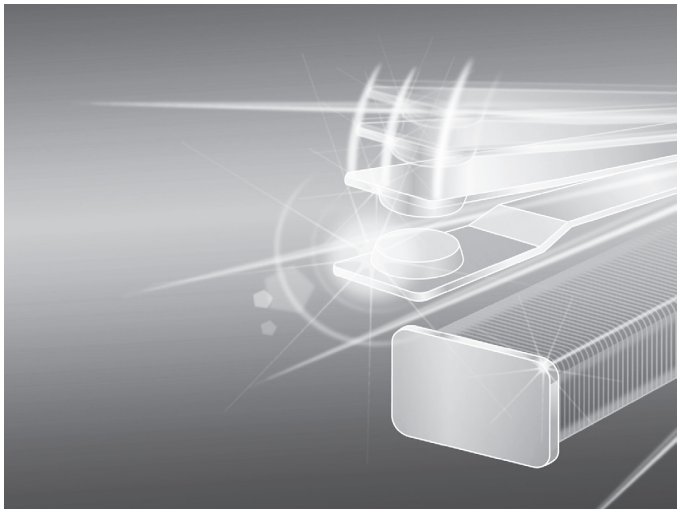
Definitions



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Definitions (Continued)

General
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TE Connectivity strongly recommends to monitor the life cycle of the product and to verify the relevant failure mode per IEC 61810-1.

Technical data
Unless otherwise stated, the stated technical data are based on laboratory tests under standardized conditions and are within the conditions of normal use for these components. The vast number of influencing factors does not allow TE to test its products for all imaginable applications and processes. Furthermore, the large number of possible variations within a relay family makes it impossible to give a comprehensive description of the different characteristics for all variants in one datasheet. Typical data are derived from the standard versions.
The decision on the suitability of a specific component is solely responsibility of the user. To ensure the suitability of the product for a specific application the user has to test these products before the use under the most stringent conditions they will be exposed to in the actual application. Taking into consideration the aspects of operational availability and safety, the user has to rate the actual service life in an adequate relation to the expected life of the relay.
The use of the relay beyond its specified characteristics or beyond sufficiently tested life expectancy bears the risk of dangerous conditions; the user has to prevent such conditions by adequate measures, being entirely responsible in case of non-observance.

All product data are intended for users with knowledge and experience in the application of such specifications. The utilization is at the entire risk of the user.
The user has to verify the accordance with existing regulations and relevant standards for the application; in particular with reference to the insulation requirements as function of applied voltages and ambient conditions.
The standards (e.g. IEC 61810 'Electrical endurance') are based on the principal assumption of occurences of malfunctions such as malfunction to make contact, malfunction to break or as insufficient dielectric strength. Such malfunctions have to be taken into consideration and must not generate risks. Depending on the specific load, its characteristics and power in the contact set, a relay malfunction situation may generate various risks such as malfunction of the equipment and its controls, electrical shock, the risk of excessive heat and fire and others. It is in the entire responsibility of the user to provide for additional precautions against such possible effects according to the relevant application standards.
Protection against risks under all operation conditions even in case of malfunction can only be ensured by the design of the equipment as well as by application instructions for the end user; it is the responsibility of the manufacturer of the equipment to take the appropriate measures. Incorrect connections by the user may lead to risks, faulty operation and abnormal heating or fire. It is also the responsibility of the manufacturer of the equipment to take appropriate measures to avoid potential danger of electrical shock by preventing access to live parts of the relay including parts as terminals and accessories.

Specification
In order to improve performance and quality, we continuously develop our products. We reserve the right to change technical parameters and product specifications. The technical data listed are for description purposes of the components only and are not an agreement and do not guarantee specific characteristics and parameters; for detailed questions, please contact our application support. Drawings, photos data and descriptions are subject to change without prior notice.

Availability
The databooks and datasheets list a broad range of products and the descriptive part code structure (product code) does allow a large number of possible variations, but not all possible variations are defined as standard types in the current product portfolio (product code) and thus may not be included in the product range. Some products are normally maintained in stock for immediate delivery, or are available within 'normal leadtimes for industry'; however, there may be extended leadtimes for some non-stock items. Special versions to customer specifications may be supplied. Additionally, minimum quantity requirements apply and these requirements may differ from indicated packaging units. Please consult with your TE sales organization or authorized distributor regarding availability and minimum order requirements.
Right to change the availability and delivery conditions reserved.

'Definitions', datasheets, product data, application notes and all specifications are subject to change.

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Definitions (Continued)

AC-coil
Relays for direct energization with AC supply. If not otherwise stated, the data is given as V_{rms} for 50 Hz supply.

Adjacent contacts
Insulation parameters between two adjacent contact circuits (poles of a relay), which do not have a conductive connection. The level of insulation depends on the relays design, rated voltage and ambient conditions.

Ambient temperature (function, in operation)
The temperature in the vicinity of the relay (distance according to IEC 61810-1).The minimum ambient temperature is the miniumum operating temperature, the maximum ambient temperature is the maximum operating temperature for the use of the relay or accessory when operated. This temperature range should not be exceeded; within the indicated temperature range the ambient temperature does influence the electrical endurance. Ambient temperature range according to IEC 61810-1 and indicated in °C. Unless otherwise stated data is referred to an ambient temperature of 23°C.

Approvals
With the approval label the independent approval agency and/or test house confirms the compliance with the relevant product standards and/or certain product characteristics.

NOTE: the ordering code structure does allow a large number of possible variations, but not all variations are defined as standard types (ordering codes) and thus some relays may not be included in the list of approved relays. It is recommended that users also seek the pertinent approval files of the agencies/laboratories and review them to ensure that the selected product is filed and meets the requirements. Technical data and approved types on request.

	BEAB	British Electrotechnical Approvals Board, England
	CE	Conformité Européenne, marking for specific products relating to product safety in accordance to European Laws
	CQC	China Quality Certification Center, People's Republic of China
	CSA	Canadian Standards Association, Canada
	DEMKO	Danmarks Elektriske Materielkontrol, Denmark
	FIMKO	Sähkötarkastuskeskus Elinspektionscentralen, Finnland
	KEMA	Naamloze Vennootschap tot Keuring van, Electrotechnische Materialien, Netherlands
	LLOYD's	Lloyd's Register of Shipping
	NEMKO	Norges Elektriske Materiellkontroll, Norway
	ÖVE	Österreichischer Verband für Elektrotechnik, Austria
	SEMKO	Svenska Elektriska Materiellkontrollanstalten AB, Sweden
	SEV	Eidgenössisches Starkstrominspektorat, Switzerland
	TÜV	Technischer Überwachungs-Verein, Germany
	UL	Underwriters Laboratories, Inc., USA; UL Component Recognition Mark for the United States
	UL	UL Component Recognition Mark for Canada
	UL	UL Component Recognition Mark for the United States and Canada
	VDE	VDE-Prüfstelle, certificate of conformity with factory surveillance, Germany

Bandwidth
The range of frequencies for which the performance falls within the specified limits.

Bifurcated contact
See > 'Twin contact'.

Bistable relay, latching relay
In a bistable or latching relay the contacts remain in the last switching position once the coil input voltage is disconnected.
Bistable relays only require a short set respectively reset pulse and do not need any energization once the switching position changed. Unless otherwise stated the bistable relays can endure a permanent energization.
NOTE: for some relay series a permanent coil power supply is not permitted; in this case the maximum energization duration or the required coil power reduction is indicated in the respective datasheet.

Bistable relay, switching characteristics
In a bistable relay, the contacts remain in the last switching position after the input voltage is disconnected.
NOTE: Unlike monostable relays which return to their predefined contact rest state in case of power supply break down and thus might be showing a fail safe behaviour, bistable relays do not automatically return to such predefined position. Therefore the application and relay control has to be designed to cover such situations and bistable relays should not be used in applications that are rated according to ISO/TS 16949 7.5.3 'Product Identification and Traceability'.
NOTE: Even though the bistable relays are leaving production preferrably in reset contact position, the position of the contact (set position/reset position) is not defined at delivery unless otherwise stated. The user needs to check the contact position and to set/reset the relay to the required position.

Bounce
An unintentional phenomenon that can occur during the making or breaking of a contact circuit when the contact elements touch successively and separate again before they have reached their final position.

Bounce time
The time from the first to the last closing or opening of a relay contact. Unless otherwise stated the indicated times are maximum values and are for energization with rated voltage, without any components in series or parallel to the coil, and at reference temperature. Also see > 'Relay cycles' .

Breaking capacity max.
Product of the switching current and switching voltage (in W for direct current, in VA for alternating current). Also see > 'DC breaking capacity'

Bridging contact
Double contact configuration, where two movable contacts are mechanically connected and operate simultaneously. In a bridge configuration, the load current flows from one stationary contact via the bridge to a second stationary contact. See also table 'Contact arrangement'.
See > 'Form X contact', 'Form Y contact', 'Form Z contact'.

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Definitions (Continued)

Category of protection (IEC 61810)
The ´Relay Technology Categories´ (IEC 61810) describe the degree of sealing of the relay case or its contact unit:

RT 0: unenclosed relay
Relay not provided with a protective case.
RT I: dust protected relay
Relay provided with a case which protects its mechanism from dust.
RT II: flux proof relay
Relay capable of being automatically soldered without allowing the migration of solder fluxes beyond the intended areas. These are the contacts, movable parts of the magnetic system and their immediate environment.
RT III: wash tight (washable) relay
Relay capable of being automatically soldered and subsequently undergoing a washing process to remove flux residues without allowing the ingress of flux or washing solvents.
The test to evaluate the sealing of the case for wash tight relays is performed according to the IEC 60068-2-17, Qc test.

NOTE - Please refer to the 'Processing' section for additional information.
In service this type of relay is sometimes vented to the atmosphere after soldering or washing process; in this case the requirements with respect to clearances and creepage distances can change.

RT IV: sealed relay
Relay provided with a case which has no venting to the outside atmosphere, and having a time constant better than $2x10^4$s in accordance with IEC 60068-2-17.
RT V: hermetically sealed relay
Sealed relay having an enhanced level of sealing, assuring a time constant better than $2x10^6$s in accordance with IEC 60068-2-17.

Changeover contact, CO contact
See > 'Form C contact, CO contact, changeover contact'

China RoHS compliance
See > 'Material substance specification' on TE's Website:
www.te.com/customersupport/rohssupportcenter.

Clearance distance
Shortest distance in air between two conductive parts or between a conductive part and the accessible surface of the relay.

Coil data
The coil data is specified according to IEC 61810-1.
Unless otherwise indicated the data is given for
- ambient temperature 23°C,
- coil temperature equal to ambient temperature (cold coil, without pre-energization),
- 50Hz for AC supply,
- no other devices (e.g. diode) in parallel or in series to the coil
- single mounting of relays.

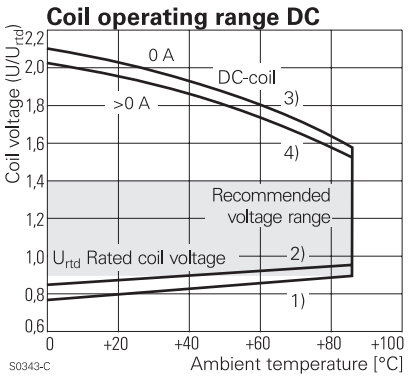
Indicated data for the operative range class, is given for the minimum allowed mounting distance.
Unless otherwise stated a duty factor of 100% (permanently operated) is permissible.

Coil inductivity
The inductivity is a nonlinear parameter due to saturation effects and depends, amongst others, on the position of the armature. The value of the relay coil inductivity depends on the measurement method and its parameters. Therefore the inductivity is not a generally guaranteed parameter; for technical questions, please contact our technical support.

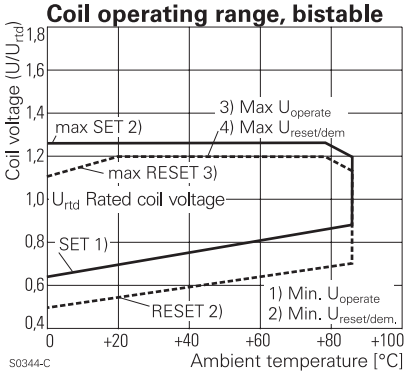
Coil insulation system according to UL1446
These requirements cover test procedures to be used in the evaluation of electrical insulation systems intended for connection to branch circuits rated 600V or less. This standard refers to insulation systems and does not cover individual insulating materials.

Coil Operative range (graph)
Admissible range of energizing voltage with respect to the ambient temperature. The upper limit is the maximum coil voltage, the lower limit is the operate voltage U_{min} (coil without pre-energization) and/or the operate voltage U_1 (pre-energized coil).
The diagrams are valid for single mounting of relays without thermal interference and connection wiring according to IEC 61810-1; unless otherwise stated the data is indicated without contact load, thus not taking into account the temperature rise due to the contact current.
The use of a relay with an energizeing voltage other than the rated coil voltage may lead to reduced electrical life (mechanical and dynamic effects).
In case the application requires an energization with other than the rated coil voltage and a recommended voltage range is indicated, the coil voltage should be within the recommended voltage range (shaded area) to keep the effects on electrical life to a minimum.

curve 1: operate-/minimal voltage U_0 (without pre-energization)
curve 2: operate-/minimal voltage U_1 (pre-energized coil)
curve 3: maximum voltage at contact current = 0 A
curve 4: limiting voltage U_2 at rated contact current I_{rated}
recommended voltage range (shaded area):
the coil voltage should be within the recommended voltage range to keep adverse effects on electrical life to a minimum.



Coil operative range for bistable relays
curve 1: operate voltage at coil temperature equal to ambient temperature
curve 2: minimum reset voltage
curve 3: maximum operate voltage
curve 4: maximum reset voltage
For bistable relays, all curves are given for pulse energization (short energization duration).



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Definitions (Continued)

Coil power
Power consumption of the coil at rated coil voltage and coil resistance, with coil temperature at 23°C, given as rated typical value.

Coil resistance
Electrical resistance of the relay coil at reference temperature; this value is indicated for the coil without any other devices in parallel (e.g. coil suppression, diode, etc.).

Coil suppression circuit
Circuit to reduce the inductive switch off voltage peak of the relay coil (EMC protection, switch off voltage peak). Most of such circuits reduce the armature release speed, which may decrease the relay lifetime depending on the application load. Especially diodes or any pn-junction of the electronic control system in parallel to the coil will significantly reduce the electrical lifetime. Recommended that relay performance testings to be evaluated with the suppression that will be used.
Note: unless otherwise specified the indicated relay data refers to coils without any components in parallel or in series to the coil.

Coil voltage
Voltage applied across the coil terminals.

Coil voltage range
Voltage range at which the relay displays the operating characteristics. These specified operating characteristics are given for a constant DC supply or sinusoidal AC supply. Other operating conditions (e.g. pulse control, ramp voltage, half wave rectifying, etc.) may lead to characteristics other than specified.

Coil-contact circuit data
Insulation parameters between the coil system and the contact circuit/system.

Combination of relay and socket, insulation requirements
The relay standard IEC 61810-1 has an important impact on the combination of a relay and the respective socket. The relay sockets have to comply with the requirements of IEC 61984 and the insulation reqirements of the IEC 61810-1. Even if the socket alone fullfills or exceeds the insulation reqirements as clearance/creepage for the relay, the combination of a relay with a socket may reduce the creepage and lead to a lower rated insulation voltage. Hence restrictions for the combination relay-socket may be the consequence, e.g. a reduction of the voltage range or of the pollution degree. Especially for miniature multi-pole relay and respective sockets with small distance between the contact circuits, these restrictions have a big impact.
Apart from the insulation properties, the thermal characteristics of the combination relay and socket are of utmost importance (see > 'Derating curves'). As sockets from different sources are not directly comparable, the compliance with the technical specification can only be confirmed for an approved combination relay-socket. As design details and characteristics for non TE products are beyond our control, confirmations for technical parameters and characteristics regarding such combinations is not possible. Risks as reduced dielectric strength, fire hazard, etc. due to use based on unclear or omitted data, limitations or restrictions must not be underestimated.
NOTE: We only confirm the characteristics and parameters for the approved combinations of relays and sockets as indicated in the catalog and datasheets.

Contact arrangement
Different applications require specific switching functions of the relay contacts; various contact arrangements are specified and described in different ways.

The most common are:

	Form description	Short description	NARM designator	Circuit symbol
Make contact	Form A	NO	SPST-NO	
Break contact	Form B	NC	SPST-NC	
Changeover contact	Form C	CO	SPDT	
Double make on armature	Form U		SPST-NO DM	
Double break on armature	Form V		SPST-NC DB	
Double make contact	Form X		SPST-NO DM	
Double break contact	Form Y		SPST-NC DB	
Double break, double make contact	Form Z		SPDT-NC-NO DB-DM	
Triple make contact	Form 3			

Examples for descriptions of multi- pole configurations:

Multi pole configurations	Form description	Short description	NARM designator	Circuit symbol
2 Make contacts	2 Form A	2 NO	DPST-NO	
3 Break contacts	3 Form B	3 NC	3PST-NC	
4 Changeover contacts	4 Form C	4 CO	4PDT	

Abbreviations
NO: normally open, NC: normally closed, CO: changeover
SPST: single pole, single throw, SPDT: single pole, double throw, DPST: double pole, single throw

Contact current
See >
- 'Rated current'
- 'Limiting making current'
- 'Limiting continuous current'
- 'Limiting short-time current'
- 'Limiting breaking current'.

Contact gap
Shortest distance between the open contact points.

Contact material
The list gives an overview of the most important plating- and contact materials and their use in signal-, automotive and general purpose relays.
The switching capacity of the contacts and the respective electrical endurance depends not only on the contact material but also to a high degree on the relay design. Decisive for the application therefore is the optimal combination of the mechanical system and the contact material. The characteristics for certain relay types cannot be transferred to other designs, nor can

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Definitions (Continued)

these values be used as given limits for existing products.
1) Plating materials:
Fine gold
- best corrosion resistance, not used as solid material because too soft, high tendency towards cold-welding, not used or only used in combination with a material with resistance against cold welding. Gold alloys (AuNi, AuAg, AuPd, AuCo)
- gold platings ≤ 1 µm (gold flashed), only as storage protection, no protection against aggressive atmosphere.
- hard gold plated: very good corrosion resistance, low and stable contact resistance at lowest loads, low tendency to cold welding
- dry-circuit switching (switching without current/voltage), recommended range of application ≥ 1 V, 1 mA, 50 mW.

2) Contact materials:
Silver-Palladium
- high resistance against material transfer in signal DC circuits, low welding tendency, higher contact resistance than Ag
- circuits with medium loads, DC- and AC-circuits, recommended for telecommunication applications.

Palladium-Ruthenium
- highest resistance against material transfer in signal DC-circuits, low welding tendency, higher contact resistance than Ag
- circuits with medium loads, DC- and AC-circuits, recommended for telecommunication applications.

Silver-Nickel AgNi90/10
- high resistance against electrical wear, low welding tendency, higher contact resistance than AgNi0.15
- circuits with medium to high loads, DC- and AC-circuits, recommended range of application ≥ 12 V, 10 mA.

Fine-grain silver AgNi0.15
- relatively low contact resistance, low resistance against aggressive atmosphere
- universally applicable in medium and low load range, especially in DC-circuits, recommended range of application ≥ 12 V, 10 mA.

Silver-Tin-Oxide $AgSnO_2$
- low welding tendency, high wear resistivity with heavy loads, low material transfer
- circuits with high requirements to make- and break currents, DC- and AC loads, recommended range of application ≥ 12 V, 100 mA.

Tungsten W
- highest melting point, for high switching rates and low ON-time
- as prerun contact in circuits with highest make loads.

Silver-Cadmium-Oxide AgCdO
- compliant with RoHS directive (Directive 2002/95/EC) only under time limited exception, therefore not recommended for new designs
- low welding tendency, high wear resistance
- for switching of inductive loads, AC-circuits, ≥ 12 V, 100 mA.

Contact materials for the use in automotive applications:

Current range	Automotive load type (DC load)	Recommended contact material
Switching and carrying 0.5 A < I < 10 A at 12 V	In low power applications	AgNi0.15 or $AgSnO_2$
Periodical switching and approx. 10^6 ops, 1 A < I < 10 A at ≥ 12 V	Long-life indicator switches	$AgSnO_2$
Switching and carrying I > 10 A capacitive load	Lamps, Capacitors	$AgSnO_2$
Switching and carrying I > 10 A resistive and inductive load	Motors, Valves	AgNi0.15 or $AgSnO_2$
Switching high inrush I > 100 A	Lamp (e.g. H4), Spark plugs, short circuit	$AgSnO_2$ in special cases: AgNi20 or Tungsten pre-contact

Contact protection circuits
The effect of an electrical arc causes primarily local contact erosion resulting in contact wear and migration and as secondary effect the generation of adverse atmosphere inside the relay (see > 'Electrical arc' and 'Vent hole' in processing section). These effects eventually lead to the end of the useful life of a relay. To reduce the negative effect of the electrical arc and thus prolong the life of a relay, contact protection circuits are recommended. This is especially important for switching of DC applications (e.g. automotive applications). The user has to ensure the correct design of the protection circuit in the respective application, as unless designed correctly, the protection circuit may even generate adverse effects.

Contact rating
In context of our datasheets this term is primarily used in context with ratings as tested/approved by external approval agencies whereas the term 'electrical endurance' is used primarily for internal test results. See > 'Electrical endurance'.
Indicated contact ratings for direct wiring of relays (according IEC 61810-1); for relays mounted on sockets or when using connectors deratings may apply.

Contact resistance
Electrical resistance between the relay terminals of a closed contact, measured with indicated measuring current and indicated source voltage. The specified contact resistance is reached reliably only above a particular load. Considerably increased contact resistances can occur with smaller loads. After a prolonged period of a steady state operate/release position or storage of the relay a certain number of cycles are recommended before measurement of the contact resistance.
According to IEC 61810-7 the following measurement parameters are applied (for general purpose relays category CC2 is applicable):

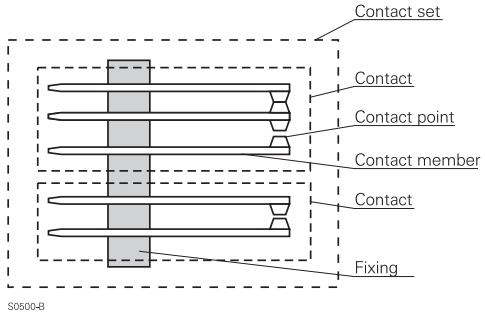
Category	Load		Measurement	
	V	A	V	A
CC0	0.03	0.01	0.03	0.01
CC1	without electrical arc		10	0.1
CC2	with electrical arc		30	1

Contact style
On one side indicates the design of the contact point itself , see >
- 'Single button contact'
- 'Twin contact, bifurcated contact'

indicating the contact function, see >
- 'Forcibly guided contact'

as well as the total configuration of the contacts within a relay
- number of poles and
- contact arrangement (see > 'Contact arrangement').

Contact terms



Creepage distance
Depending on the insulation design, usually the shortest distance along the surface of the insulating material between conductive parts according to IEC 61810-1.

Cross talk
Signal interference between adjacent conductors caused by the pick-up of stray energy.

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Definitions (Continued)

CTI
See > 'Tracking index'.

Cycle
Operation/set and subsequent release/reset of a relay.

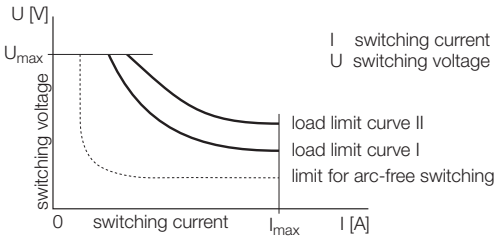
Cycle time
Sum of ON and OFF time (make, break and bounce time) of a contact. See also > 'Duty factor'.

dBm
Relative measure of signal power where the reference 0 dBm is equal to one milliwatt. See also > 'Decibels'.

DC breaking capacity
Switching of loads at voltage and current below the max. DC load breaking capacity curve is possible for a limited number of switching operations. Unless otherwise stated, the indicated curves in the DC breaking capacity diagram represent the load limit curve II (the arc extinguishes within 10ms at resistive load). The breaking capacity curve is affected in both position and shape by the contact material and relay design (contact distance, break speed of the contacts, etc.). No statement on the electrical endurance can be derived from these curves. For practical use it is recommended to keep a distinct margin from the DC load breaking capacity curve.

- Load limit curve (II) The switching arc for loads below this curve extinguishes within 10 ms (the relay is already in release position). Unless otherwise stated the indicated curve for DC breaking capacity relates to the load limit curve II
- Load limit curve (I) The switching arc of loads below this load limit curve extinguishes during the transit time of the moving contact. This limit is especially important for change over relays, when the NC and NO contacts are at different voltage levels; if the arc does not extinguish before reaching the other contact, the arc will establish a short circuit, a situation that may lead to the destruction of the relay and equipment.
- Load limit curve for arc-free switching. Load voltage/current combinations below this load limit curve in general cause no arc or an arc with max. duration of 1ms.

Unless otherwise stated the curves in the graphs refer to a 'load limit curve II'.



Decibel, dB
A relative and dimensionless unit calculated as ten times the logarithm to the base of 10 of a power ratio.

Degree of protection (IEC 60529)
Degrees of protection provided by enclosures (IP Code) for electrical equipment.
Under certain circumstances this data is relevant for industrial relays and accessories. For relays as components (e.g. PCB relays) the IP classification is generally not used, see > Category of protection; there is no direct correlation between the IP-code and the RT-category.

Definition of degree of protection (IP code) IEC 60529 outlines an international classification system for the sealing effectiveness of enclosures of electrical equipment against the intrusion into the equipment of foreign bodies (i.e., tools, dust, fingers) and moisture. This classification system utilizes the letters IP (Ingress Protection) followed by two digits.

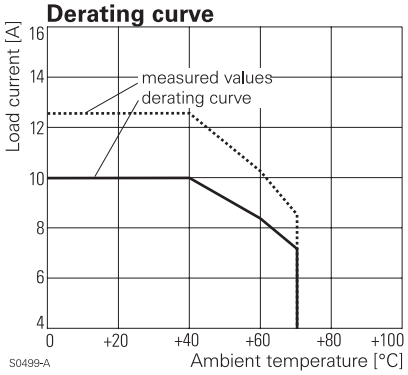
Degree of protection - First digit:
The first digit of the IP code indicates the degree that connection is protected against contact with moving parts and the degree that equipment is protected against solid foreign bodies intruding into an enclosure.

0 No special protection
1 Protection from a large part of the body such as hand or from solid objects greater than 50 mm in diameter
2 Protection against objects not greater than 80 mm in length and 12 mm in diameter
3 Protection from entry by tools, wires, etc., with a diameter or thickness greater than 2.5 mm
4 Protection from entry by solid objects with a diameter or thickness greater than 1.0 mm
5 Protection from the amount of dust that would interfere with the operation of the equipment
6 Dust-tight.

Degree of protection - Second digit:
Second digit indicates the degree of protection of the equipment inside the enclosure against the harmful entry of various forms of moisture (e.g. dripping, spraying, submersion, etc.)

0 No special protection
1 Protection from vertically dripping water
2 Protection from dripping water when tilted up to 15°
3 Protection from sprayed water
4 Protection from splashed water
5 Protection from water projected from a nozzle
6 Protection against heavy seas, or powerful jets of water
7 Protection against temporary immersion
8 Protection against complete continuous submersion in water (up to 1 meter deep for 15 minutes).

Derating curve (sockets and relay-socket sets)
EN61984:2001 table 12: according to this standard the derating curve given for a specific combination relay-socket and its accessories - indicates the maximum permissible continuous current (limiting continuous current) of a socket, loaded on all contact circuits, unless otherwise stated supplied with rated coil voltage, over the entire temperature range, measured in dense packing (usually 3 relay-socket sets).
In case of reduced duty factor of the contact load or with higher mounting distance up to single mounting, a higher load current is permissible. Please contact our technical support for specific data. According to the standards the derating curve is derived from the measured curve by applying a reduction factor of 0.80.



Other standards: the test conditions (e.g. UL508) differ from the EN standard, hence under these conditions other temperature/current combinations may be permissible; please contact our technical support for details.
In case no derating curves are given, the indicated temperature and load current refer to the approved standards for the specific product and not to the EN61984.

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Definitions (Continued)

Dimensions
Dimensions are indicated in mm and/or inches and are shown for reference purposes only.
PCB pin dimensions are indicated without solder (pre-tinning).

Dimensions, drawings
Technical drawings for product dimensions are using both ISO projections (ISO Method E or ISO Method A) according to ISO/R 128. In cases of ambiguity the projection is defined by the respective international symbol (see below).

ISO Method E projection - symbol

ISO Method A projection - symbol

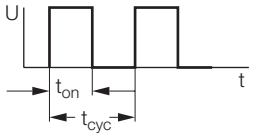
DIN-rail
Unless otherwise stated, our products for DIN-rail mounting are designed and tested for DIN-rails according to TH35-7.5 / EN60175.
Use of other rails (e.g. according to TH35-15) is neither tested nor approved.
When mounting the sockets on a DIN-rail, assembling the socket accessories and mounting/dismounting relays provide an adequate temperature (unless otherwise stated -10°C to +40°C) during the mounting process.

Drop test, free fall
Relays are dropped from a specified height onto a solid ground; this simulates the resistance to bad handling e.g. fall from a table. The test is to verify that the component meets its specification. However we strongly recommend to scrap dropped relays.

Dry switching
Defined as contact category 0 (CC0) according to IEC61810-1: a contact characterized by a maximum contact voltage of 30mV and a maximum contact current of 10mA. See also chapter 'Testing / diagnostics of relays'.

Dust-proof relay
Relay with a case to protect against penetration of dust. See > 'Category of environmental protection (IEC 61810)' - RT I.

Duty factor, duty cycle
Ratio of the duration of energization to the total period in which intermittant or temporary operation of the relay place. Duty factor is expressed as percentage of the total period at a specified frequency of operation; e.g. 30% duty cycle means that the relay is operated for 30% during a cycle time.



$$df = \frac{t_{on}}{t_{cyc}} \times 100\ (\%)$$

df	Duty factor
t_{on}	On time
t_{cyc}	Cycle time

Electrical arc
Is an electric phenomenon caused by plasma current flow between opening and closing relay contacts. An arc is generated by the electric energy of the load circuit (turn off spark) or the voltage gradient at closing contacts, ionizing the gas between the contacts and thus establishing an electrical conductive path. The stability of the arc depends on various parameters such as contact material, air pressure, contact gap, etc.
Apart from positive effect of the electrical arc as limitation of overvoltage when switching of inductive loads, reduction and dissipation of electrical load energy and electrical cleaning of contact surfaces, the arc locally produces high temperature and causes contact erosion (also see > 'contact protection circuits'). Special consideration has to be given to DC and high frequency AC-circuits where, depending on the conditions (e.g. contact gap) an arc of extended or infinite duration could occur; in this case the relay may be destroyed due to the extreme thermal stress. Also the switching of different voltages with a generation of an electrical arc and the switching of reverse polarity on adjacent contact circuits of a multi-pole relay may lead to non-extinguishing arcs.

Electrical endurance
Number of cycles a relay can perform with electrical contact load defined under specified conditions according IEC 61810-1 and IEC 61810-2. Unless otherwise specified the electrical endurance refers to:
- NO contact
- AC mains, 50 Hz for general purpose relays (schematic for contact loading A) ; 12 VDC for automotive relays
- duty factor 50%
- rated frequency of operation
- resistive load
- rated voltage (coil)
- contact opening and/or closing not synchronized to line frequency
- ambient temperature 23°C
- no failsafe behaviour (see > 'Failsafe')
- category of protection RTII - flux proof
- individual mounting of relays without thermal interference and connection wiring according to IEC 61810-1, table 12.
- relay in upright position (terminals of a print relay pointing downwards).
- direct wiring of relays (according IEC 61810-1); for relays mounted on sockets or when using connectors deratings may apply.

Unless otherwise stated, the electrical endurance is specified according to severity level B according IEC 61810-2. For relay failure modes see also > Failure criteria. Any use beyond the specified electrical endurance is not in scope of the specified data, the avoidance of such situation requires consideration by the user.

Electrical endurance graph
The electrical endurance graph indicates the typical electrical endurance with resistive load and 250 VAC rated voltage as “Mean Cycles to Failure” (MCTF) according Weibull distribution. These statistical data do not guarantee a minimum value; this data can be used to estimate the MCTF value.
Please note:
- the graph for electrical endurance is only valid for the indicated contact material (in case no contact material is specified, it is valid for the contact materials as listed in the respective datasheet), it is not permissible to deduce electrical endurance information for other contact materials.
- it is not permissible to deduce electrical endurance information by extrapolation beyond the range indicated by the curve. This applies especially to the range below 0.5 A as at this level the contact wear is small and other failure modes are dominant.

For details please contact our technical support. Also see > 'Electrical endurance'.

ELV compliance
See > 'Material substance specification' on TE's Website:
www.te.com/customersupport/rohssupportcenter.

Endurance
Electromechanical components as relays, are subject to wear (mechanical and electrical). For the reliability the typical bath-tub curve applies, hence singular statistical failure events below typical reliability values may occur.

Environmental data and tests
Relays undergo extensive environmental tests. The selection of tests depends on the product group and the intended application fields; e.g. for automotive relays, common environmental tests are:
- cold storage test, IEC 600 68-2-1
- dry heat, IEC 600 68-2-2
- climatic cycling with condensation. EN ISO 6988
- temperature cycling, IEC 600 68-2-14 Na (shock), IEC 600 68-2-14 Nb
- damp heat cycling, IEC 600 68-2-30 Db variant1
- operational humidity, IEC600 68-2-38
- corrosive gas, IEC 600 68-2-42
- flowing mixed gas corrosion, IEC 600 68-2-60 Ke method 54
- drop test, free fall, IEC 600 68-2-32.

Environmental endurance
Generic term for the relay endurance under different climatic conditions. Appropriate test conditions are classified in IEC 60068.

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Definitions (Continued)

Failure criteria
Set of rules used to decide whether an observed event constitutes a failure. A contact failure is the occurence of break and/or make malfunctions of a contact under test, exceeding a specified number.

Failure mode
The IEC 61810 defines a relay failure as occurrence of malfunctions, exceeding a specified number:
- malfunction to make
- malfunction to break (contact bridging on a CO contact as a special form of malfunction to break), or as
- insufficient dielectric strength.

Such malfunctions have to be taken into consideration and must not generate risks. Depending on the specific load, its characteristics and power in the contact set, a relay malfunction situation may generate various risks such as malfunction of the equipment and its controls, electrical shock, the risk of excessive heat and fire and others. It is in the responsibility of the user to provide for additional precautions against such possible effects according to the relevant application standards.
Standards (e.g. IEC 695-1-1'Guidance for assessing fire hazard of electrotechnical products') are based on the principal assumption of heating effects and risk of fire in case electrical currents of certain magnitude being conducted and switched. Our relays are manufactured with self extinguishing plastics corresponding to the up-to-date technology and standards requirements. Protection against excessive heat and possible spread of fire under all operation conditions even in case of malfunction can only be ensured by the design of the equipment as well as by application instructions for the end user; it is the responsibility of the manufacturer of the equipment to take the appropriate measures. Incorrect connections by the user may lead to risks, faulty operation and abnormal heating or fire. It is also the responsibility of the manufacturer of the equipment to take appropriate measures to avoid potential danger of electrical shock by preventing access to live parts of the relay including parts as terminals and accessories.
NOTE: Relays normally do not have a failsafe behaviour. See > 'Failsafe'

Failsafe
Failing behaviour with definite failing characteristic, e.g. component always fails with contacts do not open. Electromechanical relays normally do not have a failsafe behaviour

Flux proof/suitable for processing on soldering lines
See > 'Category of environmental protection (IEC 61810)' - RT II.

Force guided contact
Contact configuration according to EN61810-3 (formerly EN50205) with at least one NO contact, one NC contact and a mechanically linked system, designed that the NO and NC contacts within the complete contact set are never closed at the same time, even in case of malfunction. These relays are implemented in the control of safety technology for the protection against damage to persons or objects.
See > 'Relays with force guided contacts'.

Form 3 contact, triple make contact
Three make contacts configuration with three electrically connected movable contacts operating simultaneously. There is no external connection to the armature. See also table 'Contact arrangement'.

Form A contact, NO contact, normally open contact
A contact that is open when the relay is in its release condition (unenergized position for monostable relays) and which is closed when the relay is in its operate condition. For circuit schematic see table 'Contact arrangement'.

Form B contact, NC contact, normally closed contact
A contact that is closed when the relay is in its release condition (unenergized position for monostable relays) and which is open when the relay is in its operate condition. For circuit schematic see table 'Contact arrangement'.

Form C contact, CO contact, changeover contact
Compound contact consisting of Form A (NO, make) contact and a Form B (NC, break) contact with a common terminal. On changing the switch position, the contact previously closed opens first followed by the closing of the contact that was previously open. For circuit schematic see table in 'Contact arrangement'.
Note: in case of a switching arc the NO and NC contact may be temporarily electrically connected.

Form U contact
Two make contact configuration, with two electrically connected movable contacts which operate simultaneously. As special version main contact with pre-contact. See also table 'Contact arrangement'.

Form V contact
Two break contact configuration, with two electrically connected movable contacts which operate simultaneously. See also table 'Contact arrangement'.

Form X contact
Two make contact configuration with two electrically connected movable contacts operating simultaneously. There is no external connection to the armature. Also called bridge contact.

Form Y contact
Two break contact configuration with two electrically connected movable contacts operating simultaneously. There is no external connection to the armature. Also called bridge contact.

Form Z contact
A contact configuration with
- two make contacts and
- two break contacts

with two electrically connected movable contacts each operating simultaneously. There is no external connection to the armature. Also called bridge contact.

Frequency of operation
Number of operation cycles (opening and closing of contacts) per unit of time. The switching rate is usually indicated for switching under rated load; unless otherwise stated at ambient temperature 23°C and without any circuitry in parallel to the coil (no coil suppression circuit, e.g. diode). With contact loads considerably below rated load a higher frequency of operation may be admissible. This has to be tested for the specific application. For further assistance please contact our application support.

Full disconnection
Contact separation for the disconnection of conductors so as to provide the equivalent of basic insulation between those parts intended to be disconnected. NOTE: there are dielectric strength and dimensional requirements regarding the relay design but also referring to the connection, wiring and design on the outside of the relay.

Halogen content
See > 'Material substance specification' on TE's Website:
www.te.com/customersupport/rohssupportcenter.

Immersion cleanable/sealed relays
See > 'Category of protection (IEC 61810)' - RT III.
Relays which are sealed against the penetration of specified PCB cleaners or protection lacquers; for more information refer to chapter 'Processing Information'.

Impedance, Z0
Characteristic property of a transmission line describing the ratio between electric and magnetic fields.

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Definitions (Continued)

Industrial relays and accessories
Relays and accessories are designed for use in closed and electrically secure switching cabinets. In these applications lower standard requirements of the insulating properties of components could apply.
CAUTION: These products are to be handled by trained personnel only.

Initial contact resistance
Contact resistance measured at the time of production/final testing. Prolonged storage and adverse environmental conditions (e.g. gases) can lead to increased resistance values. The effect of electrical cleaning due to sufficient load can bring the contact resistance back to lower levels.
See > 'Contact resistance'.

Initial dielectric strength
Voltage (rms value in AC voltage, 50 Hz 1 min) the insulation can withstand between relay elements that are insulated from one another, measured at the final production test.

Initial insulation resistance
Electrical resistance (initial product condition) measured by applying a DC voltage of 500 V between two elements of a component that are insulated from one another as measured at the final production test.
The requirements according to IEC 61810-1 are:
- for functional insulation > 2 MOhm
- for basic insulation > 2 MOhm and
- for reinforced insulation > 7 MOhm.

Initial pulse withstand voltage, initital surge voltage resistance
Amplitude of a voltage impulse of short duration with a specified impulse form (e.g. 1.2/50µs) and polarity applied to test insulation paths in a relay, especially where relays are subject to overvoltage situations (e.g. effects of lightning).

Insertion cycles
The symbol A indicates that the insertion and extraction must be done without any load current on the relay/socket contacts.
Unless otherwise stated the accessories are designed for max. 10 insertion cycles, insertion and extraction without load; A (10).

Insertion loss
The loss in load power due to the insertion of a component at some point in a transmission system. Generally expressed in decibels as the ratio of power received at the load before insertion of the apparatus to the power received at the load after insertion.

Insulation
Unless otherwise stated, the insulation characteristics are indicated for the relay component, the design of the application, mounting and wiring also has to provide for required insulation properties.
In general, the relays are designed to be used within enclosures; the relay surfaces are not to be accessible for direct contact by the end user. Specific insulation requirements of the equipment and protection egainst environmental effects need special consideration.

Jump start test
Short time relay use at higher system voltages (like car start after flat vehicle battery).

Latching relay
See > 'Bistable relay'.

Limiting breaking current
The max switching current the contact is intended to break under specified load conditions. The switching current must not exceed the indicated rated current. For DC switching also see > 'DC breaking capacity'.

Limiting continuous current
Is the highest steady state load current a relay or an accessory can withstand continuously while satisfying specified temperature rise requirements; it is identical with the limiting continuous thermal current I_{th}.
NOTE that this is not necessarily the current that can be switched over the specified lifetime. Unless otherwise stated the data for relays is given under following condition: all contacts equally loaded with the respective current, input voltage 110% of nominal coil voltage, max ambient temperature, minimum allowed mounting distance, test conditions according to the heat test arrangement IEC EC 61810-1 Annex B. In combinations with accessories/ sockets the limiting continuous current is specified by the derating curve (see > 'Derating curve').

Limiting making current, inrush current
The limiting making current expressed as a current with a power factor of 1.0 (resistive load) a contact is able to make under specified conditions; for 20 ms data expressed as peak value, for 4 s data expressed as rms value. Unless othwerwise stated the data refers to the Form A contact (NO contact), rated voltage and a current for a duration of max. 20 ms for at least 100 cycles or 4 s with duty factor of 10%.
Inrush current for some loads can be significantly higher than its specified steady state current. For these load types the inrush current has to be within the limits for the limiting making current. Typical examples for loads with high inrush currents are all type of lamps (incandescent, halogen, fluorescent, etc.) as well as motors, solenoids, transformers and capacitive loads.

Limiting short-time current, Overload current
This test is done to confirm, that our relays withstand normal overload conditions, e.g. withstand short circuit conditions until a fuse opens.

For automotive applications, current and time are compatible to circuit protection by a typical automotive fuse according to ISO 8820-3 (2002) as shown in the table below. Relay will carry the specified currents at 23°C (Irated = rated current as given in contact data section for each relay).

Test current in A	Operating time in seconds	
	Minimum	Maximum
6.00 * I_{rated}	0.02 s	0.20 s
3.50 * I_{rated}	0.08 s	0.50 s
2.00 * I_{rated}	0.25 s	5.00 s
1.35 * I_{rated}	0.75 s	1800 s
1.10 * I_{rated}	100 h	No requirement

For mains fuses and fuses other than automotive, customers have to refer to the respective standards (mains condition, prospective short circuit, etc.) to test for their application.

Limiting voltage (coil)
The highest permissible input voltage (coil voltage) at the reference temperature at which the relay, with continuous energization and, unless otherwise stated under rated contact load, heats up to its max. permissible coil temperature.

Load dump
Short relay use at overvoltage (disconnection of the battery during running engine).

Load dump test
Short relay use under overvoltage conditions (simulated disconnection of the battery with charging alternator).

Magnetic system
Magnetic systems can be categorized by the switching characteristic
- monostable relays return automatically to the rest position (release state) after the coil is de-energized.
- bistable relays maintain their switching position after the energization or input voltage is disconnected. See > bistable relays

and the design of the magnetic circuit:
- neutral (non-polarized) relays operate independently of the polarity of the applied voltage (coil voltage)
- polarized relays use an additional magnet within the magnetic circuit and therefore only operate with a specific polarity of energization.
- remanent bistable relays adopt a particular switching position following an energizing direct current in any direction and are then held in this position by the remanence in the magnetic circuit.

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Definitions (Continued)

Make-before-break contacts
Contact mechanism where Form A contacts (normally open contacts) close before Form B contacts open (normally closed contacts).

Material group of insulation parts
Categorization of insulation materials according to their tracking indices, according to IEC 60664-1.

Material substance specification
For material information regarding ELV, China RoHS compliance, European RoHS compliance, Halogene and REACH refer to product specific information on TE's Website: www.te.com/customersupport/rohssupportcenter.

Max. coil power
The highest permissible input power at the reference temperature at which the relay, with continuous energization, heats up to its max. permissible coil temperature. Unless otherwise stated the data is indicated without contact load.

Max. coil temperature
As general term refers to the max. approved coil temperature, measured by change of resistance method.
UL classifies max. coil temperatures according to UL1446; this standard refers to insulation systems and does not cover individual insulating materials:
- class B - max. 130°C
- class F - max. 155°C.

Maximum energization duration
Maximum duration a coil may be energized with rated DC voltage; energization beyond the indicated duration will overheat the coil system and the relay.

Max. insertion force total
The force during the insertion of the relay into the socket has to be applied in insertion direction (no tilting) and equally on all connections. The maximum applied force must not exceed the indicated max. insertion force.

Max. operate/reset duration
Maximum duration a bistable coil may be energized with rated DC voltage.

Max. switching voltage
Maximum voltage that may occur between the switching contacts before closing or after opening the contact. Data given for AC refer to V_{rms} in a midpoint earthed 3-phase supply system.

Maximum energization duration
Maximum duration a coil may be energized with rated DC voltage; energization beyond the indicated duration will overheat of the coil system and the relay.

Maximum voltage (coil), U_{max}
The highest permissible input voltage (coil voltage) at the reference temperature at which the relay, with continuous energization and without contact load, heats up to its max. permissible coil temperature.
Also see > 'Limiting voltage'.

MCTF - Mean cycles to failure
Expected value of the distribution of operations to failure, average number of operations according to Weibull.

Mechanical endurance
Number of cycles without contact load during which the relay remains within the specified characteristics.
NOTE that the failure criteria for mechanical endurance are not the same as for electrical endurance, therefore the value for mechanical endurance has no relation and cannot be directly compared to electrical endurance for very low loads!

Mechanical life
See > 'Mechanical endurance'.

Minimum energization duration
Minimum duration the coil needs to be energized with rated DC voltage. Unless otherwise stated the proposed minimum energization duration is 100 ms.

Minimum recommended contact load
The minimum contact load a relay can reliably switch/carry depends on the relay design and used materials; there is no physical limit as for the definition of a minimum switching voltage or current. The indicated value is a recommendation, it is influenced by switching frequency, required contact resistance and its stability over time and ambient conditions. Low contact resistance is reached reliably only above a particular load, considerably increased contact resistance can occur with lower loads.
- Signal relays are capable to carry and switch minimum contact loads in the range of the thermoelectric potential which is approx. 100µV.
- General purpose relays are designed for category CC2 loads according IEC61810; basically these relays are designed for switching loads with the effect of switching arcs. Specific insulation requirements however may call for the use of general purpose relays in applications with low signal loads or for dry switching (switching without the generation of an electrical arc). NOTE that increased contact resistance may occur if the load conditions are not in scope of the test conditions for category CC2 according IEC61810. Also see the minimum contact loads recommended for the different contact materials.
- Automotive relays usually are switching higher DC loads with switching voltages above the fritting voltage and with switching power within the contact cleaning effect of an electrical arc.

Minimum recommended switching power
Product of switching current and switching voltage for reliable switching. Low contact resistance is reached reliably only above a particular load, considerably higher contact resistances can occur with smaller loads.

Minimum set/reset duration
Minimum duration a bistable coil needs to be energized with rated DC voltage.

Minimum voltage (coil)
For
- monostable relays see > 'Operate voltage'
- bistable relays see > 'Set voltage' and 'Reset voltage'.

Monostable, neutral relay, non-polarized relay, polarized relay
A relay is called monostable when its contacts return automatically to the rest position (release state) after the coil is de-energized.
Non-polarized relays operate independently of the polarity of the applied voltage (coil voltage) whereas polarized monostable relays only operate with a specific polarity of energization.

Mounting
Describes specific mounting options of the relay. See >
- 'Through-hole-technology (THT)'
- 'Through-hole-reflow (THR)'
- 'Surface mount technology (SMT)
- for Mounting on DIN-rail (relays and accessories) see > 'DIN-rail'.

See also > 'Mounting' in the processing section.

Mounting distance
The distance between two adjacent relays in parallel and unidirectional mounting according to IEC 61810-1 or distance to other electrical components including the pc-board. Insulation requirements may stipulate an increase to the minimum distance between the relays or to choose a different placement.
If not otherwise stated the product data refers to relays in 'single mounting'.
In addition to this definition we use:
- dense packing: relays mounted at minimum distance; this minimum distance is defined by the requirements of the insulation coordination at rated voltage 230 VAC, and/or by mechanical requirements for the mounting of the relay (e.g. use of sockets)
- single packing: relays mounted at a distance without any thermal impact of adjacent relays or components.

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Definitions (Continued)

Mounting position / Placement
Unless other restrictions are stated the relays can be mounted in any direction. The relay connections have to be fully contacted and with adequate cross-sections to ensure the current flow and heat dissipation.
For the arrangement of the relays the insulation requirements, heat dissipation and the magnetic interrelation have to be taken into consideration.

MTBF - Mean time between failure
Expected value of the distribution of the time between failure. For components with limiting failures due to wear (e.g. contact wear), see > 'MCTF-Mean cycles to failure'.

Nominal power (coil)
See > 'Rated coil power'.

Nominal voltage (coil)
See > 'Rated coil voltage'.

Normally closed contact, NC contact
See > 'Form B contact, NC contact, normally closed contact'.

Normally open contact, NO contact
See > 'Form A contact, NO contact, normally open contact'.

Open contact circuit data
Insulation parameters of the contact circuit.

Operate
Process in which a relay shifts from the release/rest condition to the operate condition.

Operate state, operate condition
For a monostable relay, specified condition of the relay when it is energized by the specified energizing quantity and has responded to that energization. For a bistable relay, it refers to the condition other than the release/reset condition as declared by the manufacturer.

Operate time (DC coils)
The time interval that elapses from energizing a monostable relay in the rest state with the rated voltage (pulse or square signal) at an ambient temperature of 23°C to the moment when the last output circuit is closed or opened (bounce time not included). The operate time varies with the applied coil voltage and the ambient/coil temperature.
This definition refers to DC-coils only, due to the dependency of the phase angle considerably longer operate times may occur with AC magnetic systems.

Operate voltage
Value of coil voltage at which a monostable relay operates. For bistable relays see > 'Set voltage'.

Operate voltage U_1
Value of the coil voltage at which a relay operates, having previously been energized at the same voltage and with rated contact load (thermal equilibrium has to be achieved).
Operate voltage without preenergizing U_0
Minimum permissible input voltage at which the relay operates, for a coil temperature equal to the reference temperature (23°C coil temperature without preenergizing).

Operation
One switching cycle including energizing and de-energizing of the relay coil.

Operative range
According to IEC 61810-1.
Class 1: 80%..110% of the rated coil voltage (or range)
Class 2: 85%..110% of the rated coil voltage (or range)
For diagram specification see > 'Coil operative range'.

Packaging unit
Minimum delivery quantity (e.g. per carton/plastic bar) and quantity per box. Additionally, minimum quantity requirements apply and these requirements may differ from indicated packaging units. Please consult with your TE sales organization or authorized distributor.

PCB
Printed circuit board.

Peak inrush current
See > 'Limiting making current'.

Pre-contact, pre-make contact
Contact with two operating contact points usually of different material, with one contact switching prior to the other one. Pre-make contacts are used mainly for high inrush currents.

Product code
The ordering code structure does allow a large number of possible variations, but not all possible variations are defined as standard types (ordering codes) and thus not included in the product range.
Special versions to customer specifications can be supplied. Please contact your local sales organization.

Product date code
Printed on the product. Indicates the date of production of the product; the most common format is 'year+week', 'yymm' (e.g. 0412 indicates production in 2004 week 12); this code may be followed by additional related information.

Product marking/specials

	'Caution' - this symbol indicates a general possible cause of risk - refer to the specification/data sheet for details.
	'Read instructions' - this symbol refers to important information in the respective data sheets or specification
	Symbol for a NO contact
	Symbol for a NC contact
	Symbol for a CO contact
	Symbol for a forcibly guided contact set
	Symbol for coil information

For information on production date code see > 'Product date code'.

Protection class
See > 'Degree of protection (IEC 60529)'.

Protection to heat and fire
Data of the flammability class according to the UL 94 (Underwriters Laboratories, Inc., USA) specification.
UL 94 flammability testing, conducted on plastic materials to measure flammability characteristics, determines the material's tendency either to extinguish or to spread the flame once the specimen has been ignited. According to IEC61810-1, all plastic materials have to fulfil the Glow Wire test requirements with min. 650°C.

PTI
See > 'Tracking index'.

Push-to-test button, test tab
For manual operation of the relay. The test button is to be used for test purposes of an equipment or installation. The push-to-test button is not de-

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Definitions (Continued)

signed for standard ON/OFF operations, for continuous electrical operation in the manually set ON state, and is not to be used as a switch.
Before operating the test tab, the operator has to make sure that the load and any other connected item will operate safely.
As safety functions of the equipment might be bypassed and reduced insulation requirements apply, the test button is to be operated by trained personnel only.

Quick connect terminals (spade terminals)
The connectors indicated in the datasheet may be used for the connection to the relay. When using this connector type the given plug cycles and the maximum permissible current have to be taken into consideration. The connector and wire cross section have to be selected so that under the current load the increase of the temperature at the connector point must not exceed 45 K. For high contact currents it is recommended to solder the connection.
Furthermore the correct insulation of the connectors/plugs have to be respected.

Rated coil power
Product of coil current and voltage at rated coil voltage (in mW or W for DC-coils and in VA for AC-coils)

Rated coil voltage, Nominal voltage (coil)
Rated voltage at which the relay displays the operating characteristics, given for a constant DC supply or sinusoidal AC supply. Other operating conditions (e.g. pulse control, ramp voltage, half wave rectifying, etc.) may lead to characteristics other than specified.

Rated current
Current a relay can switch on and off and a relay or accessory can carry under specified conditions. Unless otherwise defined the rated current covers:
- contact current, switching current
- limiting continuous current: For a relay the specified conditions are defined under contact ratings; see > contact ratings. For accessories the rated current is specified for a duty factor of 50% at rated frequency of operation and at ambient temperature 23°C; the respective derating curves should be followed.

Rated values
Standard values the relay is designed for. Values are used to classify relays.

Rated voltage (contacts)
Voltage between the switching contacts before closing or after opening of the contact.

REACH SvHC compliance
See > 'Material substance specification' on TE's Website:
www.te.com/customersupport/rohssupportcenter.

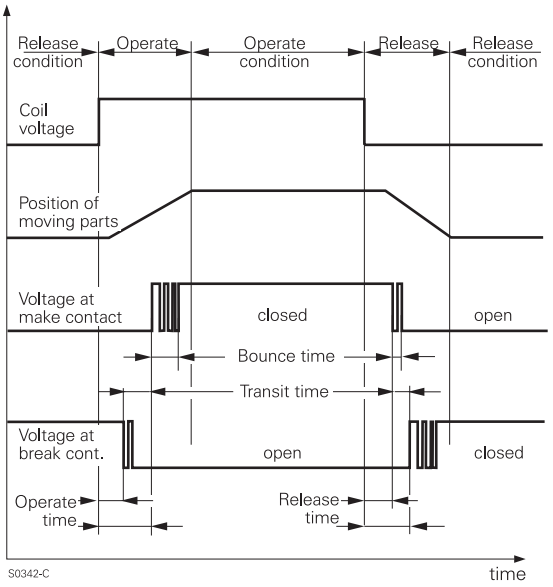
Reference temperature
Unless otherwise indicated the reference temperature refers to an ambient temperature of 23°C ('room temperature'). Also see > 'Coil data'.

Reference values
Reference values for all tests according to IEC 61810-1.

Reflection loss, Return loss
The part of a signal which is lost due to the reflection of power at a line of discontinuity.

Reinforced insulation
A single insulation system applied to live parts which provides a degree of protection against electric shock, comparable to a system comprising basic insulation and supplementary insulation (refer to IEC 61810-1, Type of insulation).

Relay cycles
Due to the self induction of the coil and the inertia of the parts to be moved, on activating a relay the operations do not take place suddenly. The function diagram below shows the different cycles for the most important relay configurations of undelayed power relays. Unless otherwise stated the indicated times are maximum values, the cycles specified apply to DC-coils energized with rated voltage (without any components in series or parallel to the coil) and at the reference temperature.
See
- 'Operate time'
- 'Release time', 'Reset time'
- 'Bounce time'
- 'Minimum energization duration'



Relay with force guided contacts
The compliance with regulations for the safety of persons and material is imperative in our technical world. National and international regulations take various risks into account. These safety standards also make demands on components which share with their function the safety level of a plant, machine or the equipment. For relays being used for safe contact monitoring purposes the contacts have to be linked mechanically in a way, that NO and NC contacts must not be closed at the same time. It has to be ensured, that over the entire life and even in case of malfunction (e.g. contact welding) the open contact gap will be at least 0.5 mm. Relays with force guided contacts comply with the requirements of EN61810-3 (formerly EN50205).

Release
Process in which a monostable relay shifts from the operate state back to the rest state.

Release state (normal position)
Switch position of a non-energized monostable relay.

Release time
The time interval that elapses from the point of time at which a monostable relay in the operating state has the rated voltage disconnected to the point of time at which the last output circuit has closed or opened (not including the bounce time). Unless otherwise stated the indicated times are maximum values and are valid for energization with rated voltage, without any components in series or parallel to the coil, and at reference temperature.

Release voltage
The input voltage at or below which a monostable relay releases to the rest state at the reference temperature.

Reliabilty
Electromechanical components as relays, are subject to wear (mechanical and electrical). For the reliability the typical bath-tub curve applies, hence singular statistical failure events below typical reliability values may occur.

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Definitions (Continued)

Reset
Process in which a bistable relay returns from the operate state back to the rest state.

Reset state
Switch position of a bistable relay as specified by the manufacturer. Unless otherwise stated the reset state is the contact position where the normally open contacts (form A, NO contact) are open and the normally closed contacts (form B, NC contact) are closed. Please note that the contact position for bistable relays is not defined at delivery.

Reset time
The time interval that elapses from the point of time at which a bistable relay in the operating state has the rated voltage (applied in the opposite direction for 1-coil systems and to the reset coil for 2-coil systems) to the point of time at which the last output circuit has closed or opened (not including the bounce time).

Reset voltage
The input voltage to a bistable coil for reset to the rest state at the reference temperature. Please note the wiring diagram and the polarity (see > 'Bistable relay').
- Reset voltage max.
  The input voltage that must not be exceeded to a bistable coil for reset to the rest state at the reference temperature.
- Reset voltage min.
  The input voltage that has to be applied to a bistable coil for reset to the rest state at the reference temperature.

Resistance to soldering heat
According to IEC 60068-2-20, method 1A.

Rest state
Switch position of a monostable relay in the unenergized state.
For bistable relays see> 'Reset state'.

RoHS - Directive 2002/95/EC, EU RoHS compliance
Directive on the Restriction of Hazardous Substances (Directive 2002/95/EU, RoHS directive) restricting the use of certain materials as Lead (Pb), Cadmium (Cd), Mercury (Hg), hexavalent Chromium (Cr6), polybrominated Biphenyls (PBB) and polybrominated Diphenylethers (PBDE).
'Compliant'
indicates that the entire product group is compliant with the RoHS directive and none of the above materials is intentionally added and/or below the limits set forth in the directive.
'Compliant versions'
indicates that certain products within the respective product group are compliant with the RoHS directive. The RoHS compliant selection is indicated together with the information on the RoHS compliance. Some products of that product group however do contain materials (e.g. Cd) listed above and thus are not compliant with the RoHS directive.

Safety relay
See > 'Relay with force guided contacts'.

Sealed relay
See > 'Category of protection (IEC 61810)' - RT IV and RT V.

Set time
The time interval that elapses from operating a bistable relay with the rated voltage (pulse or square signal) at an ambient temperature of 23°C to the moment when the last output circuit is closed or opened (bounce time not included). The operate time varies with the applied coil voltage and the ambient/coil temperature.

Set voltage
Value of coil voltage at which a bistable relay operates. For monostable relays see > 'Operate voltage'.

Shock resistance (destruction)
This test is used to evaluate the resistance of the relay to heavy mechanical shocks leading to a permanent damage to the relay. This test is performed according to the IEC 60068-2-27, Ea test.

Shock resistance (function)
This test is used to evaluate the resistance of the relay to mechanical shocks such as those that could occur in transport or during operation (no opening of closed relay contacts with a duration >10 µs). This test is performed according to the IEC 60068-2-27, Ea test.
Data valid for all relay axes unless otherwise stated. Nevertheless it is recommended to avoid shock especially in armature and contact movement direction.

Single contact
Contact system with one contact point per contact member (contact blade).

Single/double throw contact
A single throw contact connects one common line (movable contact) to one load line (stationary contact). See > 'Form A contact' and 'Form B contact'.
A double throw contact switches one common line between two stationary contacts, for example between a NO contact and a NC contact. See > 'Form C contact, CO contact, changeover contact'.

Single/double/multi pole
A single pole relay connects one common line (movable contact) to one load line (stationary contact).
A double pole relay switches two, electrically disconnected common lines with two electrically independent load lines (like two separate make relays); the same stands for multi-pole relays, the number of poles indicate the number of independently switches load lines.

Switching of different potentials on adjacent contact circuits of a multi-pole relay is permitted as long as the sum of applied voltages does not exceed the rated insulation voltage.
The switching of different voltages with the generation of an electrical arc and the switching of reverse polarity on adjacent contact circuits of a multi-pole relay without contact separated chambers however is not permitted. The contact load has to be connected to the same contact side.

Sockets and accessories
All listed sockets and accessories have been tested and approved only with the indicated relays from the TE product range.
For combinations of sockets with other relays with similar design and pinning TE cannot take responsibility for any malfunction.
Also see > 'Combination of relay and socket'.

Soldering temperature/time, IEC 60068-2-20
See > 'Resistance to soldering heat'.

Solid insulation
Solid insulating material between two conductive parts.

Steady state current limit
See > 'Limiting continuous current'.

Stripline
A type of transmission line configuration which consists of a single narrow conductor parallel and equidistant to two parallel ground planes.

Switching capacity
See > 'Switching power'.

Switching current
See >
- 'Rated current'
- 'Limiting making current'
- 'Limiting breaking current'.

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Definitions (Continued)

Switching power
Product of the switching current and switching voltage (in W for direct current, in VA for alternating current).

Switching rate
See > 'Frequency of operation'.

Switching voltage
See > 'Rated voltage (contacts)'.

Switching voltage max.
See > 'Max. switching voltage'.

Terminal assignment
For historical reasons and due to typical application nomenclature (e.g. relays in automotive applications) different terminal assignment schemes are used:
Terminal assignment to IEC 67
The terminals are identified by consecutive numbers. Please note that two digit identifiers exist in both the IEC 67 and the EN 50005 identification systems and may have different meaning.
Terminal assignment to EN 50005: the terminals are defined by a two digit code:
for the coil terminals 'A1', 'A2' are used
for contacts the first number indicates the pole, the second number indicates the function
1 for the movable form C, CO contact,
2 for the form B, NC contact,
4 for the form A, NO contact
e.g. a terminal '24' indicates the form A, NO contact of the second pole of a relay.
Automotive relays
Quick connect style coil and load terminals ISO relays may be numbered according to two different standards, the terminals have the same location and function. The respective numbers are:
1 or 86 for the first coil pin;
2 or 85 for the second coil pin;
3 or 30 for the common load pin;
4 or 87a for the form B, NC load pin;
5 or 87 for the form A, NO load pin.

NOTE that the terminal assignment graphs are indicated either 'bottom view' (as seen from the solder wave side of pcb's, pin side of the relays) or 'top view' (as seen from the component side of single sided pcb's or the cover side of a relay).

Terminal torque, screw type terminals
For screw type terminals the maximum indicated screw torque must not be exceeded.
No torque must be applied to any other terminal types of relays or accessories.

Test voltage/dielectric test voltage/dielectric strength
Voltage applied during dielectric (high voltage) tests between intentionally not electrically connected parts of the relay.

Thermal resistance
Relay parameter measured in Kelvin per Watt, which relates the consumed power with the respective temperature increase in the state of thermal equilibrium measured without load and without components in parallel or in line to the coil. Multiplied with its power consumption (at the actual coil temperature) it indicates the temperature rise of the coil above ambient temperature.

Thermoelectric potential
Voltage at the relay terminals of a closed contact resulting from a temperature difference of the different metal junctions (terminal, spring, contacts,...) inside the relay.

Through-hole reflow (THR)
An assembly process, where THT components are soldered in a reflow process instead of traditional wave soldering (also referred to as pin-in-paste). For details see chapter Processing Information.

Through-hole technology (THT)
An assembly process for mounting components where terminals are passed through supported (plated through) or unsupported (bare) holes in an interconnection substrate. Normally, traditional wave soldering is used with THT components.

Tracking
Progressive degradation of a solid insulating material by local discharges to form conducting or partially conducting paths.

Tracking index
- PTI - Proof tracking index - numerical value of the proof voltage expressed in volts which a material in test can withstand without tracking under specified conditions (according IEV 212-01-45).
- CTI - Comparative tracking index - numerical value of the maximum voltage expressed in volts which a material in test can withstand without tracking under specified conditions (according IEV 212-01-45).

Transit time
The movement time of the armature after opening of one contact set (e.g. NC) before closing of the other (e.g. NO) of a changeover relay. See > 'Relay cycles'.

Twin contact, bifurcated contact
Contact with two simultaneously operating contact points. Twin contacts increase the contact reliability considerably, especially when switching low currents and voltages (dry circuits) and/or are used for reduction of contact resistance. Bifurcated contacts are twin contacts with the two contact points on one contact member (contact blade).

U_{rtd}
See > 'Rated voltage'.

Vibration resistance (destructive)
This test is used to evaluate the resistance of the relay to heavy mechanical vibration leading to a permanent damage to the relay. This test is performed according to the IEC 60068-2-27, Ea test.

Vibration resistance (functional)
This test is used to evaluate the resistance of the relay to harmonic mechanical oscillations such as those that could occur in transport or during operation. No opening of closed relay contacts or closing of open relay contacts with a duration >10 µs is allowed to occur during the test. This test is performed according to the IEC 60068-2-6, Fc test. Unless otherwise stated the values refer to a frequency range 30...150 Hz.

Voltage drop
Effect of contact resistance, measured as voltage drop across closed contacts. See > 'Contact resistance'.

VSWR
Abbreviation for 'Voltage Standing Wave Ratio'. The ratio of the maximum to the minimum voltage set up along a transmission by reflections.

Wash tight/immersion cleanable
See 'Category of protection (IEC 61810)' - RT III.
Relays that can be cleaned together with the printed circuit board after soldering. The washing requires a suitable solvent. The term „immersion cleanable/wash tight“ is not identical with „hermetically sealed“!
Unless otherwise stated the relays are wash tight according to Qc2 IEC 60068-2-17, tested with a water immersion test at max. ambient temperature for 1 minute.
Contact our technical support for suitable solvents and washing parameters. The user needs to verify the compatability of lacquer, solvants and drying process.

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Handling, Processing, Testing and Use

Electromechanical relays are one of the most robust and reliable components. To achieve the specified performance some precautions must be taken during transportation, storage, handling, processing and testing.
CAUTION: ANY TRANSPORT, PACKAGING, HANDLING OR USE DIFFERENTLY THAN HEREIN RECOMMENDED BY TE MAY CAUSE RISKS AND IN THIS SITUATION SHALL BE ENTIRELY BORNE BY USER.

Handling / Logistics

Transport
During transport, care has to be taken to avoid excessive shock and vibration. Mechanical stress can lead to changes in operating characteristics or to internal damage of the relay (see > 'Vibration and shock resistance'). When a potential excess of mechanical stress is suspected (e.g. damaged packaging, dropped packages or relays, etc.), the relays should be checked and tested before use.

Packaging
Depending on the relay type and design and with regard to specific requirements various packaging types and technolgies are used for shipment of our products.
- THT and THR relays
  are packed in trays, cardboard or plastic tubes with stoppers on both sides of the tubes. For unpacking from plastic tubes the plugs on both sides shall be removed to prevent any relays sticking to the plugs and possible falling down onto the pick place.
- SMT relays
  the standard packing are blisters tapes wound on a reel (tape & reel) and dry packed in order to prevent the relays from humidity. The SMT relays should be kept in these containers for storage and should be removed from the box just only before the assembly process preferrably at the SMT assembly line. The boxes are equipped with shock absorbers, which protect the relays from mechanical impacts.
- Industrial relays are packed in trays or in tubes.

Handling
Modern relays are high precision components, sensitive to mechanical stress and abusive handling. Care must be taken when handling the relay during all stages of production.
- special attention must be paid, not to apply mechanical shock, e.g. by dropping relays onto the floor or other hard surfaces (e.g. assembly tables). Once dropped, relays should not be used anymore and shall be scrapped. In case of relays assembled to long wires or harnesses any mechanical shock due to whiplash effect has to be avoided.
- care has to be taken when opening tubes to prevent relays from falling out or during splicing of reels, where the loose end of the tape should not drop to the floor.
- special care must be taken, that the terminals of the relays are not bent. Straightening of bent terminals and pins is not allowed.
- handling or processing of relays in bulk is not permitted.

Storage
Generally TE's products should not be exposed to extreme high temperatures, high humidity or damaging media such as sulphurous, acid or basic atmospheres. Unless other specific requirements are documented, TE recommends in accordance with IEC 60068-1 a standard atmospheric conditions a storage temperature between 15 and 35°C (59 to 95°F) and a relative humidity between 25 and 75 %.

Dry packed SMT relays: when the packing is opened, the relays must be soldered within a defined time frame, indicated by the moisture sensitive level MSL (max time from opening the bag to soldering). When the open time is exceeded, remaining relays shall be dry repacked, or the relays must be dried before soldering.

For more information, refer to our application notes in the internet.

Processing

Testing
For electrical incoming inspection tests refer to sections > 'Contact resistance', 'Diagnostics of relays' and 'Storage'.
During incoming inspection and respective handling, special care has to be taken not to bend the relay terminals. The degradation of sealing properties up to internal failures (e.g. breaking of coil wires) could be the consequence.

Handling during processing
Relays are high precision components, sensitive to mechanical stress and abusive handling. Care must be taken when handling the relay during all stages of production. Do not exert any pressure on the pins.

Manual handling
- the relays have to be removed from the packaging in on orderly way
- processing of relays in bulk is not permitted
- when relays are manually handled and placed on PCB's, special attention must be paid, not to drop relays onto the floor or other hard surfaces (e.g. assembly tables). Once dropped, there is a risk of high mechanical shock and potential damage of the relay; these relays should not be used anymore. In case of relays assembled to long wires or harnesses any mechanical shock due to whiplash effect has to be avoided.
- open packages, tubes or splice reels with care: after prolonged storage at higher temperature there is a risk of relays sticking to the stopper plugs of tubes and for reels the loose end of the tape shall not drop to the floor.
- special care must be taken, that the terminals of the relays are not bent. Straightening of bent terminals and pins is not allowed.
- do not exert undue force (e.g. by hand tools) when inserting the relays onto a pcb or into a socket.

Automatic handling
- the mechanical stress caused by handling and/or force of automatic feeders or robots has to be adjusted to avoid mechanical damage (e.g. cracking of the relay case, detaching cap from relay base).
- the clamping force shall not exceed the values given for x, y, z direction, in order to provide for the proper internal function of the relay. The force shall be applied in the largest possible area. Picking in the dashed area would be preferred. Unless otherwise stated the clamping force should not exceed 5 N in any of x/y/z direction.
- do not excert undue force when inserting the relays onto a pcb or into a socket.

Mounting on PCB's
- the relays have to be removed from the packaging in an orderly way, processing of relays in bulk is not permitted. Dimensions and pcb layout indicated in the datasheet are indicated for the manual placement on the pcb's. For automated pick-and-place we refer to detailled component drawings.
- unless otherwise stated the relay can be mounted in any position. The relays can be further processed in the industry standard commercial soldering and cleaning (for suitable products) plants.
- when inserting the relay into the PCB, do not exert any pressure or use undue force or torque on the pins as this may compromise the pin seal or affect the integrity of the coil connections.
- no pressure should be exerted on the relay cover and terminal pins after the relay has been inserted in the printed circuit board.
- after insertion in the printed circuit board, the terminal pins must not be bent or twisted for fixation or attachment. Bending or applying mechanical stress to the pins may affect the relay parameters. Bending the terminal pins of sealed relays (wash-tight, immersion proof, sealed) may damage the sealing. However, if fixing must be carried out before soldering, please contact our application support. Also see > 'Clinching'.

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Handling, Processing, Testing and Use (Continued)

Mounting of relays and accessories on sockets and DIN-rails
When inserting the relay onto sockets, do not exert undue force on the relay and/or pins (e.g. indicated max. insertion force).
Reduced ambient temperature ranges may apply for mounting and handling of sockets and accessories (mounting on DIN-rail, assembly of retaining clips, mounting/dismounting of relays etc.); unless otherwise stated provide a temperature of -10°C to +40°C for ambient and parts for such mounting processes.

Clinching
Terminals should not be bent to hold the relay in place on the PCB to aid flow soldering. Bending or cutting the pins after insertion generates extreme mechanical stress, especially in the case of rectangular PCB terminals. Neither the relay performance nor sealing of flux resistant and plastic or hermetically sealed relays can be guaranteed if the terminals have been bent.
Also see > 'Mounting on PCB's'

Fluxing
Fluxing has to be carefully considered depending on the type of relay.

- Sealed relays, wash-tight relays:
  these relays may be processed on all standard commercial fluxing, solder and cleaning equipment for this type of electrical and electromechanical components.

- Unsealed relays, open relays, dust-proof relays:
  should be hand soldered to avoid flux contamination of the relay. Flux should be used sparingly and evenly and joints examined after soldering. If flow soldering is used however, the flux level has to be set so that it merely touches the bottom of the PCB and only wets the underside of the printed circuit board. It must not flood onto the upper surface of the PCB. This is particularly critical if multilayer PCB are used and there are unused holes under the body of the unsealed relay, the flux should only be visible as foam flux through any open perforations in the printed circuit board. If the printed circuit board is flooded by flux, bursting flux bubbles can lead to contamination in open relays and, consequently, to failures. To protect against corrosion, no acidiferous flux should be used.The recommended flux types are 1.1.3, 1.2.3 or 2.2.3 according to DIN EN 29454 T.1 or type F-SW 32 to 34 to EN 29454-1 (ISO 9454-1).

  If there is any doubt about the fluxing process, sealed relays (wash-tight, plastic or hermetically sealed) should be used.

  Acidic fluxes are not suitable for open relays due to the risk of corrosion, especially inside the coil.

Preheating
During preheating for common wave soldering processes, the temperature of the upper surface of the printed circuit board should not exceed 130°C (EN61760-1). Excessive exposure to high temperatures may affect the relay characteristics. NOTE that any not completely dried flux might evaporate in an explosive reaction and sputter; ensure that no flux penetrates the insides of open relays.

Soldering
The soldering process has to be controlled carefully in order not to impair the performance of the relays. No external force to be applied on the pins during the soldering process.

Our relays can be processed in commercial soldering and washing installations (if classified as washable). They cover the following regulations:
Flux tight type relays; open relays without cover:
- Solderability according to IEC 60068-2-20, Test Ta, method 1, aging 3: 4 hours at 155°C, dewetting
- Resistance to soldering heat according to IEC 60068-2-20, test Tb, test method 1A

Sealed type open vent hole relays:
- Solderability according to IEC 60068-2-58; dewetting
- Resistance to soldering heat according to IEC 60068-2-58

Sealed type washable relays:
- Such relays are capable of being automatically soldered and subsequently undergoing a washing process to remove flux residues without allowing the ingress of flux or washing solvents
- Sealing complies to IEC 60068-2-17; Test Qc: method 2, the relay will withstand a bubble test at 70°C for 1 min
- See also > 'Chemical Cleaning'
- Avoid designs with considerable thermal mass below the relay (e.g. high number of solder filled interlayer connections).

Soldering, wave soldering
The automated soldering process has to be controlled carefully in order not to impair the performance of the relays. Flux resistant and sealed relays can be used with most dip or wave soldering processes. The solder level has to be adjusted so that it does not flood the printed circuit board surface. The pre-soldered pins are suited for standard soldering processes with Pb-solder as well as for Pb-free solder processes.
Leadfree processing:
- for processing of relays under leadfree conditions refer to the indicated 'resistance to soldering heat', exceeding the limit may have negative impact on relay parameters. We recommend that leadfree processes should be carried out using SnAgCu-solder. The solder bath temperature for i.e. double wave soldering should be in the range of 250 to 260°C.
- the solder bath temperature should not exceed
  - 270°C for 10 s for flux-proof relay versions (RT II)
  - 260°C for 5 s for wash-tight and sealed relays (RT III and higher).
- for other bath temperatures and solder time (e.g. higher solder bath temperature with reduced dipping time) contact our technical support.

SnPb processing
- for this process refer to maximum permissible temperatures at the terminals according to CECC 00802. For SnPb Eutectic Process we recommend a maximum peak temperature Tp < 225°C. For Pb-free processing we recommend a maximum temperature Tp < 245°C. These soldering temperature profiles indicate the Pad/Pin temperature.

Soldering, reflow soldering
Unless otherwise stated the soldering should be carried out according to the recommendation of IEC 60068-2-58 and according to the recommendations of CECC 00802.

Please note that in some cases the ambient temperature may be considerably higher on top area of the relay component. In this case the component temperature should not exceed 260°C. Check for specific mounting conditions. In addition the time, parameter t_L (time span for temperature above preheating temperature) should be below 150 s.

In general, electromechanical relays should be soldered at the lower process limits of a soldering process.

Soldering, manual soldering
The relay programme offers products with various terminal styles. Some products with solder lugs are specifically designed for manual soldering whereas some products (e.g. with quick connect terminals) are not intended to be soldered. Most PCB mount relays are designed for processing in a wave soldering process. For manual soldering and repair the soldering time should be kept to a minimum and no mechanical force or torque must be applied to the relay terminals.
Unless otherwise stated we recommend for manual soldering a soldering temperature of 300 to 350°C for a maximum soldering time of 3 s.

Cooling
After wave or reflow soldering, the assemblies should be cooled in order to reduce thermal stress and to minimize the pressure difference between inside of the relay and ambient. Do not change the temperature suddenly, especially avoid thermal shock for the hot relay. Do not cool down by using cold liquids or aerosols. In case of thermal shock, the relay sealing could break and through micro-cracks cleaning fluid with dissolved flux might be sucked inside the relay; such ingress of liquids into the relay can lead to failures in operation.

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Handling, Processing, Testing and Use (Continued)

Cleaning, chemical
Preferrably a non clean flux process should be used; in this case there is no need to wash the PCB and we recommend avoiding washing processes in order to protect the environment. If cleaning is necessary, certain precautions have to be taken:

Flux tight type relays and sealed relays with open vent hole:
- immersion cleaning is not possible with these types of relays. Only the soldered side of the PCB (THT) should be cleaned and care has to be taken not to allow washing solution to flood the PCB surface to prevent penetration of solvent and dissolved flux into the relay. Any other cleaning method involving potential contamination of unsealed relays must be avoided.

Sealed relays (wash-tight, sealed and hermetically sealed), closed vent-hole:
- do not stress the terminals mechanically before or during the mounting, soldering or cleaning process
- the PCB should be allowed to cool prior to the washing process to avoid thermal shock and potential damage to the seal as well as a pressure difference (see > 'Cooling')
- the printed circuit must be washed in a timely manner after the soldering process
- do not lower the temperature while the relay is in contact with any liquid, e.g. some residue of cleaning medium can be between relay and PCB
- modern cleaning equipment uses water or alkaline solutions, if other cleaning solvents are used, ensure that the chemicals are suitable for the relay. The use of unsuitable solvents can cause cracking or discoloring of the plastic parts. Suitable solvents include isopropyl alcohol (alcohol-based solvents), water with wetting agents. Unsuitable solvents are, e.g., acetone, ethyl acetate, aqueous alkalines, phenolic combinations, thinner-based solvents, chlorosenebased solvents, trichlene-based solvents and chlorine.
- when using high pressure cleaning processes, special care has to be taken to avoid any ingress into the relay as liquids under high pressure can damage the seal of the relay. Do not use jet pressure higher than 1,5 bar or ultrasonic pressure higher than 0,5 bar.
- avoid and do not use any ultrasonic pressure for relays with gold plated contacts. See > 'Cleaning, ultrasonic'
- special care must be taken on the temperature of the cleaning and rinsing liquid; their temperature shall be similar and not deviate by more than 10°C.
- the individual wash stations must be separate from one another to prevent cross-contamination!
- after the final washing process, the printed circuit boards must be cleaned again using a clean washing medium!

Cleaning, ultrasonic
Ultrasonic cleaning is generally not recommended as this can cause friction welding of the contacts and in addition it may cause coil wire breaks. If ultrasonic cleaning cannot be avoided, it is on user's own responsibility and must be completed as quickly as possible.
For gold plated contacts ultrasonic cleaning is NOT recommended at all as this might result in cold welding of the gold contacts.

Protective coating
Relays with a category of protection II and below are not suited for coating processes. Relays with category of protection III and higher are suitable for washing processes but not all relays are necessarily suited for coating processes. In this case, please contact our application support for recommended relay versions and processes.
In case relays with insufficient protection are coated, there is a high risk that resin will enter the relay and destroy the relay. Sealed relays with an opened vent hole can only be partly coated.
- for the protective lacquering and varnishing of the mounted printed circuit boards, we recommend single-component lacquer (epoxy-based). Suitable are Epoxy, Urethane and Fluorine coatings. Silicon containing laquer or potting compound must not be used!
- we recommend a coating technology that avoids uncured varnish in the surrounding of the relay.
- the maximum drying temperature should be 70°C.
- the user has to conduct thorough testing with their processes, used lacquers, coatings or casting compound. Solvants may damage the component case or compromise their sealing properties.
- do not allow de-varnishing of PCB for repair, if unavoidable the relay has to be replaced.

NOTE:
- Lacquer or potting compound containing silicon MUST NOT be used!
- Coatings, especially potting compounds may impact the heat dissipation of the relay. Therefore it is necessary to conduct thermal tests of relays in potted assemblies.

Vent hole, nip-off pin, opening
Most PCB relays, reflow solderable relays as well as THR and SMD relays, are provided with a closed vent hole on top of the cover (removable sealing pin on relay cover).
Inside a sealed relay certain load conditions (e.g. heavy loads with generation of pronounced arcing) and/or extreme ambient conditions can generate aggressive atmosphere (diffusion, arc ionization), corrosive condensate or overpressure. To avoid such conditions and a possible reduction of electrical endurance a gas exchange with the atmosphere is advised. To allow the gas exchange, break off the vent hole or nip-off pin.

Silicone
Materials containing silicone or its derivatives must not be used in any form in or near to processing and packaging of subcomponents and the final relay assembly. Silicone and its derivatives are not allowed in the material of any component in the vicinity of the relays.
Silicone atmosphere can diffuse through the relay housing and cause contact failures, siliceous compound deposits can create an insulating abrasive layer on the contact surface.
Contamination can occur with all silicone-based materials before and after cure (contain silicone volatiles), silicone aerosols, silicone fluids, grease and hand cream, etc..
Some types of signal relays are suited for application in Silicone environment, however the suitability MUST be verified; please contact our application support.

Testing

Testing
During incoming inspection, special care has to be taken not put mechanical stress on the relays and terminals and not to bend the relay terminals; internal failure or long term effects as a result of a degradation of sealing properties could be the consequence.

Bistable relay, incoming and in-process testing
In a bistable or latching relay the contacts maintain the last switching position when the coil input voltage is disconnected.
NOTE that even though the bistable relays are leaving production preferrably in reset contact position, the position of the contact (set position/ reset position) is not defined at delivery or after transport. Thus, at the time of incoming and in-line testing, the customer needs to check the contact position and to set/reset the relay to the required position.

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Datasheets and product specification according to IEC 61810-1 and to be used only together with the 'Definitions' section.

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Datasheets, product data, 'Definitions' section, application notes and all specifications are subject to change.

Handling, Processing, Testing and Use (Continued)

Testing conditions, automated testing/diagnose
With higher integration and use of highly complex electronic circuits and resulting quality and safety requirements (e.g. cars), relays undergo stringent incoming tests and in-circuit testing during and at the end of the assembly process (end-of-line tests).
Special considerations have to be given for the selection of testing parameters, the respective test limits and development of embedded diagnostic routines:

- testing of contact resistance
- testing of magnetic system
- testing of dynamic characteristics.

The most common contact materials contain silver alloys and thus are affected by sulfidation and oxidation. Layers of oxides, sulfides and other compounds will form on the surface of metal contacts within a very short time by absorption from the ambient atmosphere. These layers increase the contact resistance, depending on the thickness of the layer, the effective contact area and the specific resistance of the used contact material and layer. To establish a reliable electric contact these layers have to be destroyed. This can be done by mechanical, electrical or thermal destruction:

- mechanical destruction: high contact pressure and mechanical switching impact
- electrical destruction: requires a specific breakdown voltage and current. This destruction process is called A-fritting. The breakdown voltage depends on the thickness and specific resistance of the layer. For practical testing refer to the values according IEC 61810-7 as indicated above; e.g. for automotive relays the breakdown voltage can be up to 3 V to start the A-fritting.
- thermal destruction: a thermal destruction requires high temperatures, usually generated by
  1) after the electrical breakdown (A-fritting) a small current is forced through very thin channels in the layer. The resulting local high current density heats the conducting channels up quickly, destroying the layers, until finally (within a few ms) a metal to metal bridge is established. This process is called B-fritting. The B-fritting voltage depends on the contact material. For practical testing refer to the values according IEC 61810-7 as indicated above.
  2) generated by high contact currents and/or electric arcs (e.g. disconnecting inductive loads, switching on capacitive loads).

Icing
Under very special environmental conditions (below 0°C) and operational, temporary relay switching failures can occur. Moisture condenses on the surface of the cold contact and forms a thin layer of ice, causing a temporary interruption of the electrical contact.

Magnetic system, coil resistance
For testing the inductivity of relay coils may need consideration (e.g. the inductivity for coils in automotive relays can exceed 1 H in the unsaturated range). This results in a time constants between 1 to 50 ms for the exponential inductive current increase (pulse response). In case the ohmic coil resistance is measured with a 4-pole measurement, the resistance value may be wrong, if measured during the inductive current rise after energization.

Dynamic characteristics
The switching times (e.g. operate time and release time) for DC-coils are usually in the low millisecond-range:

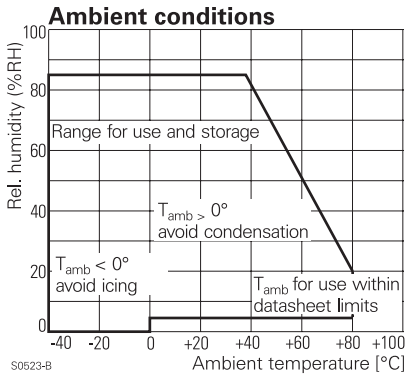
- the operate time depends on the applied coil voltage and coil temperature. Voltages higher than the rated coil voltage generally leading to reduced operate times whereas higher coil temperature and the resulting higher coil resistance leading to increased operate times. A fast dynamic response (e.g short operate and release time) also impacts the bounce time and can increase the bounce time considerably.
- the release time depends mainly on whether a coil suppresion circuit is used and on the type of the used circuit. A low ohmic device (e.g. a diode) in parallel to the relay coil can increase the release time by a considerable factor compared to the typical values shown in the datasheets.

Diagnostics of relays, recommendations
For the development of diagnostic routines these effects need to be considered:

- the contact resistance may be higher than indicated in the datasheet and due to the fritting phenomena (see above > 'testing'), also may show a non-linear characteristic. This implies, that the contact resistance, measured at too low voltage and current levels (e.g. standard tester and multimeter) can be significantly higher than the contact resistance under real application conditions (e.g. supplying a 100 W load). We recommend to perform the diagnostic routine with the actual application load and voltage (e.g. mains or board net voltage) connected to the contacts. If the diagnostic routine cannot be performed with actual application load and voltage, the measurement voltage level must secure an electrical breakdown of possible layers. We recommend a voltage level according to IEC 61810-7.
- the voltage drop can be up to 300 mV. The B-fritting is a physical phenomenon, which can occur on all metal and silver based contacts. For low level and signal applications, special signal and general purpose relays are available. For automotive applications it is recommended to set the diagnostic threshold voltage to min. 500 mV per relay contact (important for H-bridges or serial contact arrangements).
- effects like icing (see > 'Icing').
- consider the maximum possible switching times (due to, e.g., operate voltages other than the rated coil voltage, bounce time effects, ambient temperature and coil suppression circuits). If the status of the contact has to be changed for the diagnostic routine (energize or de-energize relay), the routine must wait until the intended contact status is established. Depending on electrical and ambient conditions (temperature, voltage levels, coil circuits) the times can be significantly longer than the indicated times in the datasheet. We recommend a delay time of min. 10 times of the typical switching times.
- a coil diagnostic routine must secure that the status of the contact does not change during the diagnostic cycle. If the coil driver is monitored by a watchdog routine, the energizing/de-energizing time of the coil must not result in an unintended closing or opening of the contacts. We recommend times of max. 0.5 ms.

Use

Operational humidity / Condensation
Standard conditions:
Annual mean relative air humidity ≤ 75% at ambient temperature 23°C, on 30 complete days distributed naturally over the year 95% at ambient temperature ≤ 25°C, on the remaining days occasionally 85% at 23°C. No condensing or freezing allowed (storage and/or use).
For use and storage at other conditions, condensation or freezing due to temperature changes has to be avoided. Use and storage within the limits as stated in the datasheet and as indicated in the graph.



NOTE: For use conditions the temperature limits as indicated in the datasheets apply.

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