Glossary

Technical relay terms are used differently. Depending on the relay application and the relay supplier you will face a variety of terms. For this catalog, we preferred technical terms according to IEC/EN 60 255 Part 1-00.

A

Ambient temperature
Temperature in the direct environment of the relay. Potting can hamper heat transport and consequently lead to a derating of the relay parameters (e.g. continuous current and switching capability).

Arc
Plasma current flow between opening relay contacts. An arc is enabled by the electric power of the load circuit (turn off spark) ionizing the gas between the contacts. The stability of the arc depends on various parameters such as → contact material, air pressure, → contact gap, etc. An arc locally produces high temperature causing contact erosion. In cases of strong erosion, → spark suppression becomes necessary.

Caution
If a relay that is not especially designed for 42 V applications has to switch off a 42 V load, depending on the conditions (→ contact gap, → load limit curve) an arc of infinite duration could occur. Due to the high power consumption in the arc the relay will be destroyed.

B

Bistable relay
Same as → latching relay.

Bounce time
The time from the first to the last closing or opening of a relay contact.

Break contact, Form B
→ NC contact. The break contact is closed in the → release (rest) state of a → monostable relay and opens (breaks) when the armature moves to the core (→ operate state). See also table 1.

C

Capacitive load
Switching on a capacitive load results in high inrush current. Lamp loads show similar behavior.

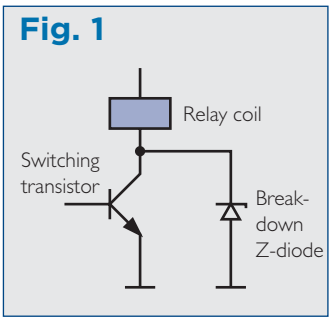
Changeover contact, Form C
Contact configuration with → make and → break contact. Changing the switch position opens the closed contact first and then closes the formerly open contact. See also table 1.

Coil resistance
Electrical resistance of the energized coil not including a parallel device for → coil suppression.

Coil suppression circuit
Circuit to reduce the inductive switch off voltage peak of the relay coil (EMC protection, → switch off voltage peak). Note that most of the circuits reduce the armature release speed, which can decrease the relay lifetime, especially valid for diodes in parallel to the coil. From the various solutions, the use of a Zener diode is particularly suitable (see fig. 1). Further information is available on request.

Class of protection
Ratings for example defined in IEC 529, indicating how completely a cover, seal, etc. protects against water, humidity, dust, direct contact etc. See also protection class.

Fig. 1



Coating
Protection of → PCB and electrical components by applying lacquers on the surfaces. For further details please see item 7 in the “Processing Information”.

Contact
Made out of → contact material and part of the → contact set where the electrical load circuit is opened or closed.

Contact carrier
Conductive metal part of the relay where the → contact is applied to.

Contact configuration, Form A, B, C
Configuration of the relay switch (→ make, → break or → changeover contact). According to the application, various contact configurations are used (see table 1). Contacts which are moved by the armature system are called → movable contacts, and non moving contacts → stationary contacts.

Contact erosion
Material loss at the contact surfaces, for example due to material evaporation by an → arc.

Contact force
Force between closed contact surfaces.

Contact gap
Gap between the contact surfaces of an open contact pair.

Most Common Contact Configurations

Denominations	Form	Abbreviations/Symbols NARM Abbreviation	Symbol of Circuit Element
Make contact Double contact make (bifurcated)	1 Form A 1 Form A (Double contact make)	SPST-NO SPST-NO DM	
Break contact	1 Form B	SPST-NC	
Make and break or Changeover contact	1 Form C	SPDT	
Double make contact on armature	1 Form U	SPST-NO DM	
Double break contact	1 Form V	SPST-NC DB	
Double make contact	1 Form X	SPST-NO DM	
Triple make contact	Form 3	–	

[1] 1 Form A
[2] 1 Form A (Double contact make)

Table 1

Contact material
For relays a variety of contact materials are in use. They operate under a wide range of loads in terms of voltage and current. Inductive loads can cause high switch off voltages and strong → arcs, capacitors create inrush current peaks. Arcs and improper → coil suppression can reduce the lifetime of a contact. So far, no universal contact material is known, that can be used on all load types with optimum performance. Contact manufacturers, relay developers, and users have established the following criteria to describe a contact:

- Electrical resistance
- Resistance to contact erosion
- Resistance to material transfer
- Resistance to welding

These criteria can be used to classify the most important contact materials according to their performance as shown in table 2 on the next page.

The table lists the major contact materials for automotive use. As the load rating for a contact depends on the used relay design as well (contact force etc.), the specification of one relay type cannot simply be transferred to others.

Contact/relay resistance (voltage drop)
Electrical resistance between the relay load terminals while the respective contact is closed. The resistance can be obtained out of the ratio of the voltage drop across the relay and the load current (Ohm's law). Surface layers (→ fritting) can result in non-linear contact – resistances and increased voltage drops (see chapter Diagnostics of Relays).

Contact set
All contacts in a relay.

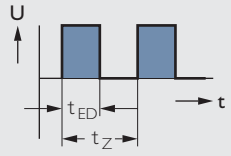
Contact Materials

Switching function current range	Load type inside vehicle	Best-suited contact material
Switching and carrying currents 0.5 A < I < 10 A at 12 V	In low power applications	AgNi0.15 or $AgSnO_2$
Periodical switching and approx. 10^6 operations 1 A < I < 10 A at ≥ 12 V	Long-life indicator switches	$AgSnO_2$
Switching and carrying of I > 10 A capacitive load	Lamps, Capacitors	$AgSnO_2$
Switching and carrying of I > 10 A resistive and inductive load	Motors, Valves	AgNi0.15 or $AgSnO_2$
Switching high inrush of I > 100 A	Lamp (e.g. H4), Spark plugs, Short circuit	$AgSnO_2$ in special cases: AgNi20 or Tungsten pre-contact

Table 2

Cycle time
Sum of make and break (i. e.: on and off) time of a contact pair (fig. 2).

Fig. 2 t_{ED} = Make time, t_Z = Cycle time



$$r = \frac{t_{ED}}{t_Z} \cdot 100\ (\%)$$

D

Double break contact, Form V
Two break contact configuration, with two electrically connected → movable contacts which operate simultaneously. See also table 1.

Double contact
Double contact configuration, where two → movable contacts are connected in series 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 1.

Double contact make or bifurcated contact, Form A (Double contact make)
Contact type with two contact studs per contact spring. Both contacts work in parallel. This is used for redundancy and/or reduction of contact resistance. See also table 1.

Double make contact, Form U
Two make contact configuration, with two electrically connected → movable contacts which operate simultaneously. As special version → main contact with pre-contact. See also table 1.

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

Drop test
Relays are dropped from a specified height onto a solid ground. This simulates the resistance to bad handling e.g. fall from a table. However we recommend to scrap dropped relays.

Dry switching
The relay contact switches no or a very small electrical load (< 1 mA, < 100 mV). See also chapter Diagnostics of Relays.

Dustproof
Covered but non sealed relay, featuring protection class IP54 according to IEC 529 → protection class.

Duty cycle
The ratio between the switch on time and total cycle time during periodical switching (see fig. 2). 50% duty cycle means the switch on time is equal to the switch off time.

E

Electrical endurance
Number of load switching operations a relay can perform without failure. The lifetime varies with the load. If not stated otherwise, the reference values shown in this data book apply for resistive or inductive loads with suitable spark suppression.

ELV
Abbreviation for End-of-Life Vehicles.

Environmental endurance
Generic term for the relay endurance under different climatic conditions. Appropriate test conditions are classified in IEC 68.

Energization, energizing value
A current driven through the relay coil to generate a magnetic field to move the armature. The energizing value is the product of the coil current and the number of wire turns of the coil.

Glossary

F

Faston blade
Flat male terminal of a plug-in relay.

Faston blade identification numbers for ISO relays
Coil and load faston blades of an ISO relay can be numbered according to two different standards. However, 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 NC load pin;
5 or 87 for the NO load pin.

Fritting
See → Icing.

Fritting
Electrical breakdown which can occur under special conditions (voltage, current) whenever thin contact films prevent electrical conductivity between closed contacts. Fritting is a process which generates (A-fritting) and/or widens (B-fritting) a conducting current path through such a semi-conducting film on a contact surface. During A-fritting, electrons are injected into the undamaged film. The electron current alters the condition of the film producing a "conductive channel". During the following B-fritting, the current widens the channel increasing the conductivity (R. Holm, Electric Contacts, 4th edition, 1967, Springer-Verlag, Berlin/Heidelberg/New York). Please also refer to chapter Diagnostics of Relays.

H

H-bridge
The H-bridge or motor-reverse circuit is used to operate a motor in two directions (e.g. door lock, steering lock, power window, seat adjustment. See chapter Automotive Applications.

I

Icing
Under very special environmental conditions and temperatures below 0°C temporary relay switching failures can occur (also defined in the Standard DIN 25424 as "secondary fail"). Moisture condenses on the surface of the cold contact and forms a thin layer of ice, causing a temporary interruption of the electrical contact.

Immersion cleanable/sealed relays
Relays which are sealed against the penetration of specified → PCB cleaners or lacquers → protection class and refer to chapter Processing Information.

Inductive load
Life expectancy strongly depends on the inductance of the load circuit.

Industrial atmosphere
Atmosphere carrying dust and certain industrial exhaust gases (sulfur, chlorine and nitrogen compounds at certain humidity levels).

J

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

L

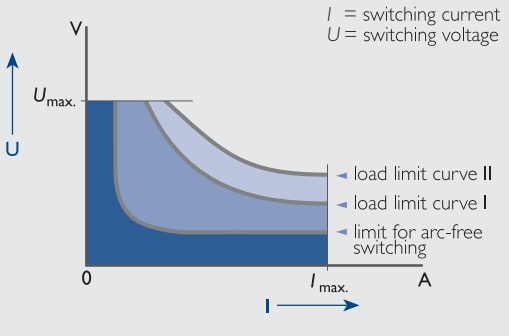
Latching relay
In a latching relay, after the coil input voltage is disconnected, the contacts remain in the last reached switching position. Tyco Electronics delivers latching relays in reset contact position. However in order to eliminate influences due to e.g. transport and processing the customer is advised to check the set/reset contact position and, if necessary, to set/reset the relay into the required position. Latching relays only require a short set respectively reset impulse. A permanent coil power supply after setting/resetting the relay is neither necessary nor allowed: maximal pulse durations depend on the relay family, for details please refer to the respective datasheets. Hence the distinguishing characteristic of monostable relays in respect to a fail safe behavior is the fact that the predefined contact rest position will be reached at break down of the power supply. This behavior cannot be shown by latching relays due to the bistable working principle they are based on. Therefore latching relays should not be used in applications that are rated according to ISO/TS 16949 7.5.3 Product Identification and Traceability.

Leadfree
See chapter Processing Information.

Limiting continuous current
The highest current (effective value for AC loads) a relay can carry under specified conditions without exceeding its specified upper limit temperature. Please note that this is not the current that can be switched with any load over the specified lifetime.

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

Fig. 3



Load limit curves
Switching limit for DC voltage and resistive loads (see fig. 3). The load limit curves were measured with low-inductive resistors, verified for 1000 switching events. The load limit curves depend on the relay design (contact gap, contact material, armature release speed, etc.). → Contact erosion and relay lifetime vary with different voltage/current values.

Load limit curve (I)
The switch off arc of all NO loads below this load limit curve extinguishes during the → transit time of the moving contact. This limit is important for → change over relays, when the → stationary NC and NO contacts are at different voltage levels, e. g. in a motor reverse application. For currents up to 100 A the load limit curve has a falling characteristic i. e. for higher currents the voltage drop across the contacts becomes lower. If a relay that is not especially designed for 24 V or 42 V loads, depending on the conditions, (→ contact gap) an arc of infinite duration could occur. In a motor reverse circuit the arc will then shortcut the battery. The current will only be determined by the resistance of the arc and could rise to several hundreds of Amps. Due to the high power consumption in the arc the relay will be destroyed.

Load limit curve (II)
The switch off arc of the NO loads below this curve extinguishes within 10 ms (the relay is already in → release position).

Load limit curve for arc-free switching
Load voltage/current combinations below this load limit curve in general cause no arc at all.

M

Make contact, Form A
→ NO contact. Contact is open in the → release (rest) state of a → monostable relay and closes (makes) when the relay coil is energized (→ operate state). See also table 1.

Main contact with pre-contact, Form U
Double make (Form U) contact with two decoupled points of contact on the movable springs. The forward contact highly resistant to burn-up, e.g. tungsten, switches the current. The main contact highly conductive, e.g. fine grain silver, conducts the current. The forward contact makes before the main contact does and opens at last.

Maximum continuous thermal load at 23°C
Maximum coil power consumption of a relay at continuous load operation at room temperature where the relay does not exceed the specified upper limit temperature.

Maximum operate voltage (or must operate voltage)
Voltage at → room ambient temperature (RT) a relay must → operate at. To guarantee proper function of all relays, the applied coil voltage in the car must be above this specified operating voltage. Please note that the actual operate voltage of an individual relay, the maximum operate voltage and the car system value are sometimes all called operate voltage.

Maximum voltage U_{max} or V_{max}
Maximum coil voltage at → RT, at which the coil reaches the specified → upper limit temperature without contact load (→ maximum continuous thermal load at 23°C).

Maximum switching power
Maximum permissible power switched by the relay contacts, i.e. the product of the switching current and switching voltage.

Mechanical endurance
Number of load free relay switching operations without failure.

Mechanical stress resistance
Characterization of the mechanical stress a relay can withstand during installation or use. The stress resistance is defined in terms of vibration, shock, drop tests, etc.

Minimum recommended voltage
Minimum load voltage to ensure an adequate contact cleaning (see also “fritting”).

Minimum voltage U_{min} or V_{min}
Minimum coil voltage at → RT where a relay is still able to operate.

Minimum release voltage (must release voltage)
Voltage at → RT a relay must → release at.
To guarantee proper function of all relays, the limit in the car must be below this specified release voltage. Please note that the release voltage of an individual relay, the guaranteed minimum (must) release voltage and the car system value are sometimes all called release voltage.

Monostable and non polarized relay
Monostable: Relay which returns to a defined release state after the coil is de-energized. Non polarized: the relay coil works independently of the polarity of the applied voltage.

Moveable contact
Moving contact during switching operation. Moveable contact is mounted on the armature/spring system.

N

NC contact (normally closed)
→ Same as break contact. The break contact is closed in the → release (rest) state of a → monostable relay and opens (breaks) when the armature moves to the core (→ operate state).

Nip-off pin
Removable locking pin of a relay cover ventilation hole. Due to the used plastic materials, an open vent hole is usually not needed for our relays. However, certain extreme ambient/load conditions can generate noxious gases (diffusion, arc ionization) or over-pressure (during SMD soldering) inside a relay, making a gas exchange with the atmosphere desirable.

NO contact (normally open)
→ Same as make contact. Contact is open in the → release (rest) state of a → monostable relay and closes (makes) when the relay coil is energized (→ operate state).

Nominal values (power consumption, voltage)
See → rated values.

Non-operating current/voltage
Coil current/voltage at which an individual relay does not operate.

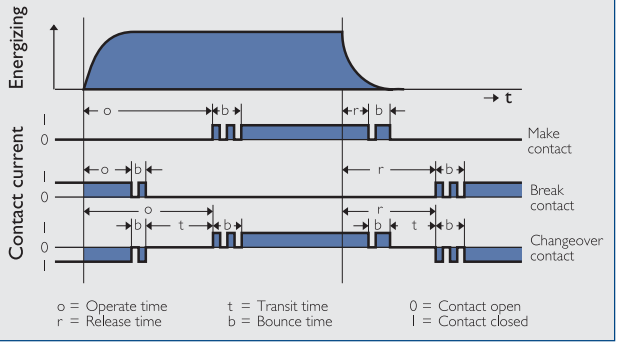
Non-release current/voltage
Coil current/voltage at which a → monostable relay does not release.

O

Operate
Relay switching process from the release state (→ NC closed) to the operate state (→ NO closed).

Operate state
Switch position of an energized → monostable relay.

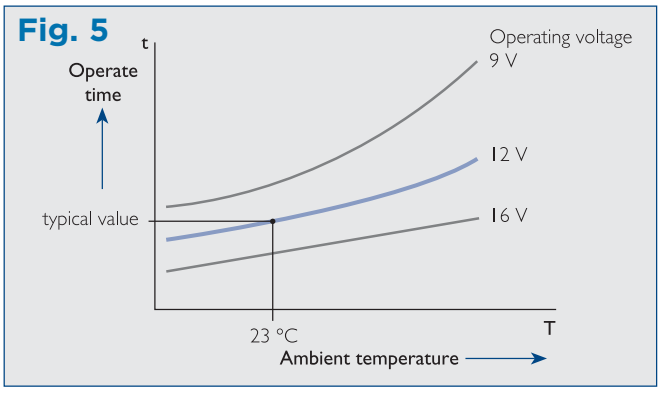
Fig. 4



The times given in this catalog are for 12 V coil voltage and RT, without any devices in parallel to the relay coil.

Operate time
Time from energizing the relay coil till the first break of the → NC contact or the first make of the → NO contact. See → relay time characteristics, fig. 4. The operate time is given as a typical value within each section "coil data" in this databook. As the coil resistance depends on the ambient temperature, the operate time varies with the operate voltage and the ambient temperature. For principal behavior see fig. 5.

Fig. 5



Overload current
This test is done to make sure, that our relays withstand overload conditions, e.g. withstand short circuit conditions until the fuse opens. 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 (I_{rated} = 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

Table 3

Operate current/voltage/power
Coil current/voltage/power at which a relay operates.

Operation
In tests, a whole switching cycle including energizing and de-energizing of the relay coil.

P

PCB
Common abbreviation for printed circuit board.

PIP
Abbreviation for → pin-in-paste

Pin-in-paste (PIP)
Insertion technology for → THR components on a → PCB. The terminals of the component are inserted into printed circuit board holes pre-filled with solder paste.

Polarity reverse
See → H-bridge.
Also see chapter Automotive Applications.

Protection class
According to IEC 529 standard following classification can be carried out for our relays.

Class IP67: Our so called "sealed" relays.

IP6X: Dust-tight. No ingress of dust.

IPX7: Protected against the effects of immersion. Ingress of water in a harmful quantity is not possible when the enclosure is immersed in water under defined conditions of pressure and time.

Class IP54: Non sealed relays which are protected against flux by their base plate and cover.
IP5X: Dust protected. Ingress of dust is not totally prevented, but dust does not enter in sufficient quantity to interfere with satisfactory operation of equipment.

IPX4: Protected against splashing water. Water splashed against the enclosure from any direction shall have no harmful effect.

In addition we classify the following types:

- Flux tight type (open relay without cover)
- Sealed type open vent hole (on top of cover)
- Sealed type tight washable
- Hermetic type

Also refer to Processing Information for → PCB Relays.

Pull-in voltage
Synonym for operate voltage.

R

Rated current
Defined as limiting continuous current at 85°C.

Rated power
Power consumption of the relay coil with → rated coil resistance at rated voltage and → at room ambient temperature.

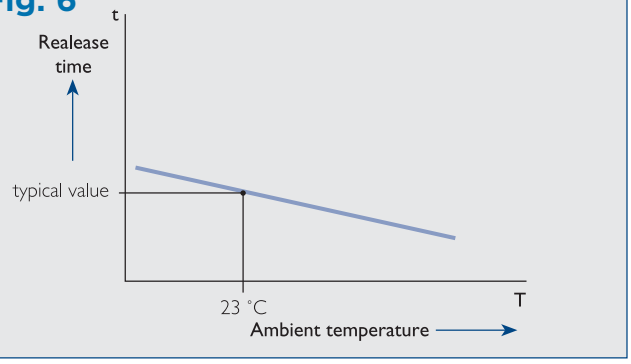
Rated values (voltage, current, resistance, etc.)
Standard values, the relay is designed for. Values are used to classify relays.

Relay time characteristics
Due to the inertia of a magnetic coil and the limited speed of the armature movement, we distinguish various characteristic relay times as shown in fig. 4.

Release
Switching process of a relay from the → operate state (→ NO closed) to the release state (NO opened or → NC closed).

Release current/voltage
Coil current/voltage at which a → monostable relay releases. Please note that the release voltage of an individual relay, the guaranteed minimum (must) release voltage of a relay type and the car system value are sometimes all called release voltage.

Fig. 6



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

Release time (drop time)
Time interval between de-energizing the coil of a → monostable relay and the first break of the → NO contact or the first make of the → NC contact.
The release time is given as a typical value within each section "coil data" in this catalog. As the coil resistance depends on the ambient temperature, the release time varies with the ambient temperature. The influence of the operating voltage can be neglected. For principal behavior see fig. 8. The release time also depends on → coil suppression circuit.

Reset current/voltage
Coil current/voltage at which a → latching relay switches back to the reset position (generally the same value as for the operating voltage).

RoHS
Abbreviation for Restriction of Hazardous Substances.

Room ambient temperature (RT)
A standardized value for the → ambient temperature. In this data book room ambient temperature means 23°C ±3°C.

RT
Abbreviation for room ambient temperature.

S

Sealed relay
Relays which are sealed against the penetration of specified → PCB cleaners or lacquers → protection class and refer to chapter Processing Information for PCB Relays.

Shock resistance
The ability of a relay to operate properly during or after mechanical shock acceleration.

Silicone atmosphere
Silicone and its derivatives are not allowed in the material of any relay subcomponent.

Materials containing silicone or its derivatives cannot be used in any form in or near to the processing and packaging of subcomponents and the final relay assembly.

Silicone atmosphere can diffuse through the relay housing and cause contact failures. Substances containing silicone are for example grease and hand cream.

Single contact
Contact configuration with a single → stationary/ → movable contact pair on the make and/or the break side (compare → twin or double contacts).

Single/double pole (single throw version)
A single pole (single throw) relay connects one common line (movable contact) to one load line (stationary contact). A double pole relay switches two, electrically not connected common lines with two electrically independent load lines (like two separate make relays).

Single/double throw (single pole version)
A single throw (single pole) relay connects one common line (movable contact) to one load line (stationary contact). A double throw (single pole) relay switches one common line between two → stationary contacts, for example between a → NO contact and a → NC contact (→ changeover relay or form C).

Spark suppression
Reduction of the → arc energy between → movable and → stationary contact during switching.

Stationary contact
Non movable contact, mounted on a → contact carrier which is directly connected to a relay pin/faston blade.

Steady state current limit
See → limiting continuous current.

Storage
Relays should be stored in a clean area within the specified temperature limits. Extreme humidity and condensation can cause corrosion of the metal parts in and outside of the relay. Solderability is best within a storageperiode of up to 6 months under 15 to 35°C; 25 to 75% relative humidity, according to IEC 68. SMT relays have to be dried before the soldering process to prevent damage caused by evaporating humidity absorbed in the plastic. This is done in the preheating zone of the SMD oven. Temporarily increased contact resistance caused by the formation of oxides and other layers during a longer storage period, is typical for most contact materials.

The growth of such layers depends on the ambient atmosphere and is more rapid at high temperature. Special attention is required if relays are tested or used with low contact loads after extended storage periods. See also “Diagnostics of Relays” in the Application Notes.

Surface mounted device (SMD)
See surface mount technology (SMT).

Surface mounted technology (SMT)
An assembly process where electrical connection of components → (surface mount device) is made to the surface of a conductive pattern of a PCB without component terminal holes. SMT soldering should be carried out according to the recommendations of CECC 00802 and IPC/JEDEC J-STD-020C if not stated otherwise in the respective datasheet.

Switching current
Current switched by the relay contact.

Switching rate
Number of → operations (contact closings and openings) per second. The rated “maximum switching rate” is measured for load free switching at → room ambient temperature and no → coil suppression device parallel to the coil.

Switching voltage
Voltage between the relay contacts before closing or after opening the contacts.

Switch off voltage peak of the relay coil
Induced voltage peak caused by the collapsing magnetic field of a de-energizing relay coil. The product of the coil current and the resistance* of the device parallel to the coil approximately gives the amplitude of the switch off voltage.

* In case of a 36 V rated coil the use of a 60 V Varistor or Zener diode is recommended.

T

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 thermal equilibrium.

Without load and parallel resistor, the thermal resistance of a coil multiplied with its power consumption (at the actual coil temperature) gives the temperature increase of the coil above ambient temperature.

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.

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

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 (→ relay time characteristics, fig. 4).

Triple make contact, Form 3
Three make contacts configuration (new form) with three electrically connected movable contacts operating simultaneously. There is no external connection to the armature. See also table 1.

V

Vent hole open (open vent hole)
Reflow solderable relays as well as THR and SMD relays are provided with an open vent hole on top of the cover.

Vibration resistance
The ability of a relay to maintain the operating state during mechanical vibration.

Voltage drop/voltage mV drop
See → contact/relay resistance.

W

WEEE
Abbreviation of Waste Electric and Electronic Equipment.