Klippon® Relay

Reliable switching of power and signals

Relay modules for various applications

Weidmüller

Rely on the right one

Electromechanical relay modules from Weidmüller

Introduction
When selecting a relay module, there is a risk of incorrect dimensioning of the loads or signals to be switched. This can lead to malfunction or premature loss of the relay module. This brochure is intended to help you select the appropriate relay for each load or signal you wish to switch.

Selection guide for electromechanical relay modules

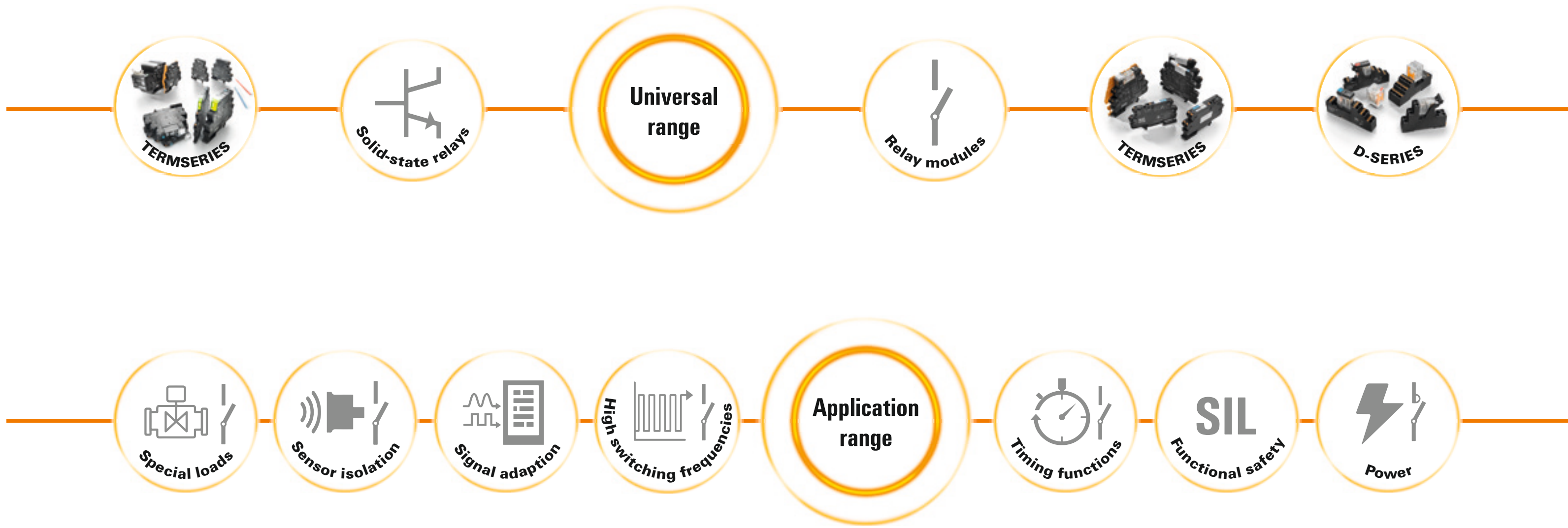
Solutions for more productivity

Highly flexible design processes – with Klippon® Relay

For more than 40 years, we have specialised in the optimisation of cabinet infrastructures. Our wide range of relay modules, solid-state relays and additional value-added services combine the highest standards with ultimate quality. Less wiring effort, housing optimisation through space saving, optimal marking and cost reductions – our customers challenges are our motivation.

Our assortment impresses through reliability, longevity and safety. Supplemented by our digital data support, switching load consulting and online selection guides, we support our customers throughout the entire work process – from the planning phase to installation and operation.

In our universal range, you will find an extensive portfolio of relay modules and solid-state relays in various designs.



In our application range, you will find a tailor-made portfolio of products to increase your productivity and safety for various fields of application.

Visit our website for more information
www.weidmueller.com/klipponrelay

Switch to simple – with Klippon® Relay

High-quality relays with unique all-round service

Whether switching, separating, amplifying, or multiplying: relays perform a multitude of different tasks in industrial applications. They have very specific characteristics and are available in almost innumerable varieties on the market.

Klippon® Relay from Weidmüller makes your choice easy. Our worldwide unique all-round offer combines maximum relay variety with matching accessories and first-class service. We provide you with high-quality products that have been thought out down to the smallest detail, combined with comprehensive support from product selection to modern data services. Only with Klippon® Relay can you be sure to get the right relay for your specific needs – and save time and money.

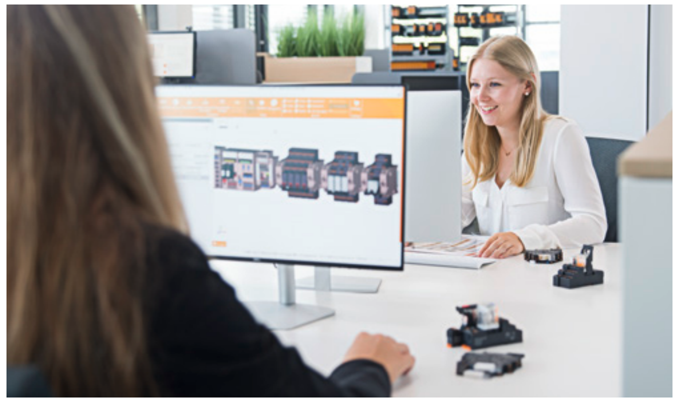
That's our promise!

Simply unique

Visit our website for more information
www.weidmueller.com/switchtosimple

Switch to simple – with Klippon® Relay
High-quality relays with unique all-round service

Switch to secure selection – with Klippon® Relay
The comprehensive relay portfolio with the perfect support



However complex your application environment, the wide Klippon® relay portfolio offers robust and efficient relays for every imaginable application. To ensure you find exactly what you need from our large selection, we offer comprehensive support in choosing the right product. We support you in selecting accessories and provide tips for installation and maintenance. This saves a lot of time and ensures you that you always get the optimum product for your specific application. Quick, easy – and without selection errors!

Switch to reliable – with Klippon® Relay
Optimal relay selection for maximum plant availability

Is system availability your top priority? Then with our high quality Klippon® Relay portfolio you are on the safe side. We offer you comprehensive support to ensure you get the optimally dimensioned product for your application. With decades of experience in the relay segment, we choose the optimal products for you and ensure they are available within the shortest possible time. In this way you can reliably avoid unnecessary machine and system damage, minimise downtimes, and ensure system availability.

Switch to efficient – with Klippon® Relay
Innovative relay solutions for fast and easy wiring

Time is money. Especially in switch cabinet production and plant engineering. Relay modules and solid-state relays from the Klippon® relay portfolio can be installed particularly easily, quickly, and conveniently. The innovative PUSH IN technology shortens your wiring times and avoids incorrect wiring due to coloured pushers. Our KITs, consisting of relays with status LED and sockets with retaining clips, offer you even more convenience. They are supplied fully assembled and functionally tested for time-saving installation and fast commissioning with shorter processing times.

Switch to maintainable – with Klippon® Relay
User-friendly relays for fast and error-free operation

Regardless of the application and environment, maintenance and repairs are unavoidable and must be carried out at regular intervals. With Klippon® Relay you can considerably reduce the required effort. We have focused on many details that make everyday maintenance work faster and easier. These include optimum marking options, clear status LED, consistent product labelling, connection markings, and much more. This makes work easier, faster, more cost-effective, and safer.

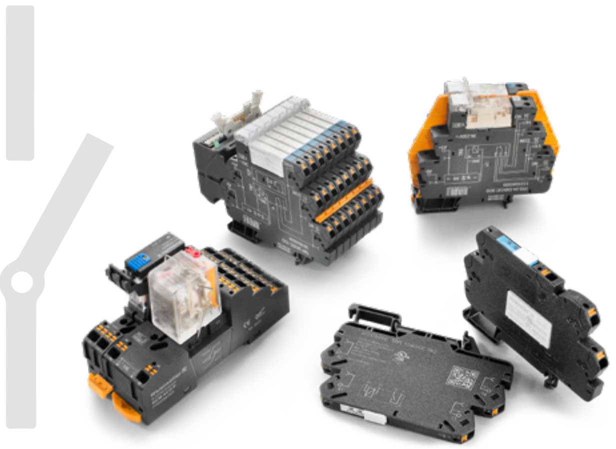
Switch to safe – with Klippon® Relay
Fully reliable special relays with comprehensive certification

Many machines and plants are applied worldwide and under the most diverse conditions. Therefore, they have to operate reliably under very different environmental conditions. In addition, they must comply with specific standards and directives. With Klippon® Relay, you have a range of products available to meet these requirements optimally. Whether high temperature ranges, strong vibrations, fast switching cycles, or specific safety requirements: With Klippon® Relay you will always find a suitable solution.

Switch to profitable – with Klippon® Relay
Multifunctional relay solutions for efficient warehousing

Warehousing and logistics play an important role in the assessment of total costs. With Klippon® Relay you can significantly reduce your logistic expenses. For example, we provide many of our products with Multivoltage inputs, which reduces the width of your stock. In addition, we can supply you with a wide range of convenient relay KITs that are pre-assembled, function and insulation tested. With these KITs you can reduce material numbers and speed up the storage and retrieval process considerably. An important contribution to process optimisation in everyday life.

Find suitable relay modules for your application
Basics for relay module selection



Electromechanical relays are a varied and cost-effective solution for a wide range of switching processes. They can be used for level and power adaptation and form interfaces between control, signalling and regulating equipment and peripherals. In spite of rising raw material prices, they are still very inexpensive and can be easily integrated into a wide variety of circuit types.

Relay modules from Weidmüller are extremely reliable, durable, and available in many different designs. The diversity of their applications in the various industrial sectors makes it necessary to select a suitable relay for each specific application. The following applies: Due to their design, relay modules are subject to mechanical and electrical wear, which must be taken into account when relay circuits are set up.

EN 60947-4-1 and EN 60947-5-1 describe various industrial reference loads such as resistive, capacitive, and inductive loads that stress the switching contact of a relay modules more or less. Electrical loads are formed out of a mixed load with ohmic, capacitive, and inductive load shares, though in practice, loads with a large inductive load share are used mostly. These include contactors, solenoid valves, motors, etc. We will take a closer look at these areas of application in the following.

Switching of large AC loads

If large AC loads are switched, the relay can in principal be operated until the specified maximum value of switching voltage, current, or power is reached. However, when switching AC loads, the switching voltage has a much smaller influence on the service life of the relay contact than the switching current. The reason for this is that the arc that occurs when the relay is switched off usually extinguish automatically at the next zero crossing of the load current. In applications with inductive loads, an effective protective circuit should be provided, as otherwise a significantly reduced service life can be expected.

Switching of large DC loads

Relays can only switch off relatively small direct currents because the zero crossing for extinguishing the arc is missing here. The maximum direct current value is also dependent on the switching voltage as well as on design conditions such as contact gap and contact opening speed. Corresponding current and voltage values are documented in load limit curves.

With undamped inductive DC loads, these values are lower because the energy stored in the inductance can ignite an arc that carries the current through the open contacts. The resulting arc significantly reduces the service life compared to an resistive load.
An effective contact protection circuit can increase the service life of the contacts by 5 to 10 times compared to inductive loads that are not or unfavorably protected.
Type 1N4007 freewheeling diodes are preferably suitable for this purpose.

Switching of utilization categories according to EN 60947

When selecting the relay, the maximum breaking capacity for AC loads and the DC breaking values taken from the load limit curves provide only rough reference values. In practice, however, this is not sufficient because real loads in industrial applications predominantly have inductive or capacitive load shares. Those variables can result in very different values for the service life.

To avoid these disadvantages, the contactor standard EN 60947 divides the loads into different use categories, such as DC-13 or AC-15. The standard is also partly applied to relays. However, users must be aware that these values are only partially suitable for practical use since all DC-13 and AC-15 test loads are highly inductive and operated without a protective circuit.

More precise statements on switching capacity and service life can be given based on specific application data. The more extensive the data collection, the more accurately the service life can be estimated for the respective applications and, if necessary, optimisation suggestions made. For critical applications, the users should determine the service life values themselves.

Switching of small resistive and inductive loads

Selection table for signal relays

Digital selection guide for electromechanical relay modules
www.weidmueller.com/relayselector

The table below helps you to select suitable relay modules for the specified loads. A service life of around 100,000 switching operations is assumed.

TERMSERIES + TERMSERIES-compact

D-SERIES

Suitable KITs are available for all series on this page.







		1 NO / 1 CO AgNi	RSS 1 CO AgNi	RSS 1 CO AgSnO	RCL 1 CO	RCL 1 NO AgSnO	RCL 1 NO AgSnO + W	RCL 2 CO	RCH 2 CO FG	DRI 1 CO	DRI 2 CO	DRM 2 CO	DRM 4 CO
Example Part No. Single relay 24 V DC input		-	4060120000	1984090000	1984040000	1984080000	8866920000	4058570000	2723360000	7760056315	7760056340	7760056069	7760056097
Example Part No. KIT 24 V DC input		2773890000	2618000000	2618020000	2618100000	2618090000	2617930000	2618400000	2706430000	2576210000	2576190000	2576120000	2576140000
Insulation between input and output		reinforced insulation	reinforced insulation	reinforced insulation	reinforced insulation	reinforced insulation	reinforced insulation	reinforced insulation	reinforced insulation	basic insulation	basic insulation	basic insulation	basic insulation
Contact material		AgNi	AgNi	AgSnO	AgNi	AgSnO	AgSnO + W	AgNi	AgNi	AgSnO	AgSnO	AgNi	AgNi
Width plugged on socket		6.4 mm	6.4 mm	6.4 mm	12.8 mm	12.8 mm	12.8 mm	12.8 mm	12.8 mm	16 mm	16 mm	31 mm	31 mm
Socket connection technologies		PUSH IN	PUSH IN and screw	PUSH IN and screw	PUSH IN and screw	PUSH IN and screw	PUSH IN and screw	PUSH IN and screw	PUSH IN and screw	PUSH IN and screw	PUSH IN and screw	PUSH IN and screw	PUSH IN and screw
Max. Operating temperature		60 °C	60 °C	60 °C	60 °C	60 °C	60 °C	60 °C	60 °C	55 °C	55 °C	55 °C	55 °C
Resistive AC load	AC1 loads: Heaters 250 V AC	< 5 A	< 5 A	< 5 A	< 12 A	< 13 A	< 12 A	< 6 A	< 6 A	< 10 A	< 5 A	< 10 A	< 5 A
Inductive AC load	AC15 loads: Valves, contactors 250 V AC	< 1.5 A	< 1.5 A	< 1.7 A	< 3 A	< 3.5 A	-	< 1.5 A	< 2.5 A	< 3 A	< 1.5 A	< 2.5 A	< 1.5 A
	AC3 loads: 1-phase motors 250 V AC	< 0.5 A	< 0.5 A	< 0.6 A	< 1 A	< 1.5 A	-	< 0.7 A	< 0.8 A	< 1 A	< 0.5 A	< 1 A	< 0.5 A
Resistive DC load	DC1 loads: Heaters 24 V DC	< 3 A	< 3 A	< 3 A	< 8 A	< 9 A	< 8 A	< 4 A	< 6 A	< 8 A	< 4 A	< 7 A	< 3.5 A
Inductive DC load	DC13 loads: Valves, contactors 24 V DC	< 1 A	< 1 A	< 1.2 A	< 2 A	< 3 A	-	< 1 A	< 1.5 A	< 2 A	< 1 A	< 2 A	< 1 A
Inrush current optimized		-	-	-	-	80 A, 20 ms	165 A, 20 ms 800 A, 200 µs	-	-	-	-	-	-
Recommended field of application		Miniature switching relay for decoupling PLC's and for switching industrial small loads < 1.5 A in the smallest space.	Miniature switching relay for decoupling PLC's and for switching industrial small loads < 1.5 A in the smallest space.	Miniature switching relay for decoupling PLC's and for switching industrial small loads < 1.7 A in the smallest space.	Miniature industrial relay for decoupling PLC's and switching industrial small loads < 3 A.	Miniature industrial relay with a special contact for switching industrial small loads < 3.5 A with inrush currents up to 80 A / 20 ms. Additional information on page 18.	Miniature industrial relay with a special tungsten pre-contact for switching industrial loads with very high inrush currents up to 800 A / 200 µs. Only very conditionally suitable for inductive loads. Additional information on page 19.	Miniature industrial relay for decoupling PLC's, multiplying signals, and switching industrial small loads < 1.5 A.	Miniature industrial relay with forcibly guided contacts according to EN 61810-3 type B for decoupling of PLC's and for switching of industrial small loads < 2.5 A.	Miniature industrial relay with optional mechanical test button for decoupling PLC's and switching industrial small loads < 3 A.	Miniature industrial relay with optional mechanical test button for decoupling PLC's, multiplying signals, and switching industrial small loads < 1.5 A.	Miniature industrial relay with optional mechanical test button for decoupling PLC's, multiplying signals, and switching industrial small loads < 2.5 A.	Miniature industrial relay with optional mechanical test button for decoupling PLC's, multiplying signals, and switching industrial small loads < 1.5 A.

The indicated currents only apply to the normally open contact. The data of the normally closed contact are to be set at approx. one third of the specified values. The real service life can be both above and below the specified value because each load stresses the switching contact differently and other environmental factors influence the service life of the switching contact, e.g. ambient temperature, mounting position, switching frequency, and many more. Therefore, these values are without guarantee and serve as orientation for better dimensioning. They may not be used as B10 or B10d values for the calculation of failure data such as MTTF or MTTFd either. The assessment of the maximum load capacity was carried out on the basis of many years of practical experience as well as life cycle tests under laboratory conditions.

Switching of large resistive and inductive loads

Selection table for power relays

The table below helps you to select suitable relay modules for the specified loads. A service life of around 100,000 switching operations is assumed.

D-SERIES

		DRR 2 CO	DRR 3 CO	DRL 1 CO	DRL 2 CO	DRL 3 CO	DRL 4 CO
Example Part no. Single relay		2765020000	2765070000	2765110000	2765160000	2765220000	2765270000
Example Art. no. KIT 24 V DC input		-	-	-	-	-	-
Insulation between input and output		Basic insulation	Functional insulation	Basic insulation	Basic insulation	Basic insulation	Basic insulation
Contact material		AgSnO	AgSnO	AgSnO	AgSnO	AgSnO	AgSnO
Width plugged on socket		38 mm	38 mm	24 mm	24 mm	34 mm	44 mm
Socket connection technologies		Screw	Screw	Screw	Screw	Screw	Screw
Max. Operating temperature		55 °C	55 °C	55 °C	55 °C	55 °C	55 °C
Resistive AC load	AC1 loads: Heaters 250 V AC	< 10 A	< 10 A	< 16 A	< 10 A	< 10 A	< 10 A
Inductive AC load	AC15 loads: Valves, contactors 250 V	< 3.5 A	< 3.5 A	< 5.5 A	< 4.5 A	< 4,5 A	< 4.5 A
	AC3 loads: 1-phase motors 250 V AC	< 1.5 A	< 1.5 A	< 3.5 A	< 2 A	< 2 A	< 2 A
Resistive DC load	DC1 loads: Heaters	< 10 A	< 10 A	< 10 A	< 7 A	< 7 A	< 7 A
Inductive DC load	DC13 loads: Valves, contactors 24 V DC	< 2.5 A	< 2.5 A	< 4 A	< 3.5 A	< 3,5 A	< 3.5 A
Inrush current optimized		-	-	-	-	-	-
Recommended field of application		Power relay (octal relay) for switching several industrial loads < 3.5 A.	Power relay (octal relay) for switching several industrial loads < 3.5 A.	Miniature power relay for switching industrial loads < 5.5 A.	Miniature power relay for switching several industrial loads < 4.5 A.	Miniature power relay for switching several industrial loads < 4.5 A.	Miniature power relay for switching several industrial loads < 4.5 A.

POWER

		DRW 2 CO	DRW 3 CO	DRH 1 NO	DRH 2 NO	PWR 1 NO	PWR 2 NO
Example Part no. Single relay		2765600000	2765650000	1219850000	1220150000	1219480000	1219550000
Example Art. no. KIT 24 V DC input		-	-	-	-	-	-
Insulation between input and output		Basic insulation	Basic insulation	Basic insulation	Basic insulation	Basic insulation	Basic insulation
Contact material		AgSnO	AgSnO	AgSnO	AgSnO	AgSnO	AgSnO
Width plugged on socket		39 mm	39 mm	39 mm	39 mm	51 mm	51 mm
Socket connection technologies		Screw	Screw	Screw	Screw	Screw	Screw
Max. Operating temperature		60 °C	60 °C	60 °C	60 °C	55 °C	55 °C
Resistive AC load	AC1 loads: Heaters 250 V AC	< 16 A @ 250 V < 10 A @ 400 V	< 16 A @ 250 V < 10 A @ 400 V	< 16 A @ 400 V	< 16 A	< 30 A	< 25 A
Inductive AC load	AC15 loads: Valves, contactors 250 V	< 5.5 A	< 5 A	< 7 A	< 6 A	< 12 A	< 8.5 A
	AC3 loads: 1-phase motors 250 V AC	< 3.5 A	< 3 A 1-phasig < 3 A 3-phasig	< 4 A	< 3,5 A	< 8 A	< 6 A
Resistive DC load	DC1 loads: Heaters	< 16 A	< 16 A	< 16 A @ 24 V DC < 12 A @ 125 V DC < 10 A @ 220 V DC	< 16 A @ 24 V DC < 7 A @ 125 V DC < 3 A @ 220 V DC	< 25 A	< 20 A
Inductive DC load	DC13 loads: Valves, contactors 24 V DC	< 4 A	< 3.5 A	< 12 A @ 24 V DC < 5 A @ 125 V DC < 3 A @ 220 V DC	< 9 A @ 24 V DC < 2 A @ 125 V DC < 1 A @ 220 V DC	< 7 A	< 6 A
Inrush current optimized		-	-	-	-	-	-
Recommended field of application		Power relay with mechanical test button for switching multiple industrial loads < 5.5 A.	Power relay with mechanical test button for switching industrial loads < 5 A or a 3-phase electric motor < 3 A.	Power relay with blow out magnet and mechanical test button specially designed for switching industrial loads with high DC voltage up to 220 V DC 3 A.	Power relay with blow out magnet and mechanical test button especially for switching industrial loads with high DC voltage up to 220 V DC 1 A.	Power relay (miniature contactor) with double contact opening for switching industrial loads < 12 A.	Power relay (miniature contactor) with double contact opening for switching industrial loads < 8.5 A.

The indicated currents only apply to the normally open contact. The data of the normally closed contact are to be set at approx. one third of the specified values. The real service life can be both above and below the specified value because each load stresses the switching contact differently and other environmental factors influence the service life of the switching contact, e.g. ambient temperature, mounting position, switching frequency, and many more. Therefore, these values are without guarantee and serve as orientation for better dimensioning. They may not be used as B10 or B10d values for the calculation of failure data such as MTTF or MTTFd either. The assessment of the maximum load capacity was carried out on the basis of many years of practical experience as well as life cycle tests under laboratory conditions.

Additional information on the selection tables

Simple formulas for calculating individual values

Calculating the service life of the relay contacts for different switching currents

In the previous tables we gave you the maximum recommended currents at various loads for a service life of approx. 100,000 switching cycles. If you switch lower currents, the service life of the relay contacts will be extended. With the following formulas you can approximately calculate how the service life of the relay contacts will change.

Example: A 24 V DC solenoid valve with 200 mA current consumption should be switched with a 6.4 mm wide TERMSERIES RSS 1 CO relay. A solenoid valve corresponds to a DC13 load. According to the table, a switching current of max. 1 A is specified for the relay at this load. To calculate the expected service life, proceed as follows:

$$x = \frac{I_{Table}}{I_{App}} = \frac{1\ A}{200\ mA} = 5$$

$$n_{new} = 100{,}000 \cdot x = 100{,}000 \cdot 5 = 500{,}000 \text{ switching cycles}$$

The expected service life when switching a 200 mA solenoid valve should be approx. 500,000 switching cycles.

I_{App}	= Switching current in the application
I_{DC}	= DC Switching current at the DC switching voltage in the application
$I_{Load\ curve}$	= DC Switching current from the load limit curve of the data sheet
I_{Nom}	= Continuous current from relay data sheet
I_{Table}	= Switching current from the selection table for the respective load
n_{new}	= Service life at switching current in the application
x	= Reduction factor of the switching current

Calculating the switching currents for voltages that deviate from the values in the table

AC switching voltage:
With AC loads, the switching current has the greatest influence on the service life. Therefore, the switching currents from the table can also be used for switching voltages up to 100 V AC. For values below 100 V AC, the service life increases at the same switching current:

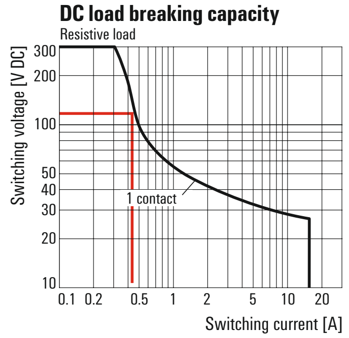
- at 24 V AC four times the service life
- at 60 V AC twice the service life

Example: If the table shows a switching current of 2 A for a 250 V AC AC15 load, then these 2 A are also applicable for 120 V AC. At 24 V AC switching voltage, the expected service life increases four times to 400,000 switching cycles.

DC switching voltage:
When switching DC loads, the switched voltage has a large influence on the maximum switching current of the relay contact. This can also be seen from the DC load breaking curve given in the data sheet. The following formulas can be used to roughly determine the maximal switching current for other DC switching voltages:

Example: A TERMSERIES RCL 1 CO relay with a DC13 load and a switching voltage of 110 V DC. According to the table a maximum of 2 A at 24 V DC applies to a DC13 load for a service life of 100,000 switching cycles.

DC load breaking capacity



The curve shows a maximum switching current of approx. 0.45 A with resistive load. This must now be set in relation to the rated current of the relay (16 A) from the data sheet and the value for a DC13 load from the table.

$$x = \frac{I_{Table}}{I_{Nom}} = \frac{2\ A}{16\ A} = 0.125$$

$$I_{DC} = I_{Load\ curve} \cdot x = 0.45\ A \cdot 0.125 = 0.056\ A = 56\ mA$$

To achieve 100,000 switching cycles, a DC13 load of 56 mA can be switched with a switching voltage of 110 V DC.

Select contact materials suitable for the application

Information of various contact materials

Relay modules are used in a wide variety of industrial areas and environments. The relays must therefore be adapted to the various tasks by selecting suitable contact materials. The following applies: the load capacity of the contacts for voltage, current, and power depends essentially on the material used. To make the selection easier for you, we have compared the most important characteristics of the contact materials.

- Au Gold
- Ni Nickel
- Ag Silver
- W Tungsten
- Sn Tin
- O_2 Oxygen

Criteria for the selection of the contact material:

- Welding tendency
- Burn-off resistance
- Contact resistance
- Material migration
- Resistance to harmful gas atmospheres

Please obtain information when selecting a relay in this table:

Material	Characteristics	Recommended applications
Silver-nickel (Ag Ni)	• Higher welding tendency than AgSnO • High burn-off resistance • Lower contact resistance than AgSnO • Mean material migration • Low resistance to harmful gas atmospheres	• Suitable for low to high resistive and low inductive loads (solenoid valves, fans, heaters) • Standard contact material for a variety of relays • Limited suitable for high inrush currents • Suitable for loads > 12 V/10 mA or 5 V/100 mA
Silver-nickel flash gold plated (Ag Au Ni)	• Higher welding tendency than AgSnO • High burn-off resistance (gold just storage protection) • Lower contact resistance than AgSnO • Mean material migration • Low resistance to harmful gas atmospheres	• Suitable for low to high resistive and low inductive loads (solenoid valves, fans, heaters) • The flash gold plating is a storage protection, but offers no functional improvement to AgNi • Limited suitable for high inrush currents • Suitable for loads > 12 V/10 mA or 5 V/100 mA
Silver-nickel hard gold plated (Ag Au Ni)	• Very low resistance to burn-off • Lowest contact resistance • High resistance to harmful gas atmospheres	• Suitable for decoupling control inputs and other small resistive loads • Suitable for loads > 1 V/1 mA and < 30 V/10 mA • After switching loads > 30 V/100 mA, small powers can no longer be switched reliably because the hard gold plating has been burned-off. Only the characteristics of the base contact material AgNi still apply.
Silver-Tin-Oxide (Ag O_2 Sn)	• Lower welding tendency than AgNi • High resistance to burn-off • Average contact resistance • Lower material migration than AgNi • Very low resistance to harmful gas atmospheresn	• Suitable for medium to high resistive DC-loads and low up to medium inductive DC loads due to low material migration. Thanks to the low tendency to weld, it is also well suited for loads with higher inrush currents such as lamp loads, light capacitive loads, fluorescent tubes, etc. • Suitable for loads > 12 V/100 mA
Tungsten (W)	• Lowest welding tendency • Very high resistance to burn-off • Highest contact resistance • Low material migration	• Suitable for loads with very high inrush currents of up to 165 A/20 ms or 800 A/200 µs (e.g. lamp loads, capacitive loads, fluorescent tubes, switched-mode power supplies etc.) • Often used as a pre-making contact in parallel to AgSnO contacts

Protect relay contacts effectively

Selection criteria for protective circuits of inductive loads

In our selection tables we specified the maximum recommended switching currents for inductive loads without protective circuits. If you want to increase the service life of the contacts, you must equip the relay contacts with an effective protective circuit.

The protective circuit on the coil side of a relay module can, for example, be implemented with an integrated or additionally pluggable freewheeling diode. However, this only protects the controlling periphery from the voltage peaks that occur in the coil of the relay module. The relay contact is usually not sufficiently protected against the voltage peaks of the inductive load to be switched, although with optimum dimensioning almost the same values for switching capacity or switching cycles can be achieved as with resistive load.

The largest reduction factor for the service life of a relay contact is the arc generated during switching off inductive loads. It is caused during the switching process by the energy stored in the coil and can destroy the contact through material evaporation and material migration.

With DC voltage and standing arc, the relay can even fail during the first switching cycle. Voltage peaks caused by electric arcs can reach values up to several 1,000 volts.

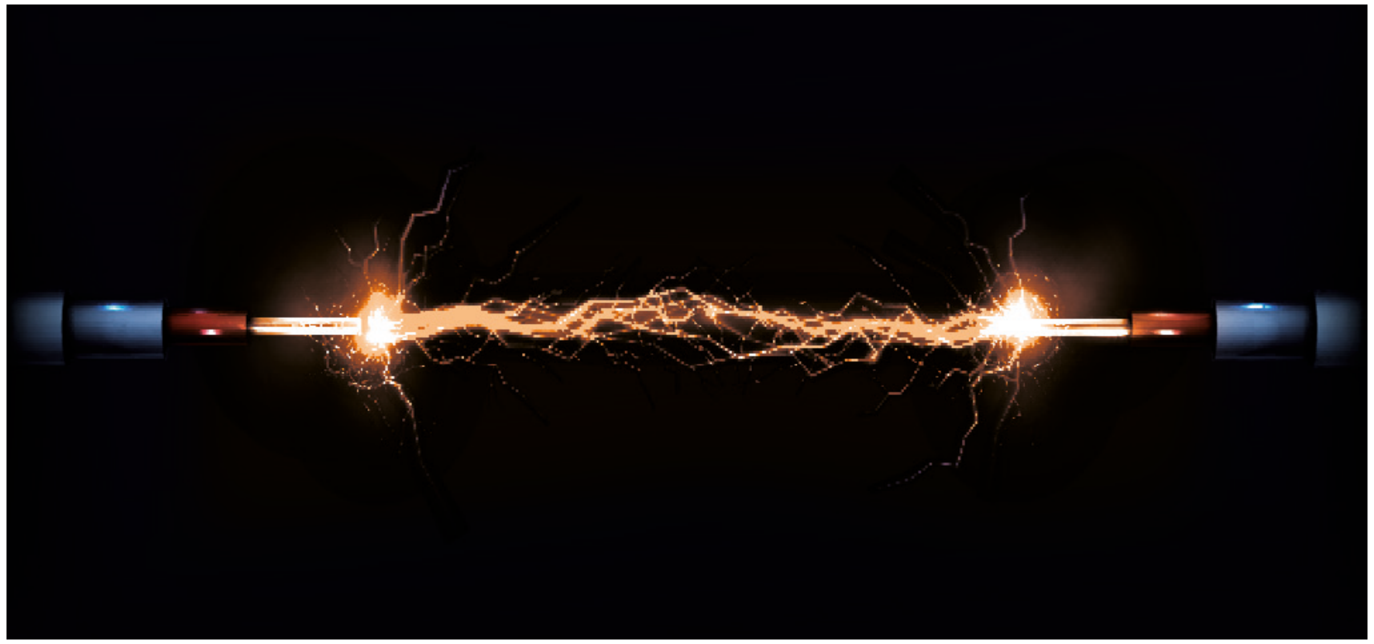
A protective circuits must be used to suppress the formation of electric arcs.

In the following, we will explain the correct installation of the protective circuit and the effectiveness of the most common types of protective circuit. There are various ways to install an effective protective circuits. For example, the protective circuit can be mounted either parallel to the relay contact or parallel to the load.

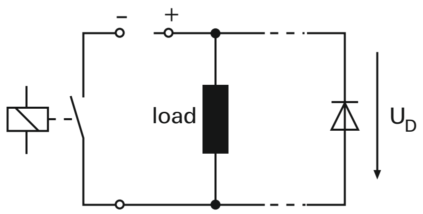
However, the protective measure should always apply directly to the source of the fault. Therefore, the protective circuit of the load is preferable to the circuit of the contact.

Advantages of a protective circuit at the load:

- When the contact is open, the load is still galvanically isolated from the operating voltage
- The switch-off peaks of the load cannot be coupled into the control lines running in parallel



Free-wheeling diodes

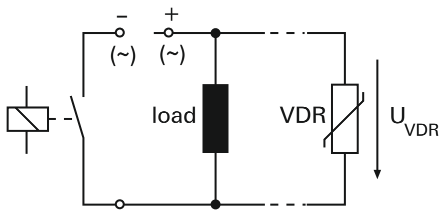


Free-wheeling diodes are used to protect against overvoltages caused by self-induction when an inductive DC voltage load is switched off (e.g. solenoid valves or electric motors). They ensure that the voltage peaks that occur are reduced to the value of the diode forward voltage (U_D).
However, this leads to a delay in the voltage drop and thus in the switch-off process of the load.

Advantage:
- Uncritical dimensioning
- Very positive effect on the service life of the contacts

Disadvantage:
- Significantly extended switch off process
- Only suitable for DC voltage

Varistors

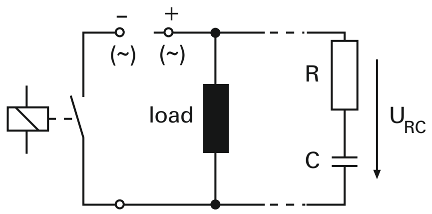


The functional principle of varistors is also based on breakdown voltages (U_{VDR}). High energies can be dissipated, but this causes the component to aging. Therefore, the breakdown voltage is reduced over time and the leakage current is increased.

Advantage:
- Uncritical dimensioning
- Suitable for DC and AC voltage
- Slightly extended switch off process

Disadvantage:
- Complex and expensive with increasing power
- Low effect on the service life of the contact

RC modules



With RC modules, voltage peaks are compensated via a capacitor. Thanks to its special characteristics during charging and discharging the interference pulses are already filtered out during the voltage rise and not only when the breakdown voltage (U_{RC}) is reached.

Advantage:
- Suitable for DC and AC voltage
- Slightly extended switch off process

Disadvantage:
- Exact dimensioning required
- High inrush current
- Low effect on the service life of the contact

In order to implement a protective circuit tailored to the load, suitably dimensioned protective circuits are available as accessories from many manufacturers of inductive loads such as contactors or solenoid valves. This enables simple integration of the protective circuit on the load.

Switching of capacitive loads

Relays for LED lamps and devices with high inrush currents

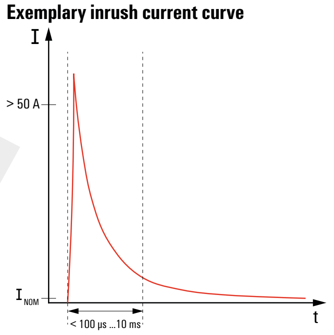
Loads with capacitive load shares, especially LED lamps, require extreme demands on switching contacts regardless of the voltage type. They cause highly energetic current peaks at the moment of switch-on. These can reach over 150 A and weld the contact.

Until a few years ago, the lighting of buildings and facilities was provided almost exclusively by light bulbs or fluorescent tubes of buildings and facilities. Nowadays, they are replaced by LED lamps, which consume much less power and are often much more durable. With retrofit solutions, such as LED lamps with E27 bases, this can be done quite easily. In new installations, LED lights are provided anyway.

However, problems often arise with relay circuits, such as those found in staircase illumination: LED lamps generate very strong inrush currents due to their design. Although these are much shorter than with conventional light sources, they can generate currents of over 150 A and thus weld the relay contact at the moment of switch-on.

Therefore, when switching LED lamps with standard relays, welded contacts occur after a very short time, sometimes even after the first switch-on. Furthermore, in more and more conventional industrial loads, such as solenoid valves and contactors, capacitive load shares are hidden in input circuits, as these enable operation over a wide input voltage range. In order to switch such loads reliably, relays specially designed for this purpose are required. These relays have special contact materials and designs that can reliably switch significantly higher current peaks than conventional relays with e.g. AgNi as contact material. The characteristics of the various contact materials are listed below and assigned to recommended areas of application:

Exemplary inrush current curve



TERMSERIES

Special relay modules with tungsten contact for very high inrush currents of up to 800 A for 200 µs

Single relay, 12.8 mm wide	Order No.
RCLS3T024W	8866920000
Complete module/KIT, 12.8 mm wide	
TRP 24VDC 1NO HCP	2617930000
TRS 24VDC 1NO HCP	1479810000
TRP 24-230VUC 1NO HCP ED2	2663140000
TRS 24-230VUC 1NO HCP ED2	2662980000

Special relay modules without tungsten contact for high inrush currents of up to 80 A for 20 ms

Single relay, 12.8 mm wide	Order No.
RCLS3L024W	1984080000
Complete module/KIT, 12.8 mm wide	
TRP 24VDC 1NO HC	2618090000
TRS 24VDC 1NO HC	1479780000
TRP 24-230VUC 1NO HC ED2	2663130000
TRS 24-230VUC 1NO HC ED2	2662970000

TERMSERIES

Solid state relays for short and high inrush currents (<10 ms) e.g. of LED lamps or devices with wide range inputs

Pluggable solid-state module DC output, 12 mm wide	Order No.
SSR 10-32VDC/0-35VDC 5A	1421450000
SSR 24VDC/0-24VDC 3,5A	1132310000
Pluggable solid-state module DC output, 5 mm wide	
SSS Relais 24V/24V 2Adc	4061190000
Complete module/KIT, 12.8 mm wide	
TOP 24VDC 24VDC5A	2618840000
TOS 24VDC 24VDC5A	1990960000
TOP 24VDC 24VDC3.5A	2618700000
TOS 24VDC 24VDC3,5A	1127630000
Complete module/KIT, 6.4 mm wide	
TOP 24VDC 24VDC2A	2618720000
TOS 24VDC 24VDC2A	1127170000
Pluggable solid-state module, AC output, 5 mm wide	
SSS Relais 24V/230V 1Aac	4061210000
Complete module/KIT, 6.4 mm wide	
TOP 24VDC 230VAC1A	2618420000
TOS 24VDC 230VAC1A	1127410000

MICROOPTO

Solid state relays for short and high inrush currents (<10 ms) e.g. of LED lamps or devices with wide range inputs

Complete module, 6.1 mm wide	Order No.
MOS 24VDC/8-30VDC 2A	8937970000
MOS 24VDC/8-30VDC 2A E	1283230000

HCP relay with tungsten contact in detail

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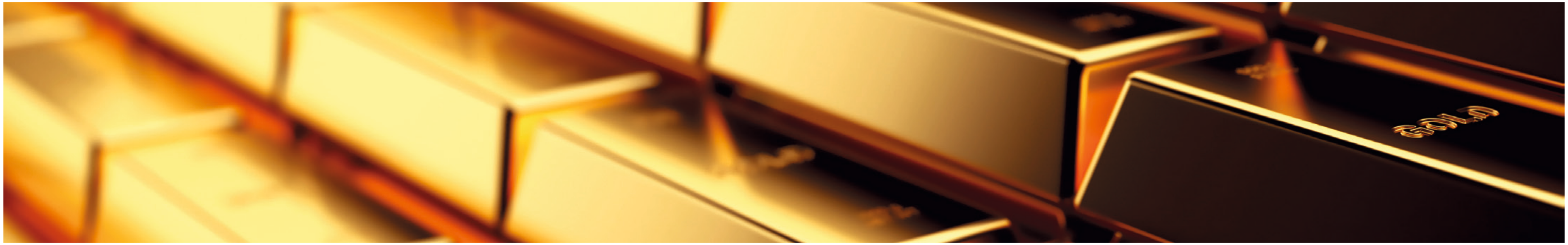
Switching of very low power circuits

Relay for forwarding control signals



Low power circuits with values below 30 V/10 mA are mainly used in applications where signals has to be transmitted to control inputs, e.g. to a PLC. Such low loads do not produce a sufficient arc at the contacts.

However, this arc has two important functions:
On the one hand, it ensures continuous cleaning of the contacts; on the other hand, it can penetrate non-conductive foreign layers at the contacts. Such foreign layers are usually created by oxidation or sulfidation of common contact materials such as silver (Ag), silver-nickel (AgNi), or silver-tin oxide (AgSnO). The foreign layers can increase the contact resistance after a short time to such an extent that reliable switching of low loads is no longer possible.

For these reasons, gold (Au) is used as the contact material for relays switching small loads. It has proven itself due to its low and constant contact resistance and its resistance to ambient air containing sulphur.

TERMSERIES

The all-rounder. Modular relay modules from 6 mm width with extensive accessories, large selection of variants, and unlimited cross-connection possibilities.

Single relay, 5 mm wide	Order No.
RSS112024	4061590000
Complete module/KIT, 6.4 mm wide	
TRP 24VDC 1CO AU	2618110000
TRS 24VDC 1CO AU	1123000000

Single relay, 12.8 mm wide	Order No.
RCL425024	4058580000
Complete module/KIT, 12.8 mm wide	
TRP 24VDC 2CO AU	2618530000
TRS 24VDC 2CO AU	1123730000

D-SERIES

Industrial relay modules with innovative features and a large selection of variants for various applications.

Single relay, 21 mm wide	Order No.
DRM270024LT Au	7760056185
DRM570024LT Au	7760056189

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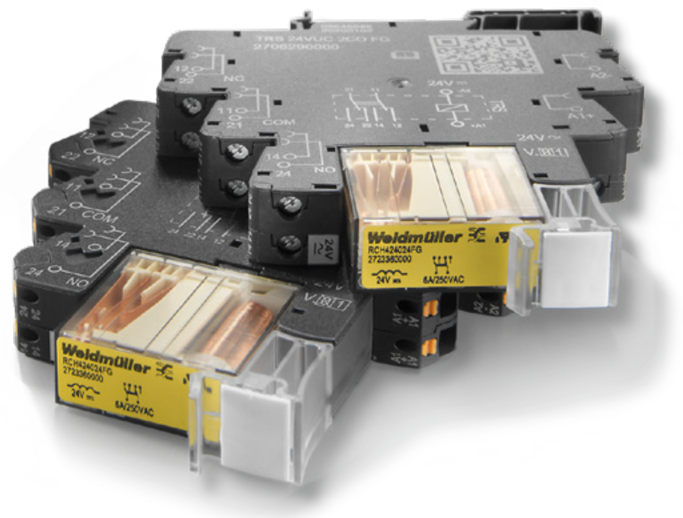
Forced guided contacts explained in detail

The difference to relays with conventional contacts

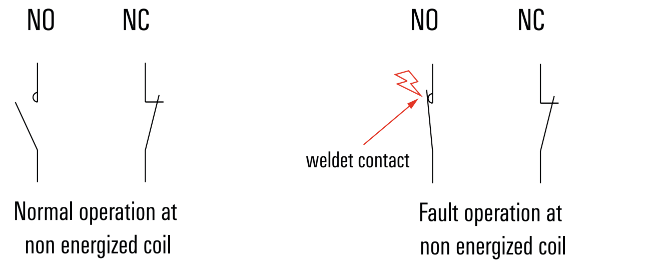
Relay modules with forcibly guided contacts use elementary relays according to IEC 61810-1 with a contact set according to IEC 61810-3. From the outside, they can hardly be differentiated from relays with conventional contacts, if at all. Due to their design, an opening failure of forcibly guided contacts can be reliably detected. Relays with such contacts have the following additional characteristics compared to relays with conventional contacts:

- Forcibly guided NC and NO contacts are designed in such a way that they cannot be closed at the same time
- If a contact of a forcibly guided contact set is welded, the antivalent contacts cannot close and the contact opening must be > 0.5 mm
- The contacts are located in contact chambers and are thus specially protected against other contacts and against the coil

Due to these normative requirements, the design and manufacturing effort for relays with positively driven contacts is much higher.

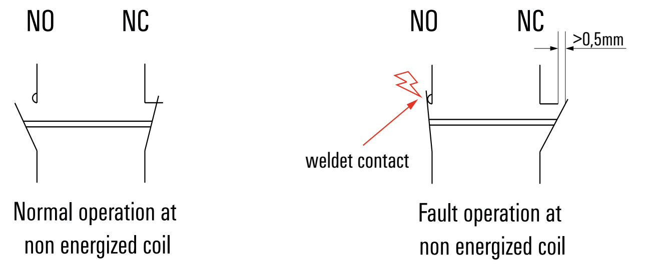


conventional relay



The normally open contact (NO) is welded in this example. With standard relays, a normally closed contact (NC) can also be closed in case of the de-energized state. In this way, the NC and NO contacts can be closed at the same time and an opening failure cannot be reliably detected.

relay with forcibly guided contacts



The normally open contact (NO) is welded in this example. In this case, relays with forcibly guided contacts cannot have a normally closed contact (NC) which is closed in the de-energized state. In this way, the NC and NO contacts cannot be closed at the same time and an opening failure can be reliably detected. It is mechanically ensured that the NC contact remains open with a minimum contact gap of 0.5 mm even in the de-energized state.

In addition, the standard distinguishes between two types of positive guidance, type A and type B:

Type A

With type A relays, **all** contacts are mechanically positively driven with each other.

In an example of a six-pole relay with four NO contacts and two NC contacts, the four NO contacts are forcibly guided with both NC contacts. In this example, if one of the NO contacts welds, both NC contacts may no longer close if the relay is de-energized.

Type A relays with forcibly guided contacts can be found in our SAFESERIES Contact Extension.

Type B

In a type B relay, **not all** contacts of a contact set are positively driven with each other.

In an example of a six-pole relay with four NO contacts and two NC contacts, the four NO contacts are forcibly guided with just one of the NC contacts. In this example, if one of the NO contacts welds, the non-force-guided NC contact can still close if the relay is de-energized. The other forcibly guided NC contact may not close. The status of the other NO contacts is undetermined. The non-force-guided NC contact can close because it is not forcibly guided to the other contacts in the relay. The contacts which are not forcibly guided must be specified in the data sheet.

Positively driven relays with changeover contacts (CO) are assigned to type B by the standard, only one NC or NO contact may be used per changeover contact. The reason for this is that the phenomenon of contact spring breakage cannot be excluded, so that in the event of a spring breakage of a changeover contact set, the NO and NC contacts of this contact set can be short-circuited.

Type B relays with forcibly guided contacts can be found in our TERMSERIES FG and RIDERSERIES FG.

SAFESERIES Contact Extension

Visit our online catalogue for more information

TERMSERIES FG

RIDERSERIES FG

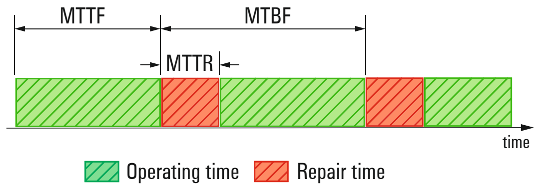
B10(d) + MTTF(d)

Short explanation and example calculation

1. Introduction of MTTF and MTBF

Failure data such as MTTF (Mean Time To Failure) or MTBF (Mean Time Between Failure) are becoming increasingly important in the planning of machinery. This article will explain the importance of these values for electromechanical relays and solid state relays.

For the planning of electrical machines, it is necessary to know the MTBF values for the individual components such as relays in order to calculate the probability of failure for the entire system. MTBF is the mean time between failures, so it includes the mean operating and the mean repair time (MTTR = Mean Time To Repair). MTBF, MTTF and MTTR values are usually given in years. However, in the case of electronic components such as relays, the repair time is not determined because it is not economical to repair defective relays. They are replaced after they are worn. That is why relays are referred just to MTTF. So you can also say: MTBF is equal to MTTF for electromechanical relays and solid-state relays. The MTTF value is a statistical key figure/parameter. It is determined by tests and empirical values and therefore gives no guarantee of a certain service life.



Difference between MTTF and MTTFd

The difference between MTTF and MTTFd (Mean Time to Failure dangerous) is that the MTTF value indicates the mean operating time to (any) failure, while the MTTFd value indicates the mean operating to a dangerous failure. Non-dangerous failures can lead to machine damage, but they are not relevant for safety considerations within the risk and hazard assessment.
The MTTF value for individual components is usually obtained directly from the manufacturer. However, the manufacturer cannot provide an MTTFd value because he cannot ultimately assess which error in the application leads to a dangerous failure at the customer. In addition, the arrangement and alignment of several elements can also have an influence on the total time span until a dangerous failure. Above all, the possibility of executing a function in two channels and therefore redundant has a considerable influence on the MTTFd value of the entire system.

This means that the MTTFd must be determined by the person who develops the machine/plant and also plans the safety functions. This is usually the developer or the designer. These persons can calculate the MTTFd.

MTTF for electromechanical relays

With electromechanical relays, the service life is strongly dependent on the number of switching cycles, the switched load and other environmental parameters such as temperature, mounting orientation, switching frequency and many more. This is because electromechanical relays are subject to mechanical and electrical wear, mainly due to contact erosion. For these reasons, the MTTF cannot be calculated from statistical values as it is the case with a solid-state relays, instead B10 values are determined. These B10 values are determined in complex and time-consuming test setups for various load cases, so there is only a selection of different B10 values and not every possible combination of switching current, load type and environmental parameters.

B10-value

The B10 value indicates the nominal service life in switching cycles where 90% of a unit of tested relays still work. It is therefore the average number of switching cycles, according to which 10% of relays are to be expected to fail. This value is a statistical expected value that was determined on the basis of lifetime tests. In real applications, the lifetime values differ from the B10 value, as each load is different and the environmental parameters, such as humidity, air pollution, heat, vibrations, radiation, etc., have an influence on the service life.

The loads used for the determination of the B10 values are specified in the contactor standard EN 60947 in different categories of use suchas z.B. DC-13 or AC-15. However, users must be aware that these loads reflect practice only to a limited extent. Because all DC-13 and AC-15 test loads are highly inductive and operate without a protection circuit. Furthermore, the B10 values are determined at significantly higher switching frequencies than usual in reality. This is done to shorten the test execution time, otherwise tests would take years to deliver a result. An increased switching frequency also represents an increased load on the relay than usual in reality. However, it is almost impossible to compare B10 values of different providers. To compare different relays, the relays would have to be measured in exactly the same test setup. For this reason, the B10 values are often only provided by the manufacturer on request.

MTTF calculation using the B10-value

For the calculation of the MTTF value, the respective B10 value which most closely corresponds to the real application is converted into the following formula from the standard EN ISO 13849-1:

MTTF = B10 / (0,1 x annual switching cycles in the application)

The annual switching cycles in the application must be determined by the user himself.

B10d-value

The B10d indicates the number of switching cycles according to which a dangerous failures occur in 10 % of the units considered. The addition "d" stands for "dangerous". The value is for the creationa risk and hazard analysis relevant and thus also for the evaluation of the safety of a machine or plant. If there is no knowledge of the number of hazardous failures, EN ISO 13849-1 recommends the following calculation for the B10d value:

B10d = B10 x 2

This means that it is assumed that every second failure is a dangerous failure.

MTTFd calculation using the B10d-value

For the calculation of the MTTFd value, the respective B10d value which most closely corresponds to the real application is converted into the following formula from the standard EN ISO 13849-1:

MTTFd = B10d / (0,1 x annual switching cycles in the application)

The annual switching cycles in the application must be determined by the user himself.

2. Exemplary MTTF calculation of an electromechanical relay

B10 values available for the relay:
90,000 switching cycles at a DC13 load: 24 V DC / 1.5 A
250,000 switching cycles at an AC15 load: 230 V AC / 3 A
400,000 switching cycles at one AC1 load: 230 V AC / 6 A

Application:
Switching a solenoid valve: 230 V AC / 2 A

Switching frequency of the relay:
3x per minute

Operating hours of the plant:
250 days a year
22 hours a day

1) First, the appropriate B10 value of the relay for the application is selected.
Since a solenoid valve at 230 V AC is very similar to an AC15 load, this value is selected for the calculation:

250,000 switching cycles at an AC15 load: 230 V AC / 3 A

2) After that, the annual switching cycles of the relays must be determined. This is determined with the following formulas:

Formula signs:
t_{Zyklus} = Mean time between two consecutive cycles in seconds
h_{op} = Average operating time in hours per day (0 - 24 hours)
d_{op} = Average operating time in days per year (0 - 365 days)
n_{op} = Average number of switching cycles per year

t_{Zyklus} = 60 seconds / switching frequency of the relay per minute
t_{Zyklus} = 60 seconds / 3 = 20 seconds

n_{op} = (d_{op} x h_{op} x 3600 s/h) / t
n_{op} = (250 days/year x 22 hours/day x 3600 seconds/hour) / 20 seconds
n_{op} = 990,000 switching cycles/year)

3) Calculation of the MTTF

MTTF = B10 / (0.1 x Annual switching cycles in the application)
MTTF = 250,000 switching cycles / (0.1 x 990,000 switching cycles/year)
MTTF = 2.52 years

The MTTF for the sample relay is therefore 2.52 years.

3. MTTF for solid-state relays

The MTTF value for solid-state relays is calculated from the failure rates of the individual electronic components, as they have no mechanical components that wear out due to mechanical abrasion or contact burn-off. The MTTF values of the Weidmüller solid-state relays can be found in the data sheet. The calculation was carried out in accordance with the standards SN 29500 and EN ISO 13849-1. The value refers to an ambient temperature of 40°C. When calculating the values for solid-state relays, the following things are not taken into account:

- Electrical connections and plug-in connections
- PCB (not included in the SN29500 standard)
- Soldering process due to quality control processes in manufacturing

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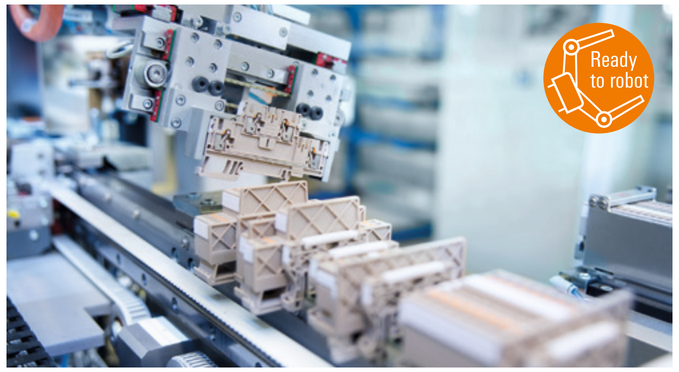

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Selection guide for electromechanical relay modules
Our selection guide in digital and printed form support you in finding the right relay for safe and reliable switching of different loads:
www.weidmueller.com/relayselector

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Weidmüller Interface GmbH & Co. KG
Klingenbergstraße 26
32758 Detmold, Germany
T +49 5231 14-0
F +49 5231 14-292083
www.weidmueller.com

Personal support can
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