## Technical appendix/Glossary

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Advantages of electromechanical relay modules (EMR)

+ AC and DC operation in load circuit possible
  Versatile (advantage as interface between different plant equipment)

+ No leakage current in the load circuit
  A semi-conductor does not achieve 100 % isolation

+ Low residual voltage in the load circuit
  Low voltage drop

+ No power loss in the load circuit
  In contrast to the semi-conductor in opto modules there is no electrical resistance in the contacts of the electromechanical relay modules that can lead to a rise in temperature when under load. Therefore, heat sinks are not necessary.

+ Multiple contacts possible
  A single control signal can switch several load circuits.

+ Control circuit less sensitive to transients*)
  Unwanted switching operations caused by voltage fluctuations are prevented by the make capacity of the magnetic coil.

*) Refer to page W.8 in the Glossary for a detailed explanation of this term.
Depending on the requirements, the choice between electromechanical and solid-state relays is made based on the different advantages that the different versions offer:

**Advantages of solid-state relays (SSR)**

+ Long operational lifetime and reliability
  No moving parts or contact wear

+ Small dimensions
  Saves space on the PCB and mounting rail

+ Low control power
  An LED is activated - no mechanical parts are moved

+ Fast response times
  Fast switching, which allows high frequencies to be achieved

+ No contact bounce
  Reduces switching delays

+ No switching noise
  Suitable for use in noise-sensitive environments

+ Not susceptible to shock and vibration
  Prevents unwanted switching statuses

+ No electromagnetic radiation due to switching sparks or coils
  No interference of adjacent assemblies or electronics components
Relay modules – an overview

Historical background

The term ‘relay’ was originally used for a station where stagecoaches were able to change their tired horses for fresh ones. The term ‘relay’ was given a totally different meaning by the English physicist Charles Wheatstone (1802–1875). In Wheatstone’s times, departing trains were advised of by a bell ringing at the next railway station up the line.

This was achieved by connecting a battery in the first station to a bell in the second. However, as the railway stations were generally several kilometres apart the power arriving at the second station was often insufficient to ring the bell. Wheatstone invented a switchgear apparatus that was installed at the second railway station. This continued to function even with low power supply levels. The switchgear apparatus switched a second electrical circuit that actuated the bell. This was the birth of the electromagnetic relay.

How a relay functions

A relay is an electromagnetic switch comprising of two galvanically isolated circuits. Firstly the control circuit and secondly the open circuit with the normally open contact. As soon as the control circuit is energised, the coil creates a magnetic field in the core/yoke and attracts the armature. The actuator now actuates the switch at the output, the normally open contact (make contact) closes and the normally closed contact (break contact) opens. When the control circuit is turned off, the magnetic field diminishes and the return spring returns the armature to its initial position. The actuator moves the normally open (make contact) back to its normal position, the normally open contact opens, the normally closed contact (break contact) closes.

Consequently, with low power input – battery power for example – a relay provides the option of switching heavy loads as well as being able to serve as a switching amplifier. Thanks to the isolation between the input and output, relays are also suitable for providing separation when the power of the control and the open circuits differ. Equipped with several NO (make) contacts, a relay can also be utilised for multiplying signals.

From relay to relay module

There are two alternative methods that make a relay module suitable for use in industrial applications: mounting onto a PCB – in combination with the corresponding assembly techniques and circuitry – or plugging onto a specially designed relay base.

Generally, the design and rating data determine if a relay coupler is or is not suitable for a particular application.

For example, relay modules with plugged on relays are only partly suitable for use in applications subjected to heavy vibrations. In this case, relay modules with soldered relays should be preferred. Low, compact designs such as those provided by the RIDER SERIES are utilised in small consumer units where the overall available height is limited. Conversely, the compact design of the TERM SERIES helps to save space in electrical cabinets.

Protective separation

It is essential that all electrical equipment required to provide protective separation be designed in such a manner that the insulation cannot be impaired, for example by mechanical errors. If a mechanical error occurs in a relay (bent soldering pin, broken winding wire or broken spring), ‘protective separation’ must be guaranteed. Relays are specified and tested in accordance with EN 61810-1. However, the standard makes no reference to EN 50178 (Electronic equipment for use in power installations); equally no definition is given for the term ‘protective separation’. Things are made worse by the fact that different measurement conditions are given for the test voltages stipulated for relays. As a consequence, the test voltages cannot be applied to the standards EN 50178 or EN 61140. And because the user is nevertheless increasingly deploying electrical equipment that is supposed to guarantee ‘protective separation’, a large number of manufacturers of relays point to the EN 61140 and carry out the tests accordingly. And of course the values are then ‘protective separation’ conform.
Standards

The following individual standards are applied in accordance with the corresponding requirements:

Relay modules
• DIN EN 50178:
  Electronic equipment for use in power installations

Relays
• DIN EN 61810-1:
  Electromechanical elementary relays (electromechanical elementary relays without specified time response characteristics)
  Part 1: General and safety requirements

Relay base
• DIN EN 61984
  Connectors - Safety requirements and tests

EMC – Electromagnetic compatibility

DIN EN 61000-6-1
Part 6-1: Generic standards; Immunity for residential, commercial and light-industrial environments

DIN EN 61000-6-2
Part 6-2: Generic standards - Immunity for industrial environments

DIN EN 61000-6-3
Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments

DIN EN 61000-6-4
Part 6-4: Generic standards - Emission standard for industrial environments

Coil suppression circuit

In DC circuits, the inductance of the relay coil generates a release voltage when de-energised that is capable of damaging or destroying the connected control electronics. A free wheel diode connected in parallel to the coil limits the release voltage, protects the control electronics and prevents induction of the cut-off voltage to other signal lines.

Large circuits or long cable runs are subjected to increased electrical and electromechanical interference and damage. Malfunctions or even total failure of the relay module can result. The radiated interference, and not to forget leakage currents emanating from trigger modules, can also mean that a triggered relay does not drop out. As standards specify that the drop-out voltage is limited to about 15 percent of the rated voltage, the interference voltage generated can be sufficient to prevent the relay from opening. One way of resolving this problem is to connect an RC combination line side to filter out disturbances and provide capacitive suppression of interference voltages.

TERMSERIES products are supplied ex works with these protective circuits already integrated in the electronics; for the RIDERSERIES these are available as modular series electronics.

The same principles apply as with contact protection circuits.
Relay modules – an overview

Switching large and small capacities

Basically, the reliability of the contacts in a relay reaches a maximum at a medium current load thanks to the continuous self-cleaning effect. As the contact load increases and hence leads to more severe erosion of the contacts, the switching reliability decreases with an increasing number of switching operations. This reduces the service life of the contacts. Although at very low loads the minimal erosion of the contacts does raise the service life more or less to the level of the mechanical service life, the lack of a self-cleaning effect contributes to a lower contact reliability.

Reliable contact at low currents, especially when only small voltages are involved as well, depends on the choice of contact material. Contacts of silver-nickel, which is standard for the majority of Weidmüller relays, are generally suitable for currents of approx. 10 mA and higher. Such large-surface contacts can switch both low and high currents. However, at low currents occasional failures can occur due to erosion and the lack of the self-cleaning effect. The higher the current, the more reliable is the contact – thanks to the self-cleaning. Silver-nickel is suitable as a contact material for low currents/voltages. It provides, however, only moderate switching reliability. If this is acceptable, then conventional standard relays represent an inexpensive solution.

For applications that call for improved contact reliability or low currents/voltages, conventional relays with hard-plated gold contacts are preferable because they do not erode and therefore operate more reliably.

If maximum switching reliability is necessary, especially for low currents/voltages, a relay should not be your first choice. In these instances Weidmüller advises the use of solid-state relays. Wear and abrasion caused by mechanical movements are non-existent in solid-state relays.

Protective circuits for the contacts

The switching of inductive or capacitive loads produces switching sparks which can influence the electrical service life of the relays. The following protective circuits for the contacts reduce contact wear:

**Diode**

**Free-wheeling diodes (DC)**

Free-wheeling diodes are used primarily to protect against overvoltages, which occur through self-induction when switching off inductive DC loads (electric motors, relay coils). Voltage spikes are limited to the equivalent value of the diode forward voltage and excess voltage is discharged via the diode. However, this leads to a delay in the voltage drop and as such also delays the switching operation.

Advantage: Can be used for all capacities, low surge, minimum space required, low price
Disadvantage: Very long release delay

**Diode and Z-diode**

**Zener diode / suppressor diode (DC)**

These function as normal diodes in the forward conducting direction. In the blocking direction they become low resistant at a certain voltage (breakdown voltage). High levels of overvoltages can lead to the destruction of the zener diode / suppressor diode.

Advantage: Low surge (defined by Z-diode), short release delay
Disadvantage: Cannot be used for large capacities
Varistor

The functional principle of the varistor is also based on a breakdown voltage, but with faster reaction times. This allows higher levels of energy to be shunted, however, these lead to the component aging. This in turn reduces the breakdown voltage over time and increases the leakage current.

- **Advantage:** Low surge, short release delay
- **Disadvantage:** High current load on the contacts when switching on; more complicated and expensive at greater capacities

RC combination

The RC element compensates voltage spikes by means of a capacitor. Due to the charging and discharging characteristics interference pulses are filtered out when the voltage is rising and not first when overload is reached. For this reason, RC elements are used to protect against interference pulses and exclude faulty switching operations.

- **Advantage:** Short release delay, low price
- **Disadvantage:** Cannot be used for all operating voltages and capacities

\[ U_s = \text{Voltage progression} \quad 1 = \text{Closing} \quad 2 = \text{Opening} \]
Glossary: Relay modules

A

AC
Refers both to alternating values (such as voltage or current) as well as to those devices and variables which reference these devices. Specifications are valid for 50 Hz, unless otherwise indicated.

AC coil, alternating current coil
Relay; excitation with alternating current (AC). Specifications are valid for 50 Hz, unless otherwise indicated.

Adhesion (contacts)
This refers to when the relay armature does not return back to its starting position after the coil voltage has been turned off. The armature can get stuck if there is too much retentivity in the iron core or if the reset force is too small.

Approvals and testing marks
Testing approvals are independent confirmation from governmental or private registration services and testing facilities. They certify that the product complies with the relevant regulations and maintains the specified product characteristics. Note: The ordering scheme gives you the choice of many variations, but not all variations are established as standard types (order numbers). Therefore, they may not be included in the list of approved relays. Technical specifications and list of approved types are available on request.

CSA Canadian Standards Association, Canada
GL Germanischer Lloyd, Germany
TÜV Technical Monitoring Association, Germany
UL Underwriters Laboratories, Inc., USA;
UR Component Recognition Mark for the United States
cUR UL Component Recognition Mark for Canada
cURus UL Component Recognition Mark for the United States and Canada
cULus UL Component Listing Mark for the United States and Canada
VDE VDE testing location, Germany (advisory reports with production monitoring)

B

B10
The number of switching cycles for a load where 10 % of the relays fail. This value is used to determine the probability of system failure.

Bounce (chatter)
An unintended phenomenon that may arise during the closing or opening of a contact circuit when the contact elements touch and separate again before they have reached their final positions.

Bounce times
The time (average value) between the first and last closing (or first and last opening) of a relay contact. These times are valid when the rated voltage is used for excitation, without other components in series or in parallel to the coil, and at the reference temperature.

Breaking capacity
Maximum switching current that a relay contact can switch off under specified conditions, whereby the switching current must not be greater than the nominal current.

Burn-off
Loss of contact material due to switching electrical arcs.
<table>
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<th>Abbreviation for Communauté Européenne (the European Community). Manufacturers use the CE label to confirm that their products comply with the corresponding EC directives and the “essential requirements” therein. The EMC Directive 2004/108/EC and Low Voltage Directive 2006/95/EC are currently binding.</th>
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### Combination of relay and plug-in socket, Insulation requirements

The combination of relay and plug-in socket is described in the new relay standard IEC 61810-1. The relay sockets must meet the requirements of IEC 61984 and the insulation requirements of IEC 60664-1. Even if the socket itself already meets (or surpasses) the insulation requirements, there may still be reduced clearance and creepage distances (and thus reduced insulation rated voltage) for the combination of the relay and plug-in socket. Restrictions – such as a reduced voltage range or reduced pollution degree – should be expected for the relay/socket combination. This should be taken into consideration for miniature multi-pole relays with plug-in sockets which have minimal gaps between the contact circuits.

In addition to the insulation properties, the thermal properties of the combined relay/socket are very important (refer to the derating curves). The plug-in frames from different manufacturers cannot be compared directly, which is why the technical specifications are only guaranteed for approved relay/socket combinations. Possible risks of fire or reduced dielectric strength may result when non-approved combinations are in use.
The list below provides an overview of the most important performance coatings and contact materials. The load capacity of the contacts and their life span can vary depending on the contact material and construction used. It is important to achieve the best combination of relay function and contact material. The specifications for individual relay types are only partially valid for other variants.

1) Performance coatings:
- Pure gold – the best corrosion resistance but too soft when used as solid metal; high tendency toward cold welding in layer thickness > 1 μm (gold-flashed); only functions as a gold gilding and does not protect against corrosive gases.

2) Contact material:
- **Hard gold (hard gold-plated)** - Very good corrosion resistance for dry loads; measuring and switching circuits; control inputs (1 mV – 10 V, 0.1 mA – 100 mA); low and constant contact resistance with the smallest switching power; low cold-welding tendency and low current/voltage switching; recommended operating range > 1 V, 1 mA, 50 mW. After switching higher loads (>10 V, 100 mA), small loads can no longer be switched.
- **Silver Nickel AgNi90/10** - High resistance to burn-off; minimal tendency towards cold welding; higher contact resistance than AgNi0,15; circuits with medium to high loads; DC and AC circuits (solenoid valves, fans, heaters); not suitable for high capacitive in-rush currents; range of use > 12 V, 10 mA.
- **Fine-grain silver AgNi0,15** - Relatively low contact resistance; low resistance to corrosive gases; all-purpose use for average loads and low loads; preferably in DC circuits (solenoid valves, fans, heaters); not suitable for high currents; range of use > 12 V, 10 mA.
- **Silver-tin-oxide AgSnO2** - Minimal tendency to weld; high resistance to burn-off at high switching capacity; low material migration; circuits with high input and output loads; DC and AC circuits (lamp loads, capacitive loads, fluorescent tubes, switching power supplies, etc.). Well suited for resistive, inductive and capacitive DC applications due to low occurrence of material migration, range of use > 12 V, 100 mA.
- **Silver-cadmium oxide AgCdO** – minimal tendency to weld; high resistance to burn-off; especially suitable for switching inductive loads; AC circuits, range of use > 12 V, 100 mA.
- **Tungsten W** – highest melting point; for high switching frequency at minimal duty cycle; as a lead contact in circuits with high in-rush and switch-off loads.
### Glossary: Relay modules

#### Continuous current limit

The highest current value (RMS value for AC) which a closed contact can continuously conduct at specified temperature limits; this corresponds to the thermal continuous current limit \( I_{th} \).

Unless otherwise specified, the data refers to the following conditions: equal load on all contact circuits, input voltage is 110\% of rated coil voltage, maximum ambient temperature, opened vent, dense mounting (mounting clearances of 0 mm), and test conditions according to the positioning for the heating test in IEC EC 61810-1 Appendix B.

#### Continuous current

The current that can be continuously conducted without exceeding the contact-overheating values under defined conditions.

#### Continuous operation

Operating mode in which a relay remains energised until it reaches thermal equilibrium.

#### D

- **DC**
  
  Refers to the electrical variables such as voltage or current (DC, DC voltage) that are not dependent on time.

- **DC switch-off capacity, Direct-current switch-off capacity**
  
  Values below the DC switch-off capacity curve (for max. permitted switching voltage/current at resistive load) can be switched on and off reliably; e.g. an arc is extinguished (max. arc duration is 10 ms at resistive load). The position and shape of the load-limit curve is influenced by the contact material and relay construction (contact gap, opening speed of the contacts, etc.). Information about the electrical lifespan should not be derived from these curves!

![DC load breaking capacity](image-url)

**Note:**

- Switching conditions:
  - Stable switching
  - Switching rate 10 per minute
  - Rejection of arcing contacts

**Load types:**

- Resistive, inductive, capacitive

**Contact materials:**

- Silver-plated contacts
  - Copper-plated contacts
  - Silver-plated copper contacts

**Contactor ratings:**

- 96 V DC inductive load with a switching voltage of 240 V DC
- 300 V DC resistive load with a switching voltage of 300 V DC

**Connection types:**

- Push-in, screw, clip connection

**Mounting types:**

- Standard, panel, DIN rail, surge suppression

**Accessories:**

- Adaptors
  - Power supply
  - Logic supply

**Supplementary insulators:**

- Insulators without accessories (e.g.frei floats)

**Limitations:**

- Switching frequency
  - 60 Hz
- Switching rate
  - 60 cycles per minute
- Contactor lifetime
  - 60,000 cycles
- Rated coil voltage
  - 24 V DC
  - 48 V DC
- Rated coil current
  - 0.1 A
  - 0.2 A
- Rated current
  - 0.5 A
  - 1 A
  - 2 A
  - 5 A
  - 10 A
  - 20 A

**Note:**

- The curve for 2 contacts in series is only valid for the contact voltage of 70 V, and not for 24 V.
- The shape of the load-limit curve is influenced by the contact material and relay construction (contact gap, opening speed of the contacts, etc.).
Derating / derating curve

The continuous current is reduced at higher ambient temperatures; this is shown using a derating curve (a load reduction curve). Current flow generates heat, which increases as the current increases. Electrical components have an upper temperature limit which limits their ability to function. The temperature influencing the components is a combination of the ambient temperature and the heat generated by the current. So to ensure that the limit temperature is not exceeded, the current must be reduced when the overall temperature rises. The derating curve depicts the relationship between the prevailing temperature and the resulting maximum amperage with regards to the temperature limit.

Dielectric strength, test voltage
Voltage (RMS value for AC voltage, 50 Hz, 1 min) which can be applied between mutually insulated relay components during the voltage test.

Dimensions
Dimensions in millimetres.

DIN rail
Unless otherwise noted, Weidmüller’s products are built and tested for mounting on DIN rail (rails according to TH35-7.5 / EN60175). Other installations (e.g. TH35-15) may function but have not been tested or approved.

Duty cycle, relative duty cycle
Describes the ratio of the excitation duration of a relay (duty cycle) to the entire cycle time in intermittent, continuous or short-time operations. The duty cycle is expressed as a percentage of the total cycle duration.
Earth and ground loops

Denotes the connection of two potentials via their earth or ground connection. A potential difference between the earth or ground connection of two devices (for example, a sensor and controller) that are directly wired to one another causes current flow via the earth of the shared housing. These interference currents can lead to different problems, for example in the acquisition of measurement signals or when controlling actuators. When transmitting switching or measurement signals using a device with electrical isolation between the control and load circuits, it is important that a closed circuit via the earth or ground connection can never occur – so that no interference currents are generated.

Electrical lifespan curve

The curve for the electrical lifespan specifies the typical lifespan as the mean cycles to failure (MCTF) and is based on the Weibull distribution. No guaranteed minimum values can be interpreted from this statistical data.

Note: The curve for the electrical lifespan applies only to the specified contact materials (or those in the datasheet). The lifespans for other contact materials cannot be derived from this curve. It is also not possible to derive information about the electrical lifespan by extrapolating the curve.
| **Electrical lifespan, lifespan of contact** | Number of switching cycles for a relay with electrical contact load under full operational capacity (according to IEC 61810-1 and IEC 61810-2). Unless indicated otherwise, the contact data and electrical lifespan are valid under the following conditions:  
• On NO contact,  
• AC mains frequency of 50 Hz,  
• 50 % relative duty cycle,  
• Nominal switching frequency,  
• Contact load, schedule A,  
• Resistive load,  
• Rated voltage (coil),  
• Ambient temperature 23 °C,  
• Protection degree RTII - flux-proof  
• Individual assembly  
• Vertically installed (the connections of a PCB relay point downwards).  

The electrical lifespan is specified according to the criteria for “useful life”, severity level B according to IEC 61810-2. The data does not cover all usage beyond the specified electrical lifespan. The user is obliged to avoid such situations. Experience shows that the electrical lifespan remains relatively constant up to a 0.8 power factor. When working with loads that have a power factor less than 0.8, we recommend consulting with the user. |
|---|---|
| **Error, relay failure** | According to IEC 61810, a relay failure is defined as the occurrence of malfunctions that exceed a certain number:  
• Malfunction On contact closing  
• Malfunction on contact opening (contact bridging for CO contact, as special type of malfunction during contact opening) or as  
• Insufficient dielectric strength.  

Such malfunctions must be considered in the scope of the application – they should not create any risks. Depending on the specific loads and the contact power, a malfunction can cause excessive heat or even a fire. The user is responsible for taking the necessary precautions in accordance with the relevant regulations. |
| **Flammability according to UL** | Indicates the flammability class according to the specification from UL 94 (Underwriters Laboratories, Inc., USA). Flammability tests according to UL 94: for testing plastic materials and classifying the propagation/extinction characteristics when the material burns. The UL 94 flammability classes which are relevant to relays are V-0, V-1, V-2 and HB. |
**G**

**Galvanic isolation**
Potential-free isolation between electrical components. Electrical (or galvanic) isolation means that no charge can flow from one circuit to another. There is no conductive electrical connection between the circuits. The circuits can nevertheless exchange electrical power or signals via magnetic fields, infrared radiation or by charge displacements.

**H**

**Humidity / condensation**
Standard conditions: annual average relative humidity > 75 % at an ambient temperature of 21 °C in 30 days, evenly distributed throughout the year, and 95 % at ambient temperature w of 25 °C. On other days: occasionally 85 % at 23 °C. No icing or condensation is allowed - affects storage and/or operation. When storing or operating under other conditions, you must take steps to avoid temperature changes which could cause icing or condensation. Operating and storage should be within the limits specified in the graphic.

![Environmental conditions diagram](image)

**I**

**Impulse withstand voltage**
The highest withstand voltage of a specified shape and polarity that does not lead to an insulation breakthrough or flash-over, under the specific conditions.

**Inductive loads**
Refer to usage categories.

**Inrush current**
Specified as the switching current by resistive loads that can turn on a relay under defined conditions. The data refers to the NO contact, nominal voltage, and a current value for a duration of max. 20 ms for at least 100 switching cycles, or 4 seconds with a relative duty cycle of 10 %, unless otherwise indicated.
**Insulating material group**

According to their CTI (comparative tracking index) values, the insulating materials are categorised in one of the following four groups:

- **Group I**: 600 CTI
- **Group II**: 400 CTI < 600
- **Group IIIa**: 175 CTI < 400
- **Group IIIb**: 100 CTI < 175

The figures for the comparative tracking index, according to IEC 60112 (DIN IEC 60112 / DIN VDE 0303-1) are determined using special samples prepared for this purpose with test solution A.

**Insulation according to EN 50178**

Specifications for insulation coordination with:
- Type of insulation
- Nominal voltage of the supply system
- Pollution severity level
- Impulse withstand voltage
- Surge voltage category

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**Max. switching current**

The max. switching current indicates the maximum level of current that can be switched.

**Max. switching frequency at rated load**

The number of switching operations that occur in a specific unit of time. The maximum switching frequency for average loads may be higher than the value specified for the nominal load when the switching characteristics of the load (such as arcing) do not cause the contact temperature to increase. The maximum switching frequency for no-load switching can also be used for loads where no arcing will take place (purely resistive loads cause no significant arcs up to 12 V or 50 mA at 12 – 250 V, because the arc breaks off fairly quickly through the contact opening (insulation)).

**Max. switching power**

The switching capacity is calculated as the product of the switching voltage and the switching power (in VA for AC; in W for DC).

**Mechanical service life**

Number of switching cycles for de-energised relay contacts, where a relay must remain functional within specific conditions.

**Micro-switch-off**

Reasonable contact opening in at least one contact that ensures functional safety.
Note: The contact opening has a requirement for the dielectric strength but not for the dimensions.

**Minimum switching capacity**

Calculated product of switching current and switching voltage – a measure of reliable switching. Low contact resistance values are realised only above a certain load. Greatly increased resistances may occur at lower switching loads which can prevent the load circuit from being safely switched. The minimum contact loads for different contact materials should also be taken into account.

**Mono-stable relay, switching behaviour**

A relay is referred to as mono-stable when its contacts return to the idle state automatically after the energising parameter (the input voltage) is switched off.

**Mono-stable, non-polarized relay, neutral relay**

The switch position change in a neutral, mono-stable relay does not depend on the polarity of its excitation.
### Mounting distance

Distance between two adjacent components when using parallel, uni-directional positioning; or the distance to other electrical components. Because of the insulation requirements, you may need to increase the minimum gap between the components or select a different positioning. These values refer to components in “single-file arrangement”, unless otherwise indicated. Also relevant for this definition:

- Density of assembly: assembled with minimum mounting clearances; this minimum distance is determined by the insulation requirements at 230 V AC and/or mechanical requirements for the installation (e.g. use of sockets),
- Individual installation: components are mounted with gaps so that there is NO thermal influences from adjacent components.

### Mounting position

Mechanical and electronic relays can usually be installed in any position when there are no qualifying limitations. To ensure the proper current flow and heat dissipation, the connections must be properly contacted and the cross-sections must be adequate. Several factors must be taken into consideration when positioning: including the insulation requirements, heat dissipation and the possible mutual magnetic influence.

### Nominal current (contact)

Current that a relay contact can switch off or on under specific conditions, or the current that the relay accessories can conduct. The nominal current specification covers the following data, unless otherwise specified:

- Contact current, switching current
- Continuous current limit

The conditions for the relay are specified under the contact lifespan; For accessories, the nominal current is specified for a relative duty cycle of 50 %, at the nominal switching frequency, and for an ambient temperature of 23 °C.

### Nominal switching voltage (contact)

Voltage between the switching contacts - before the contact closes or after it opens.

### Nominal torque

The specified value for the torque of the screws (screw connection) must not be exceeded.

### Number of contacts

Number of working contacts in a relay (normally-open, normally-closed or change-over)

### Operating temperature

Permissible ambient temperature – relative to a specific relative humidity – at which a product should be operated at nominal load.
Operational voltage range

Allowable input voltage range – depending on the ambient temperature.
The top part of the range is specified by the maximum voltage; the lower part of
the range is specified by the response/minimum voltage.
Curve 1: response time/minimum voltage \( U_0 \) (without pre-excitation)
Curve 2: response time/minimum voltage \( U_1 \) (after pre-excitation)
Curve 3: maximum voltage \( U_2 \), contact current = 0 A
Curve 4: maximum voltage at contact current \( I_{\text{nom}} \)

P

Packing unit
Indicates the smallest amount (a pack, for example) or the quantity per carton.

Plug-in cycles
Sockets and accessories are designed for 10 insertion cycles without electrical
load – unless otherwise specified.

Pollution severity level
Pollution (contamination) includes any foreign material – whether it is solid,
liquid or gaseous (ionised gas) – which is capable of influencing the surface
resistance of the insulating material. The standard defines four degrees of
pollution. Their numbering and classification is based on the quantity of the
contaminant or the frequency with which the contaminant reduces the dielectric
strength and/or surface resistance.

Pollution degree 1:
• there is no contamination or only dry occurrences of non-conductive pollution.
The pollution has no influence.

Pollution degree 2:
• there is only non-conductive pollution. Temporary occurrences of conductivity
caused by condensation may also occur.

Pollution degree 3:
• conductive pollution or dry, non-conductive pollution that can become
conductive due to condensation is likely to occur.

Pollution degree 4:
• the contamination leads to continual conductivity which can be caused by
contaminants such as conductive dust, rain or snow.

Note:
Pollution degree 3 is typical for industrial environments and similar settings;
pollution degree 2 is typical for households or similar.
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</table>

**Positively-driven contacts**
Arrangement of contacts in accordance with EN 50205, with at least one NO and one NC contact; mechanically constructed so that the NO and NC contacts of the entire contact system can never (even in the event of a malfunction) be closed at the same time. Such relays are used in safety engineering controls in order to prevent injury and property damage.

**Power rating**
The nominal value of the power that is converted when the nominal control voltage is applied.

**Protection degree - (IEC 60529), IP**
The degree of protection afforded by an enclosure is indicated by the IP Code (IP = International Protection). This specification is equally valid for industrial relays and accessories.

For the purposes of "component" relays (such as PCB relays), refer to the RT protection degree.

A two-digit number is used to indicate the protection provided against touch contact and foreign bodies (the first number) and against humidity (the second number).

Protection levels for touch contact and foreign bodies (the first digit): the first digit indicates the degree of protection inside the housing against ingress of solid foreign objects and against any human access to hazardous parts.

- 0: no protection
- 1: protection for large body parts with a diameter > 50 mm
- 2: finger protection (diameter 12 mm)
- 3: tools and wires (diameter > 2.5 mm)
- 4: tools and wires (diameter > 1 mm)
- 5: full protection against touch contact
- 6: full protection against touch contact

Degree of water protection (the second digit)

The second digit indicates the degree of protection provided against the ingress of water into the housing:

- 0: no protection
- 1: protection against vertically falling drops of water
- 2: protection against water droplets falling diagonally (up to 15°)
- 3: protection against water spray that falls at an angle up to 60° from vertical
- 4: protection against splashed water from all sides
- 5: protection against water jets
- 6: protection against powerful jets of water (flooding)
- 7: protection against sporadic submersion
- 8: protection against constant submersion

**Pull-in / drop-out current, AC/DC coil**
Value of the coil current at which a relay responds (spark-over) or drops out.

**R**

- **Rated control voltage**
The nominal value of the sparkover voltage for the relay.

- **Rated voltage (Isolation)**
Voltage level at which the insulation specifications are measured – this is the basis for sizing the creepage distance.
**Relay times (time response)**

Because of the self-inductance of the coil and the inertia of the moving parts, the steps involved in operating a relay do not occur instantaneously. The following chart illustrates several time-function terms for the main contact variants of non-delayed switching relays.

These specified times are valid when the rated voltage is used for excitation, without other components in series or in parallel to the coil, and at the reference temperature.

- Sparkover time
- Drop-out/reset time
- Bounce time
- Min. excitation period

---

**Relays and sockets**

The relays in this catalogue have been designed, specified and tested in accordance with the relay standard IEC 61810-1 “Electro-mechanical elementary relays - part 1: General considerations and safety-related requirements”. Where the appropriate approvals have been specified in the data sheet, the relays and sockets have been tested according to IEC 61810 or EN 61984 and UL 508.

**Reliability**

Electro-mechanical components such as relays are subject to wear (both mechanical and electrical). A typical “bathtub curve” depicts the reliability. This means that there may be isolated statistical exceptions which are below the typical levels of reliability.

**Reset**

Process in which a mono-stable relay resets from the working position to the rest position.
**Reset time**
Time interval (average) between when a mono-stable relay is in its working state with the coil voltage switched off and the time at which the final output circuit is closed or opened (not including the bounce time). These specified times are valid when the rated voltage is used for excitation, without other components in series or in parallel to the coil, and at the reference temperature.

**Reset voltage**
Value of the input voltage at which a mono-stable relay reliably returns to the rest position while at the reference temperature.

**Response**
The process in which the relay transitions from the normally-closed (break) contact position into the normally-open (make) contact position.

**Response voltage / drop-out voltage**
Value of the coil voltage at which a relay responds (spark-over) or drops out.

**Rest position**
The switched position of a mono-stable relay in its unexcited state.

**RoHS Directive 2002/95/EC**
RoHS stands for “Restriction of (the use of certain) Hazardous Substances”. According to the EU Directive 2002/95/EC from 01.07.2006, all EU member nations must forbid the use of hazardous substances which damage human health and the environment (including mercury (Hg), cadmium (Cd), lead (Pb), hexavalent chrome (Cr6), polybrominated biphenyls (PBB) and polybrominated diphenyl ethers (PBDE)) in new electrical and electronic devices.

The term “compliant” means that the entire product group meets the requirements of the RoHS Directive. The maximum weight percentage in homogeneous materials is below the limits specified in the directive: 0.1 % for lead, hexavalent chrome, mercury, PBB and PBDE; and below 0.01 % for cadmium, or qualifies for an exemption in accordance with the annex to the RoHS Directive.

**S**

**Self-heating**
The heating up of an operational component based on the power loss from the relay coil and the switching contacts.

**Series-circuit relay contacts**
When two or more NO contacts in a relay are connected in series, the contact opening is increased while switching off. Arcs which occur from DC loads are cleared more quickly which results in reduced burn-off on the contact. This increases the electrical lifespan and the breaking (switch-off) capacity.

---

**DC load breaking capacity**

![DC load breaking capacity diagram](image-url)
**SIL**

Safety Integrity Level. The components must meet the requirements of IEC 61508 in order to reduce risk. This standard provides general requirements for avoiding and minimising device and equipment outages. It stipulates organisation and technical requirements concerning device design and operation. Four safety levels are defined (from SIL 1 for minimal risk to SIL 4 for very high risk) for classifying facilities and risk-reduction measures. Measures taken to reduce risk must be more reliable when the classified risk level is higher.

<table>
<thead>
<tr>
<th>Standardised labelling of connections</th>
<th>A1, A2: coil</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>13, 14: NO contact (contact closes when applying a voltage to the coil)</td>
</tr>
<tr>
<td></td>
<td>11, 12: NC contact</td>
</tr>
<tr>
<td></td>
<td>11, 12, 14: CO contact (11 is the common contact, i.e. the root)</td>
</tr>
</tbody>
</table>

**Status indicator**

The status LED display on the input control circuit can differ from the state of the contact circuit in the following cases:
- when there are welded-together or broken switching elements,
- when there is interference or residual voltages on the signal lines.
A reduction in light intensity may result when the ambient temperatures are greater than 50 °C.

**Storage temperature**

The permitted ambient temperature, related to a specific relative humidity level, for which the product should be stored while in a current-free state.

**Surge voltage category**

The overvoltage category of a circuit or an electrical system is numbered conventionally (from I to IV) and is based on limiting the assumed surge voltage values that can occur in a circuit (or electrical system with different mains voltages). The assignment to a particular overvoltage category is dependent on the measures which are used to influence (reduce) the surge voltages.

**Overvoltage category I**
- Devices that are intended to be connected to the permanent electrical building installation.

The measures for limiting transient surge voltages to the proper level are taken outside of the device. The protective mechanisms can either be in the permanent installation or between the permanent installation and the device.

**Overvoltage category II**
- Devices that are intended to be connected to the permanent electrical building installation (such as a household appliances or portable tools).

**Overvoltage category III**
- Devices that are a part of the permanent installation and other devices where a higher degree of availability is required. This includes the distributor panels, power switches, distribution systems (including cable, busbars, distributor boxes, switches and outlets) that are part of the permanent installation, devices intended for industrial use, and devices that are continually connected to the permanent installation (such as stationary motors).

**Overvoltage category IV**
- Devices that are intended to be used on or near the power feed in a building’s electrical installation – ranging from the main distribution to the mains power system. This includes electrical meters, surge protection switches and ripple control equipment.
<table>
<thead>
<tr>
<th>Glossary: Relay modules</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Switch-off delay</strong></th>
<th>Usual time interval from switching off the coil voltage of a switched relay until the first opening or closing of the last output circuit (not including the bounce time).</th>
</tr>
</thead>
</table>
| **Switch-on delay**  | Usual time interval from switching on the coil voltage of an idle relay until the first opening or closing of the last output circuit (not including the bounce time).  
Coil voltage: pulse or square wave excitation, with rated voltage at the reference temperature of 20 °C. |
| **Switching capacity** | The calculated product of the switching current and switching voltage (in W for DC, in VA for AC). |
| **Switching current** | Current strength required to switch a relay on or off. |
| **Switching cycle**   | A single occurrence of the sparkover and subsequent reset. |
| **Switching voltage**  | The voltage between the switch contacts (contact elements) that is applied prior to the closing or after the opening of the contact (DC for DC voltage; AC for AC voltage). |
| **Switching voltage, max.** | The maximum allowable voltage between the contact elements prior to closing and after opening a relay contact. |

| **T** |
| **Test button, manual operation** | For operating the relay manually; the test button is used only for test purposes during the initial commissioning and testing of equipment. The test button is not appropriate for normal on/off switching and has not been designed for continuous electrical load while in the mechanical ON position. The button should also not be used as a switch. Before pressing the test button, make sure there is no danger posed by loads or other connected devices. Only trained personnel should operate the test button. This prevents the facility’s safety mechanisms from being circumvented and the insulation requirements from being compromised. |
| **Transients** | Transients are short-term current or voltage spikes caused by interferences in the mains supply grid or by electromagnetic radiation. On the control side of the optocoupler these can trigger unintended switching operations or, in extreme cases, cause the destruction of the component. In an AC-driven load circuit, transients can lead to the maximum permissible forward voltage being exceeded, which in turn can activate the thyristor or Triac. As these operate at quite high switching speeds, even very short pulses can suffice to falsely trigger a switching operation. |
| **Type code** | The ordering scheme gives you the choice of many variations, but not all possible variations in the current product line are established as standard types (building codes, ordering designations). Special versions are available on request to meet customer specifications. |
| Type of contact | DIN 41020 describes various switching functions of the relay contacts and the specific contact configurations, constructions and descriptions based on these functions.  
• NO (normally open) contact: contact which is closed in the relay’s operating position and open in its rest position.  
• NC (normally closed) contact: contact which is closed in the relay’s rest position and open in its working position.  
• CO (change-over) contact: a CO consists of an NO and an NC contact with a common terminal (root) connection. When changing the switch position, first the previously closed contact opens and then the previously opened contact closes.  
Note: A temporary electrical connection may be established between the NC and NO contacts due to the switch-off arc. |
|----------------|---------------------------------------------------------------------------------------------------------------|
| Type of insulation | Quality of the insulation system, depending on the design and application conditions:  
• Functional insulation: insulation between live components – necessary so the relay functions properly.  
• Basic insulation: insulation of live parts to provide basic protection against electrical shock.  
• Doubled insulation: consisting of a base insulation and additional insulation.  
• Reinforced insulation: a single “enhanced” insulation of active components, which ensures the same protection against electric shock as doubled insulation. The doubled insulation is composed of a base insulation and an additional insulation; the extra insulation protects against electric shock if the basic insulation fails. |
### U

**Usage category according to EN 60947 (mechanical relays)**

<table>
<thead>
<tr>
<th>AC1</th>
<th>DC1</th>
<th>AC14</th>
<th>AC15</th>
<th>DC13</th>
</tr>
</thead>
<tbody>
<tr>
<td>non-inductive or slightly inductive load, such as heating elements</td>
<td>non-inductive or slightly inductive load, such as heating elements</td>
<td>small electro-magnetic loads (&lt; 72 VA), such as mini-contactors</td>
<td>small electro-magnetic loads (&lt; 72 VA), such as power contactors</td>
<td>electro-magnetic loads, such as solenoid valves</td>
</tr>
</tbody>
</table>

### W

**Wash resistant**

Wash-resistant relays can withstand a washing process. During the wash process, none of the cleaning agent should be able to penetrate inside the relay.

**Withstand test voltage**

The voltage applied to a device under specific test conditions which causes no breakthrough or flash-over of the test piece.
Definition / mode of operation

Opto modules – mode of operation

Opto modules are electronic components for switching load circuits by means of a control circuit. On the one hand this allows applications with different performance ratings to be operated by relatively low switching currents. And on the other electrical isolation*) between control and load circuits is provided to assure protection of components should a malfunction occur.

In contrast to electromechanical relay modules opto modules do not have any mechanical parts that are prone to wear. To enable the switching operation a light signal is triggered via an LED in the control circuit that causes a light-sensitive semiconductor receiver to complete a connected load circuit. Transmitter (LED) and receiver (for example a phototransistor) are embedded in a light conducting plastic material and encased in a light-proof casing that protects against outside influences.

Two design types are differentiated: 
**Face-to-face design** with LED and transistor mounted across from each other with direct light contact
**Coplanar design** with LED and transistor on the same level. In this case the beam of light is transferred by reflection according to the principle of fibre-optics.

Opto module

The voltage, which can be applied to the opto output itself, is restricted by the sensitivity of the semiconductor receiver (phototransistor). In applications in which only low currents or voltages are required in the load circuit it is possible to use the component without an additional auxiliary circuit in an opto module.

**Solid-State Relay**

In order to switch higher currents it is necessary to make adaptations to accommodate the different performance levels of the phototransistor and the load circuit (switching amplification).

Modules other than optos equipped with a switching amplifier are called **solid-state relays (SSR)**.

*) Refer to page W.36 in the Glossary for a detailed explanation of this term.
Basic functions

Opto modules and solid-state relays are generally used in the following fields of applications:

**Potential isolation**
Many applications require that the control circuit is electrically isolated from the load circuit. This primarily protects the control level from interference from the field, such as:

- Interference currents e.g. from *earth and ground loops*)
- Interference pulses e.g. from inductive effects of *transients*)

The separation of the control and load circuits in the opto module provides the required isolation. However, this must withstand an isolation test of at least 2.5 kV in all opto modules and solid-state relays. To guarantee isolation it is necessary that a minimum of 3 mm clearance and *creepage distance*) be maintained in all components.

**Signal conditioning**
The separation of the load and control circuits, in conjunction with the variety of options this offers to configure both circuits separately, means that opto modules are often used for signal conditioning purposes. This allows the different electrical potentials of signals from the control and load circuits (for example sensors and control) to be equalised.

**Switching amplification**
Applications with current and voltage values that exceed the capacity of the phototransistor require an auxiliary circuit on the output side of the opto module for switching amplification purposes. During the switching operation the opto module LED activates a base current in the phototransistor. This activates a second semiconductor (transistor, thyristor) selected to meet application requirements which then becomes conductive for the load current.

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* Refer to page W.36 in the Glossary for a detailed explanation of this term.
Control circuit

The input circuits (control circuit)

Most industrial applications cannot be connected directly to an opto module, generally requiring voltage regulation by means of series-connected resistances or capacitors. To obtain exact-as-possible switching points a Schmitt Trigger*) can be used to assign the control signals an unambiguous status (0 - 1) when moving from high to low or low to high, which is then passed on to the opto module.

Depending on the design, all Weidmüller opto modules and solid-state relays are equipped with suitable protective devices (varistors, diodes) and filters to protect against interference pulses from the control circuit.

DC input:
An additional reverse-polarity protection diode guarantees protection against the opto module being destroyed if the control voltage is incorrectly wired. The switching status of the control circuit is signalised by a status indicator.

AC/DC input:
A rectifier with smoothing capacitor is connected in series for AC control voltages. Reverse polarity protection for DC current is not necessary. The following construction corresponds to a DC circuit.
Due to the smoothing capacitor the switching frequency of AC control signals is fundamentally less than half the mains frequency. A higher switching frequency would result in the control signal being constantly switched through in rhythm with the mains frequency.
The advantage of being able to choose between an AC or a DC current input contrasts with the disadvantage that the smoothing capacitor also restricts the switching frequency of the DC control signal.

AC input:
The circuit diagram corresponds in principle with an AC/DC circuit. Instead of series resistors it is possible to use capacitors to regulate the voltage in a purely AC operation. In contrast to resistors there is no power loss with capacitors and as a result no heat that needs to be dissipated.

*) Refer to page W.36 in the Glossary for a detailed explanation of this term.
Load circuit

The output circuit (load circuit)

As a rule, an operating voltage range is stated for the rated switching voltage of opto modules and solid-state relays (for example 5 ... 48 V DC); it is not permitted to exceed or fall below this value.

The same applies to continuous current. Exceeding this value too often can result in premature wear-out and destruction of the opto modules semiconductor.

As a direct correlation exists between the current and ambient temperature a derating curve*) is provided for all opto modules and solid-state relays.

Overvoltages are shunted by protective devices such as diodes or varistors.

To prevent damage caused by current spikes (for example starting or off pulses) some modules are equipped with a power boost*) which is capable of carrying higher levels of current than the maximum stated for a short period of time.

It is possible to connect AC or DC loads subject to the output circuit having corresponding amplifier semiconductors.

DC output:
With a 2-pole DC output the connection terminals are to be considered in the same manner as with a conventional switch. All that is required is that care is taken to observe the predetermined polarity.

With a 3-pole DC connection an auxiliary voltage assists the output circuit to control the amplifying transistor more precisely. Several applications also require this auxiliary voltage for short-circuit protection in the interface or protective circuitry.

AC output:
To activate AC switching and control devices a semiconductor is connected on the load side of the opto module component to switch the AC voltage (TRIAC or thyristor).

* Refer to page W.36 in the Glossary for a detailed explanation of this term.
Switching amplification

The phototransistor of the opto module has a low current and voltage rating. As a consequence, an additional semiconductor element is accessed for larger output loads that is capable of switching the corresponding rated switching voltages and rated switching currents.

**Bipolar Transistor (DC)**
Used for low currents (0.5 A). The bipolar transistor has short response times, which makes high switching frequencies possible as a result.

**MOSFET (DC)**
Used for high load currents (up to 10 A). The low contact resistance of the MOSFET create only very small leakage currents (< 10 µA) with low power loss.

**Triac (AC)**
A Triac combines the functional principle of antiparallel connected thyristors in a single component. The mode of function of a thyristor is comparable with that of a one-way diode. Therefore, an opposing parallel circuit configuration consisting of two thyristors is used for AC currents.
Switching diverse loads

The different types of loads resulting from the possible applications (resistive, inductive, capacitive loads) represent a particular challenge for the load circuit arrangements of opto modules and solid-state relays. With reference to the planned application, one should always be aware of what effects the loads will have on the modules and how the corresponding protective devices have to be designed.

Generally speaking, it must be ensured that the power loss at the amplifier semiconductor does not exceed the permitted limit for any length of time. This would lead to overheating and finally to the destruction of the component.

Switching resistive loads
Due to the fact that in resistive loads the amperage in the load circuit and the voltage across the amplifier semiconductor are inversely proportional to one another these do not generally pose a problem. It is sufficient to adhere to the maximum current and voltage ratings of the modules.
Switching glow lamps represents a special case. It is possible that when being switched on that overcurrents 10 to 20 times the operating current can occur due to the low cold resistance.
Therefore, the components must be designed to cope with these possible overloads situations which correspond to the effect of capacitive loads.

Switching capacitive loads
Capacitive loads occur if there is a capacitor in the load circuit. The effect is similar to to a short-circuit at the point of activation and results in a high inrush current.
If this current is not limited it can lead to the destruction of the amplifier semiconductor.

Switching inductive loads
Problems can arise with inductive loads when they are being switched off, in particular when coils are used in the load circuit. The flow of current in the coil builds up a magnetic field that suddenly collapses and creates a high induction voltage.
This voltage spike has to be short-circuited via a diode connected in parallel (free-wheeling diode). However, the time required leads to delayed release.
Protective measures

The construction of the opto module enables fast and sensitive switching, however, the component is also more prone to interference. For this reason, all Weidmüller opto modules and solid-state relays are equipped with a variety of measures to protect against overloading and interference pulses.

**Free-wheeling diodes (DC)**
Free-wheeling diodes are used primarily to protect against overvoltages, which occur through self-induction when switching off inductive DC loads (electric motors, relay coils). Voltage spikes are limited to the equivalent value of the diode forward voltage and excess voltage is discharged via the diode. However, this leads to a delay in the voltage drop and as such also delays the switching operation.

**Zener diode / suppressor diode (DC)**
These function as normal diodes in the forward conducting direction. In the blocking direction they become low resistant at a certain voltage (breakdown voltage). High levels of overvoltages can lead to the destruction of the zener diode / suppressor diode.

**Varistor (AC/DC)**
The functional principle of the varistor is also based on a breakdown voltage, but with faster reaction times. This allows higher levels of energy to be shunted, however, these lead to the component aging. This in turn reduces the breakdown voltage over time and increases the leakage current.

**RC-element (AC)**
The RC element compensates voltage spikes by means of a capacitor. Due to the charging and discharging characteristics interference pulses are filtered out when the voltage is rising and not first when overload is reached. For this reason, RC elements are used to protect against interference pulses and exclude faulty switching operations.
## Glossary: Solid-state relays

### A

<table>
<thead>
<tr>
<th>AC</th>
<th>Refers both to alternating values (such as voltage or current) as well as to those devices and variables which reference these devices. Specifications are valid for 50 Hz, unless otherwise indicated.</th>
</tr>
</thead>
</table>

### Approvals and testing marks

Testing approvals are independent confirmation from governmental or private registration services and testing facilities. They certify that the product complies with the relevant regulations and maintain the specified product characteristics. Note: The ordering scheme gives you the choice of many variations, but not all variations are established as standard types (order numbers). Therefore, they may not be included in the list of approved relays. Technical specifications and list of approved types are available on request.

- CSA Canadian Standards Association, Canada
- GL Germanischer Lloyd, Germany
- TÜV Technical Monitoring Association, Germany
- UL Underwriters Laboratories, Inc., USA;
- UR Component Recognition Mark for the United States
- cUR UL Component Recognition Mark for Canada
- cURus UL Component Recognition Mark for the United States and Canada
- cULus UL Component Listing Mark for the United States and Canada
- VDE VDE testing location, Germany (advisory reports with production monitoring)

### C

<table>
<thead>
<tr>
<th>CE</th>
<th>Abbreviation for Communauté Européenne (the European Community). The CE marking is a way for the manufacturer to confirm that their product complies with the relevant EC directives and the “essential requirements” contained therein. The EMC Directive 2004/108/EC and Low Voltage Directive 2006/95/EC are currently binding.</th>
</tr>
</thead>
</table>
Clearance and creepage distances

Clearance and creepage distances are critical factors which influence the insulation capability of electrical components. The creepage distance denotes the minimum clearance that two live parts along a surface must have in order to prohibit a flow of current across the insulating material at the specified operating voltage.

In addition to the operating voltage, the choice of insulating material (material group) and the protective measures to counteract pollution (pollution severity) affect the creepage distance. The clearance distance denotes the minimum direct clearance (through the air) that two live parts must have to one another in order to prohibit a charge passing through the air (an arc). The expected surge voltage (rated impulse voltage) forms the basis for calculating the distances. The surge protection category and pollution severity are further factors that influence dimensional design considerations.

Continuous current

The current can be continuously conducted without exceeding the overheating values under defined conditions.

Cut-in (switch-on) voltage

The voltage level at which an opto module or solid-state relay is conductive.
**D**

| **DC** | Refers to the electrical variables such as voltage or current (DC, DC voltage) that are not dependent on time. |
| **Derating / derating curve** | The continuous current is reduced at higher ambient temperatures; this is shown using a derating curve (a load reduction curve). Current flow generates heat, which increases as the current increases. Electrical components have an upper temperature limit which limits their ability to function. The temperature influencing the components is a combination of the ambient temperature and the heat generated by the current. So to ensure that the limit temperature is not exceeded, the current must be reduced when the overall temperature rises. The derating curve depicts this relationship between the prevailing temperature and the resulting maximum amperage with regard to the limit temperature. |

![Derating curve diagram](image)

**Dimensions** | Dimensions in millimetres. |
| **DIN rail** | Unless otherwise noted, Weidmüller’s products are built and tested for mounting on DIN rail (rails according to TH35-7.5 / EN60175). Other installations (e.g. TH35-15) may function but have not been tested or approved. |
| **Dropout voltage** | The voltage level at which an opto module or solid-state relay blocks itself. |
Earth and ground loops

Denote the connection of two potentials via their earth or ground connection. A potential difference between the earth or ground connection of two devices (for example, a sensor and controller) that are directly wired to one another causes current flow via the earth of the shared housing. These interference currents can lead to different problems, for example in the acquisition of measurement signals or when controlling actuators. When transmitting switching signals or measurement signals using a device with electrical isolation between the control and load circuits, it is important that a closed circuit via the earth or ground connection can never occur – so that no interference currents are generated.

Flammability according to UL

Indicates the flammability class according to the specification from UL 94 (Underwriters Laboratories, Inc., USA). Flammability tests according to UL 94: for testing plastic materials and classifying the propagation/extinction characteristics when the material burns. The UL 94 flammability classes which are relevant to the relay are V-0, V-1, V-2 and HB.

Galvanic isolation

Potential-free isolation between electrical components. Electrical (or galvanic) isolation means that no charge can flow from one circuit to another. There is no conductive electrical connection between the circuits. The circuits can nevertheless exchange electrical power or signals via magnetic fields, infrared radiation or by charge displacements.
Humidity / condensation

Standard conditions: annual average relative humidity > 75 % at an ambient temperature of 21 °C, in 30 days, evenly distributed throughout the year, and 95 % at ambient temperature w of 25 °C. On other days: occasionally 85 % at 23 °C. No icing or condensation is allowed - affects storage and/or operation.

When storing or operating under other conditions, you must takes steps to avoid temperature changes which could cause icing or condensation. Operating and storage should be within the limits specified in the graphic.

<table>
<thead>
<tr>
<th>Ambient temperature [°C]</th>
<th>Relative humidity [% RH]</th>
</tr>
</thead>
<tbody>
<tr>
<td>-40</td>
<td>100</td>
</tr>
<tr>
<td>-20</td>
<td>80</td>
</tr>
<tr>
<td>0</td>
<td>60</td>
</tr>
<tr>
<td>+20</td>
<td>40</td>
</tr>
<tr>
<td>+40</td>
<td>20</td>
</tr>
<tr>
<td>+60</td>
<td>0</td>
</tr>
</tbody>
</table>

Impulse withstand voltage

The highest withstand voltage of a specified shape and polarity that does not lead to an insulation breakthrough or flash-over, under the specific conditions.

Inductive loads

Refer to load category

Input frequency

The number of switching operations that occur in a specific unit of time. The maximum switching frequency for medium loads may be higher than the value specified for the nominal load, as long as the switching of the load does not result in an increased temperature.

Insulating material group

According to their CTI (comparative tracking index) values, the insulating materials are categorised into one of the following four groups:

- Group I 600 CTI
- Group II 400 CTI < 600
- Group IIIa 175 CTI < 400
- Group IIIb 100 CTI < 175

The figures for the comparative tracking index, according to IEC 60112 (DIN IEC 60112 / DIN VDE 0303-1) are determined using special samples prepared for this purpose with test solution A.

Insulation according to EN 50178

Specifications for insulation coordination with:
- Type of insulation
- Nominal voltage of the supply system
- Pollution severity level
- Impulse withstand voltage
- Surge voltage category
### L

<table>
<thead>
<tr>
<th><strong>Leakage current</strong></th>
<th>The current on the load side of an opto module or solid-state relay that flows towards the output stage while in a blocked state.</th>
</tr>
</thead>
</table>

**Load category (solid-state relay)**

Classification of the load of a solid state relay, in accordance with EN 62314

- LC A – resistive loads or minimally inductive loads
- LC B – motor loads
- LC C – electrical discharge lamps
- LC D – incandescent filament lamps
- LC E – transformers
- LC F – capacitive loads

### M

<table>
<thead>
<tr>
<th><strong>Max. switching current</strong></th>
<th>The max. switching current indicates the maximum level of current that can be switched.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Max. switching power</strong></td>
<td>The switching capacity is calculated as the product of switching voltage and switching current (in VA for AC / in W for DC).</td>
</tr>
</tbody>
</table>

**Mounting distance**

Distance between two adjacent components in parallel, uni-directional positioning; or the proximity to other electrical components. Because of the insulation requirements, you may need to increase the minimum distance between the components or select a different positioning. These values refer to components in “single-file arrangement”, unless otherwise indicated.

Also relevant for this definition:

- density of assembly: assembled with minimum mounting clearances; this minimum distance is determined by the insulation requirements at 230 V AC and/or mechanical requirements for the installation (e.g. use of sockets),
- individual installation: components are mounted with gaps so that there are no thermal influences from adjacent components.

**Mounting position**

Mechanical and electronic relays can usually be installed in any position when there are no qualifying limitations. To ensure the proper current flow and heat dissipation, the connections must be properly contacted and the cross-sections must be adequate. Several factors must be taken into consideration when positioning: including the insulation requirements, heat dissipation and the possible mutual magnetic influence.

### N

<table>
<thead>
<tr>
<th><strong>Nominal control current</strong></th>
<th>Input current that is required, under specific conditions, to switch the output.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nominal switching voltage</strong></td>
<td>Voltage at the output - before the closing or opening of the contact.</td>
</tr>
<tr>
<td><strong>Nominal torque</strong></td>
<td>The specified value for the torque of the screws (screw connection) must not be exceeded.</td>
</tr>
</tbody>
</table>

### O

| **Operating temperature** | Permissible ambient temperature – relative to a specific relative humidity – at which a product should be operated at nominal load. |
### Packing unit
Indicates the smallest amount (a pack, for example) or the quantity per carton.

### Plug-in cycles
Sockets and accessories are designed for 10 insertion cycles without electrical load – unless otherwise specified.

### Pollution severity level
Pollution (contamination) includes any foreign material – whether it is solid, liquid or gaseous (ionised gas) – which is capable of influencing the surface resistance of the insulating material. The standard defines four degrees of pollution. Their numbering and classification is based on the quantity of the contaminant or the frequency with which the contaminant reduces the dielectric strength and/or surface resistance.

**Pollution degree 1:**
- there is no contamination or only dry occurrences of non-conductive pollution. The pollution has no influence.

**Pollution degree 2:**
- there is only non-conductive pollution. Temporary occurrences of conductivity caused by condensation may also occur.

**Pollution degree 3:**
- conductive pollution or dry, non-conductive pollution that can become conductive due to condensation is likely to occur.

**Pollution degree 4:**
- the contamination leads to continual conductivity which can be caused by contaminants such as conductive dust, rain or snow.

**Note:**
Pollution degree 3 is typical for industrial environments and similar settings; pollution degree 2 is typical for households or similar.

### Power rating
The nominal value of the power that is converted when the nominal control voltage is applied.
Protection degree - (IEC 60529), IP

The degree of protection afforded by an enclosure is shown using the IP Code (IP = International Protection). This information is equally relevant for industrial relays and accessories. For the purposes of “component” relays (such as PCB relays), refer to the RT protection degree.

A two-digit number is used to indicate the protection provided against touch contact and foreign bodies (the first number) and against humidity (the second number).

Protection levels for touch contact and foreign bodies (the first digit): the first digit indicates the degree of protection inside the housing against ingress of solid foreign objects and against any human access to hazardous parts.
- 0: no protection
- 1: protection for large body parts with a diameter > 50 mm
- 2: finger protection (diameter 12 mm)
- 3: tools and wires (diameter > 2.5 mm)
- 4: tools and wires (diameter > 1 mm)
- 5: full protection against touch contact
- 6: full protection against touch contact

Degree of water protection (the second digit)

The second digit indicates the degree of protection provided against the ingress of water into the housing:
- 0: no protection
- 1: protection against vertically falling drops of water
- 2: protection against water droplets falling diagonally (up to 15°)
- 3: protection against water spray that falls at an angle up to 60° from vertical
- 4: protection against splashed water from all sides
- 5: protection against water jets
- 6: protection against powerful jets of water (flooding)
- 7: protection against sporadic submersion
- 8: protection against constant submersion

Rated control voltage

The nominal value of the sparkover (response) voltage for the solid-state relay.

Rated voltage (Isolation)

Voltage level at which the insulation specifications are measured – this is the basis for sizing the creepage distance.

ROHS Directive 2002/95/EC

RoHS stands for the “Restriction of (the use of certain) Hazardous Substances” According to the EU Directive 2002/95/EC from 01.07.2006, all EU member nations must forbid the use of hazardous substances which damage human health and the environment (including mercury (Hg), cadmium (Cd), lead (Pb), hexavalent chrome (Cr6), polybrominated biphenyls (PBB) and polybrominated diphenyl ethers (PBDE)) in new electrical and electronic devices.

The term “compliant” means that the entire product group meets the requirements of the RoHS Directive. The maximum weight percentage in homogeneous materials is below the limits specified in the directive: 0.1 % for lead, hexavalent chrome, mercury, PBB and PBDE; and below 0.01 % for cadmium, or qualifies for an exemption in accordance with the annex to the RoHS Directive.
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<thead>
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<tbody>
<tr>
<td><strong>Schmitt trigger</strong></td>
<td>Strictly speaking, switching voltages for digital control follow an analogue pattern (no changeover from 0 to 1 between maximum and minimum voltages). This can lead to inaccuracies in switching results, above all when signals are being transmitted rapidly. In this case, the Schmitt trigger functions as a threshold switch. If the threshold voltage set in the Schmitt Trigger is exceeded, the output assumes the maximum possible output voltage (logic 1). Otherwise it is the minimum possible output voltage (logic 0). The Schmitt trigger is normally designed with a hysteresis. The threshold voltage set for activating is higher than that for deactivating. That prevents small irregularities from triggering a switching operation.</td>
<td></td>
</tr>
<tr>
<td><strong>Self-heating</strong></td>
<td>The heating up of an operational component based on the power loss from the relay coil and the switching contacts. For semiconductors (such as a transistor output), the increase in heat is caused by power loss.</td>
<td></td>
</tr>
<tr>
<td><strong>Short-circuit-proof</strong></td>
<td>Shuts off the output stage of a solid-state relay when there is a short circuit, in order to prevent the output circuit from being damaged.</td>
<td></td>
</tr>
<tr>
<td><strong>Solid-state relay</strong></td>
<td>Semiconductor relay that uses an electronic component as the switching mechanism, such as a transistor, thyristor or Triac. Semiconductor relays function with no wearing parts and have a high switching frequency compared with normal relays. But compared to normal relays they have a higher power loss in the load current circuit. An integrated optocoupler is used for galvanic isolation.</td>
<td></td>
</tr>
</tbody>
</table>
| **Status indicator**  | The status LED display on the input control circuit can differ from the state of the contact circuit in the following cases:  
• when there are welded-together or broken switching elements,  
• when there is interference or residual voltages on the signal lines.  
A reduction in light intensity may result when the ambient temperatures are greater than 50 °C. |                                                                 |
| **Storage temperature** | The permitted ambient temperature, related to a specific relative humidity level, for which the product should be stored while in a current-free state. |                                                                 |
**Surge voltage category**

The overvoltage category of a circuit or an electrical system is numbered conventionally (from I to IV) and is based on limiting the assumed surge voltage values that can occur in a circuit (or electrical system with different mains voltages). The assignment to a particular overvoltage category is dependent on the measures which are used to influence (reduce) the surge voltages.

**Overvoltage category I**
- Devices that are intended to be connected to the permanent electrical building installation.

The measures for limiting transient surge voltages to the proper level are taken outside of the device. The protective mechanisms can either be in the permanent installation or between the permanent installation and the device.

**Overvoltage category II**
- Devices that are intended to be connected to the permanent electrical building installation (such as household appliances or portable tools).

**Overvoltage category III**
- Devices that are a part of the permanent installation and other devices where a higher degree of availability is required. This includes the distributor panels, power switches, distribution systems (including cables, busbars, distributor boxes, switches and outlets) that are part of the permanent installation, devices intended for industrial use, and devices that are continually connected to the permanent installation (such as stationary motors).

<table>
<thead>
<tr>
<th><strong>Switch-off delay</strong></th>
<th>The usual time interval from switching off the control voltage of a conducting solid-state relay to the time when the output circuit is blocked.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Switch-on delay</strong></td>
<td>The usual time interval from switching on the control voltage of a closed solid-state relay to the time when the output circuit is conductive.</td>
</tr>
</tbody>
</table>
Glossary: Solid-state relays

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<td><strong>Transients</strong></td>
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</table>
| **Type of insulation** | Quality of the insulation system, depending on the design and application conditions:  
- Functional insulation: insulation between live components – necessary so the relay functions properly.  
- Basic insulation: insulation of live parts to provide basic protection against electrical shock.  
- Doubled insulation: consisting of a base insulation and additional insulation.  
- Reinforced insulation: a single "enhanced" insulation of active components, which ensures the same protection against electric shock as doubled insulation. The doubled insulation is composed of a base and an additional insulation; the extra insulation protects against electric shock if the basic insulation fails. |

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<tr>
<td><strong>Voltage drop</strong></td>
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<tr>
<td><strong>Withstand test voltage</strong></td>
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