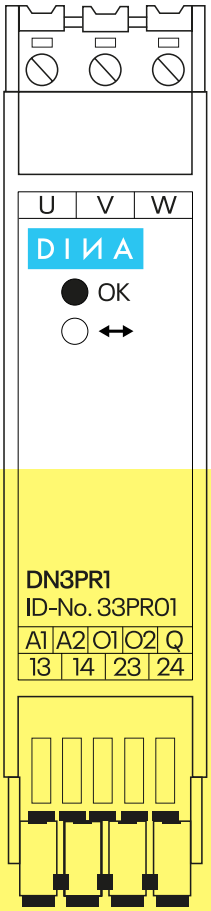
# SAFEONE DN3PR1

## Hardware




Safety module for sensorless detection
of direction of rotation

dina.de

**DINA Elektronik GmbH**
Esslinger Straße 84
72649 Wolfschlugen
Germany

**Phone** +49 7022 9517 0
**Fax** +49 7022 9517 700
**Mail** info@dina.de
**Web** www.dina.de



**Legal information**

| | |
|---|---|
| Handbook: | Hardware |
| Target group: | Elektroniker, Elektrokonstrukteur |
| Editor: | DINA Elektronik GmbH |
| File name: | BA_dn3pr1_20210611 |
| Language: | ENG |
| Publication as at: | 11. June 2021 |

# Table of contents

# 1 Structure of the document

## 1.1 Conventions

Information of particular important is emphasized in this documentation through the use of symbols, typography or formulations.

### 1.1.1 Emphasizing information

The following symbols indicate important information:

| | |
|---|---|
|  | Degree of hazard (e. g. **WARNING**):<br>Triangular symbols indicate the degree of hazard in warnings. |
|  | Type of hazard (e.g. **electrical shock – dangerous voltage**):<br>Triangular symbols indicate the type of hazard in warnings. |
|  | **Information:** Additional clarification |
|  | **Tip:** Additional information to help optimize the workflow. |

### 1.1.2 Emphasizing paragraphs using typography

The following typography is used to emphasize paragraphs with special functions:

| | |
|---|---|
| ▶ | Indicates an instruction. |
| ◀ | Indicates an expected reaction. |
| ▼ | Indicates an unexpected reaction. |
| ● | Indicates an item in a list. |

### 1.1.3 Emphasizing words using typography

The following typography is used to emphasize words with special functions:

| | |
|---|---|
| ❶ | Represents a numbered item in a figure. |
| → | Indicates a cross-reference to another page, figure or document. |

## 1.2 We value your opinion!

We do all we can to provide complete, accurate documentation for the product. If you have any suggestions for improvement or advice for us, please share your thoughts with us. Send us your comments by e-mail to the following address.

**E-Mail: info@dina.de**

# 2 Safety

## 2.1 Warnings

### 2.1.1 Function of warnings

Warnings warn users about hazards when handling the product. The hazards are classified, specified, described and supplemented with information about how to avoid them.

- **If there is a warning before a list of instructions, the hazard is present throughout the entire activity.**
- **If there is a warning immediately before an instruction, the hazard is present during the next step.**

### 2.1.2 Design of warnings

All warnings are indicated by a signal word and a warning symbol. The different combinations of the signal word and warning symbol indicate the degree of danger.

| | |
|---|---|
|  | **DANGER**<br>For an immediate hazard that will result in severe injuries or death. |
|  | **WARNING**<br>For an immediate hazard that could result in severe injuries or death. |
|  | **CAUTION**<br>For a potentially hazardous situation that could result in injuries. |
|  | **CAUTION**<br>For a potentially harmful situation in which the product or an item near it could be damaged. |
|  | **CAUTION**<br>For a hazard that could cause environmental damage. |

### 2.1.3 Hazard symbols

**Note**

The warning symbol may be present alongside another hazard symbol that represents the type of hazard, in order to attract the reader's attention.

Hazard symbols are indicated by a triangular symbol in the context of warnings. The following hazard symbols are used in this documentation:

**Electric shock – dangerous voltage!**

## 2.2 Qualification of personnel

**DINA Elektronik GmbH** distinguishes between specialist staff with different qualifications when it comes to carrying out work on the product. The minimum required qualifications are specified for each task and are defined as follows:

### 2.2.1 Electrician

Specialist who installs, maintains and repairs the electrical system in the product. A specialist is a person whose specialist training means that they have the knowledge and experience, including knowledge of relevant regulations, necessary to assess the work assigned to them and the potential hazards.

**Note**

When evaluating a person's specialist training, multiple years of work in the relevant field may also be taken into account.

→ **DIN VDE 1000-10** Requirements for persons working in a field of electrical engineering

### 2.2.2 Electrical designers

Specialists who design the electrical system and the product. A specialist is a person whose specialist training means that they have the knowledge and experience, including knowledge of relevant regulations, necessary to assess the work assigned to them and the potential hazards.

**Note**

When evaluating a person's specialist training, multiple years of work in the relevant field may also be taken into account.

→ **DIN VDE 1000-10** Requirements for persons working in a field of electrical engineering

## 2.3 Intended use and improper use

The product has exclusively been developed for use for the purpose described here. The specifications set out in these operating instructions must be strictly complied with.

- **DN3PR1 is a safety module for sensorless direction monitoring of three-phase asynchronous motors.**
- **The safety module is intended for use on machines and plants to prevent hazards from arising.**

Any other form of use is regarded as improper use.

If the product is
- **not used as intended,**
- **improperly maintained or**
- **incorrectly operated,**

the manufacturer will not assume any liability for any damage that results. In this case, the risk shall be borne exclusively by the user.

### 2.3.1 Certification data

The product is certified as safety equipment in accordance with:

DIN EN ISO 13849-1:2016-06,
PLe, Sil 3, Kat. 3
Pld, Sil 2, Kat. 3

In compliance with the following safety regulations:

**WARNING**

**To check for failure of a motor phase**

With PLe, Sil 3, Cat. 3: The motor must be switched torqueless for at least 5 s once a day.

With Pld, Sil 2, Cat. 3: The motor must be switched torqueless for at least 5 s once quarterly.

## 2.4 Documentation

Operating instructions contain instructions on how to use a product safely, correctly and cost-effectively. Follow the instructions in these operating instructions in order to prevent hazards, avoid repair costs and standstill, and improve the reliability and service life of the product.
You must read the documentation and ensure that you understand them.

▶ Before working with the product, read the documentation that come with the product.

▶ Always ensure that the documentation is available where the product is in use.

## 2.5 Safety regulations

The safety regulations listed below must always be complied with. In the event that these safety regulations are not complied with or the device is used improperly, **DINA Elektronik GmbH** accepts no liability for any resulting injury or damage.

- **The product must only be installed and commissioned by a skilled electrician or a trained, instructed person, who is familiar with these operating instructions and the applicable specifications regarding occupational health and safety and accident prevention.**

**WARNING**

**Danger to persons and materials!** In the event that specifications are not complied with, this can result in death, severe injuries or significant material damage.

▶ Observe VDE, EN and local regulations, in particular with regard to protective measures.

- **If the emergency stop is used, either the integrated restart prevention function must be used or the machine must be prevented from restarting automatically using a superordinate control system.**

- **When installing the device, the required distances as per DIN EN 50274, VDE 0660514 must be taken into account.**

▶ During transport, storage and operation, comply with the conditions set out in EN 60068-2-1, 2-2.

▶ Assemble the device in a control cabinet with at least IP54 degree of protection. Otherwise, dust and moisture can impair the functions. The device must be installed in a control cabinet.

▶ Ensure that the output contacts have sufficient protective circuitry for capacitive and inductive loads.

▶ Follow the specifications in the general technical data.

**Note**

More detailed information can be found in the R **Technical data** section.

**WARNING**

**Electric shock – dangerous voltage!** During operation, switching devices conduct dangerous voltages.

Never remove protective covers from electrical switching devices during operation.

▶ **Replace the device the first time a fault occurs.**

Dispose of the device in accordance with nationally applicable environmental regulations.

## 2.5.1 Retrofitting and conversion

- Unauthorized conversion voids any warranty. This can cause hazards that can lead to severe or even fatal injury.

## 2.5.2 Basic safety regulations

The safety regulations listed below must always be complied with. In the event that these safety regulations are not complied with or the device is used improperly, **DINA Elektronik GmbH** accepts no liability for any resulting injury or damage.

- **The product described here has been developed to perform safety-related functions as part of an entire system.**
- **The entire system is made up of sensors, analysis units, reporting units and safe switch-off concepts.**
- **It is the manufacturer's responsibility to ensure that a system or machine is functioning correctly as a whole.**
- **The manufacturer of the system is obligated to check and document the efficacy of the implemented safety concept within the entire system. This documentation must be produced again every time the safety concept or safety parameters are modified.**
- **The manufacturer's specifications for the system or machine with regard to maintenance intervals must be complied with.**

- **DINA Elektronik GmbH** is not able to make any guarantees regarding the properties of an overall system not designed by the company.
- **DINA Elektronik GmbH** accepts no liability for any recommendations given or implied in the following description.
- No new guarantee, warranty or liability claims that go beyond **DINA Elektronik GmbH**'s general delivery conditions can be derived from the following description.
- To prevent EMC disturbances, the physical environmental and operating conditions where the product is installed must correspond to the EMC section of DIN EN 60204-1.
- If contact outputs are used, the safety function must be requested at least once per month for Performance Level (e) and once per year for Performance Level (d).

## 2.6 Working on live parts

**WARNING**

**Electric shock – dangerous voltage!** Touching live components can cause severe or even fatal injury, depending on circumstances, as a result of an electric shock.

- ▶ Never assume that a circuit is dead.
- ▶ Always check circuits as a safety precaution! Components being worked on may only be live if this is absolutely necessary and stipulated.
- ▶ Accident prevention regulations (e.g. VBG4 and VDE 105) must be observed during all work.
- ▶ Only use suitable, intact tools and measuring equipment.

# 3 EC declaration of conformity

DINA

## Original EG-Konformitätserklärung

(gemäß der Richtlinie 2006/42/EG, Anhang II, 1A)

## Original EC-Declaration of Conformity

(according to Directive 2006/42 / EC, Annex II, 1A)

DINA Elektronik GmbH
Esslinger Str. 84
72649 Wolfschlugen
Deutschland

Wir erklären, dass folgendes Produkt allen einschlägigen Bestimmungen der Richlinie 2006/42/EG entspricht.
We declare, that the following product fulfils all the relevant provisions of Directive 2006/42 / EC.

| Produkt/Product | Funktion/Function |
|---|---|
| DN3PR1<br>Drehrichtungswächter ohne Sensorik/<br>direction monitoring without sensor<br>ID-No. 33PR01 | Sensorlose Drehrichtungsüberwachung<br>bei Dreiphasen-Motoren<br>Sensorless direction monitoring for 3-phases motors |

| Weitere EU-Richtlinien/Further EC- directives |
|---|
| 2014/30/EU EMV-Richtlinie/EMC-Directive<br>2011/65/EU RoHS Richtlinie/RoHS-Directive |

| Benannte Stelle/Notified Body | EG Baumusterprüfbescheinigung/EC Type-Examination certificate |
|---|---|
| TÜV Rheinland Industrie Service GmbH<br>Am Grauen Stein<br>51105 Köln<br>Germany<br>NB 0035 | Reg.-Nr./No.: 01/205/5832.00/21 |

| Bevollmächtigter für die Zusammenstellung der technischen Unterlagen/<br>Authorized representative for the compilation of the technical documents |
|---|
| DINA Elektronik GmbH<br>Esslinger Str. 84<br>72649 Wolfschlugen<br>Deutschland |

Stefan Najib
Geschäftsführer/CEO

Wolfschlugen, 06.11.2020

# 4 Function description

The two-channel evaluation unit of the safety module measures the frequency of the rotating field on the motor at the measurement inputs U, V, W and evaluates the direction of rotation based on the phase position of the motor drive voltage U, V, W.

A change in the direction of rotation changes the switching status of the enabling current path 13/14, 23/24.

Operation on electrical power drive systems with adjustable speed is possible. Operation on a single-phase motor is not possible.

**WARNING**

The device is only suitable for asynchronous motors. When using frequency converters, the supply voltage of 277V AC (480V AC phase to phase) must not be exceeded.

**Note**

The direction monitoring takes place in the frequency range 5 Hz to 100 Hz.

The enabling current path remains switched on at frequencies <5Hz. At frequencies> 100Hz, the previous state of the outputs is retained.

## 4.1 Acknowledge Input

The acknowledgment input enables the enabling current path to be switched on.

The start takes place with a falling edge of a 24V signal. The start signal is subject to time monitoring. The 24V signal must be present at input Q for at least 200ms and a maximum of 10s.

## 4.2 Signal outputs

You can use the signal outputs O1 and O2 to control e.c. a non-safety PLC or signal units.

The message outputs have the following properties:

- **24V, digital**
- **potential-bound**
- **short circuit and overload protection**
- **not safety-related**

The output O1 indicates the state of the enabling current path.

The output O2 indicates the operational readiness. This switches off in case of an error.

## 4.3 LED-Display

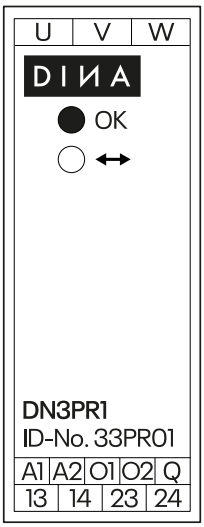
The safety switchgear indicates its operational readiness and the status of the enabling current path by the two-color LEDs „OK" and ⟷ .

The module is ready for operation when the OK LED lights up green.
The red flashing LED "OK" indicates an error.

| Legend | |
|---|---|
| | LED on |
| | LED off |
| | LED flashing |

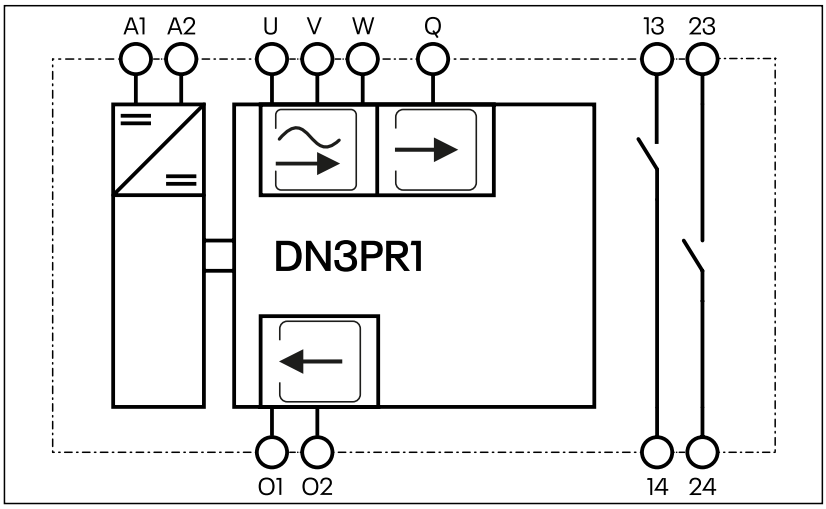
| SAFEONE DN3PR1 | | Status |
|---|---|---|
| LED OK | LED ⟷ | |
| | | Enabling current path closed |
| | | Enabling current path open |
| | | **Error**<br>Enabling current path open |
| | | **Device defective**<br>Enabling current path open |

## 4.4 Pin assignment




| | |
|---|---|
| **U, V, W** | Measuring inputs are to be connected directly to the motor, without switching contacts between. |
| **A1** | Power supply +24V DC |
| **A2** | Power supply 0V |
| **Q** | Acknowledgment input for manual, monitored starting. |
| **O1, O2** | Digital positive switching semiconductor outputs for the transmission of switch-ing states to a higher-level control for diagnostic tasks. |
| **13-14/23-24** | Enabling contacts (2 NO-contacts) |
| **OK-LED** | Operational readiness |
| ⟷ | State of the enabling current path 13-14/23-24 |

## 4.5 Block diagram




Measuring inputs

Inputs

Outputs

# 5 Launch

▶ Disconnect the device from the power supply before starting work.

▶ Wire the device according to the intended use.

After applying the operating voltage (24 V DC) to terminals A1 and A2, the safety relay will operate a self-test. The safety relay is in safe condition for the duration of the self-test. All enabling current paths are open.

After a successful self-test, the device is ready for operation. The LED OK lights up green.

▶ Start the drive and acknowledge via the acknowledgment input.

▶ Check whether the enabling current path switches on in the desired direction of rotation and switches off in the opposite direction. The switching states can be changed by swapping phases U and V.

**CAUTION**

The drive must not be able to brake within 20ms at a speed corresponding to 100Hz, to change the direction of rotation and back to 100Hz accordingly to accelerate.

**CAUTION**

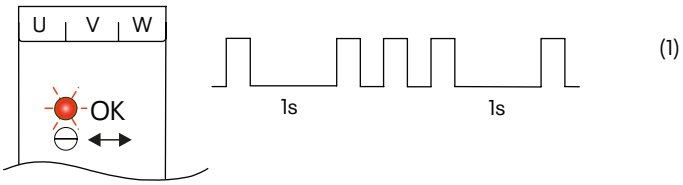
Note that the method of frequency measurement does not recognize a mechanically blocked motor or an overloaded motor!

# 6 Diagnostics

The safety switching device shows diagnosed errors that lead to a safe condition of the device by means of a flashing code of the "OK" LED on the device.

The flashing code is repeated continuously with a pause of 1 s.

The meaning of the individual flashing codes can be found in the table.

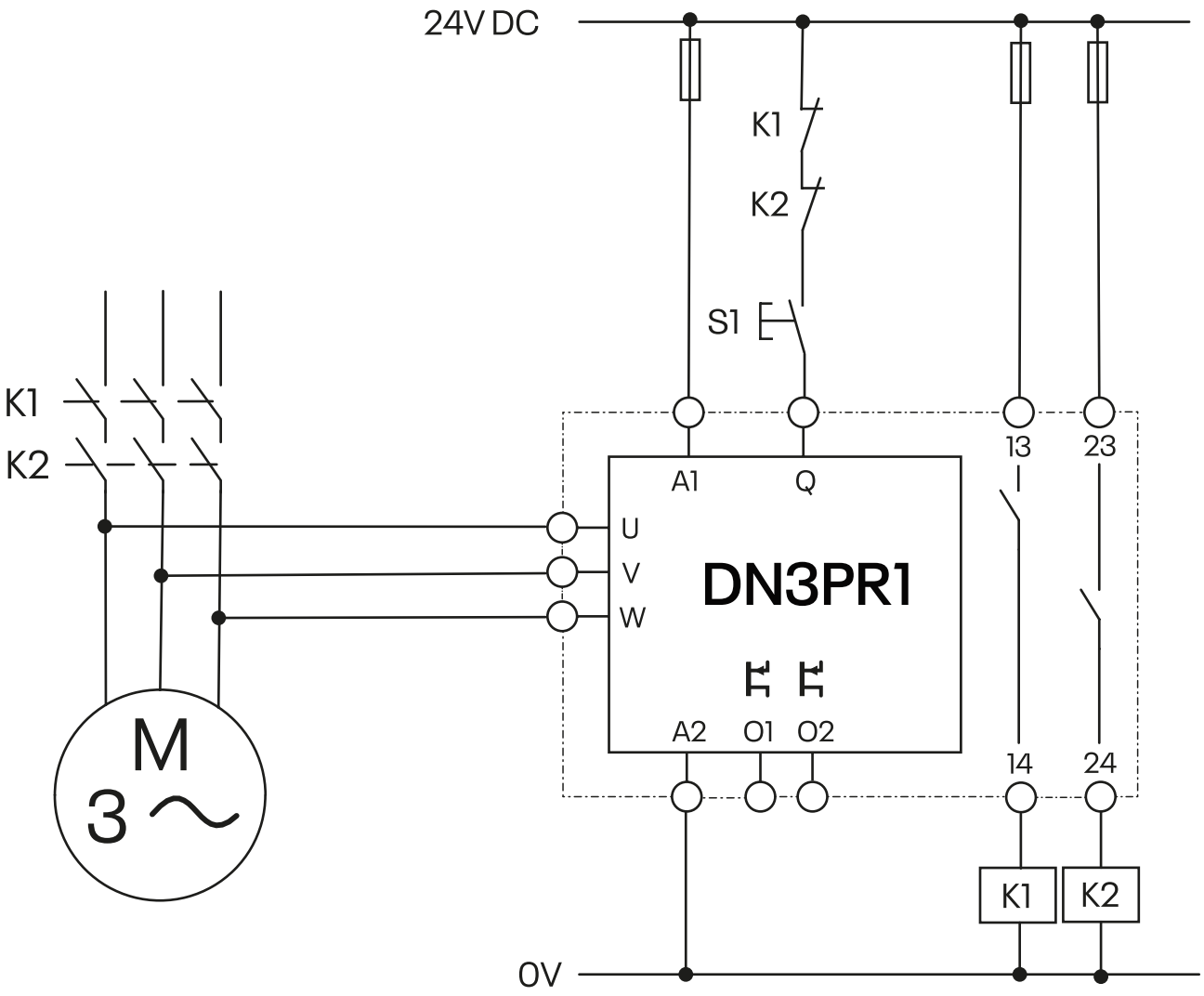



(1)

| Code | Meaning | Remedy |
|---|---|---|
| **1 x flash** | Incorrect power supply | ▶ Check power supply<br>UB = 20.5V-26,5V DC |
| **2 x flash** | Parameter-/EEPROM-/<br>Check sum error | ▶ Restart the device or send the device to DINA Elektronik. |
| **3 x flash** | Incorrect acknowledge signal at input Q | ▶ Check the wiring at input Q for cross or short circuits.<br>**For manual acknowledgment:**<br>▶ Check whether the start signal is within the time range of min. 200ms to max. 10s. |
| **4 x flash** | Open circuit on U, V, W | ▶ Check the wiring at the measuring inputs for<br>• Short circuit<br>• Cross-connection<br>• Wire break |
| **5 x flash** | Error phase shift | ▶ Check the wiring at the measuring inputs for<br>• Wire break |
| **6 x flash** | Relay error | ▶ Send the device to DINA Elektronik for testing. |
| **7 x flash** | Single-channel error | ▶ Check the wiring at the measuring inputs for<br>• Short circuit<br>• Cross-connection<br>• Wire break |
| **8 x flash** | Frequency > 1500Hz | ▶ Check the frequency at the measuring inputs.<br>The working range goes up to 1200Hz. |
| **9x flash** | Frequency of direction changes too great. | ▶ Check the wiring at the measuring inputs for<br>• Short circuit<br>• Cross-connection<br>• Wire break |
| **10x flash** | Coast failure: The frequency measured last was > 50Hz | The motor signals were switched off abruptly.<br>▶ Check that the converter is ready for operation. |
| **11x flash** | Internal error | ▶ Send the device to DINA Elektronik for testing |
| **12x flash** | Internal error | ▶ Send the device to DINA Elektronik for testing |

# 7 Example of application

| | |
|---|---|
| **Measuring inputs** | The measurement inputs U, V, W of the DN3PR1 are directly connected to the three phases of the motor M. |
| **Switch off safely** | When the DN3PR1 detects a change of direction, the enabling current paths 13/14, 23/24 open and shut down the motor in a safety-related manner. |
| **Resetting the safety function** | The acknowledgment button S1 is used to reset the safety function after the motor turns again in the preferred direction. |
| **Monitoring of external contactors** | The external, positively driven contactors K1, K2 are integrated in the start circuit of the safety switching device. |



# 8 Order data

| Description | Produkt | ID-No. |
|---|---|---|
| **Sensorless direction detection, 2 contact outputs** | DN3PR1 | 33PR01 |

# 9 Technical data

## 9.1 Operating

| | |
|---|---|
| **Operating voltage $U_B$** | 24 V DC (-15/+10%) |
| **Current draw at 24V** | 80 mA |
| **Power consumption at A1/A2** | 1,9 W |

## 9.2 Digital inputs

| | |
|---|---|
| **Inputs** | 1 safety input Q |
| **Voltage** | 24V DC (-15/+10%) |
| **Current** | < 5,0 mA |
| **Power consumption** | typ. 4 mA (at $U_B$) |

## 9.3 Measuring inputs

| | |
|---|---|
| **Measuring inputs** | U, V, W |
| **Voltage** | 90V AC to 480V AC (phase to phase) |
| **Power consumption** | 0,24mA to 480V AC |
| **Maximum frequency** | 1200Hz |

| | |
|---|---|
| **Detection of rotation direction** | >5Hz to 100Hz, two signal periods |
| **Minimum-PWM** | 1kHz |

## 9.4 Signal outputs

| | |
|---|---|
| **Outputs** | O1, O2<br>unsafety |
| **Voltage** | UB – 1V |
| **Max. current** | ≤ 100mA, shot-circuit and overload protection |

## 9.5 Contact outputs

| | |
|---|---|
| **Outputs** | 13/14, 23/24 |
| **Contact material** | $AgSnO_2$ |
| **Operating voltage** | 24V DC / 230V AC |
| **Minimum switching current** | 3 mA/ 24V DC |
| **Maximum switching current** | 6A / 24V DC / 230V AC |
| **Short-circuit strength** | 1000A SCPD 6A gL/gG |
| **Mechanical life** | $10^7$ switching cycles |
| **Switch-off time** | 2 x (period (reciprocal value of the set frequency) + max. 2ms cycle time) + max 10ms relay switch-on time |
| **Process safety time** | 1,8 s |
| **Contact fuse** | 6 A gL/gG |
| **B10d values acc. to DIN EN 61810-2-1, 01.2012** | **AC15:** 5A/230V AC, >2x$10^5$ switching cycles<br>**AC1:** 6A/230V AC, >2x$10^5$ switching cycles<br>**DC13:** 4A/24V DC, >3x$10^5$ switching cycles<br>**DC1:** 6A/ 24V DC, >7x$10^6$ switching cycles |

## 9.6 General data

| | |
|---|---|
| **Type of protection(housing and terminals)** | IP 20 |
| **Type of protection (place of installation)** | min. IP 54 |
| **Air and creepage distances** | acc. DIN EN 50178 |
| **Rated insulation voltage** | 400V AC to ground<br>690V AC phase to phase |
| **Rated surge voltage / insulation** | **Basic insulation 6kV:**<br>between all current paths and housing.<br>**Safe insulation, reinforced insulation 8kV:**<br>between U, V, W and A1, A2, O1, O2, Q<br>between U, V, W and 13/14, 23/24 |
| **Degree of contamination** | 2 |
| **Overvoltage category** | III |
| **Housing material** | Polyamid (PA), not reinforced |

## 9.7 Connection data

| | | | |
|---|---|---|---|
| **Terminals** | Push-in terminals | | Screw |
| **Number of positions** | 4 | 5 | 3 |
| **Connection cross-section** | 0,25 – 2,5mm² | 0,25 -1,5mm² | 0,25 – 2,5mm² |
| **Connection cross-section AWG** | 24...12 | 24...16 | 24...12 |
| **Tightening torque** | - | - | 0,5Nm/0,6Nm |
| **Connection wire** | Only 60/75°C copper | | |

## 9.8 Environmental conditions

| | |
|---|---|
| **Operating temperature** | -20°C to +55°C |

| | |
|---|---|
| **Storage temperature** | -40 °C to +85 °C |
| **Altitude of place of use** | < 2000m above sea level |
| **Output relay shock resistance** | 10–150Hz, 1g |
| **Vibration resistance** | 15g |

## 9.9 Dimensions

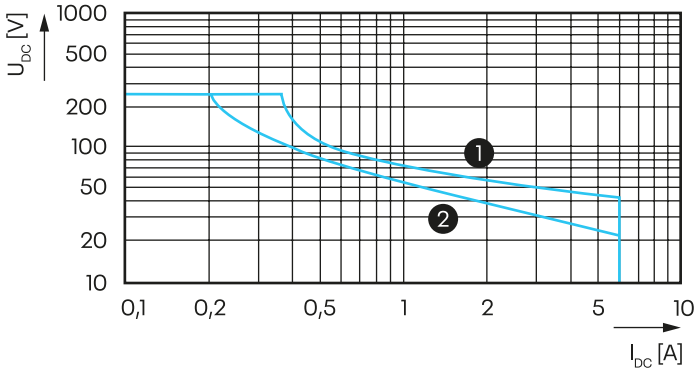
| | |
|---|---|
| **B x H x T** | 22,5 x 114 x 111 mm (0.886 x 4.488 x 4.370 in) |
| **Size of DIN rail** | 35,0 mm (1.378 in) |
| **Weight** | 130 g |

## 9.10 Safety-related parameters in accordance with DIN EN ISO 13849-1:2016-06

| Utilization category | | PFHd [h] | MTTFd [a] | DCavg |
|---|---|---|---|---|
| 6A DC1 | 2 cycles/h | $4{,}91 \times 10^{-9}$ | 471 | 99% |
| 4A DC13 | 2 cycles/h | $1{,}19 \times 10^{-8}$ | 203 | 99% |
| 6A AC1 | 2 cycles/h | $1{,}16 \times 10^{-8}$ | 157 | 99% |
| 5A AC15 | 2 cycles/h | $1{,}87 \times 10^{-8}$ | 157 | 99% |

## 9.11 Relay load curve

Ohmic and inductive load for the enabling NO-contacts 13/14 und 23/24



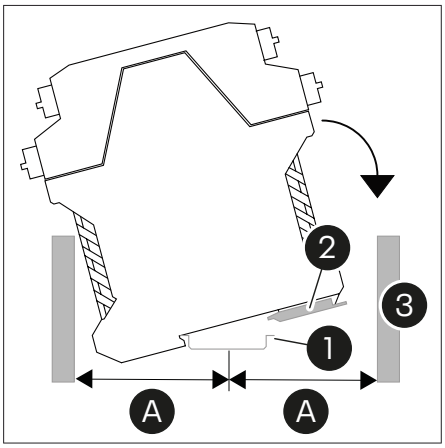

1 ohmic load L/R = 0ms

2 inductive load L/R = 40ms

# 10 Installation and removal

## 10.1 Installation a module

### 10.1.1 Overview



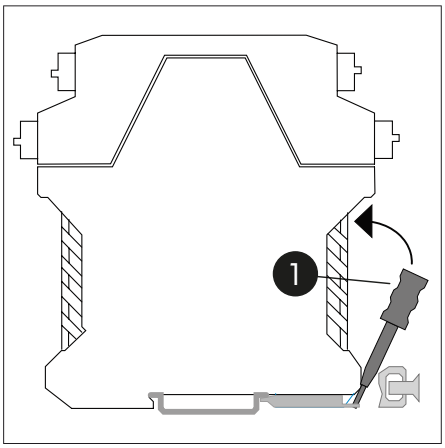

Ⓐ 70-75 mm (2,756-2,953 in)
❶ DIN rail
❷ Locking slider
❸ Cable duct

**Procedure**

► Hook the module onto the top hat rail and press it downward.

◄ The locking slider ❶ engages under the rail.

## 10.2 Removing module




**Procedure**

► Use a screwdriver ❶ to move the locking slider away from the module.

► Move the module upward and remove it from the rail.